McGRAW-HILL HOME ECONOMICS SERIES

ANNIE LOUISE MACLEOD, Ph.D., Consulting Editor

THE CHILD

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TEN COMMANDMENTS FOR PARENTS

By Paul M. Pitman

I. Thou shalt love thy child with all thy heart, with all thy soul, with all thy strength, but wisely, with all thy mind.

II. Thou shalt think of thy child, not as something belonging to thee, but as a person.

III. Thou shalt regard his respect and love, not as something to be demanded, but something worth earning.

IV. Every time thou art out of patience with thy child's immaturity and blundering, thou shalt call to mind some of the childish adventures and mistakes which attended thine own coming of age.

V. Remember that it is thy child's privilege to make a hero out of thee, and take thou thought to be a proper one.

VI. Remember also that thy example is more eloquent than thy fault-finding and moralizing.

VII. Thou shalt strive to be a sign-post on the highway of life rather than a rut out of which the wheel cannot turn.

VIII. Thou shalt teach thy child to stand on his own feet and fight his own battles.

IX. Thou shalt help thy child to see beauty, to practice kindness, to love truth, and to live in friendship.

X. Thou shalt make of the place wherein thou dwellest a real home—a haven of happiness for thyself, for thy children for thy friends and for thy children's friends.

Reprinted Courtesy of Parents' Magazine.

Frontispiece.—"Fitter Families" Medal formerly presented by the American Eugenics Society to families meeting certain standards of mental, physical, and hereditary excellence. The artist here has well expressed the spirit of this book.

THE CHILD

His Origin, Development, and Care

BY

FLORENCE BROWN SHERBON, A.M., M.D.
Professor of Child Care and Development
Department of Home Economics
University of Kansas

SECOND EDITION
SIXTH IMPRESSION

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK AND LONDON
1941

THE CHILD

PRINTED IN THE UNITED STATES OF AMERICA

THE MAPLE PRESS COMPANY, YORK, PA.

To my former teachers

Professors PATRICK, SEASHORE, AND HOUSER

and the late Professor MACBRIDE

of the University of Iowa

who have inspired many to search for reality

PREFACE TO THE SECOND EDITION

The first edition of this text has had six years of trial by use. The author, in revising it, has sought to take into consideration her own experience with it and that of other users as well. In particular she has been influenced by the opinions and experiences of students who have graduated, married, and had children during this period. So many students have said, "I only really used my text after I married," that she has found herself rewriting the material with the parent-in-service in mind. Also two stimulating experiences with a man student in a women's class, together with the discovery that engaged and married students were sharing their texts with fiancés and husbands, led her to change the word "mother" to "parents" in many connections and led her to think more intensively of the family group as a constant presence and of the father as a personality to be considered.

Six years ago the author was convinced that the subject of child development and training should have the academic status of a major science. The first text was integrated, after a fashion, with the field of general science. As stated in the Preface to the First Edition, a constellation of scientific discoveries of about that time had given her a vision of the great unity of all science, including that of human origin and development. The intervening years have been crowded with investigations and discoveries in physics, chemistry, biology, psychology, neurology, and education. Boundary lines between sciences have grown thin and yet more thin. It has been an exciting task to explore, even as superficially as conditions made necessary, the ramifications of the child's life into the expanding universe. It has been difficult to keep the scientific background within bounds. The book, in spite of condensation, still presents more science than can be fully used in many college courses as now planned. It is expected that some chapters will be used only in advanced and theoretical classes and as supplemental reading. The author believes, however, that many students and many college-graduate parents will dip into these chapters and find in them, she hopes, a stimulus to further study. *At least they had to go in! The subject would not form an "organic whole" without them.*

The attempt to explore all science by a person having no adequate technical training in any one science was an audacious undertaking which would have come to disaster without the friendly guidance of professional conferees, who have been most generous and helpful in checking the various chapters and who prevented the author from making various errors. At least she alone is responsible for any that yet remain.

It is impossible to name all who have influenced the thinking of the author during these six intensive years. Her debt to the following persons, however, is so great it must be acknowledged. The following members of the faculty of the University of Kansas read and criticized the chapters indicated by the subject named. Professor Carl V. Kent, of the Department of Physics; Dr. C. F. Nelson, of Biochemistry; Dr. H. H. Lane, of Biology; Dr. O. O. Stoland, of Physiology; Dr. R. H. Wheeler, of Psychology; Dr. H. C. Tracy, of Anatomy; and Professor Kathryn Tissue, of Food Chemistry. To Dr. Anne Louise Macleod and Dr. Frances Markey Dwyer, of the Department of Home Economics of the University of Syracuse and to Dr. Vernette S. Vickers, of the Department of Child Welfare of Harvard University, the author is indebted for many helpful suggestions. Special acknowledgment is due Dr. James Papez of Cornell University for painstaking criticism of the chapter on the Nervous System. Finally, to Dr. Raymond Schwegler, of Lawrence, is due particular thanks for reading the entire manuscript from the standpoint of a specialist in obstetrics and pediatrics.

To Franseca Frazier and Walter Yost thanks are due for drawings.

To the many publishers who gave generous permission for the use of the numerous quotations and illustrations the author is exceedingly grateful. First, last and always, a toast and a cheer to the fine young women who have passed through the author's classroom and others to become modern mothers—and to two courageous men who "crashed the gate."

FLORENCE BROWN SHERBON.

LAWRENCE, KANS.,
June, 1941.

PREFACE TO THE FIRST EDITION

This book represents the fruit of some fifteen years of teaching child development and child care to women students in the University of Kansas. From a simple, elementary beginning the course inevitably gathered scientific accretion as the sciences of biochemistry, biology, genetics, psychology, and education, by their significant investigations during this period, illuminated the subjects of growth and behavior. Indeed these years have seen the study of the very young child assume a position of pivotal importance in certain branches of the sciences named.

The author has found herself confronted with an ever-increasing need to synthesize (as well as one may who is not a specialist in any one scientific field) current scientific discovery in terms of the phenomena of childhood. In doing this she has quite naturally followed a scheme of unification based upon her own personal philosophy which, at the present time, is rather strongly organismic in trend.

It happens that the period covered by this teaching experience marks the rapid development of the organismic idea. On the one hand, in the fields of biology and neurology, Ritter, Child, Herrick, Morgan, Lashley, and others were apparently establishing the fact of the unity of the organism, the priority of pattern, and the dominance of the whole in growth and in evolution. On the other hand, and coincidentally, Koffka, Köhler, Ogden, Patrick, Burnham, Wheeler, and many others were finding a similar unity of pattern or "wholeness" in behavior. The unification of these two lines of research and the full realization of their implications for child study came to the author only with the reading of the publications of Arnold Gesell, notably *Infancy and Human Growth*, 1928 and Coghill's *Anatomy and the Problem of Behavior*, 1929. Almost abruptly the child stood out as a behaving organism, but an organism integrated within the entire scheme of cosmic organization.

We should be reminded, in this connection, of the debt of all the sciences dealing with living matter to biochemistry. Indeed the use and continued advance of the study of nutrition and the physiology of growth, and the expression of these in behavior, are conditioned upon development in biochemical research. It follows that any intelligent study of the child must borrow its initial interpretations from the science of chemistry.

The author, therefore, makes no apology for presenting heredity, growth, nutrition, behavior, and training in the light of such modern scientific explanation as she has been able to find. The reader, however, is under no obligation to accept the stated conclusions. Indeed, readers uninterested in the scientific content and treatment may completely disregard these and still find a sufficient body of factual data to serve as practical rules of conduct.

The text has been in process of creation for so long a time it is impossible to acknowledge complete indebtedness or fully unscramble sources. Actually everyone who has ever read or listened to any part of it has left some imprint within its pages.

The author, however, is under special obligation to the following persons for patient reading and for especially helpful criticism and suggestion: to Viola Anderson and Katheryn Tissue of the Department of Home Economics of the University of Kansas for criticism of the material on foods; to Dr. Mary Swartz Rose of Columbia University for permission to use material on food and for helpful suggestions; to Cora B. Hodson and to Leon Whitney of the English and American Eugenic Societies, respectively, and to Dr. Caroline Hedger of the Elizabeth McCormick Memorial Fund, for reading and criticizing the entire manuscript in its early form; to Dr. Edwin D. Starbuck and Dr. R. E. Currier of the University of Southern California for philosophical criticism; to Dr. Frances Gaw, director of the Child Study Department of the public schools, Seattle, for criticism and encouragement; to Dr. Bert Nash of Kansas University and Dr. T. L. Collier of Washburn College for criticism of the psychological and educational theory; to Dr. O. O. Stoland of the Department of Physiology of the University of Kansas for reading the chapter on Glands of Internal Secretion; to Dr. Josephine Burnham of the Department of English of the Uni-

versity of Kansas for invaluable technical criticism; to her sister, Maud A. Brown, for continuous encouragement and advice.

The author is particularly indebted to the members of a loyal office staff, without whom the book could never have been produced. Emily Ferris, Harriet Stevenson, Alta Gaskell, Louise Irwin, Margaret Chamney, Evelyn Armstrong, and Margaret Roberts all worked faithfully and well upon the manuscript in its various revisions.

To the child-care students of former years gratitude and appreciation must be expressed for the way in which they have generously shared their "Exhibit A" babies with newer classes, and for very convincing photographs, some of which appear within.

The reader will become aware of the further indebtedness of the author to certain progressive parents who have contributed pictures and incidents and who have been most generous and cooperative in sharing their rich and satisfying experiences.

Between the lines of these pages also peep the laughing faces of the two whom the author knows the best, as they early made her aware of her need for knowledge and understanding; and who, by their patience with maternal shortcomings and by their never-failing loyalty, have motivated much of the endeavor represented in this book.

To the many publishers and authors who have freely given permission to use poems, illustrations, and quotations, thankful appreciation is here extended.

Last, but not least, mention must be made of the young women who have been the occasion of the writing of the book and who are never-ceasingly both stimulus and inspiration. As they challenge the teaching, go out joyously, with "heads high in the air," and come back, still more joyously, with glorious babies in their arms, their teacher becomes more and more optimistic for the future of the race. She has acquired a great confidence in the present-day college-trained mother, who is the highest expression of maternal efficiency yet achieved.

FLORENCE BROWN SHERBON.

LAWRENCE, KANS.,
August, 1934.

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TO THE INSTRUCTOR

Writing a text both for beginning and for advanced students, and for short and for long courses, has presented difficulties. The author takes it for granted that each instructor will select the content for her course and assemble it to meet the particular situation. If the material presented here does not completely meet the objectives of the course an instructor desires to give, she must, of course, supplement it from the present wealth of material in these and other reference lists. Suggestions are presented here for using this book in two-, three-, and five-hour courses, which the author hopes may be helpful. It has been her desire to present a sufficiently satisfying and complete account of the child in his universe to serve the needs both of those who must take a brief bird's-eye view (she believes even this should comprehend the whole picture) and of those who want more or less complete details, either practical or theoretical.

Two-hour Courses (36 hours)

Cover Chaps. I and II in Part I; all of Part II and Part III, using selected portions only of the more difficult chapters. Use Chaps. III to XIV, inclusive, as incidental reference and assigned reading, according to the interest of the group and the particular emphasis and objectives of the course. Use such chapters or parts of chapters from Part IV as time and interest may dictate.

Three-hour Courses (54 hours)

Cover Chaps. I to X, inclusive. In Chap. XI define endocrines and hormones, and use the account of the Anterior and Posterior Pituitaries and the Gonads as necessary to construct the story of the fertilization and development of the ovum. Omit Chap. XII. Take Chap. XIII. Cover Parts II and III and such chapters as desired from Part IV.

Five-hour Courses (90 hours)

Cover the entire text together with observations of children and additional reference work on the nursery school.

Observation of Children

The author is accustomed to invite mothers to bring to the class children of approximately the age under consideration. A class period is spent in talking with the mother and observing the child. Students then write a case story. Some of the stories are read and discussed at a subsequent class period.

In advanced classes, each student takes on the case study of several infants in their own homes and makes studies of individual children in the local PWA Nursery School. (The University of Kansas does not have a Child Laboratory.)

Mothers will be found to be very cooperative in sharing their young children with students. A few rules must be strictly observed: In class demonstrations, no one but the mother touches any child. No one goes within "breathing distance" of any young child. (The author uses a stage for demonstration.) In home visits, no student having a cold visits any home. The privacy of the home is respected and the value of the courtesy extended is appreciated in that no student ever talks about the child or family, and fictitious names are used in the reports. No student gives advice. Requests for information are relayed to the instructor.

TO THE STUDENT

Dr. Lois Hayden Meek, formerly director of the Child Development Institute of Columbia University, in her annual report for 1930–1931, sums up modern educational philosophy thus:

> The movement in child development is an outgrowth of a basic philosophy pertinent to education on all levels. It is based on the principles of integration and continuity. Integration implies that the child reacts as a total organism, that at any one moment of his life what he is and does depends upon his entire physical, mental, emotional, and social development. Moreover, these aspects of child behavior are interacting and interdependent. This philosophy emphasizes that education must be concerned with all aspects of the child, and that a knowledge of physical growth, nutrition, hygiene, emotional development, social development, and mental hygiene is as necessary for the best guidance of children as is a knowledge of mental development, the learning process, and subject matter. Continuity implies that each moment of a child's life is inseparably tied with the past and full of possibilities for the future. Emphasis should be placed upon a genetic study of growth and development for all who are concerned with children of any age.[1]

This text endeavors to present the whole child, from his earliest origins until we lead him to the schoolroom door. In order that you may grasp the import of this statement, and to prevent you from jumping to the conclusion that you are entering upon a series of short courses in chemistry, biology, and psychology, I ask you first merely to read hastily the entire text. Do not stop to worry about details—read to get the plan of the book and to get a bird's-eye view of the child in the various aspects indicated. Skip new words; or look them up if you must have them to make sense (you will find most of them defined at

[1] MEEK, LOIS HAYDEN, *Report of the Director of the Child Development Institute*, p. 3, Bureau of Publications, Teachers College, Columbia University, 1931.

the beginning of each chapter). *Try to see the whole child.* Especially read the poetry now, and again and again. The poet is a true scientist and often gives us in a magic flash of words the gist of a weighty scientific tome. By the time you have done this you should have acquired a lively curiosity as to what the child is made of, where he came from, his mysterious parasitic life within his mother's body, the meaning of his long infancy, the significance of his patterned behavior tendencies; and especially, you should be eager to make the acquaintance of some active child and see for yourself if these things are true.

In other words, we are not studying the child by analyzing his fingers, toes, stomach, and brain (although the endeavor to memorize the content of separate chapters might easily give you this impression) and then trying to construct a child out of the parts. Rather—you are looking at an amazing piece of living machinery—and you are eager to see what makes the wheels go round. You will feel the need of the chapters on chemistry, heredity, and biology! You will go back to them continually merely to satisfy your curiosity.

The time has come when we must live scientifically, rather than empirically, in order to survive; certainly we must do so in order to derive satisfaction from our expanding leisure time. College-trained parents should want more than dogmatic formulas by which to rear their children; indeed they must have more than formulas. They must have the vocabulary with which to read understandingly the wealth of popular scientific child-development literature and current reports on new discoveries. They must have knowledge of the basic factors of behavior and development so that they may make their own formulas to meet the constantly varying and intensely individual problems presented by the life of any child. Parent education is the newest and perhaps the most important extension of the educational system. Do not think you will be in any sense of completeness prepared for parenthood when you have finished this course. You will have only an introduction to a lifelong course of study!

THE CHILD

CHAPTER I

BEFORE THE CHILD

Then Almitra spoke again and said, and what of Marriage, master?
And he answered saying:
You were born together, and together you shall be forevermore.
You shall be together when the white wings of death scatter your days.
Aye, you shall be together even in the silent memory of God.
But let there be spaces in your togetherness.
And let the winds of the heavens dance between you.

Love one another, but make not a bond of love:
Let it rather be a moving sea between the shores of your souls.
Fill each other's cup but drink not from one cup.
Give one another of your bread but eat not from the same loaf.
Sing and dance together and be joyous, but let each one of you be alone,
Even as the strings of a lute are alone though they quiver with the same music.

Give your hearts, but not into each other's keeping.
For only the hand of Life can contain your hearts.
And stand together yet not too near together;
For the pillars of the temple stand apart.
And the oak tree and the cypress grow not in each other's shadow.

KAHLIL GIBRAN.[1]

Marriage and Parenthood.—The child we are about to study must have parents. His parents must have met, loved, and married. Children are born to them (wanted and welcomed, we hope). They want to be good parents; to have healthy, happy, creatively successful children. The logical place to begin the study of child development and training, and the setting of the stage for Our Child, is with the matter of having the right kind of parents to welcome him, and a proper home ready for him in which he may flourish and be joyously happy. What should young people consider as they face this aspect of their lives?

[1] Reprinted from *The Prophet* by permission of and special arrangement with Alfred A. Knopf, authorized publishers.

What may be put down as the most fundamental considerations in marrying, in founding a family, in establishing a home? Few will question the desirability of the factors of a successful marriage and parenthood about to be mentioned. To attain them requires clear vision and concerted and continuous effort.

Integrity of Character.—First of all, parents must be worthy of respect; they must be able to respect and admire each other and both must have personalities which, infinitely diverse though they be, will command the instinctive love and respect of the child. Both love and respect are spontaneous; they cannot be forced.[1] Selfish, undisciplined, and unreliable individuals are incapable of satisfying human relationships. If it were socially possible, they should be condemned to celibacy and childlessness, since they wreck the happiness of all who are forced into intimate association with them. From the consequences of that association mate and child, in particular, have no escape. Such socially unfit persons are "predisposed to unhappiness."

Domestic harmony based upon deep affection is an essential requisite to the development of the child. Adjustments to married life should have progressed to a degree such that a reasonably harmonious atmosphere is assured for the child, at least one that is free from petty disagreement and bickering. This does not mean that there will not be differences of opinion, frankly and even warmly stated; the conceded right to free expression is the essence of democratic relationships. Domestic affection and understanding furnish a safe setting for free expression and exchange of opinion. Only sincere love and affection enable any married pair to come safely through the inevitable adjustments to the restrictions and intimacies of married life.[2]

[1] ". . . With prejudices, preconceptions and wishful thinking out of the way, what do we see? The new cue word, we find, is no longer authority; it is leadership. No one has inherent rights to leadership; leadership must be won and continuously held. A leader may not demand respect even, he must win respect. No act of parental authority, as no act of legislature, may assure love; but love may be won and held; so with leadership." HUGHES MEARNS, *The Creative Adult*, Chap. XX, p. 281, The Parent as Creative Leader, Doubleday Doran & Company, Inc., 1940.

[2] "The quality of deep, enduring love should be assiduously sought after in selecting a mate. Without this love there should be no marriage. *Eugenics is making sure that one is worthy of being loved.* Eugenics ascer-

One adviser to the newly married pair says, "You may always *love* each other but there will be times when you will not *like* each other." The bond of true affection is the anchor of safety in every time of domestic stress and storm. "Married love is a creative enterprise. It is not achieved by accident or instinct."[1] The most inalienable right of any child is that his parents shall have understanding affection for each other and for him, an affection strong enough to withstand the impact of human imperfections.

Romantic love which also embodies the fine quality of friendship, and parental love, which also should embody the quality of friendship, will continue to be the strongest emotional bonds in human life. But violent romantic attachment is no longer held to be the only factor in successful marriage. The rosy glamour of early passion fades and is succeeded by long days and years of daily companionship in which mutual interest, community of tastes, ease in each other's presence, are essential to happiness and to the emotional security of children. Sheer boredom has wrecked the happiness of many homes. The constant scratch of petty frictions (Chesterton's "tremendous trifles") wears down even deep morale, while emergencies and crises bring out the best in both parties. A woman who will stand wholeheartedly back of a man accused of crime may be thrown into irritable nervous explosion by his persistent habit of drumming with his finger tips or noisily clearing his throat.

Harmony also involves deep understanding as to beliefs and issues that seem important to one or both of the married pair. If one considers a certain religious belief to be the one and only true doctrine of salvation, it is inviting disaster to marry an individual who does not and cannot believe that way. Every couple contemplating marriage should know each other well enough and for long enough to be certain that they will not get on each other's nerves, that they will find rest and repose in each other's presence, and that they agree—or are certain of

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tains, as far as possible, beforehand that there are qualities making for the permanence and increase of love." RALPH E. DANFORTH, "Family and Conjugal Affection as a Factor in Human Evolution," *Scientific Monthly*, January, 1929.

[1] CARREL, ALEXIS, "Married Love," *Reader's Digest*, July, 1939.

being able to make adjustments—in regard to tastes, beliefs, personal habits and practices, and in all the matters involved in the close associations of their daily lives. That they may be able to agree about mutual interests, there must not be too great disparity in age and education.

In the primitive marriage sex is probably the dominant factor. Civilized marriage is quite otherwise; it includes sexual intimacy, of course, but only as a relatively small item in a highly complex situation. The sex factor may seem important at first but is soon merged in wider interest—intellectual and social copartnership, children, a house and garden, a joint career, children's careers, and friends held in common. Sex, as developed by civilization, is very complex.[1]

The successful matings are those that come about through daily compromise based upon high philosophical comprehension of the necessary contradiction of opposites.[2]

As to practical rules for marital harmony, it is difficult to improve upon the ten rules formulated by Mrs. Franklin D. Roosevelt.

1. Have a definite life pattern.
2. Keep a household budget.
3. Apportion between husband and wife the home-making duties as well as individual responsibilities.
4. Expect to disagree.
5. Let neither husband nor wife strive to dominate.
6. Be honest with yourself and with the other.
7. Be loyal: the less said about married troubles, except between yourselves, the better.
8. Talk things over: meet every situation in the open.
9. Avoid trivial criticisms.
10. Keep alive the spirit of courtship, that thoughtfulness which existed before marriage.[3]

The Home.—After marriage comes the establishment of a home and preparation for bearing and rearing children. The con-

[1] Elton, Mayo, "Should Marriage Be Monotonous?" *Harper's Magazine* September, 1925.

[2] Mearns, Hughes, "Parental Madness," *Survey Graphic*, December, 1927.

[3] *Kansas City Star*, Nov. 9, 1931. By permission of Mrs. Roosevelt and of the *Kansas City Star*.

ditions under which the modern young couple do these things are very different from the conditions their parents had to meet. The mechanization of living has given the bride of today a kitchen which is a dream of beauty and convenience, an almost ready-to-eat food supply, and a house much more easily cleaned and kept in order than the first home her mother had to manage. Housekeeping is no longer drudgery, and no longer consumes all the time and creative effort of the homemaker.

The present turbulent economic and social situation, the new freedom of woman, the lengthening of the period of education and training, the rise of birth control—all contribute to a tendency to delay parenthood. However, of late there appear to be more college students who marry on graduation or even before, pool resources and income, and live simply at a minimum cost. There are some points in favor of early marriages. The average modern college girl does not expect to wait until her fiancé can give her a home and an income and "take care of her." She does not *want* to be taken care of! She wants the gay adventure of early struggle, and the joint struggle does much to integrate personality and develop and temper character. Early marriage solves the problem of prolonged premarital chastity, which is at present a much-discussed problem of the unmarried young adult.[1] The one hazard of the early marriage is that the premarital acquaintance may be fragmentary and incomplete, and early marriage may be based upon glamour and sex attraction rather than upon the solid factors of conjugal harmony just discussed. Certainly such a young couple should not be too romantically intoxicated to consider every possible contingency in the way of illness, financial stringency, unanticipated pregnancy, etc.

Children.—In any situation the engaged pair will have to determine whether they will both work after marriage until they achieve a degree of financial security that will permit a home and children, or whether both will work until their financial goal is achieved and then marry. Before marriage they should decide whether they will rent a furnished apartment or buy or rent a house. They should plan for savings, discuss budgets, etc. They should agree as to when they will expect to have the first

[1] Wile, Ira S., editor, *Sex Life of the Unmarried Adult*, Vanguard Press, Inc., 1934.

child and consider the ever-present possibility of accidental pregnancy, since no contraceptive device has yet proved 100 per cent certain. We hope they will plan for more than one child.[1] For various reasons they should not postpone parenthood longer than is really necessary. For one thing, married life is incomplete without children. For another, young children need young parents. One couple had four children in succession during the first years of married life while they were struggling to pay for a farm. The mother said, "We thought we'd do all our struggling at once and enjoy our children while we're young and we'll *all* be ready to enjoy prosperity when it comes." And they were a jolly, rolicking family, the parents as young as the children.

Again, a couple who put off having children until, as is so often said, "we can give them the advantages we want them to have," are likely to become so routinized in their habits of living and thought that it is difficult to make the radical adjustments that then become necessary to satisfactory living with children. It is the child who sometimes must, quite unfairly, do the accommodating. In some cases, parenthood is put off and off until the years of set maturity slip in unawares. Then childbearing becomes a more hazardous matter and mental elasticity lessens. The parents lose some measure of ability to enjoy and understand children, as well as losing years of delightful companionship.

After all, the material needs of young children are few: shelter, of course, and outdoor space, and food. Given these essentials, which are not necessarily expensive, the simpler the living, the better for both health and character and the deep satisfactions of life for parents and children. As for the child's mental health and character—an atmosphere of serenity, affection, and understanding, with proper outlet for creative energy, are all that the child requires. The supreme gift of understanding and affection is within the power of any home—but it is the thing that the child world most sorely lacks. Ponies and pianos and servants can never compensate for indifference or discord or lack of understanding companionship in the home.

[1] To maintain the present population at a stationary figure, each fertile married pair must have two children to replace themselves, and at least two more to replace the individuals who have no children, or only one.

In practical planning for children, the couple should consider these things. (1) They should select a living place suitable for children. This means, especially, outdoor space. No child should be raised in an apartment if it is possible to live otherwise —there is no adequate substitute for free, outdoor life. (2) They should consider the cost of pregnancy and childbirth; possibly, the subsequent loss of the mother's earnings; the cost of food, clothing, and medical supervision for the child; and they should see their way clear to meet these expenses on a minimum basis (see page 307). In some communities, cooperative hospital insurance is possible, and accident and health insurance always gives a certain security against emergencies and at reasonable cost.

The practical details being met, some time may profitably be spent by the pair in reading. This will enlarge their horizons and contribute to understanding and efficiency. The prospective parents should understand the physiology of pregnancy and birth. They should be somewhat prepared for the plateaus of development in the child, and they may find it interesting to read modern theories of child training.[1] They should discuss everything until they do see alike theoretically in essential matters involving the child and can assure for the child unity of policy and serenity of atmosphere. There is considerable hazard in waiting until parenthood is imminent to discuss these points, and still greater hazard in waiting until the child is here. If there are radical differences of view upon basic subjects, these must be ironed out before happiness can be assured for parents or for child.

The engaged pair should discuss their own bringing up—frequently parents carry over the customs of their own parents. A father who, as a child, was slapped and whipped for everything may punish sharply and quickly because he does not know how else to govern, to the distress of the mother who, in her own

[1] Among many suitable books for building attitudes and backgrounds, the author suggests Hughes Mearnes's series: *Creative Youth, Creative Power, The Creative Adult*—all from Doubleday, Doran & Company, Inc. George Santayana's *The Last Puritan;* James Plant's *Personality and the Cultural Pattern,* The Commonwealth Fund, 1937; and Lillian Gilbreth's *Living With Our Children,* D. Appleton-Century Company, Inc., 1929.

childhood, may have been governed by affection. Harmony between parents is so essential to happy childhood and to character development that the prospective parents should take every possible measure to ensure this for their children.

Establishing a Pattern of Living.—Granting that theoretical agreement has been reached before marriage, it still remains for the pair, when married, to set up a frame of living into which they may properly induct the child—a daily routine which protects their own health and conserves their own energy, money, and time; which provides a balance in sleep, food, recreation, and creative living—a routine to which they are adapted and disciplined before the child comes, and which will not be seriously disrupted by the addition of new members to the family. The routine of budgeting time and money, of insurance, of periodical health examination should be considered bedrock essentials of satisfactory living for individuals, and they are critically essential when there is responsibility for children.

Fortunately, preparation for parenthood does not differ from preparation for any normal, balanced domestic living: orderly, healthful routine; emotional and intellectual understanding; and a program of continuing mental growth. *The continuing mental growth is an all-important factor in successful parenthood.* Unless parents can go along with their children into the new intellectual worlds that open up with each cycling year and generation, the interests and attitudes of parent and child are bound to become separated and lack of understanding inevitably arises.

The New Role of the Father.—At present the sharp lines which traditionally have demarcated the roles of father and mother in the life of the family group are fading under current revolutionary scientific and social changes.[1] Mother no longer stays strictly in the home, devoting her full time to feeding, clothing, and serving the personal needs of the family. Father's function is no longer strictly out in the world, earning the bacon that he brings home for mother to cook. Certainly, father is fast losing his traditional prestige as head of the family, whose word was law and who commonly functioned as referee and heavy disciplinarian. It is at last coming to general attention among edu-

[1] Plant, James S., *Personality and the Cultural Pattern*, pp. 40, 91–95, The Commonwealth Fund, 1937.

cators that the child has two parents.[1] Here and there study groups have been organized for fathers and even for expectant fathers.[2] The Maternity Center Association of New York City, a volunteer organization, which has established numerous consultation centers and which carries on a broad educational program for mothers, has for several years conducted very popular classes for the instruction of expectant fathers, and the director of the Center has recently published a delightful book for them.[3]

Here and there young men are asking admission to college classes in child care and child development and are indicating their desire for instruction as to the functions, responsibilities, and educational philosophies involved in parenthood. Preparental education is the logical place for establishing bedrock parental education. Parents in action have too much to unlearn and it may then be difficult or impossible for the father and mother completely to overcome previous conditioning to the degree that they can accept modern science and become able to see alike. With all the preparation they can make, there will be many unanticipated problems.

Because of the general shortening of work and office hours the average father has more time in the home than formerly. He no longer "leaves home before the children are up and gets home after they are in bed." Young mothers and fathers are now more inclined than formerly to read the same books, talk over what they read, go together to classes and conferences, and really share parental responsibilities.

A striking example of sharing parental responsibility was that of a remarkably superior young couple teaching in a small college, who were able so to arrange their teaching schedules that their hours alternated. From the time that the baby was three weeks old to the end of the school year, the father took care of the child during the hours when the mother was carrying on her work on the campus. The father said that he wished to do it, he enjoyed

[1] VICTOR, DAVID, *Father's Doing Nicely*, Bobbs-Merrill Company, 1937; WOLF, ANNA W. M., "Forgotten Father," *Parents' Magazine*, December, 1940.

[2] GUEST, EDGAR A., JR., "Prenatal Care for Father," *Hygeia*, August, 1939.

[3] CORBIN, HAZEL, *The Expectant Father*, The Macmillan Company, 1939.

it, and he thereby "felt that it was really half his baby." When the infant was five months old, the mother said proudly that John could and did do everything for the baby quite as well as she, except for the one item of breast feeding. It was reported that the whole matter of the arrival and care of the baby was of great interest to the campus and that the young father lost no prestige with faculty or students.

Two mature students in a certain university decided to marry. In the spring of their junior year they were brought face to face with the responsibility of approaching parenthood. By very careful planning they were able to carry on their college work with the loss only of one semester by the mother, and both achieved honors without the slightest neglect of the lovely baby. The expectant father educated himself intensively and took full care of mother and babe from the third day following the birth (fortunately, during vacation), thus greatly reducing the expense (see page 308). Health came first always, and they were a joyous domestic trio, taking everything in an adventurous stride.

The father should have some fairly regular time for close companionship with his children. Under usual family conditions the bedtime hour may be the best available time. In the interest of sleep, this ought not to be actively exciting. The good old romp with daddy had better come in the morning when children are fresh and rested. Evening should be devoted to reading, storytelling, and quiet companionship, maybe culminating in a pickaback ride to bed. Excursions with father to the country, downtown, or anywhere at all, widen the horizon of experience for the child and deepen the bond between the two.

Always, however, the best times are, or should be, those shared by the complete family circle. The child should grow up with a fund of happy memories that give him a sense of unity and harmony, complete security, understanding, and deep affection as the atmosphere of his daily life and living. "Families which play together, stay together." The child should have the roots of his personality sunk deep in the soil of a harmonious home within which he shares the struggles and stresses and responsibilities, as well as the joys and advantages—in short, an organic family life in which the personalities ("field properties," see page 31) are consistent and integrated.[1] Such a child will face life "the captain of his soul," drawing courage and vigor from the deep taproot of early memories.

Science and Parenthood.—Certainly no one is entirely fit for parenthood who does not have a correct perspective of his own place in the social organization and who cannot see with impersonal clarity the place of his child and of any child in the social and in the cosmic structure. It makes an essential and illuminating difference whether one views a child in his relation to the entire past and to the future of the human race, or as a personal possession, a personal miracle, who too often develops a baffling, uncontrollable personality. Also, anyone dealing with childhood in any capacity should have sufficient creative imagination and spiritual insight to guarantee that he will not do violence to normal growth in personality in his own child or any child entrusted to his care.

Upon college-trained parents, therefore, rests an especial responsibility—that they bring all the forces of their trained minds to bear upon the supreme experience of parenthood. Having a child is the highest human experience; the life of the child ramifies into all the sciences and into cosmic history back to the beginning of time. Educated parents should not only understand the dramatic events taking place within the mother's body, they should try to understand life itself. Certainly there can be no more challenging subject and no more specific obligation than to try to follow all these ramifications of the child's life to their alluring end, and to see their child as the product of all the forces of the past and the promise of the future.

No one in the world needs a larger view than does the parent. The more clearly he sees the place of the child in the universe, the more he knows of the origin and significance of life, and the more clearly he sees the great unity of the cosmos, the more understanding and tolerant will he be and the more effective in his efforts to assist growth. He will be less likely to meddle with growth, and more happiness and ease will be attained between child and parent. It is, therefore, without apology that the author presents the subject of the origin and development of the child against the background of modern science.

[1] GILBRETH, *op. cit.*

Child development has become a science. In some colleges, courses in child development are assigned for group fulfillment in biology, psychology, and education. This is as it should be; the science of child development and training is the essence of all living sciences. Departments of child research are found in the leading educational centers. Modern child research draws upon all fields of both pure and applied science. It is supremely satisfying to see the scientific recognition of the child as the acme of creative evolution and to be able to see even dimly the cosmic forces that unite in him.

CHAPTER II

THE CHILD

And a woman who held a babe against her bosom said, Speak to us of Children.
And he said:
Your children are not your children.
They are the sons and daughters of Life's longing for itself.
They come through you but not from you,
And though they are with you yet they belong not to you.

You may give them your love but not your thoughts,
For they have their own thoughts.
You may house their bodies but not their souls,
For their souls dwell in the house of tomorrow, which you cannot visit, not even in your dreams.
You may strive to be like them, but seek not to make them like you.
For life goes not backward nor tarries with yesterday.
You are the bows from which your children as living arrows are sent forth.
The Archer sees the mark upon the path of the infinite, and He bends you with His might that His arrows may go swift and far.
Let your bending in the Archer's hand be for gladness;
For even as he loves the arrow that flies, so He loves also the bow that is stable.

KAHLIL GIBRAN.[1]

Here is a child—Our Child—any child. We are about to study him. We wish to understand his body, mind, and behavior; we wish to be able correctly to care for his body and wisely to direct his experiences as he grows into life, in order that he may be healthy, happy, and, above all, creatively useful in his relations with other human beings. As we think about this objective, it becomes a never-ending challenge to intelligence; parental affection is essential, but alone it is not enough. Take the very familiar matter of growth. The infant who appears in Fig. 1 has head, chest, and abdominal measurements approximately equal; his head length is a fourth of his body length; his arms equal or may exceed his legs in length. He appears entirely normal to us; in fact, an infant would appear very queer whose body was proportioned like an adult's, and an adult would appear equally

[1] Reprinted from *The Prophet* by permission of and special arrangement with Alfred A. Knopf, authorized publishers.

queer whose body was of infantile proportions. We begin to wonder why the infant is so proportioned—why his legs and arms are so short and so useless; why his head is so large—and also so useless.

Even new amebae into which the parent ameba has sacrificially divided itself will roll around and find and absorb nutriment from the fluid environment. A newborn calf or kitten instinctively finds its mother's milk. Birds and babies, however, are completely helpless and would speedily perish without parental care. Of all living things, the human infant is the most helpless and has the longest period of infancy. In fact, one of the features of the scheme of evolution seems to be the continuous lengthening of the period of necessary social protection of growth, which keeps close step with the evolution of mind and social intelligence. This fact is reflected in our customs and laws.

Less than 100 years ago children were put to hard physical work long before the age of puberty or adolescence. In this country today, the entrance of children into industry is protected (even with the still existing weak spots) as never before in history. The period of compulsory school attendance constantly lengthens. Measurable growth of the physical body goes on into the twenties, while modern neurologists announce that nature seems to have provided space and facilities within the brain cortex for increments of growth of brain cells and fibers and for creation of new paths of association which may go on actively until the actual disintegrations of very old age set in. *We never cease to be able to learn, and education extends throughout life.* There is evidence that more people are reaching an active, creative old age than ever before.[1] We wish so to bring up Our Child that he may live a long, creative life, full of vigorous activity and free from mental and physical suffering.[2] We wish to conserve every

[1] This accounts for the fact that the average span of human life in the United States has increased from 48.2 years for males and 51 years for females in 1901 to 61.5 years for males and more than 65 years for females in 1939. Actually, the extreme span of life has not lengthened—there are only more very old people living, fewer babies die, and not so many babies are being born.

[2] The general mortality per 100,000 population in 1900 was 17.6; in 1936 it was 11.5; and in 1939, 7.6 (*Metropolitan Life Insurance Company Bulletin,* 1940). Since so many persons are living to old age, and since all must some-

aspect of growth. To achieve this for all children means broad specific education for parents, educators, and statesmen.

The Study of Growth.—If we are to assist nature by making conditions favorable for the physical and mental growth and development of Our Child, we must try to understand what growth is (when the term is used in the broad sense, including differential development). We promptly discover that the manner in which any child grows and behaves will depend in some measure upon the sort of families his parents come from—in other words, *heredity.* We also promptly discover that even identical twins will become to some degree different in differing *environments.* How are we to distinguish in an individual child the physical and mental characteristics that are due to completely realized heredity—such as height—and which cannot be essentially modified or altered, and those potential traits—such as weight—which may be stimulated or suppressed in development as they are influenced by environment?

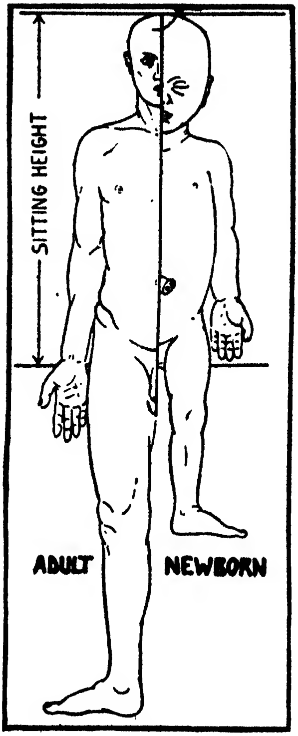

FIG. 1.—Outlines of adult and new-born human, being a diagrammatic comparison between the exact bodily proportions of each, both reduced to the same sitting height. It is to be noted that while the leg had doubled in length the arm has increased only about one-third. The arm of the new-born is precociously long. (*After A. H. Schultz from Davenport, How We Came By Our Bodies, Henry Holt & Company, Inc.*)

Heredity.—Logically, we start by scrutinizing the parents of the child. We may discover that the mother is quick-tempered, irritable, stocky in build, and brunette in color; that she has prominent eyes and a slightly enlarged thyroid gland. We discover that the father is tall, blond, and friendly in temperament.

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time die, the degenerative diseases of old age, such as cancer, pneumonia, and nephritis, have increased, while the diseases of childhood have markedly decreased. *Annual Report,* U. S. Public Health Service, 1938.

The child has brown eyes, in this resembling the mother. He is slender, like the father, and of a sunny disposition. But, strange to relate, his hair is red; and he has a web between two toes, and possesses a nose unusually prominent for a child. The father's nose is of average proportions, but he says that his mother's people had thin, long, Roman noses; he thinks that the child gets his nose from them. There is no red-headed grandparent, aunt, or uncle of the child on either side; but the mother's mother says that her mother had very red hair and that one of the grandmother's brothers also had red hair. Further inquiry (fortunately all the grandparents are living and can give information) brings out the fact that webbed toes have occasionally appeared in the maternal grandmother's family. Before we have finished merely looking at the child and his parents we shall have concluded that it is necessary to go further back than the parents in order to account for the baby's perfectly obvious physical traits.

Reading a text on heredity, we learn that this child's parents had in their bodies, when they were born, the potential germ cells (containing all determiners for all possible traits) that were to unite and become *him.* Therefore, he could not inherit *from* those parents so much as inherit *through* them from past generations. This accounts for the appearance in him of traits for hair, nose, and toes not belonging to his immediate ancestors. When we try to determine how far back his inheritance extends, we uncover an unbroken chain of "life arising from life," back to the first life that quivered in the warm shallows of the ancient seas. We discover that the story of the ancestry of our child is a long, long story of evolutionary differences grafted upon hereditary similarities. Someone has said that evolution is nature's scheme for "structuralizing experience." We decide that the poet is right in saying, "Your children are not your children, they are the sons and daughters of life's longing for itself."

Environment.—We noted that the mother has prominent eyes and a slight enlargement of the thyroid, that she is quick-tempered, nervous, and irritable. No one knows of another such instance among any of her relatives. We now consider the fact that she worked hard and had many social and financial worries both before and after marriage. Her physician says that she is being overstimulated by her thyroid gland and advises an operation. We later learn that her disposition, nervousness, and general health are greatly improved after she has had the operation. We therefore conclude that, as far as can now be determined, her thyroid trouble, with its characteristic mental and physical symptoms, was produced by environmental experiences rather than by heredity. We now hear of a woman neighbor recently arrived, who has another type of goiter (thyroid enlargement, see page 150), the kind caused by too little iodine, and that she had a child who was born mentally and physically defective (a cretin), but that this child improved greatly—in fact, became quite normal—under treatment immediately after birth with thyroid hormone, *thyroxin* (see page 149). Quite obviously, this child's prenatal nutritional environment distorted a probably normal hereditary pattern.

Environment assumes great significance when we consider that the child starts as a microscopic fertilized egg and that when he is born he is *all environment* except for that original minute speck of chemical matter in the egg. We wonder at the chemical potency of that invisible bit of protoplasm which, somehow, causes the materials of the child's body to assemble in precise sequence and pattern, out of the elemental chemical substances in the mother's blood stream—elemental chemical substances which, in turn, she takes from her environment in the form of food, water, and air, which, in their turn, came directly or indirectly, via the plant world, from the soil of the earth. *There is no break from soil to soul.*

So, we see, our effort to understand what is going on in a child's body leads us quite directly to the chemical elements of the earth: on one hand to the elements listed in Table II (see page 37), which were in the original sea water and which became alive, on through the story of the steadily progressive, apparently purposeful evolution of life as it has laid hold of, organized, and activated the elements of the earth in heredity and in evolution—an evolution which at long last has produced Our Child. On the other hand, we must try to understand the very intimate and intricate relationship between this infinitessimal "speck of hereditary urge" and the chemical elements of the environment out of which heredity makes not only *a* child, ***but a specific indi-***

vidual—Our Child. There is no logical place to begin except by going back as far as human knowledge and human imagination can take us and trying to see the outlines of the magnificent story as a whole. Modern philosophy tells us that we can account for parts only on the basis of the "wholes" which contain and relate or integrate their parts. There must be a whole for something to be a part of. What is the "whole" of which the body-mind of our child is part?

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New Words in Chapter III

alchemists. Medieval chemists who sought to transmute baser metals into gold, to find a universal solvent, and an "elixir of life." Hence, alchemy refers to any magical power or process of transmutation.

atom. The smallest particle of an element that can exist and retain the character of the element.

compound. A chemical combination of two or more elements of a definite composition and definite internal structure.

cosmos. The world or universe as an ordered whole; creation in its entirety.

duterium. "Heavy hydrogen," an isotope of hydrogen (see isotope).

electromagnetic. Refers to electromagnetism, dealing with the relation between electric current and magnetism.

electron. A unit of negative electricity, regarded as one of the ultimate particles of which all atoms are built.

energy. An attribute by virtue of which one portion of matter can produce changes in another; ability to do work. According to modern science all that we observe in the universe is due to energy charges.

field. A portion of space controlled or affected by a specific type of force (as, a magnetic field, the space through which the influence of a magnet is exerted).

field properties. Characteristics belonging to a field that are peculiar to the particular field.

force. An influence that produces motion or change of motion; sometimes used as a synonym for *energy* or *power* or to indicate a natural phenomenon, as electricity.

galaxy. A major group of sun systems. The Milky Way is the galaxy to which our sun with its planets belongs.

infrared. That part of the light spectrum lying just beyond the visible spectrum at its red end.

isotope. Any atom containing neutrons in its nucleus (see neutron), as, "an isotope of hydrogen."

kilometer. One thousand meters; 3,272.5 feet.

molecule. The smallest portion of an element or compound that retains identity in character with the substance in mass.

neutron. A neutral body having approximately the weight of a proton. The presence of one or more neutrons in the nucleus of an atom forms an isotope.

planet. Any body, except a comet or a meteoroid, that revolves about a sun.

proton. One of the fundamental units of atomic structure (electropositive) and composing, with electrons (electronegative) and neutrons, the atoms of all elements.

quantum (plural, **quanta**). A hypothetical particle composed of the smallest amount of energy capable of existing independently or this amount of energy regarded as a unit.

spectrum (plural, **spectra**). A characteristic sequence of images formed when a beam of light is passed through a prism so that the rays are arranged in order of their wave length.

static. Pertaining to bodies at rest or forces in equilibrium.

ultraviolet. Invisible rays of light energy lying just beyond the visible spectrum at the violet end.

valence. The relative combining capacity of an atom with other atoms, compared with standard hydrogen atom, which has a valence of 1.

wave. A vibrational disturbance propagated from particle to particle through a body of elastic medium, as in transmission of sound, light, etc.

X ray. Röntgen, or X, rays are rays of very high frequency or short wave length used to photograph or examine solid objects through substances opaque to ordinary light (as bone through flesh).

CHAPTER III

THE UNIVERSE

Down through an atom
Up through a star,
Man is looking
Far—so far.

But whence the atom
And whence the star
And whence the man
Who looketh far?

Shall he find no
Dividing bar
Twixt him and God—
Life's Reservoir?

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The Great Unity.—From the earliest alchemists[2] to the miracle workers in our modern laboratories, one of the ideas that have increasingly dominated the minds of searchers for truth is that the whole material universe must be composed of varied arrangements of one basic substance, that there must be a common origin for everything. The alchemists tried to reduce everything to gold, the most precious substance known to them. At present, chemists and physicists are proving that everything in the known universe is reducible to energy, or rather to a nicely balanced arrangement of positive and negative electromagnetic energy.

To the ordinary person energy means a force arising from some change or movement in some tangible substance, such as heat from combustion of fuels, sound from vibrations of air which may be set in motion by vocal cords or a tuning fork, mechanical force from a machine or a muscle in action, or light energy from

[1] *Kansas City Star*, July 5, 1932.

[2] Alchemy is the name that was given to the early search (eleventh and twelfth centuries) for the secret of the composition of matter. Much mysticism and superstition was involved in the methods used, but alchemy represented a search for truth that paved the way for science.

a candle or from the sun. We are familiar with the fact that heat can be made to produce light or sound, or to start an engine into powerful action. We have only to look about our homes to be reminded that electricity can be converted into light, heat, power, and sound. In short, any form of energy can be converted into any other form, although it is not fully understood just how this is accomplished in the natural world.

Science now tells us that universal space is filled with electromagnetic energies, which radiate equally in all directions (like the

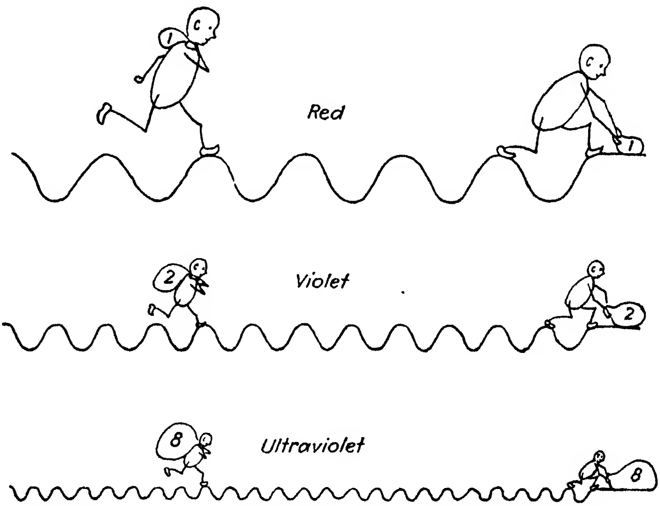

FIG. 2.—Messengers of light (quanta) carrying packsacks of energy over red, violet, and ultraviolet pathways (waves). (*Sheard, C., Life Giving Light, The Williams & Wilkins Company.*)

rays from a lighted candle) from everything in space, including the earth and everything upon it. Science also tells us that even free energy has structure, and that all energy, instead of being a steady stream of force, consists of discontinuous particles, points, or *quanta*, which move in undulating, or wavelike, paths. Differences in energies are due chiefly to differences in the wave lengths in which the disconnected particles of energy move.

All electromagnetic energies move through empty space (a vacuum in which they meet no obstruction) at the incredible speed of light: 186,000 miles, 300,000 kilometers, or 7½ times around the earth in 1 second. As shown in Fig. 2, a quantum of energy moving in large wave lengths will have less force or penetration than will one traveling in short wave lengths. Figure 2 is a diagrammatic representation of light quanta of the colors indicated, moving in waves.

Of the electromagnetic energies which travel at the speed of light, the most powerful and the most penetrating known are the *cosmic rays*, whose wave lengths are something like 1/100,000,000,000 inch. Next in decreasing order of "frequency" come the *gamma rays*, *X rays*, *ultraviolet rays*, the *visible light spectrum*, with its well-known seven colors, *infrared*, or *heat*, *rays*, and longest of all, *radio waves*, which may be miles in length.

The human sense organs are "tuned" to respond to a limited number only of the respective radiations of these energies. We can see X rays, ultraviolet, and infrared rays only when they are transformed into visible light with its seven colors (each color having its own wave length, see Fig. 2). We can hear wireless and radio waves when they are transformed by our radios into sound waves that are within the range to which our auditory nerves respond. We feel all electromagnetic energies when they are transformed into heat. It is certain that there are many sounds, odors, and colors beyond the range of human sensibilities to apprehend. In fact, it is commonly observed that insects, birds, and animals can see, smell, and hear much of which human beings are completely unaware. Indeed, there may be in the universe many phenomena of which we are totally unaware because we have no sense organs to correspond.

Man, however, has learned to reinforce his limited senses with mechanical amplifications such as are provided by the telescope, microscope, electronoscope, radio, etc., until he can literally see "down through an atom, up through a star," and—in every direction—he sees only *organized energy*.

The Structure of Matter.—An element was formerly believed to be a substance that cannot be broken apart or reduced to simpler component substances, and an atom was the indivisible unit of an element, there being as many kinds of atoms as there are kinds of elements. This view was held by science up to relatively few years ago. It was believed that atoms themselves were homogenous (alike all through) and could never be broken into smaller or simpler particles. It seems now to be proved that atoms really have an exceedingly complicated and characteristic structure; and now atoms are broken apart and elements are transmuted into other elements, both in nature and in the laboratories. The structural units of the atom are the points of positive and negative electrical energy mentioned on page 30. The points, or particles, of positive energy are called *protons* and are found in the center or nucleus of the atom. The points, or particles, of negative energy are called *electrons*, and these move about the nucleus much as the earth revolves in a fixed orbit about the sun and as the moon revolves about the earth. The proton and the electron have equal and opposite pull or "charge," thus holding the energies of the universe in total balance.

In addition to the proton and the electron, there is a neutral body called the *neutron*, which, some think, is formed by a proton and an electron so firmly welded together that they neutralize each other and act as one body. A neutron, although it has the same weight as a proton, has no electrical charge. Neutrons are found in many atomic nuclei, thus causing a variation in weight of atoms of like kind, but not in the number and relation of protons and electrons and not in electrical charge. Atoms containing neutrons are called *isotopes*.

The atom of hydrogen, the simplest element known, consists of one proton about which revolves one electron. When a neutron is added to the nucleus, an isotope of hydrogen is formed, known as *heavy hydrogen* or *deuterium*. When another proton is added to the nucleus and another electron revolves in its special orbit about the nucleus, an atom of the next element, *helium*, is formed. The addition of a third proton and electron forms *lithium*, the third element; and so on, up to the last of the elements in the Periodic Table of Elements (see Table I), *uranium*, which has 92 protons (and variable numbers of neutrons) in its nucleus, about which 92 electrons revolve in layers or concentric shells of orbits ("the onion atom")—truly a giant atom.

There are 92 known elements of which the earth and (it is believed from spectrum analysis) all the other heavenly bodies are composed. Thus, we see, all space is filled with free energies and all matter is patterned, or organized, units of these energies. Each organized unit, large or small, radiates free energy equally in all directions in mathematically decreasing intensity. We shall speak of this again.

Molecules and Compounds.—When new protons are actually incorporated into the structure of an atomic nucleus, a new element is formed. When only the electrons of two atoms enter into structural relationship, leaving the two nuclei separate, a *molecule* is formed. Two atoms of hydrogen may unite to form a new element, helium, having a new nucleus of two protons and two encircling electrons; or the electrons, only, may form new orbits about the two nuclei making a molecule of hydrogen, H_2. If now the electrons of a hydrogen molecule, H_2, enter into certain precise relationships with the electrons of one atom of oxygen, a

TABLE I.—THE CHEMICAL ELEMENTS

Element	Symbol	Atomic number	Element	Symbol	Atomic number	Element	Symbol	Atomic number
Hydrogen	H	1	Germanium	Ge	32	Europium	Eu	63
Helium	He	2	Arsenic	As	33	Gadolinium	Gd	64
Lithium	Li	3	Selenium	Se	34	Terbium	Tb	65
Beryllium	Be	4	Bromine	Br	35	Dysprosium	Dy	66
Boron	B	5	Krypton	Kr	36	Holmium	Ho	67
Carbon	C	6	Rubidium	Rb	37	Erbium	Er	68
Nitrogen	N	7	Strontium	Sr	38	Thulium	Tm	69
Oxygen	O	8	Yttrium	Y	39	Ytterbium	Yb	70
Fluorine	F	9	Zirconium	Zr	40	Lutecium	Lu	71
Neon	Ne	10	Columbium	Cb	41	Hafnium	Hf	72
Sodium	Na	11	Molybdenum	Mo	42	Tantalum	Ta	73
Magnesium	Mg	12	Masurium	Ma	43	Tungsten	W	74
Aluminum	Al	13	Ruthenium	Ru	44	Rhenium	Re	75
Silicon	Si	14	Rhodium	Rh	45	Osmium	Os	76
Phosphorus	P	15	Palladium	Pd	46	Iridium	Ir	77
Sulphur	S	16	Silver	Ag	47	Platinum	Pt	78
Chlorine	Cl	17	Cadmium	Cd	48	Gold	Au	79
Argon	A	18	Indium	In	49	Mercury	Hg	80
Potassium	K	19	Tin	Sn	50	Thallium	Tl	81
Calcium	Ca	20	Antimony	Sb	51	Lead	Pb	82
Scandium	Sc	21	Tellurium	Te	52	Bismuth	Bi	83
Titanium	Ti	22	Iodine	I	53	Polonium	Po	84
Vanadium	V	23	Xenon	Xe	54			85*
Chromium	Cr	24	Cesium	Cs	55	Radon	Rn	86
Manganese	Mn	25	Barium	Ba	56			87*
Iron	Fe	26	Lanthanum	La	57	Radium	Ra	88
Cobalt	Co	27	Cerium	Ce	58	Actinium	Ac	89
Nickel	Ni	28	Praseodymium	Pr	59	Thorium	Th	90
Copper	Cu	29	Neodymium	Nd	60	Protoactinium	Pa	91
Zinc	Zn	30	Illinium	Il	61	Uranium	U	92
Gallium	Ga	31	Samarium	Sm	62			

* Element 87 has not yet been discovered. Element 85 is reported to have been discovered but is not yet named (1940).

molecule of water, H_2O, is formed. Similar or differing molecules likewise may combine to form limitless numbers and varieties of *compounds*. Atoms or molecules of different substances merely stirred together without forming chemical unions are called *mixtures*. Thus, hydrogen gas and oxygen gas mixed in the proportions of two to one have very different properties from H_2O, and molecular hydrogen is very different from helium, although the unit of each contains two electrons and two protons.

States of Matter.—There are said to be three forms in which elements and compounds may exist—three ways in which they may combine in *matter*. (1) The atoms and molecules may be evenly distributed, forming a *homogeneous state*. (2) They may assume a mechanically patterned arrangement known as *crystalloid*. (3) They may assume a still more intricate structural

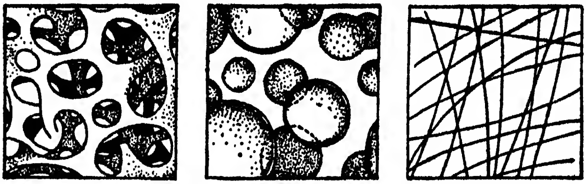

FIG. 3.—Various arrangements of protoplasmic colloids.

relationship called *colloidal* (gluelike). In colloids, atoms or molecules combine to form units larger than molecules, known as *micelles* (so large they cannot filter through animal membranes, such as capillary or cell walls). These cohere very firmly and become drawn out into microscopically thin films, filaments, or bubbles (see Fig. 3), to which other chemicals in solution adhere or by which the solution is *adsorbed*.[1] This "state of matter," as we shall see, is fundamental to the formation of protoplasm, "the stuff of life."

Relativity and Pattern.—It is bewildering to think of the whole universe of matter as being made of units of energy—"static energy," or "energy on deposit," or energy chained by the balance of power between the negative electrons and the positive

[1] When a fluid is poured from a container, some of the fluid will remain adherent to the surface of the container. This is a familiar example of *adsorption*. In living cells a great variety of chemical action takes place between the colloidal films and adsorbed solutions.

protons in the organization of every atom. There is a similar balance of energies in molecules and compounds. Whenever this balance is disturbed, there is chemical change, movement, the formation of new patterns of energy units, new compounds, new "matter." Thus the "relations" between the phenomena of the universe perpetually change and as perpetually find new balances—a process, however, which always conforms to the mathematical laws of organization underlying and determining both the stability and the evolution of worlds and of life itself.

We see that, after all, it is the *pattern* or *relation* of things to each other which is "reality." Protons and electrons related according to one pattern form hydrogen gas; related according to another pattern, the same protons and electrons will form the element helium, which will have new and very different properties. From every new pattern of organization new and different characteristics "emerge." A given pile of bricks may be "related" in the "pattern" of a wall, a pavement, or a house. And so, the primal or free energies become related in the patterns of atoms, molecules, compounds, worlds, suns, and galaxies. They also, as we shall see, become related to form protoplasm, or living matter, which perpetually arises from the elements of the earth and as perpetually goes back to the earth. Truly the universe is a great unity.

Energy Fields.—We have seen that electrons move in orbits about protons in the structure of the atom. It is true, further, that each electron and each proton also spins on its infinitesimal axis (some clockwise, some counterclockwise). This spinning is necessary to balance the pull of the charge between these two kinds of units of energy and keep the structure of the atom stable. The positive charge of the nucleus radiates equally in all directions and diminishes gradually in force until it reaches the limit of its *field*, or becomes completely dissipated. Each electron has *its* radiating field of energy. It is by virtue of these "fields" that the electron and the proton attract each other and enter into a structural relationship. Likewise, the earth spins upon its axis each 24 hours, the while it moves through its yearly orbit about the sun. If the earth did not spin, one side would become very hot, the other very cold, the energy field of the earth would disintegrate, the moon would cease to revolve about the earth, the sun would no longer be able to hold the earth within a balanced orbit of movement around itself, and the earth probably would be drawn into the sun.

In turn, the sun is spinning on its very large axis and also is moving about some center of force within the thousands of sun systems that make up our Galaxy, the Milky Way. The astronomers even tell us that the millions of galaxies that are now photographed through giant telescopes and which constitute the known universe are also apparently moving in a slow and stately cosmic march within a field of force of unthinkable dimensions. There really are no straight lines of force—there really is no fixed point from which to measure straight lines. All movement is determined by interacting fields of force—orbits within orbits, fields within fields, from the quanta of the free energies to atoms, worlds, suns, and galaxies. If we had but ears to hear and souls to comprehend, what a hum and whir of cosmic wheels were here—the true "music of the spheres," the symphony of the universe itself.[1]

The Field Theory.—"A *field* is a portion of space controlled or affected by a force" (Century Dictionary). As we gaze in imagination upon the spinning, whirling, perpetually moving machinery of a cosmos we can but wonder at the nature of the interplay of forces that holds it all in a safe and enduring nicety of balance. Basically there appears to be a like amount of positive and of negative electrical charge, which accounts for the total balance. In all nature there seems to be a fundamental compulsion to form units, patterns, fields, or "wholes." Since all is composed of radiating energy, we can readily accept the fact that every unit or whole is possessed of a gradually diminish-

[1] "Strange that we should think in straight lines, when there are none, and talk of straight courses, when every course, sooner or later, is seen to be making the sweep round, swooping upon the center. When space is curved, and the cosmos is sphere within sphere, and the way from any one point to any other point is round the bend of the inevitable, that turns as the tip of the broad wing of the hawk upwards, leaning upon the air like the invisible half of the ellipse. If I have a way to go, it will be round the swoop of a bend impinging centripetal towards the center. The straight course is hacked out in rounds against the will of the world." D. H. Lawrence, "Market Day," *Mornings in Mexico*. By permission of Alfred A. Knopf, publisher.

ing atmosphere or aura of force or attraction. This is its *field of energy.* Indeed, *organization* may be said to consist in such a relationship between component parts that a larger, new, or composite field of energy is generated.

When units of the great basic energy become associated or integrated to form a whole, the whole becomes possessed of new properties, qualities, or characteristics that none of its unitary parts possessed before and that are not possessed by any other combination of these unitary parts; these are its *field properties.* Fields tend to dissipate or fade out in arithmetical or in geometrical ratio, according to whether the object has two or three dimensions. The light of a candle radiates in all directions with a diminishing intensity, which can be mathematically (geometrically) computed. *Everything in the universe has a radiating field of energy*—from free quanta of energy, from electrons and protons, to plants, animals, suns, and galaxies. The field of force (gravity) surrounding the earth is strong enough to overcome and integrate the smaller fields of all things upon the earth, strong enough to hold the moon within its circling orbit. The field of force radiating from the sun holds all the planets, including the earth, within their fixed, unvarying orbits. *It is this dynamic interplay of fields that integrates units to form a whole and gives them new emergent field properties. Everything has a radiating sphere of influence, or field: living organisms, atoms, and galaxies.* The behavior of living organisms takes place within and is modified by, or actually created by, many impinging fields of physical and psychic force.[1] The concept of the "field" helps to clarify and unify the new science.[2]

[1] C. M. Child gave the name *gradients* to the "graded" fields of force he observed in operation in physiological growth and activity. (*Physiological Foundations of Behavior,* Henry Holt & Company, Inc., 1924.)

Kurt Lewin and others are now applying the idea of fields of influence to psychological behavior. (*A Dynamic Theory of Personality,* McGraw-Hill Book Company, Inc., 1935; also *Principles of Topological Psychology,* McGraw-Hill Book Company, Inc., 1936.)

J. F. Brown uses the field theory to explain the overlapping intensities and distortions in social organization and disorganization. (*Psychology and the Social Order,* McGraw-Hill Book Company, Inc., 1936.)

[2] A report to the meeting of the Association for the Advancement of Science, Dec. 30, 1939, by Dr. I. I. Rabi of Columbia University, provides

Summary.—Science is reducing the universe to manifestations of energy. Matter is static energy arranged in patterned units of positive and negative electromagnetic charge, known as *protons* and *electrons.* Protons and electrons become arranged in a sequence of patterns called atoms. Atoms combine to form molecules. Molecules combine to form compounds. Masses of elements or compounds become *matter.* Matter may assume amorphous, crystalloid, or colloidal form. Every unit of energy radiates a gradually diminishing field of influence. Fields integrate with one another, and new and larger fields emerge as the structuralization of the universe proceeds. New fields have new and individual field properties. All organization (combining in patterns or units) forms fields. Since there seems to be in all the universe a like total amount of positive and of negative energy, creation is held in enduring balance, in spite of the perpetual movement within and between all phenomena, *as time passes.*

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confirmation of the facts sketched in this chapter. Dr. Rabi and associates have perfected a radio-frequency spectroscope which reveals the fact that every atom, every molecule, and every living body constantly "broadcasts waves of influence," which can be detected and measured by this new wonder-working machine. It is even predicted that telepathy may become, through its use, a scientifically explanable phenomenon. Dr. Rabi received the award of the American Association for the Advancement of Science for the outstanding contribution to science of the year.

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New Words in Chapter IV

acids. Substances soluble in water, sour to taste, turn litmus paper red; dissociate in aqueous solution with the production of hydrogen ions; unite with bases to form salts.

amphoteric. Reacting with either bases or acids.

bases. Substances soluble in water, bitter to taste, turn litmus paper blue; capable of reacting with acids to form salts; the hydroxyl ion of a positive element or radical.

Berger rhythms. The name given to characteristic electrical changes occurring in functioning brain tissue.

brain waves. A synonym for Berger rhythms.

catalyst. A substance that accelerates a reaction while remaining in the end unchanged itself.

cytoplasm. The protoplasm of the cell exclusive of the nucleus.

dissociate. To separate into parts or elements.

electrolytes. Substances which, when dissolved in water or other solvent, convey electrical charges.

enzyme. An organic chemical compound elaborated within living cells which causes specific chemical action but remains unchanged itself; an organic catalyst.

gradient. Rising or descending by regular degrees of inclination. The rate of increase or decrease of a variable magnitude. Here applied to areas of graded activity in living tissues.

ion. Either of the two substances (positive or negative) into which a compound is decomposed by electrolysis.

ionization. The process of separating into ions.

matrix. That which gives form or origin to a thing or which serves to enclose it. Intercellular substance of a tissue.

radical. In many chemical equations certain atoms remain firmly united and pass through chemical changes as units.

salt. Any compound of base or alkali and an acid.

transmutation. The transformation of one element into another.

volt. A unit of electromotive force.

CHAPTER IV

THE ORGANIZATION OF MATTER

Matter itself arises as an outcome of the organization of protons and electrons, which themselves are below the level of matter. At a vastly later period in evolution, mind arises as the ideal expression of a living organism of an exceedingly high degree of complexity. Matter and mind both represent early stages in evolution, not antithetical forms of being. We may say that Nature climbs to life and mind through the organization of matter. —G. T. W. PATRICK.[1]

Since we must do our scientific thinking about life, growth, and behavior in terms of atoms and energies and fields, it will be necessary further to consider what is known of their organization. The fascinating subjects of the tremendous forces binding the parts of the atom together, the making of new elements, the transmutation of elements one into another, the smashing of atoms (breaking electrons from the nucleus, requiring millions of volts of energy), and other equally interesting current activities of science cannot be considered here. Nutrition, growth, reproduction, and behavior, however, are so essentially chemical in character, it will be necessary to consider a few fundamental chemical phenomena if we are to obtain an intelligent understanding of these subjects.

Chemical Activity.—Chemical action in general consists in large part in electronic movement, in the giving and taking of electrons from the outer valence spheres or shells of electrons, which seem to revolve in wavelike, undulating layers about their atomic nuclei. The minute electric fields of nuclei and electrons, with their attractions and repulsions, are closely involved in all chemical action. There is constant variation in electrical charge between positive and negative corpuscles, both in inorganic and in organic changes. All chemical action releases free energy. *Minute electrical charges are generated in all chemistries, even in*

[1] PATRICK, G. T. W., *An Introduction to Philosophy*, p. 109, Houghton Mifflin Company, 1935.

TABLE II.—THE COMPOSITION OF THE HUMAN BODY

A. The Elements

Element	Approximate Percentage in Body
Oxygen	65.0
Carbon	18.0
Hydrogen	10.0
Nitrogen	3.0
Calcium	1.5
Phosphorus	1.0
Potassium	0.55
Sulphur	0.25
Sodium	0.15
Chlorine	0.15
Magnesium	0.05
Iron	0.004
Manganese	0.0003
Iodine	0.00004
Copper	Very minute amounts
Zinc	Very minute amounts
Fluorine	Very minute amounts
Silicon	Very minute amounts
Aluminium	Very minute amounts
Cobalt	Very minute amounts

B. The Groups[1]

Group	Approximate Percentage in Body
Water	65.0
Protein	15.0
Fat	14.0
Salts	5.0
Other organic compounds	1.0

[1] GORTNER, ROSS A., *Outlines of Biochemistry*, p. 275, John Wiley & Sons, Inc., 1938.

living tissues. Recently, apparatus of exceeding delicacy has been perfected for measuring and recording the electrical currents generated by thought, the so-called "brain waves" or "Berger rhythms," and also for detecting and measuring many other currents generated by physiological chemistries (see page 178).

While 92 elements have been discovered and studied,[1] only about 20 of these exist in nature in free or uncombined state, and 14 of these make up 99 per cent of earth, sea, and air.[2] This

[1] Actually, element 87 has not been discovered, probably because it exists in minute amounts or in compound. That it will eventually be found is quite certain, and its composition is known (see Table I).

[2] WATKEYS, C. W., and associates, *An Orientation in Science*, p. 126, McGraw-Hill Book Company, Inc., 1938.

conveniently narrows our range of study. The subject is further narrowed by the fact that the great collective mass of rock, soil, water, and air, and the great mass of organic matter are alike made up largely from four only of these, "the big four": oxygen, hydrogen, carbon, and nitrogen. Reference to Table II will show that 96 per cent of the human body is made up from these four elements, and 99 per cent from the first six elements of the table. The other elements listed serve chiefly to instigate shifts in energy currents among these four and thus cause specific, delicate, and precise alterations in electronic and atomic "fields" that generate energy and produce chemical changes within structural masses.

Oxidation and Reduction.—Of the big four, oxygen is the most unstable. The field of force of the oxygen atom is not completely neutralized by the fields of force of the neighboring atoms held in direct combination with it.[1] Oxygen readily gives up electrons to other atoms with the release of energy in the form of heat, light, and movement—a process known as *oxidation*, or *burning*. The substance giving up the electrons is said to be *oxidized*, while the substance receiving the electrons is said to be *reduced*.[2]

Oxidation-reduction may proceed slowly, as in the gradual rusting away of a piece of iron, or "quick as a thought" in the cells of a brain, or with explosive suddenness on the ignition of gunpowder. The process is the same both in nonliving and in living matter.

Ions: Acids, Bases, Salts.—A different sort of shift of electrical field forces occurs among certain electrically unstable compounds known as *electrolytes*. Water (or other solvent) is necessary to any chemical reaction; completely dry substances are inert and will not combine. Electrolytes must be dissolved in water (or, rarely, another amphoteric solvent), whereupon they break up, *dissociate*, into their component atoms or *radicals* (radicals are groups of atoms which stay together as units during chemical

[1] TAYLOR, H. S., *Elements of Physical Chemistry*, D. Van Nostrand Company, Inc., 1937.

[2] "The oxidation-reduction potential is a measure of the tendency for a substance to give up or take on electrons. Stated in a different way, it is the quantitative measure of the free energy which is involved in the electronic transfer." ROSS A. GORTNER, *Outlines of Biochemistry*, p. 128, Reprinted by permission of John Wiley & Sons, Inc., 1938.

changes) and become able to conduct positive or negative electric charge. In order to be electrically positive or negative, an atom or molecule must lose or gain electrons from its valence shell (see page 36), whereupon it becomes an *ion.* An ion (negative or positive) is any charged element or radical. Only electrolytes ionize and become *acids* (carrying negative charge), *bases* (carrying positive charge), and *salts* (neutral combinations of acids and bases). Only ions (acids, bases, and salts) carry active electrical charge. Most chemical changes are reactions between ions; therefore, it is important to understand the role of ionization in the chemistries of life.

Perfectly pure water will not convey electrical current, but the presence of even a trace of electrolyte in solution will cause water to dissociate and convey charges. It is well known that wetness is a good electrical conductor, as in a storm or in handling a live wire, and that dryness is a quality of a nonconductor. This is because water as commonly known always contains some electrolytes in solution. It is even difficult to secure completely pure water for experimental purposes. When an electrolyte is dissolved in water, some of the water molecules, H_2O, are torn apart (dissociated) in such a way that one of the hydrogen atoms is robbed of its one electron, leaving the one proton of the single hydrogen atom unattached and with a powerful positive attraction. It is then known as a *hydrogen ion* and is designated as H^+. The hydrogen electron remains attached to the OH^- radical, creating a strong negative charge, which will then repel other electrons, and the radical becomes the *hydroxyl ion,* OH^-. The electrolyte is also dissociated into its component parts, or radicals, which proceed to accept hydrogen ions, thus forming acids, or hydroxyl ions forming bases, or alkalies.

If the two poles of a battery are introduced into an electrolytic solution at some distance from each other, the hydrogen ions will "hop along" from molecule to molecule toward the positive pole of the battery, while the hydroxyl ions will hop along toward the opposite pole. Only a few of the molecules of either water or electrolyte dissociate at the same time. The degree of acidity or alkalinity in any particular solution depends upon the amount and rate of dissociation. It is the ceaseless activity or unrest that causes the characteristic chemical activity or sensitivity among ions. It is almost as if the dissociated radicals were playing a lively game of tag with the unattached protons and electrons. The protons and electrons that are left out (the "Its") become disposed of in various ways (free hydrogen and oxygen gas, etc.) which cannot be considered here. It is sufficient for our purpose to see that electrolytes accepting hydrogen ions, H^+, become acids, while those accepting hydroxyl ions, OH^-, become bases.

Since there always are some hydrogen ions present in any ionized solution, it has become the custom to measure the acid-base concentration or activity in terms of the hydrogen ions present. A logarithmic table of 14 units has been constructed, with 7 as the neutral point where hydrogen and hydroxyl ions cancel each other. As the H^+ concentration in the solution falls below 7, the reaction becomes increasingly acid. As it goes above 7, it becomes increasingly basic. The symbol of the logarythmic reciprocal of hydrogen ion concentration or activity is pH. Three of the most commonly known powerful bases are the elements sodium, Na, potassium, K, and calcium, Ca. The ions of these are extremely important in body chemistry. So important are they that nature has created specific glands (the adrenal cortex, see page 150, and the parathyroids, see page 151) for the regulation of calcium-potassium-sodium metabolism. Three commonly known powerful acids are hydrochloric, HCl, nitric, HNO_3, and sulphuric, H_2SO_4, which, with the exception of hydrochloric acid (see page 127), must be completely ionized by way of plant life before entering the body.

The importance of ionization balance in living chemistry is indicated by the fact that the hydrogen ion concentration, pH, of the blood is maintained, regardless of variations in food, activity, etc., at the slightly alkaline pH of 7.3 to 7.4. In life, this does not vary so much as 1 degree. The beating of the heart, clotting of the blood, movement of nerve currents, osmosis through cell membranes, etc., depend upon very delicate balances between the sodium, potassium, and calcium ions mentioned. Cell nuclei are slightly alkaline—about pH 7.6—while cytoplasm is slightly acid—about pH 6.9.[1] In the blood serum, sodium is

[1] CHAMBERS, ROBERT, "Hydrogen Ion Concentration of Protoplasm," *Bulletin of National Research Council*, May, 1929.

combined with chlorine to form sodium chloride (common salt), a neutral salt and a very sensitive electrolyte. Within tissue cells there is an excess of potassium ions. This balance is essential to osmosis through cell membranes. These extremely important and delicate "balances" are maintained in part by the presence in the blood of *buffers*, such as bicarbonates and phosphates, which combine with and neutralize excess in either acids or bases. There are various buffer mechanisms; even protein molecules have important buffer properties (see page 239). Ions may act as catalysts in oxidation reactions and enter into the formation of some enzymes. The affinity of hemoglobin for oxygen is affected by ions, and the diffusion of oxygen from hemoglobin to tissues is determined by hydrogen ion activity.

Catalysts and Enzymes.—In addition to oxidation-reduction and ionization, another peculiar mode of chemical behavior is very important in living function, and that is when chemical elements or compounds accelerate or retard chemical action between other substances, notably oxidation and ionization, but *in the end* remain unchanged themselves. Chemical elements or compounds behaving in this manner are called *catalysts*. Organic chemical compounds that seem to be created in living tissue specifically for this function are called *enzymes*. Certain of the less abundant of the 92 elements have variable catalytic effects, and may be quite as important and indispensible in the structuralization and behavior of matter as are the big four (hydrogen oxygen, carbon, and nitrogen) that form the bulk of the living and nonliving matter of the physical universe. The chief function of the 16 elements (minerals) listed in Table II as making up approximately 4 per cent of the body is to catalyze the big four into specific activity. There are limitless numbers of enzymes, chiefly protein in character.[1] The role of enzymes is exceedingly fundamental in all biological reactions, as we shall see further. In fact, any vital reaction would be quite impossible without regulation and perhaps instigation by enzymes, for the reason that it would take eons of time to accomplish organic chemical change without catalysts and enzymes. The actual trick whereby catalysts and enzymes perform their curious function

[1] Gortner, Ross A., *Outlines of Biochemistry*, p. 931, John Wiley & Sons, Inc., 1938.

still eludes complete understanding, but it involves the subtle energy balance and electrical reactions here described, and also involves the *adsorption* relationships between surfaces and fluids, which will be mentioned on page 47.[1]

In short, physical science is laying before us a picture of vast matrix fields of energies, within which "gradients" or "fields" of organization arise according to preestablished cosmic pattern, and become atoms, elements, worlds, galaxies, and universes, *and also become alive.* It is the becoming alive that constitutes the next step in the vast preparation for Our Child.

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[1] *Ibid.*, pp. 919, 920.

NEW WORDS IN CHAPTER V

adsorption. The adhesion of the molecules of gases or dissolved substances to denser surfaces, resulting in a relatively high concentration of the gas or solution at the point of contact.

amino acids. Acid compounds containing nitrogen which are the structural units of proteins.

amphoteric. Reacting with either bases or acids.

amorphous. Having no definite patterned form; shapeless.

chlorophyll. The green coloring matter of plants.

chromosomes. Small, densely staining protein bodies which form in the nucleus of a cell when it is about to divide.

chromomeres. Nucleic acid compounds enclosing genes in the formation of chromosomes.

coazervate. The primitive colloidal solution within which living protoplasm was formed, "colloidal slime."

colloid. A state of matter in which the structural units are too large to diffuse readily through vegetable or animal membranes.

crystalline. Atoms, radicals, or molecules arranged in characteristic and patterned structure.

eon. An immeasurable period of time; an age.

gel. A colloid that is firm in consistency though containing much liquid; a colloid in gelatinous form.

genes. Minute chemical units, now believed to be single protein molecules, making up chromosomes. Genes are believed to convey traits and determine the specificity of the cell.

hydrocarbon. Any of a class of compounds containing only hydrogen and carbon.

hydrosphere. The water and water vapor enveloping the earth.

igneous. Produced by fire or intense heat; rocks of volcanic origin.

miscelles. The units of structure of colloids; aggregates of molecules.

monomolecular. Films one molecule thick are said to be monomolecular.

photosensitiveness. Chemical response to the rays of energy in light.

photosynthesis. The process of constructive metabolism in the chlorophyll-containing tissues of plants exposed to light. This is a necessary step in all transformation of inorganic matter into organic matter.

progeny. Child; offspring.

proteins. Organic compounds composed of amino acids and essential to the structure of protoplasm and cell nuclei.

protoplasm. A complex substance (typically colorless and of a viscid semifluid consistence) regarded as the physical basis of life; having the power of spontaneous motion, reproduction, etc.; and forming the living matter of all plant and animal cells and tissues.

radical. An atom or group of atoms regarded as an important constituent of molecules that remains unchanged during certain reactions.

sol. A colloidal solution in which the particles of solute are micelles too large to pass through living membranes.

spatial. Pertaining to space.

sterol. One of the fatlike substances known as *lipins* or *lipoids;* soluble at ordinary air temperature in alcohol, ether, or other fat solvent. Cholesterol and ergosterol are well-known examples.

ultramicroscopic. Too small to be seen under a microscope.

virus. A microorganism too small to be seen through any microscope.

Earth

Grasshopper, your tiny song
And my poem alike belong
To the dark and silent earth
From which all poetry has birth;
All we say and all we sing
Is but as the murmuring
Of that drowsy heart of hers
When from her deep dream she stirs:
If we sorrow, or rejoice,
You and I are but her voice.

Deftly does the dust express
In mind her hidden loveliness,
And from her cool silence stream
The cricket's cry and Dante's dream:
For the earth that breeds the trees
Breeds cities too, and symphonies,
Equally her beauty flows
Into a savior, or a rose—
Looks down in dream, and from above
Smiles at herself in Jesus' love.
Christ's love and Homer's art
Are but the workings of her heart;
Through Leonardo's hand she seeks
Herself, and through Beethoven speaks
In holy thunderings around
The awful message of the ground.

The serene and humble mould
Does in herself all selves enfold—
Kingdoms, destinies, and creeds,
Great dreams and dauntless deeds,
Science that metes the firmament,
The high, inflexible intent
Of one for many sacrificed—
Plato's brain, the heart of Christ:
All love, all legend, and all lore
Are in the dust forevermore.

Even as the growing grass
Up from the soil religions pass,
And the field that bears the rye
Bears parables and prophecy.
Out of the earth the poem grows
Like the lily, or the rose:
And all man is, or yet may be,
Is but herself in agony
Toiling up the steep ascent
Toward complete accomplishment
When all dust shall be, the whole
Universe, one conscious soul.

Yea, the quiet and cool sod
Bears in her breast the dream of God.
If you would know what earth is, scan
The intricate, proud heart of man,
Which is the earth articulate,
And learn how holy and how great,
How limitless and how profound
Is the nature of the ground—
How without terror or demur
We may entrust ourselves to her
When we are wearied out, and lay
Our faces in the common clay.

For she is pity, she is love,
All wisdom she, all thoughts that move
About her everlasting breast
Until she gathers them to rest:
All Tenderness of all the ages,
Seraphic secretes of the sages,
All prayer, all anguish, and all tears
Are but the dust, that from her dream
Awakes, and knows herself supreme—
All but earth when she reveals
All that her secret heart conceals
Down in the dark and silent loam,
Which is ourselves asleep, at home.
Yea, and this my poem, too,
Is part of her as dust and dew
Wherein herself she doth declare
Through my lips, and say her prayer.

John Hall Wheelock.[1]

[1] From *Dust and Light* (Yale Review Press), Charles Scribner's Sons, 1919.

CHAPTER V

THE EARTH BECOMES ALIVE

From an energetic point of view it is not correct to consider living organisms inclusively, as an isolated system limited to the surface of the earth; they should be treated as a coupled system including both the sun and the earth. The free energy used for virtually all life processes is derived from sunlight through the photosynthetic activity of plants; the cumulation and expenditure of free energy appear to be virtually equal, so that the total process may be considered roughly as a photochemical steady state.
HAROLD F. BLUM.[1]

Life, as we earth-born mortals know it, involves an essential relationship between the earth and the sun. The sun is described by Gray as one of the shining stars which

> shine by a mystery of motion which seems to underlie all things. It is exciting to realize that in fiery tempest of particles deep in the sun the weather in our streets is forged, the green magic of chlorophyll is activated, and the delicate rhythms of protoplasm, of consciousness, of mind, are shaped.[2]

Origin of the Earth.—As to the origin of our planet earth, the theory in favor at the present time is that long ago—probably several billion years ago—several tidal waves of gaseous vapor were pulled loose from the sun by the near approach of some other heavenly body, possibly another sun; or, possibly, vapor from both suns merged in the gigantic pull. These masses of hot vapor went whirling into space, where they became spherical unities with radiating fields of energy—became, in short, the earth and the other solar planets (see Fig. 4). The earth began to spin on its axis (every 24 hours) and to circle about the sun (every 365 days), somewhat like a stone at the end of a whirling string, if the string represents gravity or an energy field.

Naturally, the heavy elements, such as iron and nickel, collected in the center or core of the whirling mass, while the atmos-

[1] BLUM, HAROLD F., *Science*, Sept. 24, 1937.

[2] GRAY, GEORGE W., *The Advancing Front of Science*, Chap. III, pp. 149–150, McGraw-Hill Book Company, Inc., 1937.

phere of very hot gases gradually cooled to a point at which chemical union between atoms could take place. Molten (igneous) rocks formed about the dense, hot, metallic center, and eventually the water vapor, or steam, that surrounded all condensed in the form of water, H_2O, which in time covered the earth. As the molten rocks cooled, they wrinkled, slipped, and cracked ("faulted"), and the surface water poured through to the hot iron core, producing terrific explosions, which account, in part, for oceans and mountains. Also the water dissolved

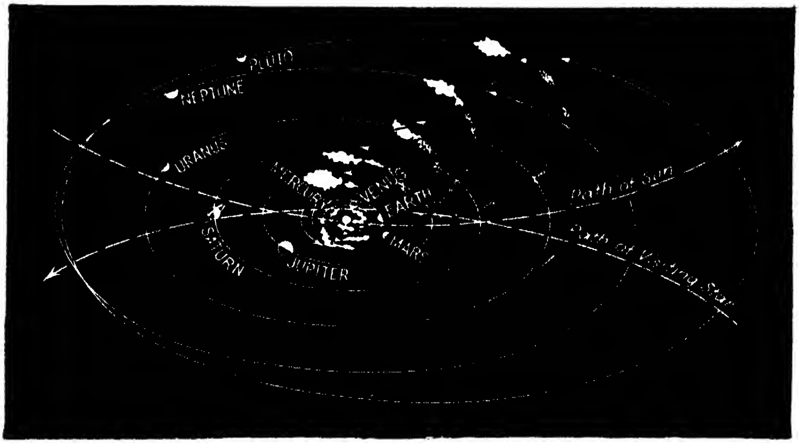


FIG. 4.—Diagram suggesting the Origin of the Solar System. (*From Fairbanks, in Watkey's Orientation in Science.*)

minerals from the core and the rocks and came to have somewhat the composition (with certain differences) of sea water as we know it today. Eventually the water evaporated until there were shallow pools exposed over long eons of time to the stimulating impact of the rays of free energies previously mentioned: cosmic rays, ultraviolet rays, etc., as conveyed in sunshine.

Colloids Are Formed.—The way the story now unfolds, in creative scientific imagination and experimentation, is to the effect that colloidal films formed in the warm, quiet pools, to the surfaces of which sea water was adsorbed (see page 29). Carbon and hydrogen, which were plentiful and unstable, formed the earliest colloids, the *hydrocarbons.* Oxygen was added, forming the primitive colloidal *carbohydrates.* Later carbon, hydrogen, and oxygen formed another type of pattern, the *sterols and fats.*

Eventually nitrogen was added to the colloidal complex and the *amino acids* were formed, which united with each other to make the first *proteins.*

Proteins.—Proteins alone, of all organic compounds, contain nitrogen, which seems to bestow marked catalytic property.

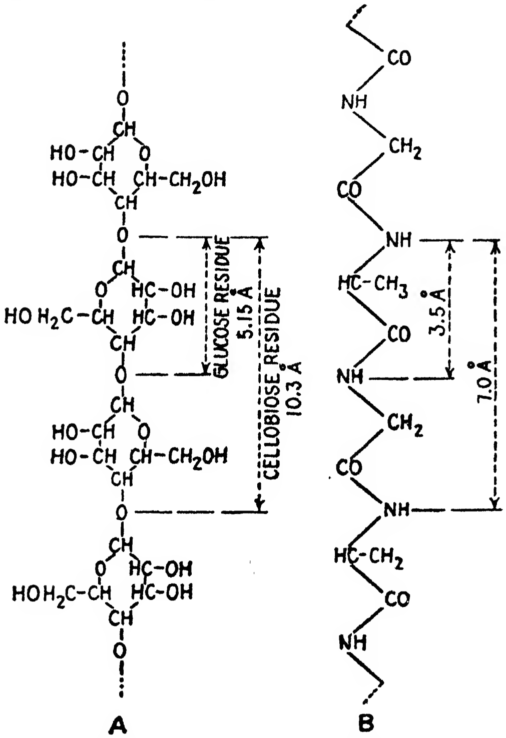
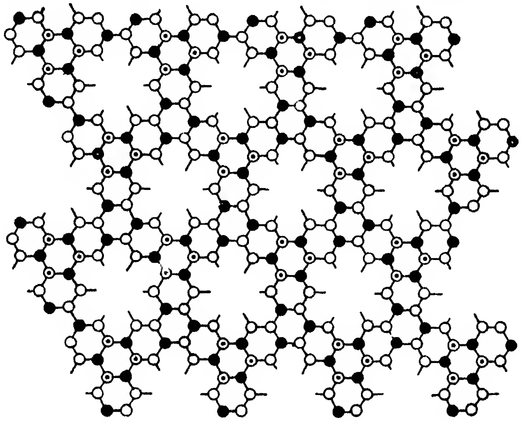


FIG. 5.—Schematic structure of cellulose (*A*) and of silk fibroin (*B*). (*Oparin, Origin of Life, The Macmillan Company.*)

Amino acid molecules are very large (as molecules go; all are too small to be seen by any microscope)[1]; some of them are made up of thousands of atoms. Some 38 amino acids are known and the formulas of some 30 have been established (see page 239). When amino acids unite to form proteins, the protein molecule becomes exceedingly complex and may contain hundreds of amino acids

[1] It is reported from Germany that two protein molecules, one a pigment from the blood of mollusks, the other from certain seeds, have been rendered visible by the electron microscope. *Science Supplement,* p. 12, Nov. 29, 1940.

and millions of atoms. It will be obvious that it is a difficult matter to determine precisely the way so many individual, invisible atoms are arranged to give the specific character of a particular protein. In fact, the structure of the protein molecule is one of the many fields of mystery remaining for science to clarify. It is certain that atoms may form long chains and side



● = N
○ = C(OH), peptide hydroxyl upwards
⊙ = C(OH), peptide hydroxyl downwards
○— = CHR, direction of side chain initially outwards
○- = CHR, direction of side chain initially upwards

FIG. 6.—The Wrinch "cyclol pattern" for proteins. The median plane of the lamina is the plane of the paper; the lamina has its "front" surface above and its "back" surface below the paper. (*Reprinted by permission from Gortner, Outline of Biochemistry, John Wiley & Sons, Inc.*)

chains through repetition of units or radicals, such as amino acids[1] (see Fig. 5). Other proteins seem to require the two-dimensional arrangement indicated in the diagram in Fig. 6, while other protein molecules must be three-dimensional or spherical.[2]

Life Appears.—It seems that certain protein molecules can assume crystalloid or static form and can pass from crystalloid to colloid or from static to dynamic and back again. W. M. Stanley, of the Rockefeller Institute of Medical Research, in

[1] WRINCH, DOROTHY M., "Chromosome Behavior in Terms of Protein Pattern," *Nature*, Dec. 22, 1934.

[2] BANGA, I., and ALBERT SZENT-GYORGYI, "Structure of Proteins," *Science*, Nov. 29, 1940.

1937 established the fact that the tobacco virus is a single-protein molecule manifesting all the properties of living matter. It has no discoverable machinery of life aside from its molecular structure. Even after being ground in a mortar and centrifuged it will again produce the mosaic disease when applied to a living tobacco leaf. It absorbs nutritive matter from the leaf, reproduces at the phenomenal rate characteristic of the simple forms of bacterial life, and exhibits the usual immunological phenomena. It now seems to be generally accepted that some, if not all, viruses[1] are living, single-protein molecules. The border line between living and nonliving, the crystal and the colloid, the organic and the inorganic, seems to have been obliterated by the group of researches that have since stemmed from the virus experiments.[2]

With each new discovery the importance of proteins is increasingly manifest. Proteins enter into the essential structure of protoplasm, "the stuff of life." The generally accepted theory is that the nuclei of all living cells are made up chiefly of single-protein molecules known as *genes*. Genes combine in organized, patterned relationships to form *chromosomes*, which function as basic units in cell activity. Genes act as catalysts (see page 41), and they activate or initiate and regulate the speed of all cell activity, whether it is manifest in reproduction, in growth, or in the innumerable manifestations of energy production in physical or mental "behavior."

The borderland between the so-called "living" and "nonliving" is still profoundly mysterious, but it is now quite evident that the transition proceeds or "unfolds" by minute steps or changes in energy relationships, steps leading ever toward increased complexity of pattern and toward the creation of new and interrelating fields (gradients) of energy.

Life arose in the ancient sea. In the waters of that sea and in the atmosphere above it, some 20 of the elements of the earth

[1] Viruses are ultramicroscopic organisms too small to be caught by any laboratory filter, a fact which has greatly hampered the study of the virus diseases, such as infantile paralysis, measles, and common cold. The clever detective work by which the tobacco virus was finally caught is related in *The Science News Letter*, Jan. 9, 1937, and in many other recent scientific writings.

[2] Stanley, W. M., *Science in Progress*, Chap. III, Recent Advances in the Study of Viruses, Yale University Press, 1939.

were found in fluid or gaseous solution (see page 37). With the appearance of colloids, bits of colloidal bubbles or foam became segregated and insulated by a monomolecular (one-molecule-thick) film of insoluble, electrically neutral sterol (see page 244). Chemical action became enormously speeded up by the localization of catalytic action within the solutions as adsorbed on the colloidal films within the insulating membrane. At some point along the way, the segregated "blob" of colloidal carbohydrates, amino acids, and proteins, with its adherent electrolytic mineral solutions, became *photosensitive* to the rays from the sun (see quotation at head of chapter), *and became able spontaneously to initiate activity*. This would be the appearance of the living cell, preplant, and plant.

Science is now able closely to simulate practically every one of the specific phenomena of life. Artificial cells have been made, amino acids have been structurally synthesized, and hydrocarbons can be manufactured. Artificial mechanisms resembling in mechanical operation lungs, hearts, etc., have been made. Science is not yet able to synthesize a protein molecule or to make protoplasm. It has not been possible to catalyze any "machine which imitates life" and start it going.[1] Scientists now seem to believe that the evolution of the human mind and intelligence may hold even this accomplishment in store.

Is Life Immortal?—The rise of life from the elements of the earth is the most tremendous event in nature. Whatever spring of energy was tapped at that significant moment, that energy represents the most delicate, the most subtle, the most perishable, the most enduring force in the universe. A striking fact is that this life force, whatever it is, by virtue of its ability to make new organisms similar to itself out of the dust of the earth, becomes potentially immortal in time and space. Given a perfectly favorable environment, there is no reason why any living thing should ever stop its self-perpetuation within the unthinkable ranges of infinity and eternity; or even until, as John Hall Wheelock states it (see page 45),

. . . all dust shall be, the whole
Universe, one conscious soul.

[1] Gray, George W., *The Advancing Front of Science*, Chap. XIII, Machines Which Imitate Life, McGraw-Hill Book Company, Inc., 1937.

Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, in 1912 succeeded in placing a few embryonic chick heart cells (embryonic heart cells retain many of the properties of one-celled organisms and contract rhythmically before being connected with the nervous system) in conditions completely favorable to their growth and reproduction. These conditions have been kept uniform and favorable, and the progeny of these cells are still (1941) contracting rhythmically, growing, and reproducing. At the end of 16 years (1928), Dr. Carrel reported that if all the progeny of these cells could have been permitted to survive (it has been necessary to divide the mass every 48 hours during all these years), they would then have filled the solar universe, and that he saw no indication that they would ever cease as long as conditions could be kept favorable. He says, "Time has no action whatever on these tissues. They are immortal."[1]

Lull, of Yale, computes that if just one paramecium (barely visible to the naked eye) could be permitted to reproduce and survive to the 9,000th generation, there would not be room for a star in the sky. The Universe would be solid paramecia.[2]

Jewett estimates that the great-great-grandchildren of one oyster, if all offspring survived and reproduced at their normal rate, would provide a heap of shells eight times the size of the earth.[3]

Waddington says:

> Probably all embryonic cells could remain alive indefinitely. It is the animal as a whole which dies rather than component cells . . . . One might cultivate piecemeal immortality by cultivating a few of his tissues . . . only the top of your little finger would grow to the size of the world in less than six months.[4]

[1] Carrel, Alexis, "The Immortality of Animal Tissues and Its Significance," *Proceedings of the Third Race Betterment Conference*, Race Betterment Foundation, Battle Creek, Michigan, 1928.

[2] Dorsey, George A., *Why We Behave Like Human Beings*, p. 99, Harper & Brothers, 1925.

[3] Jewett, F. C., *The Next Generation*, Ginn and Company, 1914.

[4] Waddington, C. H.: *How Animals Develop*, p. 119, W. W. Norton & Company, Inc., 1936.

Wilder says:

> Protoplasm is at once the most enduring and the most easily destroyed of the substances; its molecules are constantly breaking down to furnish the power for the manifestations of vital phenomena, and yet, through its remarkable property of assimilation, a power possessed by nothing else upon earth, it as constantly builds up its substances anew from the surrounding medium, usually in excess of that lost by disintegration, and possessed of qualities identical with those of the parent . . . . Through this power of assimilation there is a constant encroachment of the organic upon the inorganic, a constant attempt to convert all available material into living substance, and to indefinitely multiply the total number of individual organisms.[1]

We thus see that a tremendous *will-to-live, or instinct of survival,* is the outstanding characteristic of living things. This will-to-live or struggle toward immortality in time and space operates through the ability of protoplasm, functioning according to specific organic law, to appropriate and transform (catalyze) and use its environment toward this end. Remembering this may help us to understand the insatiable greed of the child for experience. Every vital unit in his incredibly complex organism is reaching out to conquer the universe.

The Limit of Life.—For some inscrutable reason, all life cannot survive and nothing alive today shall, in its present form, see immortality, although there seems to be a fundamental conviction in the human consciousness that it taps the source of immortality and that it comes from and returns to *infinity.* Incessant, inexorable, chemical flux and change is the essence of the creative plan that seems to be driving matter toward some distant, cosmic achievement—perhaps, ultimate perfection, harmony, or immortality. Conflict with environmental conditions and conflict between organisms inhere in the situation. This conflict leads to changes in life forms, involving *struggle, death,* and *evolution.*

No life form is yet able successfully to perpetuate its delicate electrical and catalytic balances except through its ability to create progeny. Every organism is created with a self-limited tenure of life. Its protoplasm is doomed to lose its chemical

[1] Wilder, H. H., *The History of the Human Body*, pp. 1–2, Henry Holt & Company, Inc., 1923.

sensitivity; its battery runs down; its colloids lose their dynamic adsorptive selectivity; its ionizations cease. It is returned to the earth whence it came. "We are born in death." "We return to dust."

Summary.—Everything is related to everything else. Life is so closely related to the inanimate elements of the earth that it arose from them. Even we, who believe we are of the highest type of life that has yet appeared, are literally made from the "dust of the earth," and shall return to it when something unfavorable in our environment breaks the scheme of unity that makes of each of us a functioning organism, and when our body protoplasms become unable to assimilate environment and maintain their specificities—in other words, when spontaneous electrical intrastimulation in the way of oxidizing, ionizing, and catalyzing ceases.

Every unit of matter yet conceived by science is in action. This holds true, from electrons, protons, atoms, and micelles to organisms, to planets, and to stars. *Movement involves time.* Hence, the relatedness of everything to everything else changes momentarily as *time* passes. Time must be reckoned as a factor in all phenomena of life. Time is often said to be one of the dimensions of reality.

The number of chemical elements that are known to participate in the organization of living forms is not large—some 18 or 20 in all—and of these, 4 play the major quantitative roles: hydrogen, oxygen, carbon, and nitrogen. Hydrogen and oxygen form water, which makes up the larger part of the mass (70 to 84 per cent) of protoplasmic structures. Water is the universal solvent which renders the other elements available for the rapid chemical changes necessary in life processes. Compounds of carbon, hydrogen, and oxygen form the fuels, which release energy for living activity. Certain carbohydrates became organized in the peculiar manner called *colloidal,* which provides an incredible amount of surface for the adsorption of solutions of the remaining elements known to enter into living functions and structure. Nitrogen is added in the form of the colloidal nitrogen carriers, the amino acids, which unite to form the proteins. All these become organized to form protoplasm, which is living matter.

The amazing thing science asks us to believe about the structure of the elements of the universe is that they are made from units of positive and negative electrical force in the form of corpuscles, or anchored points of force, which are called *protons* and *electrons*, and it now seems that even these can be experimentally reduced to other free energies. The scientists ask us to believe this because they have constructed mathematical formulas which do seem to account for the relationships of all the atoms of all the elements and all the compounds of these as found in molecules, micelles, and colloids. Thus far man can go in his laboratories. When it comes to touching these off with the spark of life, he still is baffled.

Nature[1] has somehow created an organism through the potent energies of the sun, which can tune in, in a brief, halting, fragmentary way, on the cosmic reservoir of intelligence—"The Great All." It seems to be in the Scheme of Things that man with his frail, colloidal brain shall rise to higher and ever higher levels of organization, wresting secret after secret from Nature, until he has discovered the true secret of life. Perhaps on other worlds the gamut has been run from elemental energy to living immortality. Who knows?

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[1] "Nature" is merely one of the terms we use to designate the Unknown Planning Force.

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New Words in Chapter VI

bacteria. Microscopic organisms belonging chiefly to plant or preplant forms. The greater number of disease-producing germs are bacteria.

battery. An apparatus of one or more cells for generating voltaic electricity.

bipolar. Having two poles of opposite electrical charge; pertaining to or found at both poles.

chondriosomes. Bodies of undetermined function found in the cytoplasm of cells.

chromatin. A protoplasmic, nucleic acid compound in the nuclei of cells, which stains deeply with basic stains.

chromomeres. Husklike arrangements of chromatic substance surrounding the genes.

chromosomes. Specific masses formed in the nucleus by the genes and chromatin under certain stimuli.

hemoglobin. The red coloring matter of the blood, which contains and carries oxygen to the tissues.

lipoids. Fatlike substances essential to certain cell structures and to many organic compounds.

metabolism. The sum total of chemical changes taking place in any living organism.

mitosis. Indirect cell division, involving typically in successive steps the segregation and equal division of the chromosomes, formation of daughter nuclei at the poles of a spindle of radiating fibers, and growth of a new cell wall through the center of the spindle.

nucleoplasm. The protoplasmic substance of the nucleus of the cell.

osmosis. The passage of substances in solution through an animal membrane, such as a cell surface or a capillary wall.

photons. The quanta or units of light energy.

plastids. Any of certain small bodies of specialized protoplasm lying in the cytoplasm of some cells.

radiation. Emission and diffusion of rays of energy.

short waves. Powerful energies which move in short undulations and penetrate atoms and compounds.

somatic. Pertaining to the body.

CHAPTER VI

LIFE MARCHES ON

Outside the cell are compounds containing carbon, hydrogen, nitrogen, oxygen, calcium, sodium—all lifeless, familiar elements, common to the earth, air and sea. "Dust and no more." These diffuse through the cell wall and are converted into foods. The food products in turn pass over into new combinations and enter a new category. They become living matter, green chlorophyll, red hemoglobin, protoplasm! Thus, endlessly the line of life marches on, forever transporting star stuff into life stuff moving by some catalytic hiddenness that is the very bridge of life.

To find that bridge has become the grand quest.

—George W. Gray.[1]

The Cell.—In the previous chapters we have seen the elemental free energies of space—electrons, protons, neutrons—become organized into patterned but inert atoms and elements. We have seen certain of these elements (some 20 of the 92) become associated in the still more elaborate designs of life. We have seen the division between the living and the nonliving growing shadowy in the borderline viruses and living protein molecules. After the transition between living and nonliving is fully passed, the unit of living chemical activity is the *cell.* The sum total of the chemical changes occurring within living matter is known as *metabolism* (see page 235). Since the chemistries of life are chiefly carried on within the minute cell laboratories, the cell is sometimes called the *metabolism unit.* The cell is the most elaborate mechanical and chemical mechanism in existence.

The cells of the myriads of living organisms in the world, from ostrich eggs to brain cells, differ greatly as to size, appearance, and function. All cells, however, have certain essential structures through which they carry on their operations. All cells are made of protoplasm (see page 50). Every cell has an alkaline, electronegative *nucleus,* which is the cell engine, the vital part. The protoplasm in the nucleus is called *nucleoplasm.*

[1] *The Advancing Front of Science*, p. 196, McGraw-Hill Book Company, Inc., 1937.

Most cells have also in the nucleus a very small body, the *nucleolus*, the function of which is unknown. Almost all cells have a lesser or greater layer of acid, electropositive *cytoplasm* surrounding the nucleus. Cytoplasm has a highly complex structure and features in cell division, heredity, and growth; it interacts with the nucleus in all the activities of the cell. Within the cytoplasm is fuel and building material, which is utilized by the nucleus in its specific activities. Some of the details of the interaction between nucleus and cytoplasm are not entirely clear; however, as investigation proceeds, the cytoplasm assumes increasing importance in the story of living functioning.

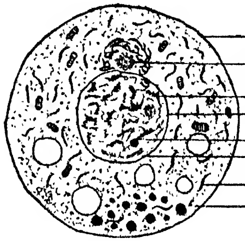

FIG. 7.—Diagram of cell structures mentioned in this text.

One reason why the study of the cell is difficult is that a cell or any protoplasmic tissue, when it is fixed and stained so that it may be examined under a microscope, is dead, static, motionless; but a living cell, when fluid, is in incessant movement. The protoplasm in a dead cell is a *gel*, while the protoplasm in living cells is in the form of fluid or semifluid *sols* (see page 60).

All plant and animal organisms begin as single cells. A one-celled organism carries on all the chemical transactions of life with relative simplicity. It absorbs nutritive matter; it eliminates waste; it grows, liberates energy, and reproduces itself. Every living cell continues to perform all these functions in maintaining its individual life. In higher organisms, however, cells have taken on additional functions and have differentiated and specialized their biochemical processes until the cells of each sort of tissue (a mass of like cells) perform one specific chemical function for the entire organism. In muscle cells, the cytoplasm fuel is oxidized or catalyzed in a way that creates mechanical or muscular energy; the thyroid cells select iodine from the blood and manufacture the hormone thyroxine (see page 148); the photoelectric cells of the retina respond to light and transmit energies to cortical cells of the sight centers of the brain, which are sensitized to receive such impacts; the cells of the mucous glands create, on demand, phenomenally copious amounts of watery secretion, as when one has a head cold or inhales pepper.

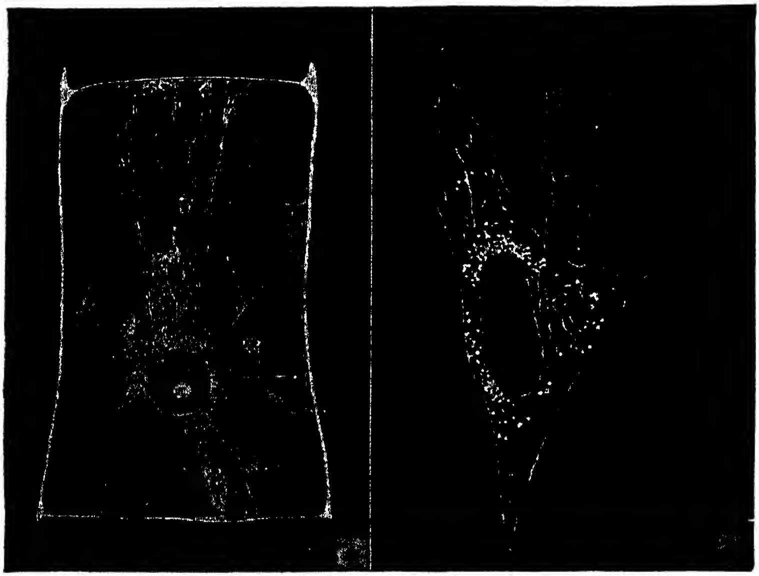

FIG. 8.—Living cells under dark-field illumination. *A*, a cell from the hair of a squash; *B*, a cell from chick embryo in tissue culture. (*Sharp, Introduction to Cytology.*)

Cell Membranes.—It has been mentioned that living protoplasm may be fluid (sol) or semisolid (gel) and that the chemical and electrical reactions of the nucleus and cytoplasm are different and oppose each other. It was long a mystery as to what kept these protoplasms apart—what kept nucleoplasm and cytoplasm from mingling and neutralizing each other. Why did not the cytoplasms of neighboring cells and tissues mingle with each other?

It is a relatively recent discovery that cells and nuclei have walls. Apparently the little blob of colloidal foam with its adsorbed sea water which first became energized to life was able to segregate itself and start its independent activity (see page 51) because in rolling about it became encased in a layer of inert, electrically neutral, fatlike *sterol* (see page 244). In fact there are two such films, one about the nucleus and one about the cytoplasm. This film is exceedingly thin—often only one molecule thick—too thin to be seen through any microscope, and detectable only by delicate chemical and mechanical tests. In some instances, the cell wall is microscopically visible and is tough enough to resist considerable pressure from a needle, and it heals from injury with incredible rapidity.[1] The structural character of this insoluble, neutral, inert film is now the subject of intensive investigation to discover how it is that osmosis between all cells and their adjacent capillaries takes place through monomolecular films, their "walls." There must be very special and specific arrangements of molecules (some think it is sievelike) to permit the rapid and delicately controlled exchange of chemical materials in osmosis.

Chromomeres, Genes, and Chromosomes.—Within the wall of the nucleus of a typical resting cell is a network of granular particles that readily take up stains; hence they are called *chromatin.* It seems that this chromatin material is composed of nucleic acid granules, *chromomeres,* which enclose in husklike fashion the submicroscopic protein *genes* (see page 73) which are now believed to catalyze all cellular activities, whether in reproduction or in body function. Genes are incredibly stable, each gene maintaining its exact chemical character through thousands of successive divisions, or generations. Indeed, the gene is probably the most stable structure in the universe; yet, even so, the gene does sometimes change (mutate), as we shall see in Chap. VII.

When a cell is about to become active in division or multiplication of itself, or in transformation of cytoplasmic substance, the chromatin granules surround the genes and arrange themselves in disks (the stripes in Fig. 9), with supportive material and nucleic acid to form very definite and characteristic, earthworm-like, microscopically visible, striped masses, called *chromosomes.* The formation of chromosomes would seem to be a matter of mechanical convenience in carrying on cell division and cell activity.

The number and shape of the chromosomes are specific for every living species—plant or animal—some having 4, some 6, and so on. The human animal has 48 chromosomes (24 pairs) in each

[1] Chambers, Robert W., *Mind-body Relationships,* Chap. VII, A. S. Barnes & Company, 1931.

and every cell. The genes of the germ cell contain the hereditary catalysts, and in forming the chromosomes, the genes from the mother's line of inheritance form one set of chromosomes, the genes from the father's line forming a duplicate set (see Fig. 12).

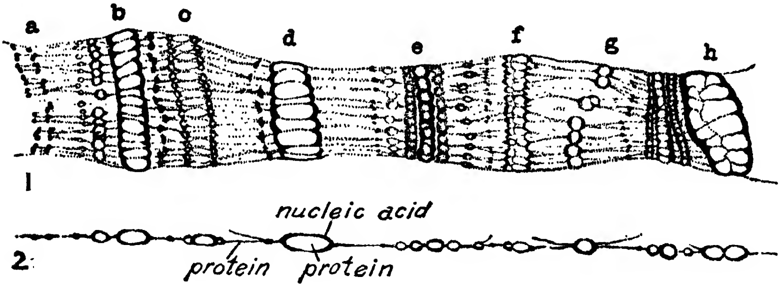

FIG. 9.—Drawing of (1) a portion of giant salivary gland chromosome of the black fly, *Simulium virgatum*, maximum magnification to show the finest details; (2) a single chromeric thread further schematized to show the linear arrangement of the constituent elements of (1). The chromonemata are seen as longitudinal, parallel lines. (*Painter, "Science in Progress," Yale University Press.*)

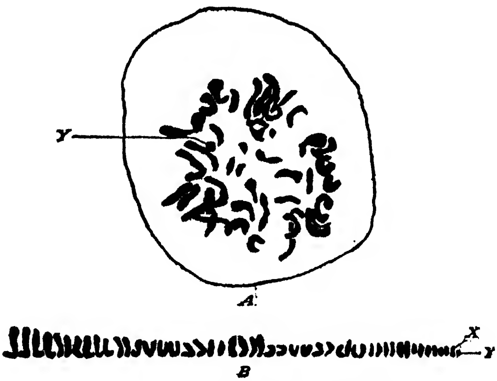

FIG. 10.—*A*, the 48 chromosomes in a cell of a white man; *B*, chromosomes arranged by pairs in order of size. (*After Painter, Eugenics, Genetics and the Family, The Williams & Wilkins Company.*)

Every cell in an organism contains the full set of genes and chromosomes characteristic of the species. The chromosomal pattern is the same within the germ cell producing an individual and within all the body (somatic) cells in the same individual. Originally each cell was potentially an individual (we remember there were originally only one-celled organisms), but the body cells had to give up their individuality as they came under the control of the integrating fields of force of an organization plan (*the organizer*, see page 95) and came to be surrounded closely by other cells, similar to or different from themselves, instead of being surrounded by air or fluid; but they still retain their original chromosome pattern. The more complex the individual, the less able is any one cell to reproduce the whole; it became specialized to such a point that it can only reproduce its own variety of tissue under the stimulus of growth hormones and integration with specific elements of the cytoplasm, or under the stimulus of a hormone-like factor generated by injured tissue.[1]

In the frog, by girdling but not completely separating the egg when it is just beginning to divide and is in the two-cell stage,

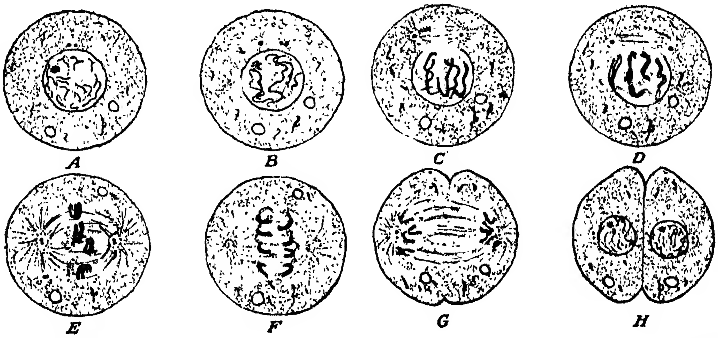

FIG. 11.—Mitosis, or indirect cell division. (*After Kirkpatrick and Huettner, Ginn and Company.*)

a two-headed individual is produced. If the two cells resulting from the first cleavage in a fertilized human germ cell happen completely to separate, it is supposed, identical twins result. (Some biologists now think that mono-ovular or identical twins separate after the first cleavage, but full details are not yet completely determined.[2]) Normally, it is probable, one of these two first cells develops into the right, the other into the left side of the body. Indeed, some twins are mirror images of each other in fingerprints and certain other traits.[3] The earthworm, if cut in two—a process that removes the environmental restraint upon the cells adjacent to the injury and also stimulates the release of the hormone-like substance mentioned—proceeds to

[1] *Science*, Dec. 31, 1937.

[2] DAVENPORT, C. B., *How We Came By Our Bodies*, p. 302, Henry Holt & Company, Inc., 1936.

[3] NEWMAN, H. H., *Twins*, pp. 139–140, University of Chicago Press, 1937.

grow new head and tail respectively upon the cut ends, so that two new individuals result, thus showing that the complete pattern is potential in each cell. It is well known that the injured crab can grow new feet or legs, the jellyfish can put out new tentacles. In some vegetable species a whole new plant will grow from a small piece of stem or even a leaf.

Mitosis.—When a cell divides itself into two new cells, the chromomeres containing the catalytic genes become organized for the purpose into the very exact patterns of the chromosomes. Very simple organisms, such as viruses and bacteria, apparently dispense with such elaboration and simply split fifty-fifty. The separate genes within the disklike chromomeres also appear to divide by simple fission. As cells become more complex, a complicated process is built up for accomplishing the fifty-fifty division of cell substances. Division of both animal and plant cells is accompanied by alterations in the chromatin structure—a process called *mitosis* (thread-forming). The chromatin first assumes the appearance of a skein of thread. Then the chromosomes form, but they appear to be strung upon the skeinlike filaments along the line of cleavage (see Fig. 11). The line of separation appears to be determined by the two centrosomes, or "attraction spheres" (see Fig. 11), which promptly form by division of the original single centrosome. (Just and some others think that the centrosomes initiate the process.[1]) The membrane between nucleus and cytoplasm dissolves. "The cytoplasm surges around the chromosomes" (Davenport). The chromosomes and genes then split in such a way that the chains of genes or chromomeres in each chromosome are shared equally by the new chromosomes. The surrounding cytoplasm separates, retaining the integrity of its enclosing membrane; the nuclear wall reforms, the chromosomes then become resolved again into diffuse chromatin granules, and two exactly similar new cells have replaced the old cell.

All growth and repair takes place by mitosis. Sexual reproduction, we shall see, involves a definite modification of this procedure known as *meioses* or *maturation*, which will be described in the next chapter.

[1] Just, E. E., *The Biology of the Cell Surface*, p. 251, P. Blakiston's Son & Company, Inc., 1939

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New Words in Chapter VII

configuration. Contour, form, the pattern of a whole concept or thing.

congenital. Applied to any trait, such as defect, present at birth; sometimes applied to defects acquired during prenatal life as distinguished from strictly hereditary traits.

conjugation. The union or joining of one organism with another for the exchange of nuclear material.

dominant. Applies to the one of the pair of traits received from paternal and maternal ancestry which appears in the offspring.

dysgenic. Detrimental to the race or tending to counteract movements for race improvement; opposed to eugenic.

entity. A thing having clearly distinct being, a real existence.

eugenics. The science which deals with the influences that improve the inborn or native qualities of a race or breed, especially of the human race.

evolution. The development of a race, species, or other group. The theory that the various types of animals and plants have developed from pre-existing types, as opposed to the theory of separate creation of each species.

flagellum (plural **flagella**). A "whiplike" process or cilium attached to many unicellular organisms, whereby they move about.

germ plasm. A general term applied to the hereditary substance which passes from one generation to another.

immunity. That condition of the body in which it is resistant to or antagonistic to disease.

intrinsic. Essential, inherent, true.

marsupial. The lowest order of existing mammals of which the females have a pouch on the abdomen, in which the young, born comparatively undeveloped, are carried.

maturation (**meiosis**). The final series of stages in the formation of the egg, by which its nucleus is prepared for union with the sperm nucleus.

meiosis (**maturation**). The process by which the number of chromosomes in the germ cells is reduced prior to fertilization. See maturation.

monogamous. The state of having one husband or wife at a time.

mutation. An abrupt change in the gene complex of a germ cell such that a new trait is introduced into the line of inheritance of the individual.

physicochemical. Pertaining to the chemical character of physical structures.

polar bodies. During meiosis the nucleus of the female germ cell divides into four cells, three of which are cast off as "polar bodies."

recessive. Applies to the one of a pair of traits received from paternal and maternal ancestry which does not appear in the offspring.

scrub. Undersized, mean, inferior, paltry.

sentience. Consciousness; also, elementary or inchoate consciousness.

sensitization. The condition of being specifically and markedly susceptible to a particular influence; *i.e.*, that bodily state in which the individual is hypersusceptible to some foreign (not normally existing in the body) protein.

sperm. The male reproductive cell, also called spermatozoon.

spermatozoon (plural **spermatozoa**). The male reproductive cell; sperm.

sport. A sudden spontaneous deviation or variation from the type—a variation that becomes inheritable; see mutation.

status quo. The state in which anything is; the state existing at the moment.

synapsis. The temporary fusion of like chromosomes during meiosis.

synthesis. The process of "building up" a compound by the union of simpler compounds or of its elements.

thermal. Pertaining to heat; warm; hot.

CHAPTER VII

HEREDITY AND EVOLUTION

A fire-mist and a planet
A crystal and a cell,
A jellyfish and a saurian
And caves where cavemen dwell;
Then a sense of law and beauty
And a face turned from the clod—
Some call it evolution
And others call it God.

WILLIAM HERBERT CARRUTH.

The Will-to-larger-life.—We have taken a swift glance at the amazing drama of an inert fragment of the cosmic universe becoming alive. We have seen the "Spirit move upon the face of the waters" and the "deep quicken." We have seen inert atoms arrange themselves in flexible, sensitive, and adaptable organized groups; and under the stimulus of mysterious force from the sun-star that seems to have given birth to our earth life, we have seen that life reach toward its parent sun with such intensity of purpose that, we are told, unhindered, it would now fill the solar universe; and we have looked at the orderly mechanism by which life proceeds.

Meiosis or Maturation.—Evolution is accomplished and life is perpetuated through the mechanism of heredity. The genes and chromosomes are the factors by which "like begets like." One-celled organisms and single cells reproduce or multiply themselves by mitosis, the exactly equal division of every constituent of the cell (see page 64, Fig. 11). When two sexes appear, the matter of perpetuating traits becomes involved. The problem now is one not of division but of union. If two human germ cells, of 48 chromosomes (24 pairs) each, were to unite, the result would be one enormous cell of 96 chromosomes, with four sets of genes, and heredity would indeed be complicated. Nature has solved this problem in a perfectly judicial manner by developing a procedure for juggling the two sets of genes according to the inexorable law of chance. Figure 12 shows diagrammatically how this is done. The germ cells (ova and sperm) may multiply by mitosis within the ovary and testicle, just as does any other cell that is merely increasing itself in numbers. *When, however, an ovum or a sperm is matured for function it undergoes meiosis or maturation.* First, the chromosomes pair

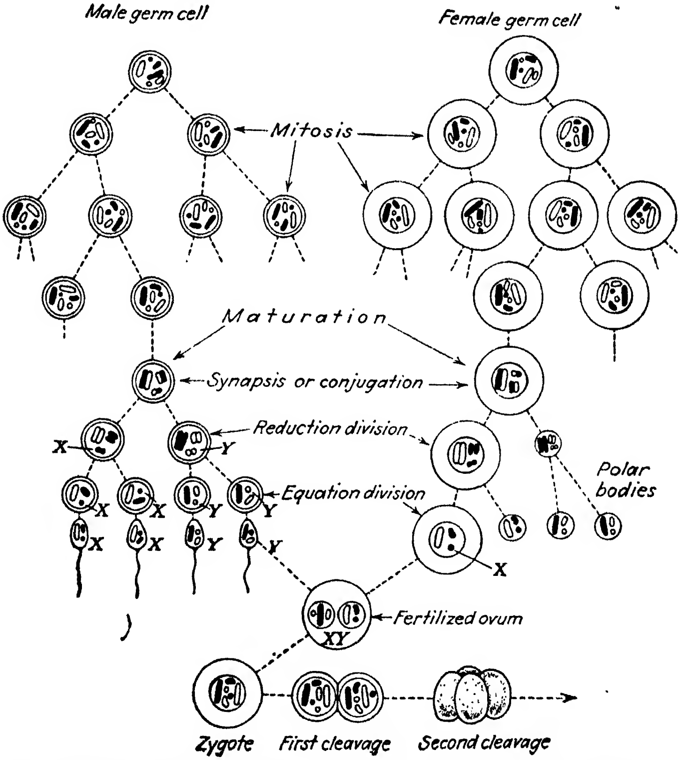

FIG. 12.—Diagram showing mitosis, meiosis, fertilization, and sex determination in a species having six chromosomes.

off, the chromosomes from the maternal side of this particular individual's inheritance (black in the diagram) lining up beside the corresponding chromosome from the paternal side (white in the diagram). In this way the genes for eye color in the white chromosome lie exactly opposite the genes for eye color in the black chromosome. Then the chromosomes fuse, permitting the paired genes to come in contact with each other for a very brief instant, called the *conjugation or synapsis.* Also the limiting membrane between nucleoplasm and cytoplasm dissolves (see page 60). It sometimes happens that genes or gene blocs change places during this instant, a procedure known as *crossing over of the genes* (see Fig. 13). This is the first place where hereditary traits begin to be juggled. The chromosomes of each pair then separate, and the cell divides without splitting the chromosomes, as occurs in mitosis. Instead, one chromosome of each pair goes to a new cell, and it is pure chance as to how the black and white (maternal and paternal) chromosomes are sorted, although obviously there are only a certain number of combinations mathematically possible.[1]

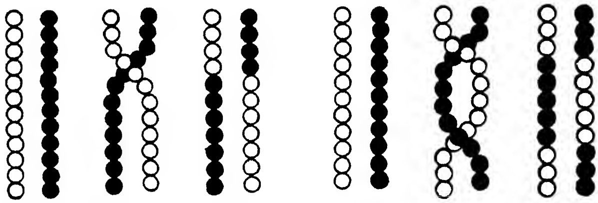

FIG. 13.—Single and double crossing over of genes during synapsis in maturation.

In most species the germ cells, for some unknown reason, then undergo one mitotic division before they are released for fertilization; in this division the chromosomes and genes merely divide fifty-fifty by mitosis. Meiosis of the male germ cell occurs during its passage through the tubules within the testicles (see Fig. 75). In the female germ cell meiosis seems to occur at the time the ovum is expelled from the ovary and while it is entering the Fallopian tube on its way to meet the spermatozoa (see Fig. 78).

The male germ cell (*sperm, spermatozoon*) is a naked nucleus, being practically without cytoplasm. Following the mitotic division last mentioned, the sperm develops an appendage known as the *body* or *mid-piece,* to which is attached a whiplike *flagellum* or *tail.* This propels the cell through the spermatic fluid with great speed, considering its microscopic size (covering about an inch in 3 minutes). The end result of meiosis of the sperm, then, is four fully matured germ cells.

[1] It was a revolutionary event in natural science when Gregor Mendel discovered that inheritance follows the mathematical law of chance—the famous *Mendelian law.*

In mammalian reproduction, in which the egg is incubated within the body of the mother, nature practices thrift and finishes only one of the four potential female germ cells. Three are discarded, as seen in Fig. 12, as "polar bodies." The end result of meiosis in the female is one cell which has retained practically all of the cytoplasm.

Determination of Sex.—The statement that the male and female chromosomes (black and white in Fig. 12) exist in identical pairs is true *with the exception of the so-called "sex chromosome."* Each male set of 24 pairs of chromosomes contains one smaller than the rest and smaller than the corresponding chromosome in the female cell, which seems to help determine the sex of the individual developing from it. This is the generally accepted theory, although some biologists now think the cytoplasm of the female cell may play some part in determining "femaleness."[1] For convenience the sex chromosomes are called *X* and *Y*. The *X* chromosome contains factors for "femaleness"; the *Y* is smaller—"almost empty of genes," in fact—and contains either a factor for "maleness," or at least an "absence of femaleness." The original female cell contains two *X* chromosomes, but the original spermatozoon, with its 24 pairs of chromosomes before division, contains both an *X* and a *Y* chromosome, having received the *X* chromosome with the mother's set of chromosomes (black) and a *Y* chromosome with the father's set (white). In the reduction division these are distributed by chance between the two resulting cells and are split fifty-fifty in the last mitotic division. The finished germ cells, then, consist of one female cell containing one set of 24 chromosomes—it may contain any of the many possible combinations of traits from her ancestry, but always contains one *X* chromosome—and four male germ cells, each likewise containing 24 chromosomes, sorted by chance, but two of the cells will contain *X* chromosomes received through the individual's mother and two will contain *Y* chromosomes received through his father.

It will be apparent that nature thus provides for an equal apportionment of the sexes. If the female cell unites with a sperm containing an *X* chromosome, the result will be a new cell

[1] GOLDSCHMIDT, RICHARD, *Physiological Genetics*, p. 279, McGraw-Hill Book Company, Inc., 1938.

with 48 chromosomes, among which are two X's, and the child, in this case, will be a female. If by an equal chance, the female cell unites with a cell containing a Y chromosome, the result will be an XY combination, or a male child. In the long run, an equal number of male and female children are conceived. However, not all fertilized cells survive, and wide fluctuations occur in the jugglings of chance. Therefore, one family may have all boys and another, all girls; and one block of birth statistics may show more males and another, more females. It is the evident intent of nature, however, that there shall be equal numbers of the sexes—a fact that would seem to set the stamp of nature's approval upon monogamous marriage.

The Way the Hereditary Mechanism Operates.—When the human child (or any bisexual animal) is born, he has present within his body in potential, undeveloped, embryonic form all the germ cells, with their power to develop or mature specific gene material, that he will ever have. Nothing that he can do can alter the potential quality of these germ cells other than through thermal, mechanical, or chemical injury. *Nothing that he can do can alter the inheritance his progeny will receive from past ancestors through him.* This was unalterably fixed at the instant of conception, which determined which two germ cells, from among those present in the bodies of his parent, were to unite at this particular time. At this moment he received his full contribution from the past and made his own to the future: his children inherit *through* him but not *from* him (see page 16).

Dominant and Recessive Traits.—The combination of traits resulting from union and fusion of the male and female germ cells becomes theoretically a matter of mathematical computation. Gregor Mendel, the famous Austrian monk, discovered that two contrasting pure traits mingled in heredity strictly according to the law of chance; *in the long run,* one-fourth of all germ cells producing pure-bred individuals like one parent, one-fourth producing pure-bred individuals like the other parent, and one-half being hybrid or mixed, but having the appearance of the dominant parent. Mendel knew nothing of chromosomes, still less of genes, but he saw clearly that there were double hereditary factors in every individual. He demonstrated that these traits separated in fertilization, although he did not know by what mechanism they did this. He demonstrated that traits are sorted in the offspring according to the law of chance and that *recessive* traits may be covered by the *dominant* traits in the hybrid, thus explaining why certain black-eyed individuals breed true and others will have progeny of other eye colors. We know that all this is explained by the sorting and distribution of the genes and chromosomes. This is essentially as simple as shaking 100 beads, 50 of one color and 50 of another, in a box. The law of chance will, in the long run, bring each color to the surface an equal number of times.

The mathematics of the combination of two traits is simple; when four or six or a thousand different kinds of beads or traits are shuffled, involving traits from remote ancestors, the mathematics becomes bewildering, but we can understand that the whole process is orderly, obedient to law, and mathematically valid.

We have seen that the trait determiners, the protein catalysts called *genes*, lie in chains of disklike chromomeres (see Fig. 9) within the chromosomes and that there are corresponding pairs of chromosomes within each cell. This actually means two "determiners" or genes, or gene groups, for each unit trait that appears in the individual. The linear arrangement of the trait-bearing genes is the same in any identical pair of chromosomes. The genes for eye color, for instance, will always lie side by side during the conjugation (synapsis) of the chromosomes, and will always be found in a certain place within a certain chromosome. This appears exceedingly complicated, but the mathematics of the procedure has been worked out, notably with fruit flies, until it has become possible to make chromosome maps of simple organisms (see Fig. 15) showing the particular order and sequence of the genes within each chromosome. Professor Thomas Hunt Morgan and others, in researches upon the behavior of genes and chromosomes, have mated, crossed, and counted traits in many millions of fruit flies.

The provision of duplicate genes or traits from two parental lines complicates inheritance, increases variation, and also provides a certain protection. A defective gene in one chain may be covered up or protected in fertilization by a normal gene in the mate, especially if the normal gene be dominant and, fortunately, most defective genes are recessive. If corresponding genes in the mating are defective, the defect will surely appear in the offspring. Similarly, good traits may be intensified in

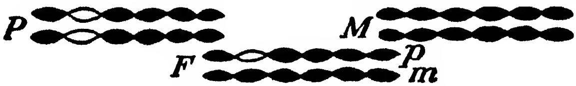

Diagram of a portion (six pairs) of the chains of genes in two parents, *P* and *M*, and in one of their offspring *F*, to illustrate the workings of heredity. The father (*P*) has two defective genes (white) in one of his pairs (the second) and is therefore personally defective. The mother (*M*) has both genes normal in this second pair. The child receives one of the sets of genes from the father (*p*), one from the mother (*m*). It therefore has in all its pairs at least one normal gene and so is not personally defective.

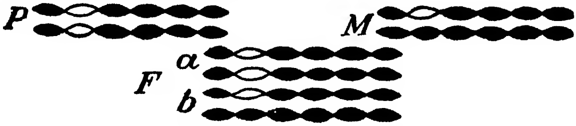

Diagram of the results in heredity in cases where one parent (*P*) has two defective genes (white) in a certain pair, the other parent (*M*) one defective gene in that pair. Some of the children (*F*) receive two defective genes in that pair (*a*) and are therefore personally defective; others only one (*b*), so that such are not personally defective.

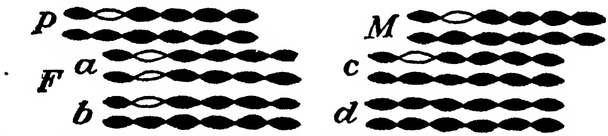

Diagram of genes, to illustrate the results in heredity when each parent has one defective gene (white) in the same pair. The parents, *P* and *M*, having a normal gene in each pair, are not defective. Of the children (*F*), some receive a defective gene from each parent, as at (*a*); such will be personally defective. Others receive but one defective gene (*b* and *c*), or none (*d*); these will not be defective.

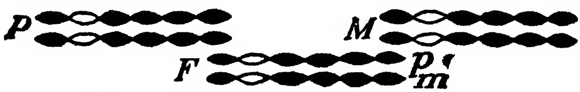

Diagram of genes, to illustrate the results in heredity when two defective parents, *P* and *M*, have both genes defective (white) in the same pair. The offspring *F* then receive one defective gene in that pair from each parent; such offspring are therefore personally defective, like the parents.

Fig. 14.—Diagram illustrating gene combination. (*From Jennings, Biological Basis of Human Nature, W. W. Norton & Company, Inc.*)

the child if both parents provide genes for these. Thus children may be either stronger or weaker in particular traits than is either parent. This explains many of the apparent inconsistencies in inheritance and shows the difficulty in prediction of traits (see Fig. 14).

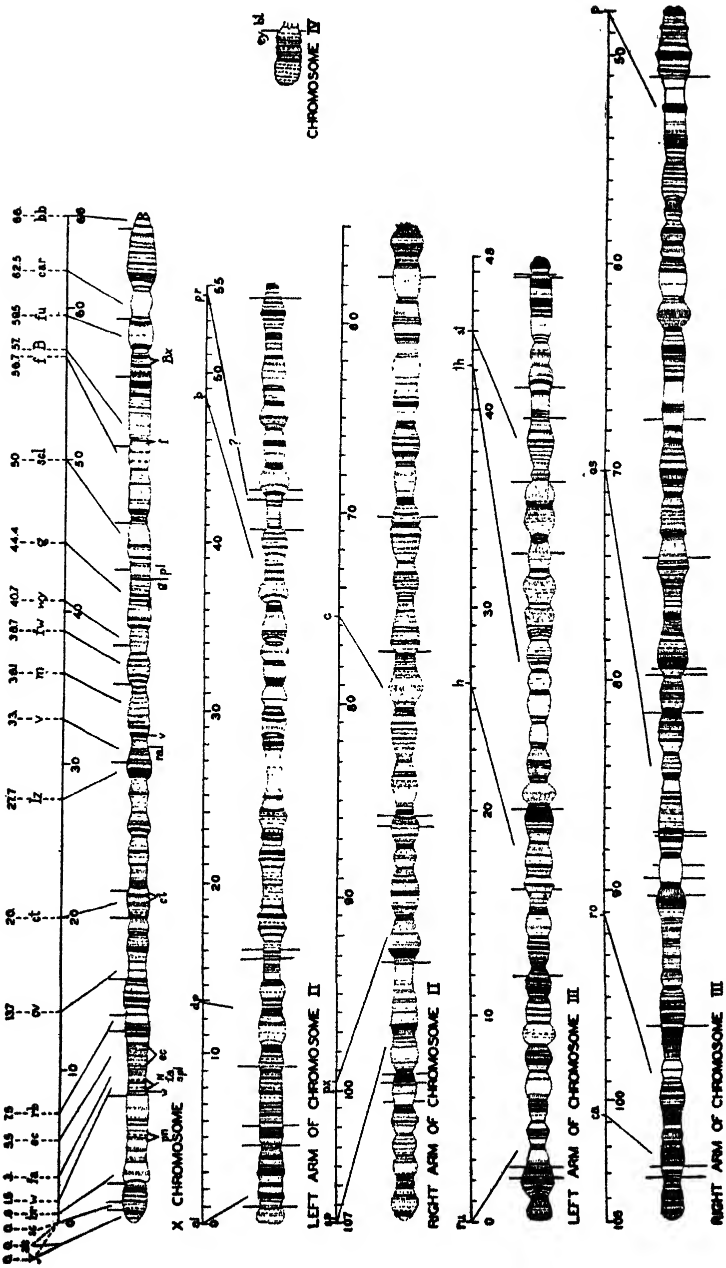

FIG. 15.—Maps of the four chromosomes of Drosophila melanogaster, as found in the salivary glands. The sex chromosome occupies the top line, chromosomes II and III, 2 lines each, and chromosome IV is given at the right. (After Painter, *Journal of Heredity*, Vol. 19, 1934.)

Sex-linked Traits.—The chromosome marked *Y* is seen to be very small, so small indeed that it was not discovered for a long time, and all earlier works say that male cells contain one chromosome fewer than female cells. (Also, the reduced mitotic cell was taken to be the representative cell form, and the earliest literature on human chromosomes gave 24 female and 23 male as being the human chromosome unit.) In the female germ cell, on the other hand, the two sex, or *X*, chromosomes are similar in size and shape. Daughters, then, inherit equally from the mother and from the *X* chromosome of the father. Sons, however, inherit somewhat fewer traits, since the *Y* chromosome is nearly empty of genes.

Traits borne by genes in the *X* and *Y* chromosomes are said to be *sex-linked.* In the fruit fly there are some 200 characters known to be carried in the *X* chromosomes of the female that are lacking in the male *Y* chromosomes. There are fewer sex-linked traits known in human inheritance. Color blindness and hemophilia (a condition in which blood will not clot, producing "bleeders") are well known. These are recessive traits, and a female may receive the genes for the defect, *e.g.*, color blindness, through the *X* chromosome of her father. Even if she marries a man who is not color-blind, her male children may be color-blind, since there is no normal gene in the *Y* chromosomes of their father to dominate the defective, recessive gene from the maternal grandfather; but the normal genes in the father's *X* chromosome will protect his daughters, although they may have color-blind sons.

Emergent Evolution.—All science is the story of the evolution of patterned units, the organization of free energies into increasingly complex and interrelated wholes, the atoms, and the integration of these with each other to form entirely new wholes: molecules, micelles, and cells. With each new whole, new field properties emerge. The mechanics of the evolution of so-called "inorganic" matter from electrons to compounds and colloids is now comparatively well known, at least well enough that the necessary direction of further research is fairly clear. The evolution of new organic patterns involves intricate forces and relationships which are still laden with mystery.[1]

[1] "The problem of pattern is the most important problem of geneticist and

All natural phenomena represent the appearance, or "emergence," of new patterns or fields formed from old material all the way back to the energies of space (see page 24). When two physical entities or units are brought into a new configuration (pattern or relationship), something new arises, or "emerges," out of this relation. Hydrogen and oxygen are two distinct gases; under certain electrical field conditions which have a catalytic effect, these gases unit very firmly in molecules of H_2O, and water is formed, resembling neither hydrogen nor oxygen nor any other combination of the two: thus the "pattern," or "field," of water "emerges." The atoms of all the elements emerged or evolved as patterned combinations of electrons, protons, and neutrons. Proteins emerged from combinations of hydrogen, oxygen, carbon, nitrogen, plus sulphur, phosphorus, etc. "Sentience [feeling, awareness] emerged from new relations within living protoplasms, and mind emerged from sentience." "Creative synthesis" is the term sometimes applied to emergent evolution, a process in which the new "whole" is always different (has new field properties) from the mere "sum of its parts," or any other arrangements of its parts. "Emergence in evolution is but one of the consequences which are held to follow from the establishment of new relations between old entities."[1]

The "new relations between old entities," however, are intimately and intrinsically bound up with and dependent upon external catalyzing conditions; in other words, the environment must be favorable. The environment really instigates the reaction. Certain precise electrical and thermal conditions must prevail before hydrogen and oxygen will form water. Certain conditions of moisture, warmth, and radiation are necessary to the formation of colloidal proteins and protoplasms. "When proteins emerged out of amino acids or, more directly, out of

embryologist. Development is the orderly production of pattern . . . Embryology is the science of pattern formation . . . what is the differentiating agent? . . . Cases are increasing in which clear relations are found between genic action and products that act as hormones. . . . We expect that such processes will be found wherever an organ differentiates in some respect as a unit." RICHARD GOLDSCHMIDT, *Physiological Genetics*, pp. 183–200, McGraw-Hill Book Company, Inc., 1938.

[1] SHULL, FRANKLIN, *Evolution*, p. 281, McGraw-Hill Book Company, Inc., 1936.

their constituent elements, only a new relation among old things was produced. There must have been some conditioning factor that was previously lacking or proteins would have been formed before."[1] All evolutionary changes, then, are but new relations or sets of relations (fields) cropping out among entities already in existence, in response to new and specific environmental factors.

In short, it seems logically possible for literally limitless variations of living forms to arise from the materials of the earth. Theoretically all the dust of the earth might be catalyzed into life. Living forms, however, must adapt to each other and actually they arise out of the natural conditions of their material environment, and this eternally limits and circumscribes the number of organisms that are possible, and determines their survival and the direction of their evolution.

Perhaps the most conspicuous property of living organisms is their community with the environment. Not only are living beings continuously dependent on the oxygen, water, and food substances which the environment supplied, but the chemical substances of which the body is composed are all derived from the environment.

So intimate is this relationship that organisms might be, and often are, conceived to be just parts of the physico-chemical world which are organized in a certain way. This conception has, quite apart from its truth or falsity, emphasized the fact that the organism is bound up with the environment in the relation of a part to the whole. Between them there is a constant interaction which is never interrupted until the organism perishes and becomes an unorganized part of the physico-chemical world. . . . What is true of an organism as a whole is true of its component cells and tissues. They all have, at every moment of their existence, an environment without which they can neither exist nor be conceived. . . . These processes of interaction between the organisms and environment, including the interactions between component parts of the organism and *their* environments, constitute what is termed functional, or physiological, activity.[2]

The Mechanics of Evolution.—The tree of animal evolution (see Fig. 16) sprouted from its seed, the genes which are now

[1] Shull, *op. cit.*, p. 284 (based upon C. Lloyd Morgan's *Emergent Evolution.*)

[2] Eldridge, Seba, *The Organization of Life*, pp. 1–2, The Thomas Y. Crowell Company, 1925.

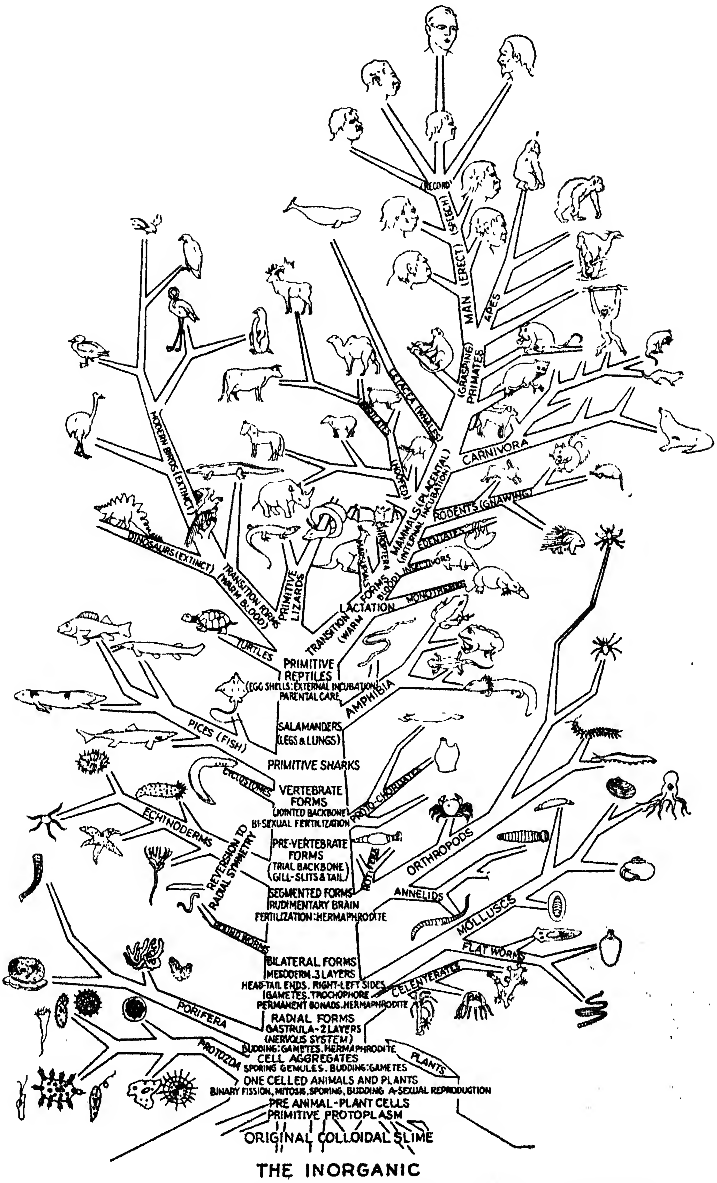

FIG. 16.—The tree of animal evolution. (*Maud A. Brown.*)

conceded to be living protein molecules (or side chains of chromosome molecules). Proteins are combinations of the 30 or more amino acids (see p. 48). The number of possible combinations of 30 unit factors passes the limits of human imagination. Enough combinations of amino acids into specific proteins are possible to account for every particular variation in living form and function existing upon the earth. In fact, the 30 amino acids may form millions of millions of millions of combinations. It is now believed that variations in proteins account for hereditary differences, for immunity, for sensitization, for vital functions, such as metabolism, glandular behavior, thinking, and feeling, and even for differences in temperament and character.

Variations.—How hereditary variations occur and produce evolution is now narrowed down to an attempt to understand the chemical actions and interactions possible between and within the genes and the chromosomes in the germ cells and the interaction of these with cytoplasm and environment. It is really immaterial whether we accept the new idea that the chromosome itself is a giant protein molecule with genes as side chains or the idea that the genes are individual protein molecules which become linked together within the chromosome. In either case, development, growth, and heredity depend directly upon the catalytic action of these bodies upon their cytoplasmic environment, and indirectly upon the interaction of the entire cell and the organism developing from it, with its environment, which is first the womb of the mother, then, following birth, the air, food, and shelter provided by environment.

Mutations.—The exact causes of *mutations* or sudden alterations in heredity have always been a mystery of science. It has been impossible to produce mutations artificially, except through injury to the germ cell by radiation, X ray, or by chemical or thermal effects. Evolutionary adaptations have consistently and continuously occurred since life began; otherwise, life still would be limited to the primitive virus molecule (see page 50). It has been impossible to "catch" nature performing the miracle of the adaptation of life to environment, and nothing seems more completely demonstrable than that "like produces like" within the limitations of the Mendelian law of chance. The son of a blacksmith will have a right arm like that of any other child. Puppies are still born with tails, although some breeds have been docked for hundreds of generations. Chinese girls are born with normal feet after centuries of foot binding. No one-legged father ever had a one-legged son. Shell shock, nervous breakdown, and technical skills are not inherited. *Susceptibilities* to some types of feeble-mindedness, to epilepsy, to insanity, and to some other diseases are believed to be inherited; but these represent injuries to germ plasm rather than evolutionary mutations. The present tendency in medical science is to regard only a few rather definite classes of defects as strictly inheritable, and to regard susceptibility to disease, rather than disease itself, as hereditary. Whether the susceptibility actually culminates in the disease depends, at least to a great degree, upon environmental conditions.[1]

All through living forms *sports, mutations,* or *spontaneous variations* do now and then occur. There is no anticipating these, and nothing is more certain than that they obey the natural laws herein described. In a mutation, quite unexpectedly, one individual will appear who is different in some particular trait from any that have preceeded him. *Not only that, but he will transmit this trait to his progeny, showing that some change has occurred in the genes in the germ plasm or the germ cells.* Many apparent variations are only accidental, such as monstrosities like Siamese twins, or double-headed calves—both caused, doubtless, by the partial separation of the fertilized germ cell in its first division (see page 94)—and will not be inherited. Birth defects (congenital) may be due to accidental changes in some of the 23 somatic, or body, chromosomes during intra-uterine life and not to changes in the hereditary germ plasm.

Once in a while, as has been stated, a variation occurs which is due to, or causes, permanent change in the genes within the chromosomes of the germ cell. This will be inherited as either a dominant or a recessive trait. Sometimes a previously dominant trait drops out, as in the case of the sport among calves that was

[1] Davenport, C. B., "Heredity of Disease," *Journal of the American Medical Association,* Aug. 28, 1928; also White, W. A., *The Meaning of Disease,* The Williams & Wilkins Company, 1926.

born on a Kansas farm and became the ancestor of all hornless "polled" Herefords. The seedless orange originated in this way. Some variations or sports add something to the traits, as in the case of the navel orange. Every variety of apple originated as a sport, although subsequently greatly modified by artificial selection, grafting, and breeding. The numerous varieties of wheat originated as sports and were selected and crossed to develop new combinations of characteristics for long roots, smooth beard, full head, or whatever it might be. Although more difficult to recognize, sports (mutations) must occur in human inheritance, as well.

The factors responsible for hereditary and evolutionary changes are of two classes: those producing gene shifts, or changes in the germ plasm itself, and those affecting survival. It is the first class that is most baffling to science; even modern biology cannot fully explain the rise of new and complex characteristics. Division by mitosis seems to be nature's device for stabilizing heredity. The juggling of the gene molecules in meiosis provides great opportunity for new combinations out of which new characteristics may "emerge" (see page 76). Mutations must occur chiefly during the intervals of the fluid synapsis, when the nuclear membrane dissolves, the genes move about, and active catalysis occurs between the various chemical elements of the cell (see page 70). Atoms or molecules may be exchanged, drop out, or be doubled, and new combinations may be formed. If even one electron is directly "hit" by a quantum of energy such as is released by activated atoms (see p. 25), chemical reaction may be instigated which may cause the mutation of a gene molecule.[1] While at present, there seems to be no doubt that the hereditary mutations chiefly responsible for evolutionary progression (or regression) are chemical (electrical) in character, the details are still somewhat vague. One reason mutations seem so mysterious is that only the spectacular ones usually are recognized. It is likely that the inheritance of small mutations over a long period of time has played an important role in evolution.

Müller says that mutations must inhere in the genes, and that all heritable variations and adaptations may be called *mutations*. He says that certain genes are vastly more mutable than others,

[1] Goldschmidt, *op. cit.*, p. 28.

and that the direction of mutation in a grouping or in a given gene may occur oftener in some directions than in others.[1]

The second thing that determines the trend of change in inheritance and makes evolution possible is the *law of survival of the fittest,* or *natural selection.* This law was worked out and given to the world by Charles Darwin, an English scientist, who died in 1882.[2] Darwin became one of the foremost scientists of history. He traveled much and studied all that was then known about previous and contemporary forms of life. He made careful records of the types of life found in isolated islands and compared them with fossil life as found in the same islands. He formulated classifications and comparisons that were an enormous contribution for any one man to make to any subject. From all these, he concluded that in the continuous warfare that goes on between the myriad forms of life upon the earth it is the individual best equipped to take care of itself that survives and transmits this favorable dominance to its offspring and, in this measure, changes or influences the trend of the general heredity of a species.

> One marsupial "survives" because it is a jumper; another because it is a sprinter; another because it is a climber. One snake survives by turning a tooth into a hypodermic syringe, his saliva into venom; another keeps his teeth, but changes his skin to look like that of his poisonous brother; another parts with teeth entirely, and develops a spine in his gullet to break birds' eggs. He is "adapted" for climbing.[3]

During an epidemic or plague, those individuals survive who have a great degree of natural immunity to the particular disease. When spawning salmon start upstream, only the stronger ones survive. Thus does nature mercilessly *select for survival* through the pitiless *struggle for existence.* This results in the *survival of the fittest,* and naturally should result in improvement of species and in increased survival in successive generations of such species.

Of course we are only saying that it is actually the environment that determines which mutations shall survive and be

[1] Müller, H. J., *Eugenics, Genetics, and the Family,* pp. 106–112, The Williams & Wilkins Company, 1923.

[2] Darwin, Charles, *Origin of Species,* D. Appleton-Century Company, Inc., 1901.

[3] Dorsey, George A., *Why We Behave Like Human Beings,* pp. 98–99, Harper & Brothers, 1925.

inherited, and which genes, among the enormous surplus provided by nature, shall come to expression.[1] Or rather, we are saying that survival and evolutionary progression depend upon the harmonious and increasing complexity of integration of organism with environment.

Artificial Selection.—The deliberate suppression of undesirable or unwanted types, the crossing of desirable strains, and the selection, protection, and perpetuation of desirable mutations, constitute what is called *artificial selection.* Segregation and sterilization of the unfit, birth control, scientific agriculture—all are illustrations of artificial selection.

Eugenics.—Eugenics may be said to be the application of the laws of heredity to human welfare, or the "self-direction of human evolution."[2] It is actually a wide application of the principle of artificial selection. Sir Francis Galton, one of the foremost of the early genetic scientists defined eugenics, a half century ago, as "the study of agencies under social control that may improve or impair the racial quantities of future generations, either physically or mentally." He also said:

> Man has the power of preventing many kinds of suffering. I conceive it to fall well within his province to replace natural selection by other processes that are more merciful and not less effective. This is precisely the aim of Eugenics. Its first object is to check the birth rate of the unfit instead of allowing them to come into being, though doomed in large numbers to perish prematurely. The second object is the improvement of the race by furthering the productivity of the fit, by early marriages and the healthful rearing of children.

These two objectives sometimes are said to comprise *negative* and *positive eugenics,* respectively. It is difficult today to improve upon these statements of social objective. The realization of these ideals, however, seemed simpler and more immediately possible when less was known about heredity and the developmental processes. We are familiar with the great contributions that such knowledge as we have of the laws of heredity has made to man's material welfare within the short period of a

[1] PLUNKETT, C. R., *Outlines of Modern Biology,* Chap. XXIV, Variation and Selection, Henry Holt & Company, 1930.

[2] FASTEN, NATHAN, *Origin through Evolution,* Chap. XIV, The Future Evolution of Men, F. S. Crofts & Co., 1929.

quarter of a century. We are just beginning to apply this new knowledge to man's racial welfare. We have been forced to make some human weed laws, and to try to eliminate some social thistles through segregation in institutions, legal sterilization, and some regulation of marriage. We have not been very wise or effective in this, partly because of lack of clear understanding of biological laws, and partly because of the difficulty of applying them to complex human characteristics. We are at present much more disposed to protect than to eliminate the unfit. The result is that the socially ineffective procreate prodigally under the protection of society, whereas they would speedily die out through natural selection if they had to protect themselves. Some think there is real danger of society's being overwhelmed with prolific undesirables. On the other hand, somewhat rigid voluntary selection is going on among individuals of good human stock who are at present rather commonly failing to replace themselves in the population.[1]

We should be studying our individual trait inheritance and at least avoid doubling our weak traits by mating like undesirables with like and thus visiting a curse upon the unfortunate "third and fourth generations." This is the reason why the marriage of cousins is prohibited in many states. The defectiveness that is often observed to follow such unions is not a moral curse, but only an instance of the operation of the Mendelian law that "where two similar dominants are mated, the offspring will resemble the parents, and will in turn transmit this dominance to all their offspring." We would state it more modernly as the bringing together of defective genes of the same sort (see Fig. 14). Recessive traits almost forgotten in family inheritance also may be doubled and crop out in new intensity. Of course there is no certainty that two cousins or even two brothers (unless identical twins) will happen to have the same dominance in their genes, but there is a greatly increased probability of this in the case of cousins as compared with that of two unrelated persons.

[1] JENNINGS, H. S., *Biological Basis of Human Nature*, pp. 351–357, P. Blakiston's Son & Company, Inc., 1930; HURST, C. C., *Heredity and the Ascent of Man*, Chap. IX, the Macmillan Company, 1935; and PATRICK, G. T. W., *Introduction to Philosophy*, Chap. XI, Houghton Mifflin Company, 1935.

Both strong and weak traits are intensified by general inbreeding. This is shown where there is inbreeding because of geographical or political isolation, as in China and Japan, or social isolation, as in the instance of the so-called "lower classes" at one extreme and royal families at the other. Even here the law of survival tends to weed out weaker traits.

Human Mating.—As to the individual application of these laws, it will be a long time before enough is known to make it possible to formulate very many safe and definite rules for the selection of mates. We do know enough to avoid mating with the defective, especially if their defects are of the same kind as those in our own ancestry, and to prevent as far as possible the propagation of the grossly unfit. Society should do this with increasing thoroughness and effectiveness through segregation, sterilization, and better and more uniform regulation of marriage. No intelligent farmer will breed his stock to scrubs, but he sometimes sanctions the marriage of his children with a scrub family.

Family Records.—As to the conscious improvement of human heredity, little can be done until we begin to keep family trait records. With the newer scientific knowledge at our service, we certainly should keep continuous and complete and detailed family histories, paying particular attention to character analysis and achievement records, as well as to chronological data.[1]

Social Control.—The very personal and important matter of improving the human animal through control of inheritance involves consideration of *birth control,* which may be either eugenic or dysgenic in its effect, according to circumstances. It also involves legal regulations of marriage, and legal sterilization and segregation of the unfit, control of immigration, and many other social and legal questions, which cannot appropriately be discussed here, in spite of the fact that the solution and management of the problems indicated have a great deal to do in determining the kind of world Our Child will come to live in. Certainly

[1] Forms for doing this may be secured from the American Eugenic Records Office, Cold Spring Harbor, Long Island, N. Y.; or from the American Eugenics Society, 50 W. 50th St., New York City; or from the Race Betterment Foundation, Battle Creek, Michigan. A thoroughly scientific record book for the first 16 years of life may be secured from the *Parents' Magazine,* 52 Vanderbilt Ave., New York City.

all thinking parents should be sociologically minded, and try to see all issues in terms of the child of the race and his best interests.

Heredity vs. Environment.—We are too prone to discuss heredity and environment as if they were separate aspects of the child's life. In so doing we are likely to make the mistake of expecting the impossible of the child if we think environment is the all-important factor, or of neglecting his proper culture if we think his heredity has settled his fate. True, it is both cruel and useless to try to make a musician out of a child who is lacking in sense of tone and rhythm. Most children, however, are capable of much greater musical appreciation and skill than ever are developed by their environments.

Let us not trouble too much with trying to differentiate between heredity and environment or between the physical and mental traits of the child. Let us rather try to think of him as above all a *unity,* "a behavior pattern in a specific protoplasm,"[1] or "a mechanism, but a mechanism which, within his limitations of life, sensitivity, and growth, is creating and operating himself."[2] In short, the child is a growing organism. If he is a potato we cannot make of him a rose, but we can help him to grow into the very best possible potato if we foster the conditions appropriate to potato culture. We doom ourselves to disappointment, and the child who is potentially a potato and not a rose to suffering and failure, if we try to force him to climb a trellis and bear red bloom.

Social Heredity.—Heredity, as we have seen, has extensive and intricate ramifications. The child inherits much more than the unique complex of genes and chromosomes from which his body comes. His first inheritance is his mother's body, out of which he grew and upon which he entirely and absolutely depends for nine month's growth, during which time he increases his initial size many million times. Does he not, in a very real sense, inherit his mother's body, as well as the particular chromosomes from her body that became him, and inherit the eons of evolutionary history that perfected it for his use? After his birth

[1] CHILD, C. M., *Physiological Basis of Behavior*, p. 123, Henry Holt & Company, Inc., 1924.

[2] COGHILL, GEORGE E., *Anatomy and the Problem of Behavior*, The Macmillan Company, 1929.

he remains dependent upon his mother's body, including her mind and emotions (which we now believe to be functions of her body), for nourishment and care. His environment now includes not only the nutriment from which he builds his body, but *maternal solicitude, a peculiar and specific attitude toward him involving sacrifice of self-interest, without which he would speedily perish.* Did he not inherit this? Does this not belong to him as basically, personally, and intrinsically as does his body pattern? Did these not come down the ages of evolution along with the pattern for his body mechanism?

Furthermore, our child inherited not only a mother but a father, in short he has inherited an evolutionary situation, the evolutionary *status quo* of the particular stream of life along which he came. This situation includes not only his particular genes and chromosomes with their catalysts of growth, but also the fact that, instead of a parental ameba that would have obligingly and sacrificially obliterated itself in twin progeny, he has two surviving and fostering parents; it also includes the fact that these parents are Caucasian, blue-eyed, and hybrid for red hair; that their native tongue is English and their name is Jones.

Nor is this all that has come to him individually and personally from the past. Scarcely less intrinsic in his environment (from which his genes have selected the "makings" of himself with such completeness and fidelity as they could) than are the facts that he is white, English, and a Jones, are the additional facts that his particular forbears, out of their protoplasmic urges, formed families in patterned groups, and also formed an organic social relationship called a *state*, a *country*. All of these he inherits, and all of these are as definitely functions of the composite protoplasmic pattern of his people as his own personality and physique are functional expressions of his own inherited protoplasmic mechanism.

The survival of our child depends upon the fact that he has inherited the parental solicitude of ages of evolution; conversely and correspondingly, he has inherited a long period of dependency and helplessness which increases, historically, as social evolution advances. As his state and country become more stable and autonomic and intricate, he has become heir to a solicitude and a protection of the part of the group such that if his parental protection and care should fail, instead of perishing promptly and at once as would have been his lot in more primitive times, he receives foster care from the social group into which he is born. Indeed, the social group may legally take the child from incompetent parents and place it under foster care in home or institution. Is not this social attitude a matter of definite organic evolution converging in our child just as clearly as his body-mind and his long infancy are definite evolutionary and hereditary products?

Social evolution follows the same laws as biological evolution, and each conditions the other. Society is only the organization of larger biological human units which interact and integrate according to their respective fields of force as determined by their inherited patterns and the effect of these upon each other in forming new, emergent social fields. Let us think of our child as a structural unit in this complex world organism. He "emerged" out of the cosmic forces or energies which happened to converge or focus in his hereditary stream at the instant of his conception. To understand the particular capacities and limitations of any child and wisely to manage these is a perpetual challenge to all the intelligence and understanding and effort the adults of his world can bring to bear upon their mutual relationship.

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New Words in Chapter VIII

Amblystoma. An amphibian commonly known as *mud puppy*, much used in experimental biology.

amphibian. An animal or plant accustomed to live both on land and in water.

biogenesis. The doctrine that the genesis of living organisms can take place only through living germs or parents.

biophysical. Pertaining to the physical structure or function of living things.

differentiate. To acquire distinct and separate characters in the process of development.

ectoderm (epiblast). The outer primitive layer of the embryo.

endocrinological. Pertaining to glands of internal secretion, or endocrine glands.

endoderm. The epithelial membrane lining most of the digestive tract.

Fallopian tubes. The oviducts, which convey eggs from ovaries to uterus.

gastrulate. An early stage of the embryo, consisting typically of a cup or open-mouthed sac with walls composed of two layers of cells. A gastrula stage occurs in the development of most animals.

individuation. The development of the individual from the general; the emergence of the individual.

mesoderm. The mesoblast; the mid layer of the developing embryo, which comes between the two layers of the gastrula—the ectoderm and the endoderm.

ontogeny. The life history or development of the individual.

organismal. Pertaining to the philosophy of organization, unity, wholeness.

phylogeny. The evolutionary history of a race, species, or individual.

protozoon (plural, **protozoa**). One of a group of microscopic organisms that are classed as belonging to the animal kingdom.

recapitulation. Repetition, in an individual, of phylogenetic development.

rods and cones. The functioning structures of the retina of the eye.

uterus. The womb; a hollow organ, the abode and place of nourishment of the embryo and fetus.

vertebrate. Having a vertebral column or structure resembling one.

CHAPTER VIII

HOW WE CAME BY OUR BODIES

Each of us was once only an egg, so we have a pardonable interest in what we looked like at that time. . . . Its diameter is about ¼ *of a millimeter, or* 1/175 *of an inch. Its weight about* 0.002 *milligrams or* 1/15,000 *of an ounce. . . . In the course of nine months the weight of this speck may increase* 1,500 *million times. The one cell will give rise to* 26 *trillion cells. During about fifteen years of growth this speck may, under favoring conditions, increase in length* 13,200 *times. The living speck will become a living man with his complicated tissues, his swirling fluids and cell movements, his vast intellect, of almost limitless comprehension, his ambitions, his emotions of hate and love, and his varying moods. There is no phenomenon in Nature, not even the universe of galaxies, that compares with the marvelous intricacies of development, composition and structure of a child.*

—C. B. Davenport.[1]

The Story of the Egg.—Let us think for the moment of the fertilized egg (ovum) that is to become Our Child. Here is a microscopic mass of protoplasm which holds within its already highly organized colloidal structure certain specific proteins (genes) received from the germinal structures of its two parents. These have the selective catalytic power to choose what shall be taken from the environment of the mother's body to make up, not only the organism that we call *a* child, but the specific qualities that make Our Child. It is these that hold or constitute the "pattern" of a human being.

Since all isolated, flexible masses are forced by the equalization of pressure of surrounding air or water to assume spherical shape, we find the fertilized egg to be a sphere. Each egg displays a surface-interior pattern. The surface becomes the environment of the center of the cell. The relationship of the various parts to each other varies, causing shifts in atomic electrical fields (see page 30) out of which new centers and orbits of force arise. Thus some points, *the organization centers,* become chemically

[1] *How We Came By Our Bodies*, pp. 3 and 6, Henry Holt & Company, Inc., 1936.

more active than others and become *gradients* or *fields* (see page 32), which differentiate into all the structures appearing in embryo, fetus, and child. It is these gradients or fields of activity which account for all growth, all physiological function—even such functions as thinking, feeling, and remembering. The appearance of the gradients or fields of growth are timed as if an invisible bandmaster waved a baton for each to tune into the symphony of growth.[1]

This one-celled egg absorbs fluid nutrient solutions from the oviduct and enlarges to the limit of its surface tension, whereupon it divides into two exactly similar halves. Division proceeds until there is a spherical mass of cells, with fluid in the interior, all alike as far as microscopic observation yet reveals (see Fig. 17 *A*, The Morula). Next, the sphere becomes a cup (The Gastrula). A surface-interior variation is established between the various internal and external cells, and presently we see these cells differentiating, or taking on differing structures and functions. *In most multiple-celled organisms the general sequence of differentiation is the same.* First, an external layer assumes a disklike form upon the sphere and becomes the *ectoderm;* then an internal layer, known as the *endoderm;* while soon, between these two, a third mass, which is the *mesoderm* (see Fig. 17 *D*). From the ectoderm develop the nervous system and the superficial structures, such as skin, hair, nails, enamel of the teeth, etc. From the endoderm develop the lining of the digestive tract, the trachea, and the lungs, and the glands that bud from the digestive tract, such as the liver and the pancreas. From the mesoderm develop the structures lying between the lining and the covering of the body, the skeleton, muscles, kidneys, blood vessels, lymph structures, etc.

While these layers are forming, the cell mass is absorbing fluid from the Fallopian tube and the uterus (see pages 293, 294); and the germinal part of the mass, which is to become the embryo itself, is becoming a flattened disk on the surface or exterior of a fluid-filled sphere (see Chap. XVI); the ectoderm is already wrinkling its surface, tubewise, and showing active gradients where the brain and spinal cord will be (Fig. 18). The surface-

[1] WADDINGTON, C. H., *How Animals Develop*, Chaps. IV, V, VI. W. W. Norton & Company, Inc., 1936.

interior pattern is becoming *axiate, i.e.*, lengthened along the axis of the neural groove in a manner that is to produce head,

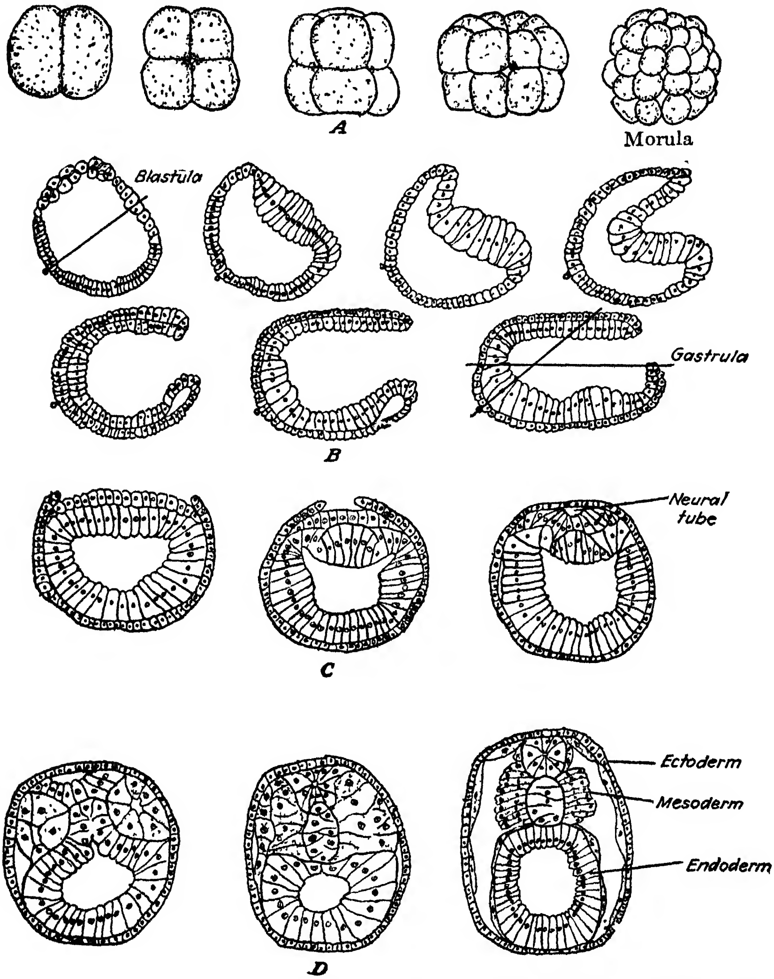

FIG. 17.—Development of embryonic layers: *A*, early cleavage of the fertilized ovum; *B*, gastrulation in Amphioxus; *C*, formation of the neural tube in Amphioxus; *D*, differentiation of ectoderm, endoderm, and mesoderm in Amphioxus. (*Modified from Wieman, An Introduction to Embryology.*)

body, and feet; presently, the axiate pattern will show *antero-posterior* variations that will cause our child to have a front and a back to his body, and also *lateral* variations that will account for arms, hands, ears, etc. It is probable that the cytoplasm contains factors that are catalyzed by the genes to produce these features; at least, pinching out pieces of cytoplasm experimentally from an amphibian egg may cause the animal to develop minus an arm, a leg, or a foot.[1] Needham thinks that there must be a hormonelike organization factor, "*the organizer*," which

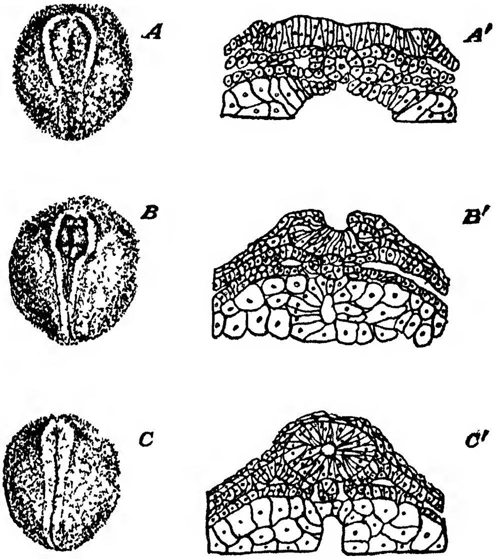

FIG. 18.—Formation of the neural groove in the egg of the Amphibian. *A*, the early neural plate of the egg; *A'*, cross section of *A*; *B*, the late neural plate, or neural groove, of Cryptobranchus; *B'*, cross section of *B*; *C*, closure of the neural tube; *C'*, cross section of *C*. (*Modified from Herrick, Neurological Foundations of Behavior, Henry Holt & Company, Inc.*)

appears in a developing system and shapes the patterning of the growth.[2]

Dr. George E. Coghill, of the Wistar Institute of Experimental Biology of Philadelphia, over a period of years made a study of the development of the nervous system in the amphibian, Amblystoma, and has been making very exact correlations between growth of structure and development of behavior. Dr. Coghill found that the *essential, fixed, or hereditary structures*

[1] DAVENPORT, *op. cit.*, p. 175.

[2] NEEDHAM, JOSEPH, *Order and Life*, p. 84, Cambridge University Press, 1932.

develop in anticipation of function and in a fixed evolutionary order. For example, sight centers in the brain are ready before the optic nerve enters the brain and before the rods and cones can be recognized in the retina. The swimming mechanism is ready before it is used, etc. He says that there is, all along the way, "an overgrowth of neural mechanisms beyond the capacity of the animal to express their full nervous potential in behavior"; and that, in respect to physical behavior, this overgrowth may have specific reference to particular future behavior, such as walking or swimming.[1]

Coghill says that behavior is not simply a combination or coordination of reflexes, but that *there is from the first a dominant organic unity,* which concerns itself first with the maintenance of the integrity of the individual, and only after the "total individuation" do local reflexes or partial patterns emerge which may be affected by outside experience.[2] In other words, heredity gives the child legs and arms before he uses them; it then depends upon the use (environment, experience) as to whether or not his muscles develop and acquire skill.

He says further that after the fixed or integrating mechanism is laid down and function begins, the further development, growth, or differentiation is constantly affected by experience, but that this always takes place as a "quality upon the ground" of the organism itself. Experience is experienced, so to speak, by the total mechanism on a basis of its central plan. "The behavior pattern is a unity from first to last in the career of the individual. . . . Although the behavior at any moment may

[1] COGHILL, GEORGE E., *Anatomy and the Problem of Behavior,* p. 92, The Macmillan Company, 1929.

[2] Carmichael and others have observed random local "piecemeal" movements in embryos of guinea pig, chick, etc., and think these observations conflict with Coghill's "total individuation" theory. (CARMICHAEL, L., "An Experimental Study of the Behavior of the Prenatal Guinea Pig," *Genetic Society Monograph,* Vol. 16, 1934.)

Wheeler, R. H. (*The Science of Psychology,* p. 408, 1940) believes there is no conflict and that the phenomenon observed by these other workers was in the nature of temporary preindividuation activity in cells or tissues not yet integrated with the nervous system, and that such movements disappear and never merge as "parts" or reflexes in the total structure.

be dominated by some particular phase of experience, it cannot be utterly disconnected from any part of the whole. . . "[1]

We shall see the reason for giving so much consideration to the meaning of the organismal concept and of its associated mechanisms as we make practical application of this to the physical and mental development of the child. It is becoming apparent that we must try to identify *the order of appearance* of the features of the pattern in the growing child and to be able to identify those that are primary, or dominant, in the organic matrix, and those that are secondary or modifiable by training and experience; *and to recognize the emergence of these in physical and mental behavior. This is the basis of understanding and effectiveness in our care and training of the child.*

The Tree of Evolution.—In this connection we must again consider the path of evolution. The will-to-larger-life leads to endless diversification in life forms, which is usually represented as a branching tree. Even a genealogical family tree becomes very complex. What shall we say of a biological family tree? In Fig. 16, page 79, we have a simplified diagram, showing some of the sequences in embryonic forms that life has assumed up to the present time. It will be seen that man is not believed to have been once a monkey or an ape (to mention an older popular misconception of evolution); rather, both man and monkeys derived from a common vertebrate stem, hence the similarities that puzzled anthropologists for so long. *All living forms have ascended a common embryonic path up to the time of their evolutionary departure from the main trunk to form new branches or forms of life.* This departure from the common path is doubtless caused, or determined, by mutations in germinal structure (see page 80) interacting with environmental conditions.

The rock strata of the earth are full of fossil records of the progress of living organization, as indicated in the diagram (Fig. 16), from protozoon to gastrulate, to vertebrate; from primitive vertebrate to early mammal, to man. The most indubitable evidence of the evolutionary sequence, however, has been preserved by nature within the delicate and indestructible tissues of the egg. Every germ cell is an egg, every egg is a germ cell. Our Child begins life as a microscopic bit of protoplasm

[1] COGHILL, *op. cit.*, pp. 106–107.

pinched off, so to speak, from the parent structure, but containing his entire pattern compressed within its tiny space. It is as primitive, for aught the microscope reveals, as the first one-celled protozoon in the ancient sea. In the mother's body it rapidly becomes a gastrula (Fig. 17), acquires gill slits and fins

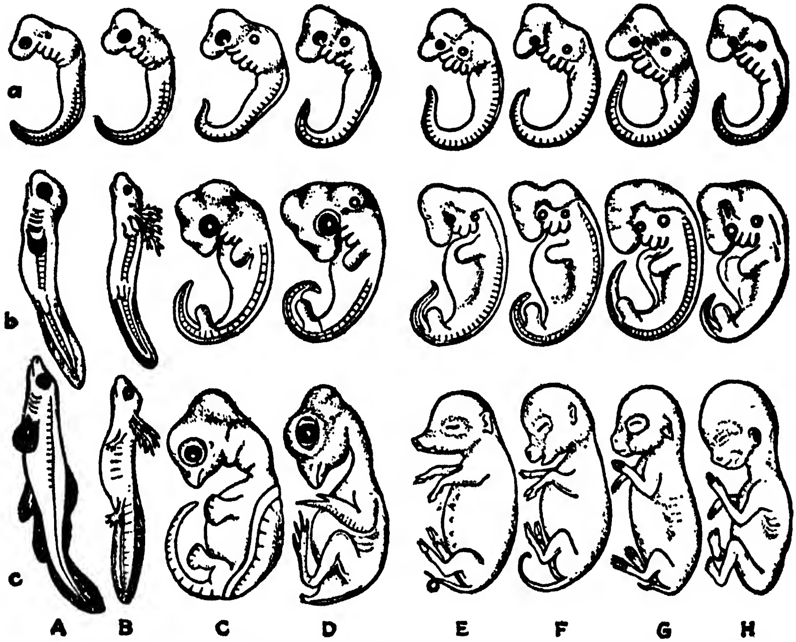

FIG. 19.—Parallel stages in the development of several vertebrates. *A*, fish; *B*, salamander; *C*, turtle; *D*, chick; *E*, pig; *F*, calf; *G*, rabbit; *H*, man. In each series, *a* is an early stage, showing the pharyngeal slits; *b*, a later stage, in which the first two have developed gills and the last six show the pharyngeal slits disappearing and the limbs and tails developing; *c*, a still later stage, in which the differences between the reptile and bird on the one hand and the mammals on the other have become pronounced, marked resemblances between those of each group persisting. (*From Guyer, "Animal Biology," after Haeckel, through Romanes.*)

(see Fig. 82), exchanges these for four legs and a tail, and becomes covered with soft fur (lanugo). When our human child is born, he is still the most unfinished, helpless living thing upon the earth. He has lost his fur and his tail, but it takes him still 12 months to come to the stage where he can use two legs instead of four, and many years to catch up with his race. In short, he climbed his biological tree from protozoon to gastrulate, to simple vertebrate, to mammal, to primate in only 9 months. In a real sense, he must still become a man.

This tendency of all living forms to rehearse certain stages of their ancestral history in their embryonic development is expressed in the *biogenetic law,* also known as the *theory of recapitulation.*[1] Sometimes it is said that "ontogeny (the history of the individual) repeates phylogeny (the history of the race)." Sometimes it is said that "the child climbs his own racial and family tree." Actually, what is recapitulated is not the adult structures of preexisting orders, but rather certain phases of their embryonic growth.[2] What this means is that there seems to be necessary uniformity in living processes. Nature has evolved, so to speak, one biophysical method of proceeding from simple to complex, a vital action pattern, which operates universally in all living organisms, although affected within definite limits by differing environmental conditions. We must think of ourselves as an expression, a passing phase, of this ceaseless struggle of nature to achieve some distant end. Conger says:

> With each new advance in the detailed investigation of the sciences there looms up higher than ever the problem of man's place in the universe . . . before the problem of man's place in the universe can be adequately answered, there must be some attempt to find the place of other things, and if at all possible, to trace the scheme and pattern of the whole.[3]

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[1] "It seems just to conclude that as the human child before birth recapitulates, more or less, certain phases of his physical history, so the child after birth recapitulates and uses for a time various phases of his prehuman ancestral behavior." ALEŠ HRDLIČKA, *Children Who Run on All Fours,* McGraw-Hill Book Company, Inc., 1931.

[2] WADDINGTON, *op. cit.,* p. 20.

[3] CONGER, GEORGE PERRIGO, *A World of Epitomization,* Princeton University Press, 1931.

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New Words in Chapter IX

hermaphrodite. An individual having or appearing to have both male and female organs or characters.

Hydrá. A fresh-water relative of corals and jellyfish which attaches itself to other objects by its "foot," or "sucker."

incubation. The period of development before an organism begins to function as a whole; the period before hatching or birth. All eggs must incubate.

lethargy. Stupor or coma, a condition of indifference, subnormal sensitivity.

mammals. The highest class of vertebrates, including man and all other animals that suckle their young.

parthenogenesis. The production of offspring from eggs that have not been fertilized by sperm.

protozoon (plural **protozoa**). A one-celled animal, usually microscopic in size.

Sauroids (sauria). A group of lizardlike animals including huge extinct species, such as dinosaurs.

sociobiological. Pertaining to the relation of social and biological factors upon each other.

Spirogyra (pond scum). A threadlike plant found chiefly in stagnant water.

Ulothrix. A green alga; a short, filamentous water plant that attaches itself to damp rocks forming a green covering.

Volvox. A spherical colony of one-celled flagellate animals attached to each other by a gelatinous secretion. There may be thousands of cells in a single layer about the central cavity.

CHAPTER IX

THE EVOLUTION OF REPRODUCTION

Afar down I see the huge first Nothing, I know I was even there,
I waited unseen and always, and slept through the lethargic mist. . . .
I am the acme of things accomplish'd, and I am encloser of things to be. . . .
Long I was hugg'd close—long and long.
Immense have been the preparations for me,
Faithful and friendly the arms that have help'd me.
Cycles ferried my cradle, rowing and rowing like cheerful boatmen.
For room to me stars kept aside in their own rings,
They sent influences to look after what was to hold me,
Before I was born out of my mother, generations guided me,
My embryo has never been torpid, nothing could overlay it.
For it the nebula cohered to an orb,
The long slow strata piled to rest it on,
Vast vegetables gave it sustenance,
Monstrous sauroids transported it in their mouths and deposited it with care.
All forces have been steadily employ'd to complete and delight me,
Now on this spot I stand with my robust soul.

WALT WHITMAN.[1]

Perhaps the master secret of life itself is the mysterious force that inheres in all organic structure through which the "vital spark" is passed along from generation to generation. The highest present accomplishment of life upon our earth is the birth of a human child. This supreme event will have somewhat more meaning for us if we consider briefly the long, long sequences of experiments whereby nature arrived at the delicate and intricate process through which we, as privileged end products (as yet) of evolution, may share in the march toward immortality. The essential events in the evolution of reproduction are presented on the trunk of the Tree of Evolution (Fig. 16).

Fasten says:

During some period in the life of every organism, certain minute entities are set aside which are capable, under proper conditions, of

[1] "Song of Myself," from *Leaves of Grass*, reprinted by permission of Doubleday, Doran & Company, Inc., Publishers.

reproducing all of the structures and functions of the adult parent from which they were derived. This power of reproduction has made possible the immortality of life since its origin upon the earth. In spite of the fact that individual organisms are constantly dying, nevertheless the most indestructible thing in all nature is life. Individually almost all organisms are mortal, but racially they are immortal. This immortality has been made possible by the unique power of reproduction which is possessed by every living thing.[1]

Forms of Reproduction. *Binary Fission.*—Any living cell multiplies itself by division of its nucleus, with its component chromosomes and genes, into two equivalent parts. It commonly does this through the process of mitosis (see page 64). In some very simple single-celled organisms mitosis may not occur or may occur in modified form. What seems to occur in all instances is that the one-celled organism on reaching the limit of its surface tension or cohesive power simply divides all its parts and structures in two exactly equal portions with or without mitosis. This is called *binary fission* (Fig. 20). Professor Lane thus describes the reproduction of amebae:

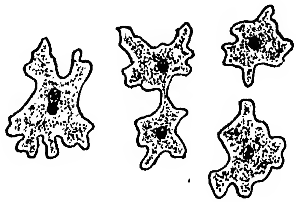

FIG. 20.—Reproduction by binary fission, or simple division, in the ameba.

When through an abundance of food an ameba has reached its limit of growth, it divides into two like any other cell. Its nucleus goes through a modified form of mitotic division before the body divides. This constitutes its method of reproduction and is called "binary fission." Thus, ameba does not suffer a *natural death;* instead its substance passes directly into that of the two daughter-amebas. There is an awesomeness in the thought that no direct ancestor of an ameba living today has ever died; it is but the front of an advancing line of protoplasm which has gone on without a break since the first ameba appeared on earth.[2]

Sir Arthur E. Shipley waxes humorous in this wise over the sentimental plight of amebae:

[1] FASTEN, NATHAN, *Origin through Evolution*, p. 68, F. S. Crofts & Co., 1929.

[2] LANE, H. H., *Animal Biology*, p. 50, P. Blakiston's Son & Company, Inc., 1929.

When we were a soft amoeba, in ages past and gone,
Ere you were Queen of Sheba, or I King Solomon,
Alone and undivided, we lived a life of sloth,
Whatever you did, I did; one dinner served for both.
Anon came separation, by fission and divorce,
A lonely pseudopodium I wandered on my course.[1]

Reproduction by Budding.—By and by, in the course of evolution, certain one-celled organisms, of which baker's yeast is an example, began to bud off a number of young in succession without sacrificing themselves with each new birth. This is called reproduction by *budding.* Each organism is thus enabled to produce several or many offspring with increasing probability of

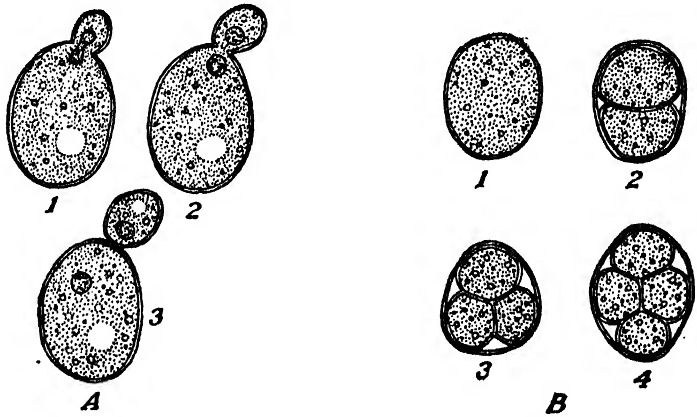

FIG. 21.—Two types of reproduction in yeast: *A*, by budding; *B*, by sporing. (*After Plunkett, Outlines of Modern Biology, Henry Holt & Company, Inc.*)

survival of the species (Fig. 21 *A*). In these transitional phases of the evolution of reproduction more than one type of reproduction may be employed by one organism. Yeast sometimes reproduces by *sporing* or "internal budding" (see Fig. 21 *B*). Hydra reproduces during part of the season by budding; during the rest it is a hermaphrodite (Fig. 25).

Reproduction by Sporing.—At a still later stage of evolution the cells budded off failed to separate; simple, multiple-celled organisms appeared, and the matter of reproduction became complicated. Nature has tried many devices, among which is the development of new cell nuclei or spores within certain cells.

[1] SHIPLEY, SIR ARTHUR E., *Life*, p. 161, The Macmillan Company, 1925.

When ripe or at the climax of growth, these cells rupture and release many small spores into the water, where they develop into new individuals (Fig. 22). Some organisms, when conditions of food, moisture, or temperature are unfavorable, form a number of divisions (spores) within the cell wall, which may shrink or dry up and rupture. When warmth and moisture are again encountered each spore forms a new organism. Some forms produce male and female spores or gametes which fuse with each other to form zygotes, which develop into new individuals. Here again we may have two types of reproduction in one organism, as in Ulothrix, a green alga (Fig. 22 *B*).

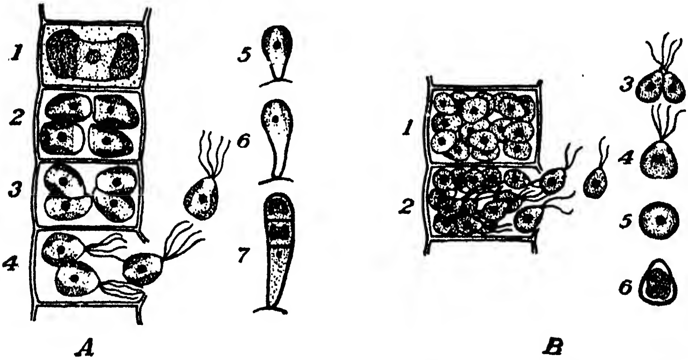

Fig. 22.—Two types of reproduction in Ulothrix: *A*, asexual sporing; *B*, sexual union of gametes to form a zygote. (*After Plunkett, Outlines of Modern Biology, Henry Holt & Company, Inc.*)

Conjugation.—The paramecium is a sexless, one-celled water animal which usually reproduces by fission. After many generations the cells lose vigor and seem about to die out. Then various pairs of paramecia fuse or *conjugate;* the nuclei unite; after a short time the cells divide again into two exactly similar individuals that seem, in certain instances at least, to have been mysteriously stimulated and rejuvenated by the experience and start out upon new careers of multiplication by division.

In Spirogyra (pond scum), a simple stagnant-water plant consisting of a chain of cells, the union of cells from different filaments that happen to come into contact results in the concentration of the contents of both cells in one, which then develops into a new plant (Fig. 23). Dorsey comments in this wise upon this peculiar phenomenon of rejuvenation: "Other protozoa only partly unite—and again separate, 'rejuvenated.' In other species, a small individual bores into and buries its body within that of a normal sized individual; the latter then divides repeat-

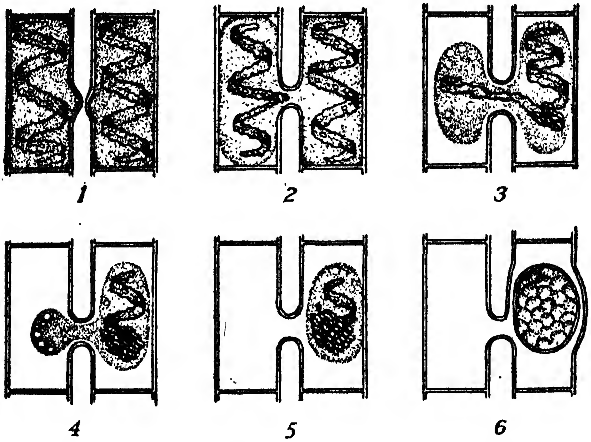

FIG. 23.—Conjugation and sporing in Spirogyra. (*After Plunkett, Outlines of Modern Biology, Henry Holt & Company, Inc.*)

edly. Thus far there has been no division of labor or true sex forms. When two unite the conjugation is an energy stimulus, as though the springs of life needed rewinding. In higher organisms, this rewinding becomes the prime function of the sperm-cell."[1]

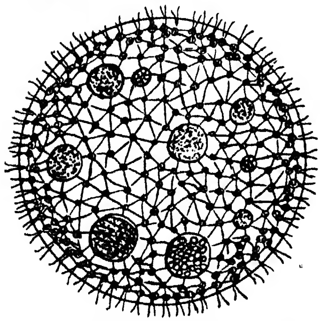

FIG. 24.—Reproduction in Volvox.

Sex Cells.—The foreshadowing of *sexual reproduction* seen in primitive types of conjugation between similar or sexless cells progresses a step further in Volvox. This is a spherical colony of one-celled organisms which adhere to one another. Each cell has long flagella, which propel the ball through the water. This fringed, hollow ball floats about in stagnant water absorbing food until it reaches maturity, whereupon certain cells enlarge and become filled with egglike bodies.

[1] DORSEY, GEORGE E., *Why We Behave Like Human Beings*, p. 105, Harper & Brothers, 1925.

Other cells become filled with smaller, slender, spermlike bodies. Both kinds of cells rupture, discharging their contents into the fluid in the interior of the sphere. Now the spermlike bodies, aided by their flagella, hasten to fuse with the larger egglike cells, and from each such pair a new Volvox develops (Fig. 24). This is clearly a foreshadowing of sexual reproduction, although both kinds of sex cells are produced in one parent colony. In some species the ova are produced in one individual colony, the sperm in another.

It is interesting to note that the parent structure soon disintegrates and dies, no matter how favorable conditions may be. This is the first real appearance of natural death, and seems to be the necessary price for evolutionary advancement. The many-celled individual is not immortal in time or space in the same sense as the one-celled organism which passes on in its entirety into its progeny. Only certain, highly specialized portions of the complex organism, known as *germ cells*, are budded off and retain this gift of perpetuating life.

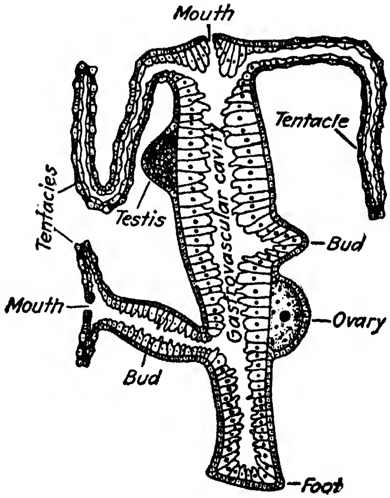

FIG. 25.—Two methods of reproduction in Hydra: budding and hermaphroditic (primitive sex organs). (*Modified from Shull, Principles of Animal Biology.*)

Hermaphrodites.—In later and more complex forms of life special male and female sex organs develop within the body of one animal, each producing successive crops of sex cells of opposite kinds. These are brought together in various ways and produce new individuals having both male and female sex organs within the body of each. A very primitive type of hermaphrodite is the Hydra (Fig. 25). Many plants reproduce in this way. Individuals having both kinds of sex organs are called *hermaphrodites*. In very rare instances both kinds of sex organs are produced in bisexual animals. This is an unnatural reversion, and the organs are rarely sufficiently complete to function.

Sexual Reproduction.—Later, very much later, in the story of evolution, separate male and female individuals appear, and possible variations in inheritance are thereby incredibly multiplied. Earlier forms of sexed organisms have few traits and simple structure, and many of the laws of inheritance have been worked out on these and have later been found to apply to all forms of life.

In truth, the male sex seems to have been created or "invented" for the purpose of increasing variations as well as for stimulation of the ovum.[1] Nature could have had the ovum develop without fertilization and does so in certain instances. This is called *parthenogenesis.* No new combinations are then possible; there is but one set of genes, weaknesses are not diluted by admixture with another strain, and the strain does not endure except in instances, such as the bee and certain other insects, in which parthenogenesis alternates with sexual reproduction. Artificial parthenogenesis is now induced experimentally in certain lower forms of life by stimulating the eggs with chemicals, needles, etc., although development as a rule is not complete.

The Mechanism of Sexual Reproduction.—Nature has gone to a great deal of pains to achieve a living and changing world and to perfect a mechanism of exchange and recombination of hereditary characteristics. Some of her methods strike us as being still somewhat crude and wasteful, but she will doubtless improve upon those within the next few million years, which are but a moment in her sight.

From protozoon to Volvox required a long, long period of time. No one knows how long, and scientists who formerly talked in terms of probable thousands of years now speak of millions. From Volvox to man has required a similar stretch of time. Nature experimented, apparently in many moods from playful to severe, and always with prodigal disregard of the individual but with jealous solicitude for improvement of the type and the perpetuation of life.

[1] Newman, H. H., *Outlines of General Zoology*, p. 186, The Macmillan Company, 1926; Wells, Huxley, and Wells, *The Science of Life*, pp. 448–450, Doubleday, Doran & Company, Inc., 1930; Plunkett, C. R., *Outlines of Modern Biology*, p. 418, Henry Holt & Company, Inc., 1930; Lane, *op. cit.*, p. 456.

After the sex organs were segregated in male and female individuals many devices were employed for bringing the sex cells together. In plants the pollen grains (male fertilizing cells) are carried to the female cell by wind, insects, birds, etc., in the colorful, fragrant ways familiar to us.

In animal sexual reproduction three types are seen. (1) In the case of most *fishes*, the female at spawning time seeks a warm and shallow spot and deposits her eggs, literally by thousands. In obedience to some obscure attraction the male fish follows and deposits sperm cells by millions over the spot where lie the waiting eggs. In spite of enormous waste, many of these cells do unite and produce young fish, who must do for themselves without maternal care from the moment of their birth. (2) In the case of *birds*, nature effected a great saving by having the sperm cells deposited by the male directly within the body of the female; thus the egg is fertilized before leaving her body. Since the robin produces perhaps a dozen eggs in a season, whereas a cod will produce millions, nature causes the parent birds to take great care of their eggs and of the young who come from them. (3) In *mammals* still greater saving was effected by having the egg both fertilized and incubated within the female body. As the mammalian animal becomes more complex or highly developed, the period of incubation before birth and of helplessness after birth lengthens and the number of young produced becomes fewer. From protozoon to man, however, the basic mechanism of reproduction is the same: cell division and separation through the marvelous chemical mechanisms here described.

The Meaning of Sex.—With the creation of two sexes, sex attraction appears, followed later by an equally powerful socio-biological force integrating the interests of parent and offspring. In other chapters attention is called to the fact that social relationships produce chemical reactions and actually modify bodily organic function. *It seems to be an actual fact that living things do not influence each other unless chemical changes are produced.* According to the field theory, individual fields of force arise in new situations and integrate with each other to form still newer, more complex dynamic fields. The converse is equally true. Injury or removal of certain glands that manufacture potent chemical secretions, such as the pituitary (see page 142), or the omission of certain essential catalysts, such as vitamin E, from the diet of experimental animals may entirely obliterate sex emotion and attraction and even change them to repulsion (see page 266). The removal of certain chemicals, notably manganese, from the diet of a mother rat may cause her to lose all maternal solicitude and even to devour her young (see page 256). Psychic field properties are thus disturbed and the whole field of personality is thrown into new tensions (see page 405).

When in the economy of nature it becomes necessary for fertilization or union of differing sex elements to occur, sex attraction becomes as powerful, as essential, as orderly, and as lawful as is the cohesive, integrating force that holds together the structure of molecule or atom. Scientifically speaking (and thinking), one physiological hunger is as legitimate and as decent as another—sex hunger is no more moral or immoral than food hunger. In the instance of sex hunger, however, a social factor of great significance is introduced because the cooperation of a second free individual is involved in the satisfaction of the craving, and the biological implication of helpless progeny endows the sexual act with tremendous social and moral significance.

With the cessation of growth, *i.e.*, with physical maturity, and the onset of the functioning of the sex glands, now manufacturing potent new chemicals, specific physical tensions arise, accompanied by local congestion which can only, or at least most effectively, be relieved by the sexual act. Civilized social custom has imposed restraint and delay in the exercise of the sexual function during the premarital life which compels the conventional individual to seek relief for organic sex tension and congestion in other intensive interests and activities. This is called *sublimation.* Seminal emissions spontaneously relieve the male to a certain extent. Mental attitude modifies the situation to a considerable degree in both sexes. The individual who has wholesome physical activities and many intellectual interests sublimates more successfully than one less fortunately equipped.

In obedience to the laws of rhythm which seem to operate throughout cosmic organization there is fluctuation or periodicity in the appearance of these tensions. Spawning time for fishes occurs with predictable regularity. The tensions of the female are relieved when she deposits her eggs in some warm and shallow quiet pool. The warmth and the quiet may facilitate the release of the eggs from the oviduct, or there may be some as yet obscure instinct which leads her to select a spot favorable to the survival of the young. There arise in the male at this time corresponding tensions and an inclination to follow the female. The discharge of the seminal fluid (milt) over the freshly deposited eggs results. The sex life of the fish is then over, and for the time being life becomes again a matter of food and survival, with no evidence of continuing individual interest or even recognition between the parties involved.

As for the frog, at breeding time the male clasps the female and goes into a trancelike state, which may last for some days. Under the stimulus of the sexual embrace the female lays her eggs, which are then directly fertilized by the sperm of the male. By the time the birds have branched off from the common biological stem, a prolonged attraction between the sexes appears, enduring for the entire mating season, and even, in some species, for the life span of the mating pair.

In birds the institution of courtship is well developed, and we see what to us seems a ludicrous duplication of the human arts and wiles of retreat and pursuit, coyness and coquetry, and showing off, which are displayed under similar circumstances in the drama of human life. We see courtship followed by the striking phenomenon of nest building, and we watch in amazement the finally mated pair as they go about their orderly preparation for their forthcoming parental obligations. After courtship has terminated in relief of physical tensions through fertilization and laying of the eggs, we see sexual excitement replaced by something resembling tender solicitude as the pair in some instances actually share the task of sitting upon the eggs, while in others the female is fed by the male. When the nest becomes filled with greedy birdlings life becomes very real and very earnest, and both parents are possessed and consumed by a joint emotion of parental solicitude. The parents will wear themselves thin, go hungry, expose themselves to hazards, and even die in the interests of their young.

Following the period of complete dependency comes a time when fledglings must be taught to fly and to feed themselves.

Nothing in living phenomena exceeds the wisdom and skill and solicitude with which the young birds are taught and trained and started upon their mature careers. Then the parents are through! Parents and progeny suddenly are strangers, and, if interests conflict, even enemies.

This picture of courtship, mating, parental devotion, and care of young can be duplicated in a thousand varied forms in animal life,[1] but there is no evidence that any special bond is felt between parent and young after the period of dependency is over and the young are able to care for themselves. In the case of the civilized human animal the parental attachment survives the dependency of the young, and is even expanded in a reversal of relationship such that the offspring may care for the parents in the helplessness of old age with a solicitude approaching that of parents for their young.

In the ascent of man in the scale of evolution and civilization, the relation of the sexes, with the concomitant and resultant parental relationships culminating in the institution we know as *the family*, has become one of the dominating and motivating emotions of human life. Merely physical sex attraction has been expanded into the mystic and powerful force called *romantic love*. As life has become more complex, emotional (and practical) bonds have constantly arisen out of the complexities and integrated them, forming the unified thing we call *society*. The rise of the integrating bond of human love in its various phases has created literature and art, and romantic love has ever been their major theme.

With the rise of a brain mechanism, which seems designed increasingly to replace and eventually to supplant the non-learned directive force of instinct, humanity in general and this generation in particular finds itself obliged to think its way through a bewildering maze of social emotions, relationships, and responsibilities. Since all of this is but a manifestation of cohesive force in the larger biological organism known as *society*, group thinking is involved. The individual cannot think, decide, and act entirely for himself (see Chap. VII).[2]

[1] LANE, *op. cit.*, Courtship, pp. 314–319; Care of Young, pp. 320–331.

[2] TIETZ, ESTHER BOGEN, and CHARLES KIPP WEICHERT, *The Art and Science of Marriage*, McGraw-Hill Book Company, Inc., 1938.

The members of the present generation, because world conditions have undergone complete upheavals and reversals, find themselves faced with the necessity of assigning new values and sanctions to their social experiences, such as physical sex relations, sex companionship, marriage, divorce, homemaking, birth control, and parenthood. The new freedom of women in itself has precipitated a new order. The organization of society must expand to provide for the enlarging functions of women. This predicates a new freedom of understanding between the sexes. If this unprecedented frankness is to bring harmony and growth and advancement and survival, and save nature from the brief embarrassment and delay of having to wipe out a civilization and begin over again, this frankness must be built upon an intensely scientific attitude of thought. The young men and women who stand midway in the stream of life today and make the momentous decision whether or not there shall be life after them need to be motivated to join the "search for reality" as their prime objective.[1]

Summary.—The story of life is a serial story, always "continued in our next." As evolution of complex forms of life progresses "the plot thickens," and new and complicated methods appear for continuing life from generation to generation. The simplest method is fifty-fifty division of parent organism into progeny. Budding enables the parent to produce numerous successive offspring. Sporing, conjugation, hermaphroditism, and finally separate individuals of two sexes bring the installments up to date. We seem to be left (as some authors serve us) under the necessity of making up our own ending and continuing the plot from this point according to our own ideas and desires. Scientific integrity of thinking alone will produce a valid and consistent "next chapter."

Should not boys and girls be brought up to consider sex matters with the same absolute frankness, casualness, and freedom from embarrassment as obtains in their introduction to any other facts of living or any other natural phenomena, such as weather, digestion, politeness, or sleep?

[1] Dell, Floyd, *Love in a Machine Age*, Chap. X, Adjustment to Reality, Chap. XV, The Modern Mating Problem, Farrar & Rinehart, Inc., 1930.

Should not boys and girls, young men and young women, be educated for parenthood coeducationally? Is the time ripe for the initiation of such a venture?

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New Words in Chapter X

calcification. Deposition of calcium salts in the tissues.

cancellated. Having a latticelike structure.

embryo. The fetus before the end of the third month.

epiphysis (plural **epiphyses**). A part or process of bone which ossifies separately and subsequently becomes integrated with the main part of the bone. In higher vertebrates the ends of the long bones of the limbs are formed in this way and in man, in some cases, do not unite with the shaft of the bone until about the twentieth year. In rickets the epiphyses of the long bones are enlarged.

false pelvis. The part of the flaring hip bones (the ilia, sing. ilium) above the true pelvis.

fetus. The unborn child after the end of the third month.

fontanelle. Any one of the unossified spots on the cranium of a young infant.

foramen ovale. The opening between auricles of the fetal heart.

fulcrum. The support, as a wedge, about which a lever turns.

inlet (of the pelvis). The upper opening of the pelvic cavity.

lever. A rigid piece capable of turning about one point or axis (the fulcrum) and having two or more other points where forces are applied. Used for transmitting and modifying force and motion.

leverage. Mechanical action of a lever. Mechanical advantage gained by a lever.

lymphatic. Pertaining to the lymphatic system of glands and vessels which give and take lymph from the tissues.

meninges. The three membranes covering the brain and spinal cord: the dura mater, pia mater, and arachnoid.

obstetrics. The science of childbirth.

ossification. The formation of bone; the transformation of cartilage into bone.

outlet (of the pelvis). The lower opening of the pelvis.

pelvis (plural, **pelves**). The basin formed by the *os pubis*, innominate (hip) bones, sacrum, and coccyx.

ptyalin. The digestive ferment in the saliva which reduces sugars and starches to simpler forms.

rickets (rachites). A deficiency disease caused by lack of vitamin D and affecting bone structure and soft tissues of very young children.

secretion. The process of separating various substances from the blood and making new compounds of them. The product of secretory action.

stresses. Strains or forces in particular directions.

suture. A seam or joining, as any nonmotile union of bones.

true pelvis. The part of the pelvis below the false pelvis, the basinlike structure holding the reproductive organs, bladder, and lower bowel.

CHAPTER X

THE SYSTEMS

I will point out one all-important point: that the cell cannot be regarded as an isolated and independent unit. The only real unity is that of the organism, and as long as its cells [tissues and organs] remain in continuity they are to be regarded, not as morphological individuals, but as specialized centers of action into which the body resolves itself and by which the physiological division of labor is affected.

—Arnold Gesell.[1]

Diversity within Unity.—As recounted in Chap. XVI, by the time the child is born, various sets or systems of organs and structures have arisen out of the constantly differentiating unity that maintains the organic wholeness of the body. The expectant mother and the mother of children should have something of a mental picture of the nature, relationship, and functions of the more important of these systems, in order intelligently to manage the fundamentally important matters of physical and mental hygiene for herself and for her children.

The Skeleton.—It is of primary importance that the chemically active organs and tissues have fixed location and support, that they be protected from injury, and that they have optimal relationships with each other. A properly developed and aligned skeleton serves all these purposes. Securing good *posture* (or to use the more modern term, good *body mechanics*) in the growing child is one of the recognized duties of those rearing young children. The human skeleton is probably the most finished piece of architecture in the universe. Every known principle of mechanics and physics is exemplified in it. The stresses and leverages are mathematically correct, at least where growth is untrammeled and the natural pattern has not become distorted. There is perfect economy in the utilization of material and of space; for example, notice the thrift shown in making the long bones hollow to increase strength without increase of weight; in expanding the ends in spongy, cancellated tissue, to give surface

[1] *Infancy and Human Growth*, p. 418, The Macmillan Company, 1929.

play for joints and attachment for muscles; and then safely stowing away within these otherwise wasted spaces the delicate, all-important blood-forming organ—the red bone marrow. Space forbids the mention of many important and interesting details; we are practically interested, however, in the developing skeleton of the child as this relates to his physical efficiency, and in the structure of the pelvis as it relates to childbearing.

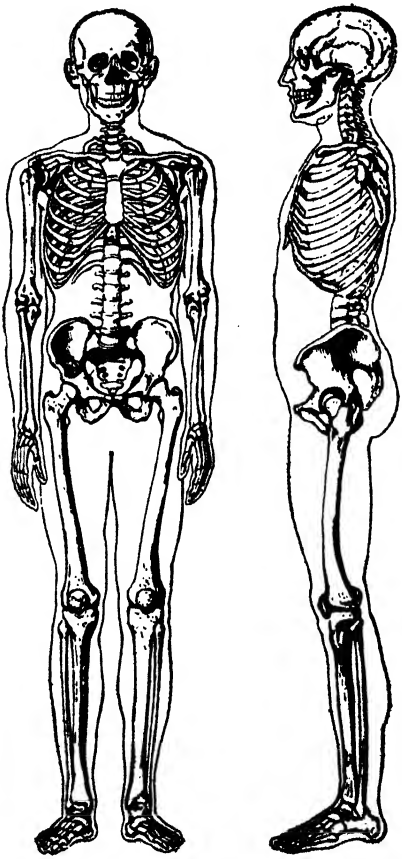


Fig. 26.—The human skeleton. (*Toldt, Atlas of Human Anatomy, The Macmillan Company.*)

Growth of Bone.—The bones of the head and face are first laid down in the embryo and fetus as dense membranes arranged in plates or pieces which begin to turn to bone (calcify) during the last period of pregnancy, but are still quite plastic at birth. During birth the head and face, in being forced through the birth canal, may be molded to an astonishing and sometimes terrifying extent. Many a mother, when first she beheld her newborn child, has thought she had given birth to a monstrosity. Within a few days, however, the parts are readjusted, and the head becomes round and shapely, with no apparent injury resulting from the strenuous squeezing. The last of the plates of the skull to be firmly welded together are the frontal and parietal bones, which join near the center of the top of the head (see Fig. 28). The pulsating fontanelle, or "soft spot," normally closes after 15 to 18 months, but the process may be delayed until later in rachitic children.

The rest of the skeleton is first laid down in cartilage, which also is calcifying at the time of birth. The replacement of cartilage with bone goes on, however, until full adulthood. Indeed, one of the most convenient practical measures of physiological age or developmental growth is the degree of ossification of the bones in the wrist of the young child, as shown by the X ray (see Fig. 27).

The long bones of the child increase rapidly in length, as will be apparent when one thinks of the relatively short legs of a newborn babe, whose legs actually are shorter than his arms (see Fig. 1). There are numerous centers (fields, gradients) of bone

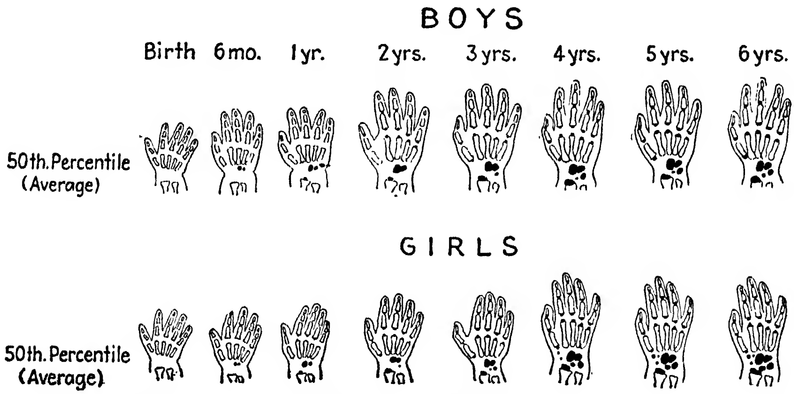


FIG. 27.—X rays of the hands of boys and girls from birth to six and one-half years: the 50th (average) percentile. (*Voght and Vickers, Radiology, October, 1938. Reproduced by permission of the President and Fellows of Harvard College.*)

growth (some 800, according to Arey) in the entire growing skeleton. Of these perhaps the most active is the growth layer between the shaft and head of the long bones, called the *epiphysis.* In rickets, tuberculosis, and other nutritional diseases affecting growth in the child, ossification does not proceed at a normal rate and the epiphyseal region remains large and soft. "Enlarged epiphyses" is one of the symptoms of rickets.

The Head.—Nature, being most jealous of the brain—the thing which the rest of the body seems designed to serve—and being at the same time under the necessity of giving it a supervisory position, has made for it a double-walled spherical case of bone, which is perched upon a revolving, extended neck. This case is made in sections with dovetailed sutures, or joinings, with blood and lymph pipes, and very modern electric wiring (nerves) concealed between layers or walls of bone. The double wall serves the same purpose as the hollow wall of a dwelling: it increases the strength, absorbs the shock of forceful blows, insulates against temperature changes, and provides safe conduct for plumbing and wiring (blood vessels and nerves). The special senses of sight, hearing, taste, and smell occupy cleverly protected cavities, or sockets, within the skull, all placed in outpost positions with the most direct access possible to the cerebral, conscious, or thinking part of the brain.

The Trunk.—The ventilating (lungs), heating (heart), and commissary (stomach and intestines) departments are arranged within the protective but flexible compartments of the chest and abdomen. The flexibility and rotation of the spine with its precise and important curvatures; the ribs with their hinges, which permit regulated excursion of the lungs in breathing; the precise angle of support to the abdominal contents afforded by the false pelvis, and the protection of the pelvic organs in the true pelvis; the strikingly clever flexible mechanics of the arm and hand, and of the instruments of locomotion, the legs, all challenge our wonder and our admiration. Good posture may be said to be that relationship of supporting parts which affords the freest function to the head, to the vital organs contained within the trunk of the body, and to the locomotive and manipulative mechanisms, the legs and arms.

The Pelvis.—We are particularly interested in the bony pelvis, within which are found the reproductive organs (see page 272). In this instance nature had several problems to solve: (1) the protection of these important organs from injury by outside force; (2) adaptation to the conditions of pregnancy; and (3) adaptation to the size and form of the child in giving birth.

Protection of Organs.—Protection of the reproductive organs has been accomplished by suspending them across a basinlike arrangement of curving bones, called the *true pelvis*, which lies within a space bounded by the os pubis, the hip bones, the sacrum, and the coccyx (see Fig. 28). The true pelvis is guarded by the projecting hip joints and also by the flaring rims of the hip bones which form the *false pelvis*. The massive muscles of the hip also help to protect the bones and the contents of the cavity from injury. All in all, the location of the important mechanism for perpetuation of the species is exceedingly strategic.

Adaptation to the changes of pregnancy is secured by the rising of the pregnant uterus out of the true pelvis at about the middle of pregnancy (see page 356). Thereafter, the false pelvis forms a partial support from below, while the elastic but strong muscles of the abdomen (from which nature considerately removed the ribs in erect animals) furnish support and a degree of protection,

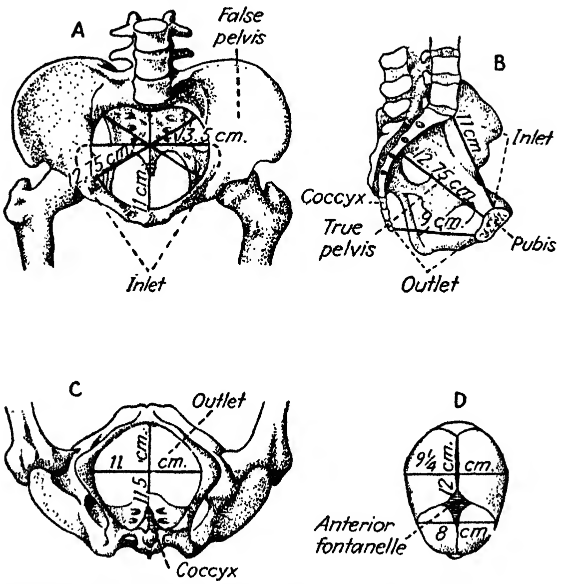


FIG. 28.—The female pelvis with diameters. *A*, from above; *B*, from the side, median section; *C*, from below; *D*, the top of an infant's head.

and at the same time give the freedom from compression so necessary in the enlargement of the uterus and the growth of the fetus.

Adaptation to the size of the child is secured by a curious and striking standardization of the size of the female pelvis, regardless of the size or proportions of the woman. We find here a partial explanation of the fact that small women give birth to large babies with no greater proportion of difficulty than large women experience. So completely has standardization been effected, that "normal" measurements of the pelvic *inlet* (upper rim of the true pelvis) and the *outlet* (lower rim of the true pelvis) are stated in all textbooks on obstetrics and very little deviation from these is found, although one woman may weigh 100 pounds and the next one twice as much. The child must pass through the pelvic openings, inlet and outlet, in the process of birth; it is therefore important that the diameters be correct. The longest diameter of the inlet between the true and the false pelvis is the transverse diameter, which is about 5 inches. The longest diameter of the outlet of the true pelvis is the anteroposterior,

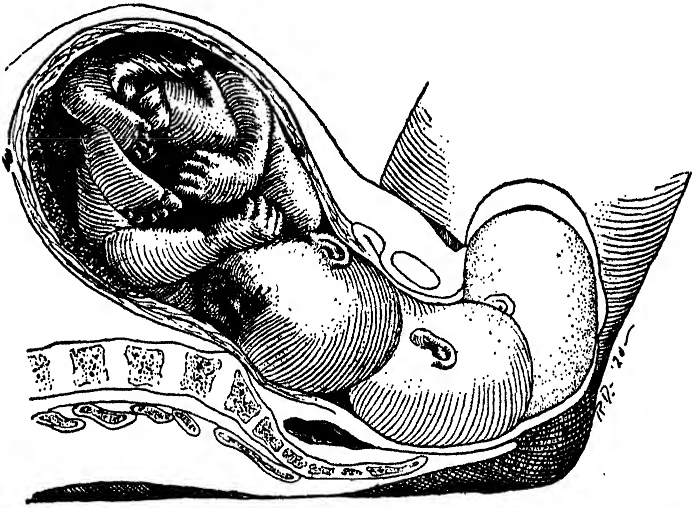
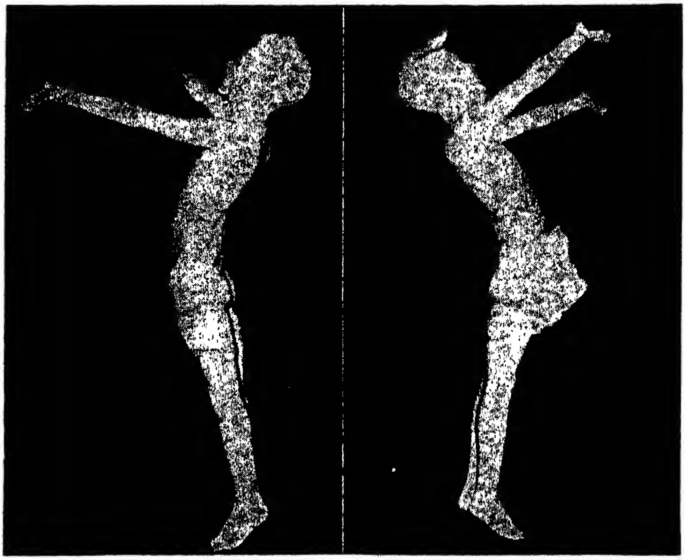


FIG. 29.—Diagram indicating the rotation and pivoting of baby's head during birth. (*VanBlarcom, Textbook of Obstetrics for Nurses, The Macmillan Company.*)

which is approximately 4.5 inches (Fig. 28). This difference in contour between the inlet and the outlet necessitates a quarter revolution of the infant's head in its progress through the pelvis (Fig. 29). Another striking adaptation is the fact that the size and contour of the head of the child are very similar to the size and contours of the pelvic circumference (see Fig. 28).

Defects of the Pelvis.—Sometimes the bones of the growing girl child are softened by rickets or distorted by tuberculosis, bad posture, or injury. The diameters may become narrowed in one direction and elongated in another, making it difficult or impossible for a child's head to pass through the openings. This is one of the complications of childbirth that must be met in extreme cases by surgical delivery (Caesarean section) through the abdominal wall.[1]

Pelvic Measurements.—A skillful physician can estimate the size of the various pelvic diameters by certain measurements, which always should be taken as early as possible in the first pregnancy. Some obstetricians take measurements of every woman coming to them for the first time, even if she has previ-



A. *B.*

FIG. 30.—"The Good Fairy." *A*, the boyish side; *B*, the girlish side. (*By permission of Jessie McCutcheon Raleigh.*)

ously borne children; in this way the doctor can anticipate complications occasioned by abnormalities of the pelvis and be prepared to meet them. A woman known to have abnormal pelvic proportions or abnormally small diameters should always go to the hospital for confinement, in order that the correct surgical facilities may be at hand if required. When proper

[1] The latter method, it is supposed, is called *Caesarean section* because of the tradition that Caesar the Great was delivered in this manner, although the term may be derived from the Latin *caedere*, "to cut." It is usually written, however, with a capital C. The operation is now quite safe for both mother and child when performed by a skillful specialist. It has even been safely performed two or more consecutive times in individual cases.

and timely arrangements are made and the condition is known before the onset of labor, there is no great danger involved in surgical delivery.

Development and Hygiene.—In early childhood there is little difference between male and female pelvic skeletons (Fig. 30).

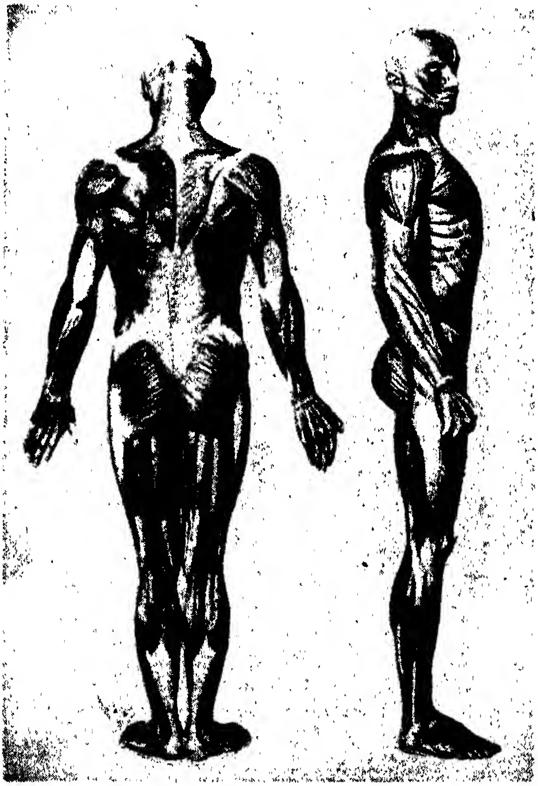


FIG. 31.—The muscular system. (*Tandler, Anatomy, Julius Springer.*)

With the changes of puberty, however, marked differences appear. The pelvic girdle of the female widens and changes in shape. The outlet of the female pelvis is much larger and the internal space is greater than that of the male.

It is important to the maternal function that the mineral metabolism and the nutrition of every girl child be normal throughout all her growing years; that she have vigorous active exercise to facilitate the proper spread and shaping of the pelvic structures; that she observe correct posture in sitting, standing, and walking; and that hampering clothing be avoided.

The Muscular System.—The muscular system is no less interesting and important than the skeletal system. Indeed, the bone levers would be quite useless without the muscle fulcrums which move them. We are interested specifically in noting the manner in which nature has strengthened and fortified

FIG. 32.—Muscles of the abdomen. The outer layer is shown on the right, the middle layer on the left. The deep layer is not shown. (*From Tandler's Anatomy, Julius Springer.*)

the human abdominal wall by providing several layers of muscles with fibers running in every possible direction. A strong band of tendon runs down the center, the *linea alba* (white line) (see Fig. 32), furnishing attachment for various sheathes of muscles and greatly strengthening the entire wall. During a pregnancy in which the muscles are lax, or in which the woman is too much upon her feet, or the uterus is large, the *linea alba* may weaken or even separate. It is usual for women who increase greatly in size of abdomen during pregnancy to wear well-adjusted abdominal support (Fig. 88). The best safeguard, however, is good development through free activity during the growing years and well-directed exercise before and during pregnancy.

The Perineum.—The perineum (see page 278) is a mass of muscle fibers running in several directions which fills the space between the vaginal opening and the rectum. It forms the floor of the pelvis. Physicians take great pains to have the perineum intact and normal following childbirth.

The Digestive System.—The mechanism whereby "selected portions of environment" are transformed into soluble fluid nutriment, which is strained or filtered through the microscopic "sieves" of the intestinal capillaries into the circulating blood of the body proper, is one of the most interesting of the many integrated mechanisms of the human body. Figure 33 is a semi-diagrammatic representation of a system of processing laboratories running *through* the body from mouth to anus, but in a sense quite separated from the functioning mechanism that constitutes the real organism. Except for the specifically prepared and standardized substances extracted from the food mass and absorbed into the body, the food canal is essentially outside the body and is separated from it by the limiting endothelial mucous membranes lining the tract.

Food is crushed by the teeth, pulverized by the muscles of the stomach and bowel, and liquefied by glandular secretions; the large colloidal particles are broken down by the digestive enzymes into simpler chemical compounds (proteins are resolved into amino acids, colloidal sugars and starches into soluble sugars, fats into fatty acids and glycerin), the whole mass being eventually converted into a nutritive milky fluid (chyle), which is strained by osmosis into the capillaries of the villi (lacteals) lining the intestine. It is then carried, in considerable part, by the portal circulation to the liver, where it undergoes further processing and where it is finally fed "on demand" into the blood stream and carried through the capillaries to every one of the billions of cells in the body. Some of the digested nutriment enters the general circulation directly.

Glands.—Glands are highly specialized organic, chemical laboratories, which select by osmosis certain of the 18 or 20 chemical elements or their compounds that are found in the blood stream, and put these together according to the individual formula assigned to each gland, each of the glands forming an entirely new compound called a *secretion.* Each secretion has a specific chemical action usually catalytic (see page 41), all fitting

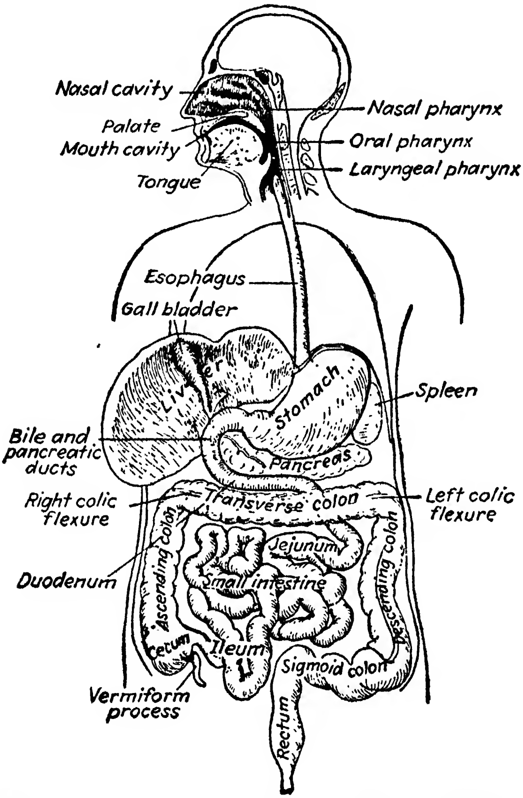


Fig. 33.—Diagram of the digestive system. (*Morris, Human Anatomy, P. Blakiston's Son & Company, Inc.*)

perfectly into the general vital scheme of physical organization and integrated chemical action.

Glands are of two kinds: those having ducts and those not having ducts (*ductless or endocrine glands, see Chap.* XI). Glands having ducts manufacture measurable quantities of fluid secretions, which are poured into cavities, as in the instance of the salivary and pancreatic glands, or upon external surfaces, as in the case of the sweat and oil glands of the skin. The digestive system is equipped with an interlocking series of glands, which bud out from the embryonic digestive cavity (see page 300). Beginning in the mouth, the *salivary glands* produce as required alkaline, mucilaginous *saliva*, containing *ptyalin*, the first of the digestive enzymes (ferments), which starts the reduction of starches into sugars.

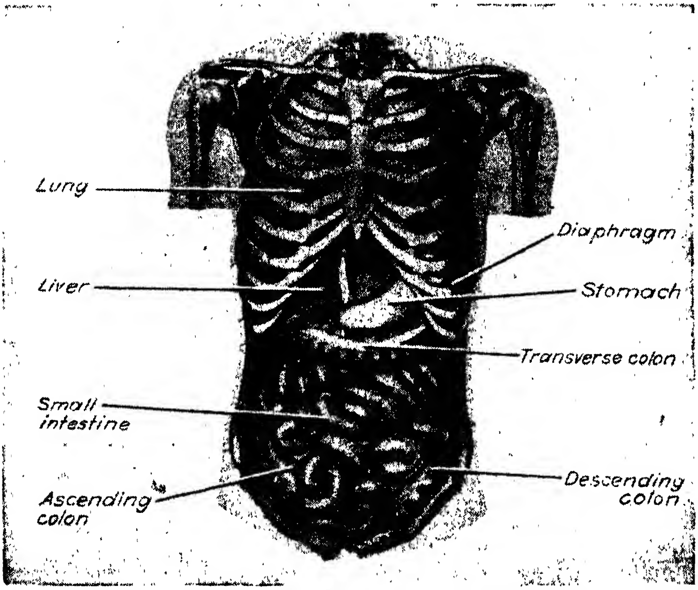


FIG. 34.—Skeleton of trunk, anterior view, showing viscera in situ. (*Warren's, Handbook of Anatomy, Harvard University Press.*)

The Stomach.—In the *stomach*, several varieties of gland cells, in response to the stimulus of the ptyalized alkaline food mass, secrete *hydrochloric acid*, *pepsin*, *rennin*, and several other catalytic or hormonelike compounds.

The Liver, Pancreas, and Bowel.—The *duodenum*, the first 12 inches of bowel, under the stimulus of the now greatly altered and acidulated and liquified food, liberates hormones which call upon the *pancreas* for its various enzyme-containing secretions, which are poured through the pancreatic duct into the bowel and further the reduction of proteins, carbohydrates, and fats. The duodenum calls upon the *liver* to empty, by way of the *gall bladder* and the *bile duct*, the antiseptic, stimulating, fat-emulsifying *bile*. *Gland cells within the wall of the intestine* also produce enzymes that put the finishing touches, so to speak, upon the process of turning fibrous, colloidal food into a watery solution that can pass through the sievelike membranes (see page 61) of the absorption villi.

The food residue, consisting of all insoluble cellulose and fiber and all undigested substances, is rendered harmless (detoxicated) by the intestinal secretions and by the bacteria normally living

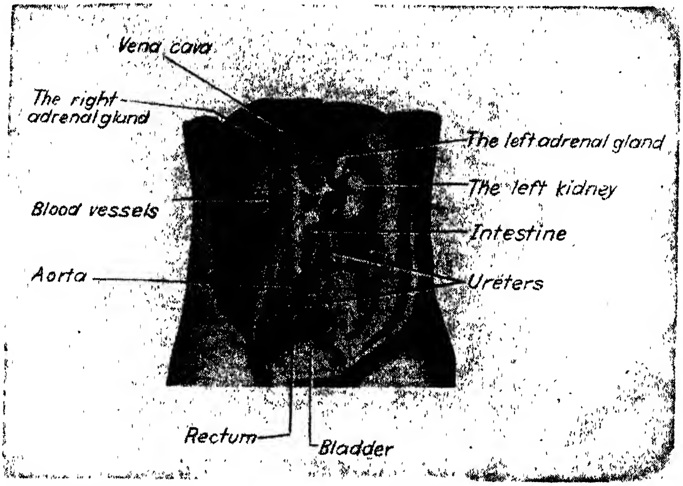


Fig. 35.—Kidneys, suprarenals, ureters, and bladder from the front. (*From Spalteholtz. Herzil Pub.*)

in the bowel, is finally stored in the *sigmoid* (Fig. 33), and thence is evacuated at intervals through the highly specialized organ, the *rectum* (see Fig. 71).

The Kidneys.—As the nutritive materials in the blood stream are taken up and used by the various tissue cells, waste compounds are formed as by-products of continuous ionization, oxidation, and catalyzation, and these must be promptly and continuously excreted from the body. The *kidneys* constitute a very elaborate glandular mechanism for straining out of the millions of blood capillaries passing through it all substances in solution that are foreign to the structure and needs of the body. The kidneys also form one of the *buffer mechanisms* (see page 41).

Urine is continuously drained through the long *ureters* (Fig. 35) into the *urinary bladder*, where it is stored between voidings.

The Circulatory System.—At 3 weeks' embryonic growth (see page 291), there is already a simple circulatory mechanism—scarcely more than a hollow tube—in the wall of which is a contractile enlargement that will become the heart. Already a bloodlike fluid is being propelled from the body to the forming placenta and back again. By 8 weeks, the liver is manufacturing blood cells and the heart shows four compartments with valves. By 12 weeks, the bone marrow also is beginning to make blood cells.

The human heart after birth consists really of two hearts—the *right heart*, which deals only with venous blood and the pulmonary

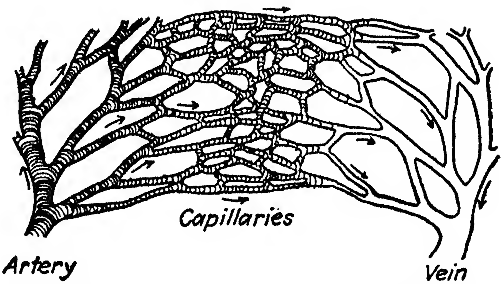


Fig. 36.—The course of the blood stream. (*Gregg and Rowell, Personal Health, World Book Company.*)

circulation, and the *left heart*, which receives oxygenated blood from the lungs and pumps it into all parts of the body through arteries. In the tissues, the capillaries serve to join the two circulations (see Fig. 36).

In the fetus, the right side of the heart does not function except to receive the venous blood passing from the body of the fetus into the right auricle and to send most of it through a valve, the *foramen ovale*, into the left auricle (see Fig. 81). The lungs receive only enough blood to nourish the lung tissue. The fetal circulation through the left heart, therefore, involves the distribution of pure, mixed, and used blood (see Fig. 81) and the complete double circulation is not established until breathing begins, following birth. When the infant first inflates the lungs with air, the foramen ovale closes (see page 291), the blood gradually ceases flowing through the cord to the placenta, and when the cord is cut and tied, a drastic change has taken place within a few seconds or minutes, involving the complete switching of the placental circulation to the lungs and the complete separation of the functioning of the two hearts.

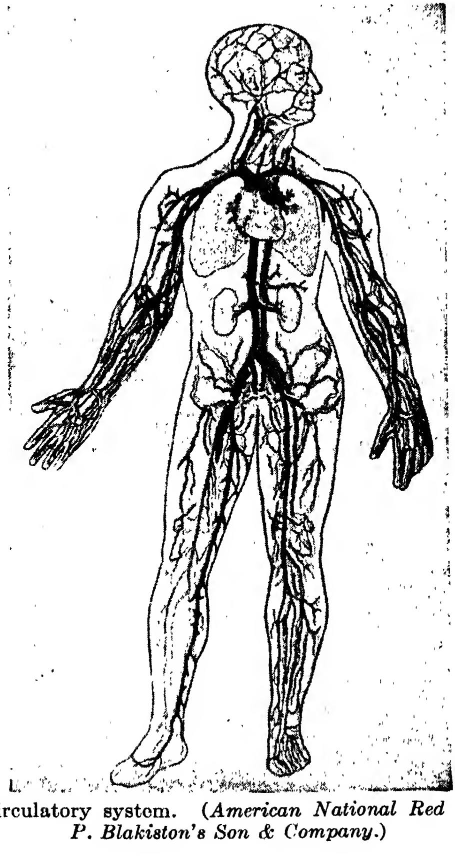


FIG. 37.—The circulatory system. (*American National Red Cross Chart III. P. Blakiston's Son & Company.*)

The Mechanics of Circulation.—The heart is the force pump that keeps the blood moving. The structure itself is unique, with its one-way valves, powerful muscle fibers that are involuntary but striated; its special circulation (coronary) through the heart muscle; its extraordinarily clever nerve supply from both autonomic and cerebrospinal nerve systems, and a striking lack of sensitive nerve endings for pain. We have seen (see page 40)

that the contractility of the heart depends upon electrical stimulation from constant ionizing of potassium, sodium, and calcium elements in the blood serum. We have seen (see page 52) that the embryonic heart cells are contractile from the time that they are set apart in the developing embryo and before they have a specific nerve supply. Altogether, the heart is probably the most unique power machine in all nature.

The Blood Vessels.—The heart, with incredible force, drives the blood into an elastic, semirigid set of tubes—the *arteries*. The arteries branch and ultimately become microscopic *capillaries* having walls made of cells cemented together to form a delicate microscopic membrane, one cell thick. The capillaries are so numerous that they lie close to every one of the billions of microscopic tissue cells, and the nutritive substances in the blood and the waste in the tissues filter, by osmosis, back and forth through the limiting membranes of the cells in the capillary walls. (Consider that even a needle prick causes blood to escape.) When the capillaries have given up oxygen and fuels and amino acids to the cells, and have taken on, so to speak, the ashes of the tissue fires, the blood, carrying the waste products of tissue metabolism, then doubles back toward the heart through the *veins* in an order exactly the reverse of that of the arteries, and finally reaches the right auricle, and passes through the auricle to the right ventricle, to be sent by the right ventricle to the lungs, from there to the left auricle, into the left ventricle, over the body, and so on, ceaselessly while life lasts. The blood from the feet and legs must flow straight uphill to get back to the heart (see Fig. 37). It is the tremendous push of the arterial blood, together with the constant squeezing of the muscles combined with the action of the venous valves, that keeps the venous blood moving (Fig. 38). It is the force of the impact of the blood against the walls of the arteries that is measured in taking the *blood pressure*. This measures in part the force of the contraction of the heart muscle and in part the tension or resistance of the arterial walls. It is often important, particularly in pregnancy, to know the condition

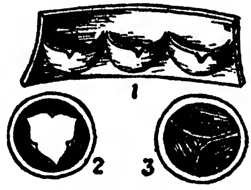


FIG. 38.—Semilunar valves in a vein; 1, vein laid open; 2, valves collapsed, 3, valves closed. (*Stiles, Human Physiology, W. B. Saunders Company.*)

of the heart and the blood vessels as indicated by blood pressure (see page 303).

The Blood.—The composition of the arterial blood is remarkably uniform. It has a fixed acid-base balance of pH 7.3 to 7.4 (see page 248); it contains approximately 0.1 per cent of glucose (sugar), 0.6–0.8 per cent of protein, 0.2 per cent of fat, 0.3 per cent lipoids, 0.83 per cent inorganic salts, and 0.03 per cent of calcium phosphate.[1]

The chemical mechanisms for keeping the blood at a relatively fixed pressure and with highly standardized chemical contents involve the *one-way lymphatic vessels* that the blood capillaries use as a floodgate to take up excesses from, and give up needed components to, the blood serum. This mechanism involves the presence of numerous sorts of buffers (see page 41), the give-and-take between electrolytes, the cooperation between the endocrine glands (see Chap. XI) and the autonomic nervous system (see page 183).

There are about 6 quarts of blood in the average adult body, and that quantity does not completely fill the vessels. The blood mass can make considerable shift from part to part, as seen in flushing and paling or in congestion of the uterus in pregnancy and premenstruation. The warm-feet-and-cool-head criterion of the trained nurse is an illustration of the importance of the local shift in blood mass.

The Lymphatic System.—The lymphatic circulation is a one-way system of vessels originating in the tissue interspaces and draining into the blood vessels above the heart. Soluble nutrients filter into the lymph vessels and from them into tissues; also, waste filters from the tissues into the lymph, and many germs are destroyed by the white corpuscles, or lymphocytes, which abound in the lymph glands. Lymph acts as a go-between for blood and tissues, equalizing blood pressure and aiding in keeping the blood composition stable.

The Tonsillar System.—Lymph vessels pass through many lymph glands. Of significant importance are the *tonsils* and *adenoid*, lymphoid glandular structures found in the throat (Fig. 70). The two *faucial* or *throat tonsils* are located behind the mus-

[1] MITCHELL, PHILIP H., *General Physiology*, p. 502, McGraw-Hill Book Company, Inc., 1923.

cular pillars on either side of the throat and are commonly known as *the tonsils.* The cauliflowerlike *adenoid* gland placed on the back of the throat, exactly where air drawn through the nose strikes the throat and is diverted into the trachea, is also lymphoid in character; and there is lymphoid tissue at the base of the tongue, known as the *lingual tonsil.* One swallows through a closed ring of lymphoid gland tissues, placed as sentinals at the entrance to the body. Scattered along the lining of the small intestine are patches of lymphoid gland tissue, known as *Peyer's patches,* or *intestinal tonsils,* which doubtless also are protective.

The Reticulo-endothelial System.[1]—This system, which is closely associated with the lymph system, consists of a great number of peculiar cells derived in part from the same source as connective (reticular) tissue and in part from embryonic endothelial cells. These cells seem to retain embryonic character and are able to adapt themselves to a variety of purposes. Reticulo-endothelial cells are found in the spleen, lymph nodes, bone marrow, liver, and thymus, and are scattered throughout connective tissue; in the form of monocytes, they even circulate in the blood. The reticulo-endothelial cells seem to play specific parts in blood formation and in the production of immunizing antibodies.

Body Temperature.—The internal temperature of the body is fixed normally within 1 degree of variation at 98° to 99°F., usually stated as 98.6°F. This is the optimal temperature for chemical action and physiological function of the colloidal sols and gels (see page 47) within the fluids and tissues. Fuels are oxidized within the cells of the body in the exact amount necessary to keep the body warmed to this "normal temperature." If the surface of the body is exposed unduly to cold, more food fuel must be oxidized, or burned, in the tissues and the more food the individual will require if he would prevent the conversion of his body substance into fuel. Thin persons burn up more fuel than do fat persons, who insulate their surface blood vessels in fat as with a cloak. Thin children should be warmly and evenly clad. They do not do well under the fad for exposing the legs entirely bare from socks to small panties in cold winter weather.

[1] Martin, Henry Newell, *The Human Body,* p. 330, Henry Holt & Company, Inc., 1934.

In hot air, the blood comes to the surface and is cooled by evaporation of perspiration. In a cold air, the skin shrinks and pales, while the blood concentrates in the vital organs.

The endocrine system is of so great importance that it will be the subject of the entire next chapter.

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New Words in Chapter XI

anion. The product evolved at the anode in electrolysis and regarded as electronegative.

antigen. Any substance which causes the formation of antibodies or immune bodies.

autacoid. A synonym for endocrine secretions, including both hormones and chalones.

branchial gill slits. The respiratory organs of fishes. Gill slits appear in the embryo of all animals above the fishes.

castration. Removal of the testes from young male animals.

cation. The product evolved at the cathode in electrolysis and regarded as electropositive.

chalone. An autacoid that slows or retards the action of an organ or tissue.

cretinism. Arrested mental and physical development due to decrease or absence of function in the thyroid gland during fetal growth.

fatigability. A tendency to fatigue easily.

goiter. An enlargement of the thyroid gland.

hormone. An endocrine secretion that stimulates activity in another organ or tissue.

hypersecretion. Excessive or too copious secretions.

hyposecretion. Diminished or too little secretion.

pernicious anemia. A type of severe anemia characterized by destruction of essential blood elements and which may be related to deficiency of antianemic hormone.

provitamin. A substance the presence of which is necessary to the formation of a particular vitamin.

rabies. The hydrophobia of animals.

reticulo-endothelium. The name given to cells having characteristics both of reticular tissue and of endothelial tissue. These cells have important functions in blood chemistry and in antibody formation.

tetanus. An acute disease in which there is a state of persistent tonic spasm of voluntary muscles.

tetany. A condition characterized by painful, tonic, spasm of the muscles of the extremities, supposed to be due to a toxic agent.

viosterol. A concentrated artificial form of vitamin D derived from irradiated ergosterol from the plant ergot.

vitamins. A group of catalytic substances (sometimes called *plant hormones*) found in natural plant and animal foods and essential to normal metabolism.

CHAPTER XI

THE ENDOCRINE SYSTEM

In the highly complex mechanism representative of the bodily activities of the higher mammals, different organs and tissues have taken over very special activities and functions. In order that the entire organism may work in harmony special mechanisms have come into being. One of these mechanisms is the nervous system, which may be likened to an intercommunicating network of telegraph wires centering in the great control switchboards of the brain, spinal cord, and ganglia [*autonomic*]. *In order, however, that life processes may proceed at a uniform rate rather than undergoing fluctuations as the environment changes, a second system of "chemical messengers" was necessitated whereby the increased activity of one organ would be reflected in an altered activity of another organ and thus, through a system of checks and balances, the complex mechanism would work as a unified whole. The hormones provide this "balance wheel." Their presence enables the organism to pass through periods of stress with all forces of the organism mobilized to meet this test and then, when the emergency has passed, to resume the normal coordination of bodily activities.* —R. A. Gortner.[1]

Endocrine Glands.—In addition to the glands of external secretion considered in the previous chapter, the body is equipped with an extensive system of extremely potent centers of chemical activity known as *endocrine*[2] *glands,* also called *glands of internal secretion, ductless glands,* and *incretory glands.*

Endocrine glands have no ducts for conveying the particular secretion to its destination, as found in the instance of the *glands of external secretion,* such as the pancreas or the salivary glands (see page 126). Indeed, the secretions are so minute in quantity they could not be so conveyed. The endocrine secretions are manufactured within gland cells and filtered directly through the cell walls into the capillaries that supply the gland; thus they enter the general blood stream and, greatly diluted, are carried over the entire body. However, only tissues susceptible to or sensitized to the particular secretions will be affected by them.

[1] *Outlines of Biochemistry,* p. 833. Reprinted by permission of John Wiley & Sons, Inc., 1938.

[2] From a root meaning "to separate within."

One writer has likened the endocrine system to railway mail service. Letters (secretions) with specific addresses are put on the mail train (the blood stream) and carried to specified towns (organs or tissues) and finally distributed by local carriers (capillaries) to the individuals addressed (the sensitized tissue cells).

The endocrine secretions are commonly called *hormones* ("arousing to action"). However, since they may either retard

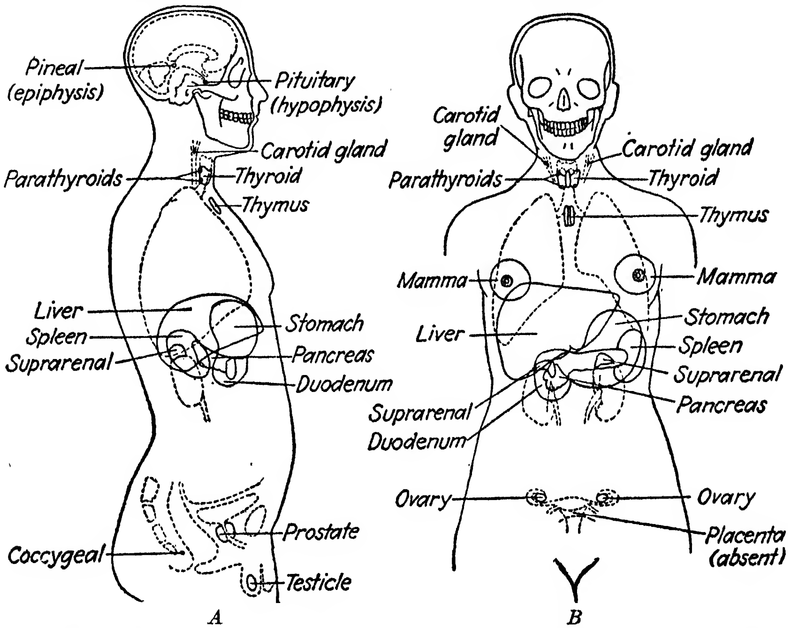

FIG. 39.—Diagram of the endocrine system. *A*, male; *B*, female. (*From Endocrinology and Metabolism, edited by L. F. Barker, D. Appleton-Century Company, Inc.*)

or stimulate chemical action, some writers limit the term *hormone* to secretions that excite activity, and call secretions that retard activity *chalones*, using the general term *autacoid* to apply to all endocrine secretions. The term *hormone*, however, is quite commonly used to apply to all internal secretions, and it is well to note, in reading, which use is made of the word by the writer.

The Number of Endocrine Glands and Endocrine Secretions.—The specific glands of internal secretion are the *thyroid*, the *parathyroids*, the *pituitary* (*anterior* and *posterior*), the *pineal*, the *thymus* (*medulla* and *cortex*), the *pancreatic islets*, the *adrenals* (*medulla* and *cortex*), and the glands of the *gonads*, or sex organs (the *follicle*, *corpus luteum*, *placenta*, and *interstitial glands*). Of these it will be noted the pituitaries, the thymus, and the adrenals actually are each two glands and the ovary and testes produce several glands. There are, in addition to specific glands, numbers of secretions having hormonelike properties given off from cells distributed within other tissues. The number of these is undetermined at present, as active investigation is in progress. While the number of known endocrine glands is not large, the specific secretions of most of them have been broken up into various subhormones, which probably are produced each by specific cells within the tiny glands. The exact number of these also is at present undetermined. Werner lists some 40 "known and postulated hormones."[1] Gortner names 31 "for which there is a reasonable amount of data in literature."[2] For the purpose of this text a brief general account will be given with special discussion of those that seem specifically important to the story of reproduction, growth, behavior, and nutrition.

The Function of Hormones.—Hormones resemble ions, enzymes, and vitamins in that they are catalytic in action and very minute amounts of the hormonic substance may instigate and stimulate great activity or check activity on the part of other organs and tissues. Hormones, like other catalysts, do not enter permanently into the structure or composition of the organ or tissue affected. Hormones participate in most of the biochemical processes of the body: nutrition, growth, and reproduction could not begin and could not be carried on without the minutely balanced actions of the endocrine system. In fact, most living chemical processes require the combined and integrated action of hormones, enzymes, and, often, vitamins.

The Endocrine System Is a Unity.—While all systems of the body are attuned (electrically and chemically balanced) within themselves and with the whole organism, the balance and sensitivity of the endocrines with each other is extraordinary. They have been likened to the instruments of an orchestra, which must be tuned to each other with minute exactness, "whereupon they may play many melodies."

[1] WERNER, AUGUST A., *Endocrinology*, Chap. IV, Lea & Febiger, 1937.
[2] GORTNER, *op. cit.*, p. 834.

This close interrelationship makes diagnosis of endocrine disorders sometimes difficult, since particular symptoms may be due, not entirely to the disordered function of the deranged gland —*e.g.*, the pituitary—but may be due to the fact that the thyroid, adrenal, and other glands do not function normally without the stimulus of the pituitary.

The Order of Appearance.—The endocrine glands begin to appear very early in fetal growth and function from the time of their appearance. The first endocrine gland to occur in animal evolution is the thyroid, and it appears in the human fetus at about 4 weeks' development. The pituitaries and the adrenals also appear early (5 to 6 weeks' fetal growth). From amphibia (turtles, frogs, etc.) on, all the endocrines are found.

The Stability of the Hormones.—While the origin and location of the glands in the bodies of various animals shift from species to species, a specific secretion, once established, remains fixed in character and action: *e.g.*, thyroxin, the hormone of the thyroid, has the same chemical composition and action whether found in frog, chicken, monkey, or man. Also it is not known that a hormone ever changes its character or composition. There may be too much or too little—abnormal amounts—but there are no abnormal hormones.[1]

The Chemical Composition of Hormones.—Although of extreme potency and concentration, hormones are made only of the elements listed in Table II, page 37. Some of the hormones have been isolated in crystalline form: thyroxin (thyroid), insulin (islands of Langerhans in the pancreas), and five hormones from the endocrine glands of the female and male gonads (sex organs). All of these except insulin have been synthesized (made artificially).

The Pituitary Gland (Hypophysis Cerebri).—The pituitary gland is a small structure about the size of a pea, situated behind the nose at the base of the brain (see Fig. 56). It is placed in the most inaccessible and best protected spot in the body, in a special receptacle of bone called the *sella turcica* (Turkish saddle). Small as it is, the pituitary comprises two distinct glands: the *anterior pituitary*, or *prepituitary;* and the *posterior pituitary*, or

[1] RENÉE VON EULENBERG WIENER, *Fearfully and Wonderfully Made*, p. 239, The Macmillan Company, 1938.

postpituitary, which includes the *pars intermedia* connecting the two glands.

There is no obvious necessity for the two pituitary glands' lying so close together, as they differ completely in structure and function. Indeed, in certain lower orders, the two pituitaries exist in separate regions of the body as separate glands. The anterior pituitary arises from the branchial gill slits (see page 298), while the posterior pituitary and pars intermedia arise as a downward growth from the hypothalamic region of the interbrain (see page 195). The posterior pituitary is found in animals from the very earliest evolutionary appearance of the brain. Its structure is in part nervous, in part secretory; it filters its secretions chiefly into the third ventricle of the brain, and may filter some directly into the hypothalamus[1] (see page 197).

The Anterior Pituitary.—This minute gland, the size of a split pea and weighing half a gram (0.5 gm.), has been called "the master gland," "the keystone of the endocrine arch," also "the physiological clock," which helps tick off the numberless organic rhythms of the body. While every endocrine secretion is indispensable, just as the smallest screw is indispensable in a machine, the anterior pituitary probably performs more spectacular functions than any other known scrap of living tissue of similar size. While the numerous and varied effects attributable to the anterior pituitary hormones seem to be quite clearly evident, it

[1] "Non-medullated nerve fibers also connect this ancient station by way of the spinal cord and the sympathetic [autonomic] nervous system not only with the thoracic and abdominal viscera, but some of them even turn back to act upon the anterior hypophysis [pituitary] itself. Hence diencephalonic [thalamic] messages may be relayed to this somewhat insulated part of the gland on whose hormones depend not only normal body growth and the normal function of certain subsidiary endocrine organs, but, indeed, the very perpetuation of the species. For without the presumably emotional discharge from this source of the hormone of sex, the chain of events leading to the escape, fertilization, and implantation of the ovum cannot take place. Though information may be gained by the independent study of its separate parts, physiologically the diencephalic-hypophyseal mechanism can only be properly interpreted when looked upon as a whole and even then only when its influence on the entire organism is taken into account. . . . Today . . . we have an increasing tendency to speak of the *hypothalamic-hypophyseal mechanism.*" WILLIAM ENGELBACH, *Endocrine Medicine,* p. 12, Charles C. Thomas, Publisher, 1932.

has not yet been possible completely to isolate or synthesize any one (with the possible exception of prolactin).[1] It is probable that the ultimate classification may vary from that used at present.

Secretions and Functions.—Small as it is, the anterior pituitary produces a number of specific secretions, which may be classified in three groups: (1) those regulating growth, (2) those regulating other glands, and (3) those regulating certain metabolisms.

1. *The growth hormone* stimulates and regulates general growth in some obscure manner, possibly through its relation to the oxidation of sugar. Apparently there is also a specific principle concerned with skeletal, or bone, growth acting upon the centers for bone growth, notably the epiphyses, the centers of growth in the long bones (see page 118). Hyposecretion (too little) during early years arrests growth and produces a certain type of dwarf. Hypersecretion (too much) during growth produces the 7- and 8-foot giants seen in side shows. Hypersecretion after growth ceases in the epiphyses excites growth of the flat bones, and the head, hands, feet, and hips enlarge, producing the tragically grotesque condition known as *acromegaly*. It is important that the anterior pituitary function normally during the growing years. Wolf says the anterior pituitary growth hormone causes cells to multiply, while the thyroid causes cells to differentiate. The growth hormone is antagonistic to the sex-stimulating hormones. The excess of growth hormones up to puberty may prevent sex development.[2]

2. *Gland-regulating, or pace-setting, hormones of* the anterior pituitary appear to coordinate and regulate the actions of most, if not all, the other endocrine glands. Subhormones have been identified that are involved in the control of the following specified glands: the *adrenotropic* (adrenal cortex), the *pancreotropic* (the pancreatic islets), the *thyrotropic* (the thyroid), the *parathyrotropic* (the parathyroid gland cells), the *gonadotropic* (the endocrine activities of the ovaries and testes). There are at least three gonadotropic hormones from the anterior pituitary that function in reproduction (Chap. XVI). The first is the *maturity*

[1] WIGGERS, CARL J., *Physiology in Health and Disease*, p. 1022, Lea & Febiger, 1939.

[2] WOLF, WILLIAM, *Endocrinology in Modern Practice*, W. B. Saunders Company, 1936.

hormone (also known as *prolan A, the master sex hormone, the motor of the ovary, the follicular ripening hormone,* etc.), which stimulates maturation—meiosis (see page 68)—of both sperm cells (spermatozoa) in the male and of ova in the female. In the female this hormone is involved in the development of the *Graafian follicle,* the capsule containing the ovum (which is lined with endocrine gland cells and is the first endocrine gland of the ovary) and with the escape of the ovum from the follicle (ovulation). Ovulation in the female is followed by the release from the anterior pituitary of the second gonadotropic hormone, the *luteum-forming hormone* (also known as *prolan B*), which stimulates the *interstitial cells* in the male testes to produce the *male sex hormones* and in the female causes the follicle to become the *corpus luteum* (the second endocrine gland of the ovary). The third anterior pituitary hormone relating to reproduction is *prolactin* (also known as *galactin*), one of several hormones involved in stimulating the development of the mammary gland and the secretion of milk.

3. Two or more *hormones involved in the metabolism of sugar and fat* are manufactured by the anterior pituitary: (*a*) the *diabetogenic principle,* which helps to oppose or balance the action of insulin, "possibly acting on the nerve centers which control carbohydrate metabolism" (Gortner); imbalance of this hormone may be involved in diabetes, as well as deficiency in insulin (see page 155); (*b*) the *ketogenic hormone,* which is supposed to lower basal metabolism, reduce blood lipids (fats), and "increase the specific dynamic effect of proteins" (Gortner).

The Posterior Pituitary.—The posterior pituitary secretes the well-known *pituitrin,* or *hypophamine,* which has been separated into two definite hormones: *pitocin* (also known as *alpha-hypophamine* or *oxytocin*) and *pitressin* (also known as *beta-hypophamine* or *vaso-pressin*). Pitocin specifically contracts the smooth muscle of the uterus at the time of childbirth and is occasionally used by physicians to increase the strength of expulsive contractions of the uterus. Pitressin raises blood pressure by contracting the capillary walls, and also causes reabsorption of water from kidney tubules (*antidiuretic* action). Hypofunction of this hormone causes *diabetes insipidus,* characterized by a great amount of sugar-free urine.

The Gonads (Sex Organs, Ovaries and Testes). *The Ovaries.* Some mysterious occult force is generated by the periodical action of the anterior pituitary upon the latent cells of the ovary, such that two glands of internal secretion, the *Graafian follicle* and the *corpus luteum* arise, perform their temporary offices, and disappear, leaving insignificant scars. A still more mysterious influence is generated by the union of the microscopic nuclei of the male and female germ cells in *fertilization.* Under this influence the endocrine gland, the corpus luteum, continues to function for the duration of pregnancy, and under its stimulus the embryo and uterus together create a large and powerful organ known as the *placenta.* The placenta ("afterbirth") is a complex organ having endocrine as well as other functions. It is interposed between the body of the fetus and the body of the mother, and is one of the most remarkable of the many evolutionary adaptations to appear in nature.

The Graafian follicle is the capsule containing the ovum; it is filled with *follicular fluid* and is lined with endocrine cells, which secrete into the follicular fluid and into its capillaries the hormone known as *female sex hormone, theelin, folliculin, estrogen,* etc. Folliculin in the blood stream *affects the lining of the uterus,* causing it to become thickened, softened, and congested, in preparation for the reception of a fertilized ovum. Folliculin also *stimulates the mammary glands* and causes certain *changes in the wall of the vagina.* The follicle, finally becoming distended with fluid to the bursting point, ruptures, and the ovum escapes ("ovulation"). The ovum is borne along the Fallopian tube and eventually, fertilized or unfertilized, reaches the uterus.

The corpus luteum (*"yellow body"*) develops within the follicle immediately after ovulation and represents changes within the ruptured Graafian follicle. The endocrine cells lining the follicle multiply and become filled with yellow sterolic substance forming the corpus luteum, which secretes a general hormone *progesterone,* or *progestin,* and this has three specific effects. (1) *After the uterus has been sensitized by folliculin, progesterone causes it to go on with preparations for reception and nutrition of the fertilized egg, culminating (in the event of fertilization) in the formation of the placenta.* (2) Progesterone has a chalone effect upon the anterior pituitary which *prevents ovulation as long as there is a* *functioning corpus luteum in either ovary.* (3) Progesterone, in cooperation with hormones from the anterior pituitary, follicle, and placenta, helps to regulate the *development of the mammary glands.*

The *corpus luteum* regresses during the last half of pregnancy, eventually removing its check upon the pituitaries—an event which is one factor in producing contractions of the uterus resulting in the birth of the child.

The placenta (*"afterbirth"*) seems to have variable endocrine functions, although no specific placental hormone has been isolated or named. It seems to support the corpus luteum in *restraining ovulation,* and it enters into the complex of secretions *controlling the mammary gland* by acting as a chalone. While the milk glands have been made ready to function by the lactogenic hormones of the anterior pituitary (prolactin), follicle (estrogen), and corpus luteum (progesterone), milk will not actually flow as long as there is placental tissue in the uterus. Milk will be secreted after late miscarriage or abortion.

Pregnancy Tests.—The activation of an ovum in fertilization initiates a spectacular chain of events, culminating in the miracle of birth. To begin with, the fluids of the body are immediately flooded with gonadotropic and ovarian hormones. These may be isolated from blood and urine and will, when injected into young female animals, cause explosive maturing of the ovaries, tubes, uterus, and vaginal tissues. The urine from the supposedly pregnant woman, in specially prepared form, is injected into standard laboratory animals and the diagnosis made from the appearance of the reproductive structures a certain number of hours later. The first such test was devised by two Austrian experimenters who used immature female mice, and the test was named from them the *Ascheim-Zondek test.* The *Allen-Doisy test* uses castrated mice. The *Friedmann test* uses young female rabbits. Various other similar hormone tests of pregnancy have since appeared. There has even been an effort to perfect a skin test whereby hormone from known pregnancy is injected under the skin in the usual manner, with positive reaction *if pregnancy does not exist.* Some success is claimed, but its use has not become general.[1]

[1] "Hormone Injection Gives Quick Test for Pregnancy," *Science News*

Male Sex Hormones.—The testes (see Fig. 75) are filled with the coiled spermatic ducts in which the sperm cells are elaborated by millions. The tube is surrounded with *interstitial tissue,* which is now supposed to secrete the male sex hormone, ***testosterone,*** or *androsterone.* The special functions of testosterone seems to be that of maintaining the general tone of the male sex organs, particularly the seminal vesicles, the prostate (see page 281) and the other secretory glands which combine to produce fluids designed to keep the sperm normal and alive.[1] Testosterone is believed to be responsible for the secondary sexual characteristics of puberty in the male, and for sexual urge. This hormone, injected into immature fowls will cause accelerated growth of comb, wattles, spurs, etc. Hens treated with male sex hormone can be made to develop male characteristics and even to crow. Castration, as is well known, causes arrest or reversion of male characteristics.[2]

The male sex hormone is a fat-soluble sterol resembling in chemical composition and general action a large number of "androgenic" substances which have been isolated or synthesized (Wiggers says 50 or more[3]) which will stimulate comb growth in fowls and regenerate atrophied sex organs in castrated animals. Male sex hormone seems to be widely distributed in nature as is also the sterolic female sex hormone, folliculin; a substance strikingly similar is found in the adrenal cortex. Mason suggests that

> Cholesterol may be regarded as the mother substance from which many of these sterols are formed through the metabolic activities of different body cells . . . It seems likely that future advances in sterol

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Letter, July 10, 1937. See also a recent report to the *American Journal of Obstetrics and Gyneacology* by Dr. Frederick Howland Falls, March, 1941.

[1] ALLEN, EDGAR, *Science in Progress,* Chap. VII, Internal Secretions in Reproduction, Yale University Press, 1939.

[2] Kurzrok says: "Sexuality is a fundamental attribute of protoplasm which enables it to react in either of two ways, resulting respectively in the production of male and female characteristics. Masculinity and femininity are, according to Riddle . . . variations in oxidizing rates, leading to maleness in the former and femaleness in the latter." RAPHAEL KURZROK, *The Endocrines in Obstetrics and Gynecology,* p. 11, The Williams & Wilkins Company, 1937.

[3] WIGGERS, *op. cit.,* p. 1079.

chemistry and sterol metabolism may attach greater significance to the fact that the cells of the adrenal cortex, corpus luteum, interstitial cells of the testis, and the interstitial and theca cells of the ovary are (1) strikingly similar in histologic structure, (2) have a common embryonic origin, (3) produce hormones which, differing but little in chemical structure, represent the only hormones of sterol nature produced by the vertebrate organism.[1]

Menstruation.—Prolan A, or the follicular-forming hormone of the anterior pituitary, causes ovulation to occur at approximately midway in the intermenstrual interval. The ovum finds its way into the Fallopian tube, where it is propelled along by the peristaltic movement of the tube with its ciliated lining and during the course of a variable number of days, estimated from three to seven, it reaches the uterus. If fertilization has not occurred in the tube, the ovum will then be expelled in the menstrual flow, which consists of the blood and secretions that have collected under the stimulus of the follicular hormone (see page 143). If the ovum has met and accepted a sperm in the tube, the fertilized ovum will lodge in the congested lining of the uterus.

The human menstrual or ovulatory cycle is illustrated in Fig. 40. After menstruation the uterine lining undergoes repair, a new follicle forms, the old corpus luteum becomes a scar, and the pendulum normally swings back and forth periodically from puberty to menopause (cessation of ovulation), with the exception of intervening pregnancies.

Normally and usually, menstruation is the sign that a fruitless ovulation has occurred. However, menstruation without ovulation may and does sometimes occur under the regular stimulus of pituitary and ovarian hormones. This simply means that the follicle produces its hormone, but fails to rupture. It is probable that the first menstruations of puberty are often without ovulation. Also, pregnancy has been known to occur before menstruation has appeared. In the regular order of nature, however, ovulation and menstruation occur in the stated sequence.

[1] MASON, KARL E., *Science in Progress*, Chap. V, Vitamins and Hormones, pp. 159–160, Yale University Press, 1939; see also, "Interrelation of Hormones and Vitamins," editorial, *Journal of the American Medical Association*, Feb. 10, 1934; and "Origin of the Steroidal Hormones," editorial, *American Medical Journal*, June 17, 1939.

Menstruation marks the end of puberty and the onset of the years of fertility for the individual. Menstruation may appear as early as ten or even nine years, or as late as eighteen or twenty years of age; the average is at twelve to thirteen years. The *menopause*, or end of fertility, may come as early as thirty-seven or forty or as late as fifty years; the average is forty-five to forty-seven. The average duration of the period is 3 to 5 days.

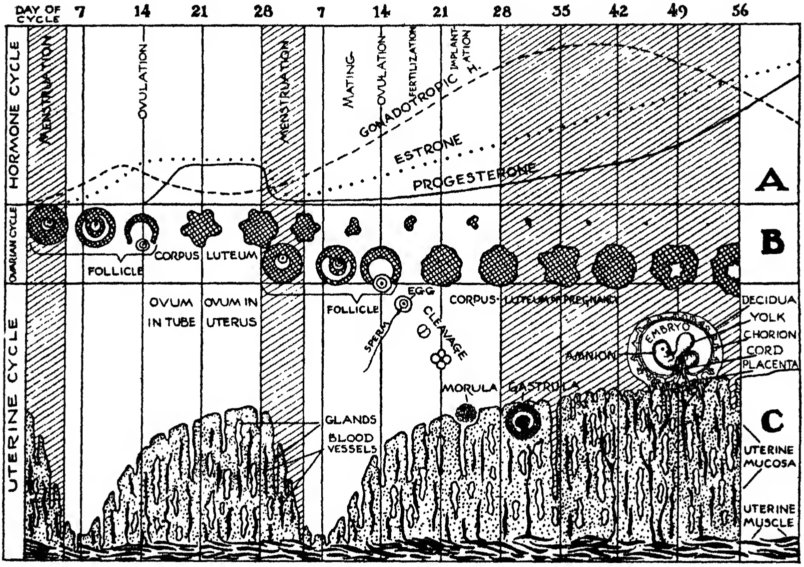

FIG. 40.—Diagrammatic representation of changes occurring in uterus, ovaries, and tubes during the human menstrual cycle and during the first six weeks of pregnancy. (*Modified from Dickinson, Amberson, Kurzrok, and others.*)

The Thyroid.—The most obvious, the first to be studied, and one of the largest endocrine glands is the bilobed gland that lies like a pair of saddle bags across the trachea in front of the neck. The thyroid has a rich blood supply—3½ times its weight in blood passing through it each minute.

We had our biological origin in sea water (see page 50) and have retained in our body fluids approximately the same mineral content, including iodine, as that of the original sea water. (See Table II.) Iodine is very important in many cell chemistries, including oxidation of fuels.

Secretion and Function.—The specific function of the thyroid is to regulate the process of transforming food iodine into the colloidal hormone *thyroxin.* Thyroxin through the catalytic action of its organic iodine *affects the rate of oxidation in all cells* (see page 255). Since oxidation is basic to energy production, the thyroid is one of the chief factors of control of the heat and energy levels of the body, which are measured in *basal metabolism* (see page 237), and which are incredibly stable in health. In addition to, or probably because of, its oxidation-regulating action, thyroxin rather specifically affects the development of the

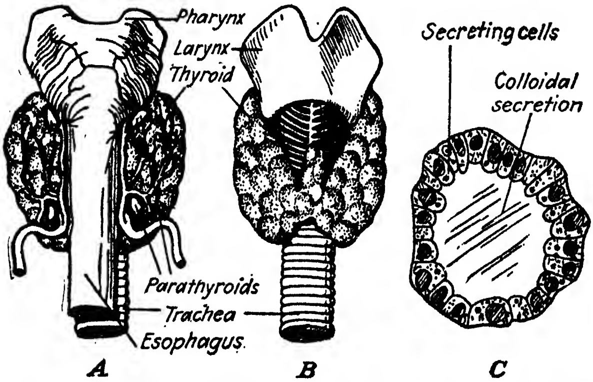

FIG. 41.—The thyroid and parathyroid glands. *A*, seen from behind, showing the four parathyroids and the blood vessels supplying the glands; *B*, the thyroid from the front; *C*, a thyroid follicle greatly enlarged.

brain and sex organs in the child before and following birth.[1] If a pregnant woman suffers from hypothyroidism, she may give birth to a child mentally, physically, and sexually undeveloped —a condition known as *cretinism.* The prompt treatment of such children with thyroxin sometimes produces spectacular improvement (see Fig. 42).

Since the thyroid is "the link between sex and brain," and has much to do with the development of the sex organs, it is likely to enlarge slightly during puberty, especially in girls. Unless there are symptoms of hypo- or hyperthyroidism, this need cause

[1] If a tadpole is fed with thyroid extract, it matures explosively, skipping, as it were, childhood and youth, and becoming at once a small adult frog. If the thyroid is removed from a tadpole, it will increase in size but remain a tadpole indefinitely, never taking on adult characteristics.

no alarm; it is usually purely physiological—a result of the increased activity of the gland at this time—and tends to disappear when menstruation (ovulation) is fully and regularly established. The gland may also enlarge slightly during normal menstruation and pregnancy.

FIG. 42.—*A*, a typical cretin, two and a half years old; *B*, the same patient at six and one-third years—effect of thyroid treatment. (*Holt's Diseases of Infancy and Childhood, D. Appleton-Century Company, Inc.*)

In order that the thyroid may provide the body with iodine in usable form, iodine must be supplied in food (see page 255). In certain regions, known as *goiter areas*, where the iodine left by the sea has been leached out of the soil by rain and is absent or diminished in water and vegetation, hypothyroidism or simple goiter abounds. It has been found that the routine administration of iodine or thyroxin will prevent this, and it has become the custom in such regions to administer protective amounts to school children, thus providing the essential growth stimulus to body and brain. Where there is lessened thyroid function in the adult, a condition known as *myxoedema* may result.

Too little iodine in the food, or functional insufficiency in the gland, causes the thyroid to enlarge in a vain effort to do its work. This is known as *hypothyroidism, or simple or colloid goiter* (the condition just mentioned), in which the gland may grow to enormous size. The person so affected is sluggish and cold-blooded, tires easily, and has slow pulse and clammy, cold skin. His bodily machinery runs slowly and with difficulty. The basal metabolism is lowered; the draft in the body furnace is poor and the fuel will not burn well. Frequently, hypothyroidism exists temporarily in mild degree without enlargement of the gland. Hypothyroidism improves under thyroxin or iodine administration.

Too much thyroxin or *hyperthyroidism, exophthalmic goiter, "inward goiter," toxic goiter*, or *"Graves' disease"* (which may be primarily a disease of the autonomic nervous system involving derangement of the thyroid and pituitary), produces the opposite effects: the individual is in some degree overstimulated, cannot tolerate heat, has a rapid pulse and muscle tremor, and may have protruding eyes and a slight thyroid enlargement. His rate of metabolism is increased. He burns his body tissues and loses weight. The draft in the furnace is wide open and the body fuel is being consumed too rapidly. He is hypersensitive and irritable, lives on a high tension, and may show complete personality change. Skillful modern surgery usually completely relieves this condition.

Unfortunately some weight-reducing nostrums contain thyroxin. It is true that the excessive thyroid stimulation will cause tissue to burn up, *but at great hazard to health.* (See page 255 for sources of iodine.)

The Parathyroids.—The parathyroids are four (sometimes more) small glands, about the size of grains of wheat, which are found embedded upon the posterior surface of the thyroid (Fig. 41). They are so small and inconspicuous that they escaped detection long after the thyroid was fairly well known. The serious effects following the first complete removal of the thyroid gland were in considerable part due to the coincident removal of the parathyroids.

Secretion and Function.—A hormone called *parathormone* has been isolated from the parathyroid glands. One of the chief functions of parathormone is the regulation of calcium-phosphorus concentration in blood and bones, in which its action is associated with vitamin D.[1]

In fact, it has been suggested that one of the functions of vitamin D may be that of stimulating the parathyroids.[2] When there is deficiency in young animals the teeth develop imperfectly, the bones are small and brittle. In case of prolonged deficiency, there is lessening of blood calcium and disturbance of the calcium-phosphorus balance (see page 250). In cases of overadministration or oversecretion of parathormone or of dietetic deficiency, both calcium and phosphorus are withdrawn from the bones and replaced with fibrous tissue, a condition known as *osteitis fibrosa cystica.* This disorder sometimes occurs in pregnancy. The blood calcium in cases of extreme parathormone stimulation in experimental animals may be raised to a point such that actual clotting of the blood in the vessels occurs, and the blood literally becomes too thick to circulate.

Since calcium and phosphorus ions are essential to nerve action, as well as to composition of blood and bones, parathormone deficiency produces marked nervous symptoms, which may result in *tetany,* or convulsions, somewhat resembling the toxic convulsions of strychine poisoning, hydrophobia (rabies), and lock-jaw (tetanus). This suggests that one function of the parathyroids may be neutralization of certain toxic chemical wastes in the body. While much remains to be discovered, it seems certain that parathormone assists in bone formation, but in particular it brings about the quick mobilization and stabilization of blood calcium and phosphorus in nerve and muscle activity. (See page 251 for dietetic sources of calcium, phosphorus, and magnesium.)

The Adrenals.—The adrenals are yellow, cap-shaped glands covering the tops of the kidneys (Fig. 39). Each of them is

[1] Aub, Joseph, *Glandular Physiology and Therapy,* Chap. XXV, Parathyroid Hormone Therapy, American Medical Association Press, 1935.

[2] Wiggers, *op. cit.,* p. 1068.

composed of two distinct glands, the *cortex*, or "bark," making up the bulk of the structure, and the *medulla*, or "core" (Fig. 43). They arose from different tissues in the embryo and at one time in biological history lay far apart in the body of the animal. The cortex is formed from the same embryonic tissue as the reproductive organs; the medulla is formed from the embryonic tissue that gives rise to the autonomic nervous system. The adrenals have the richest blood supply of all the organs in the body, receiving 7½ times their weight in blood each minute.

The adrenals appear early in intra-uterine life, during the second month being twice as large as the kidney and consisting chiefly of cortex. This large fetal cortex has something to do

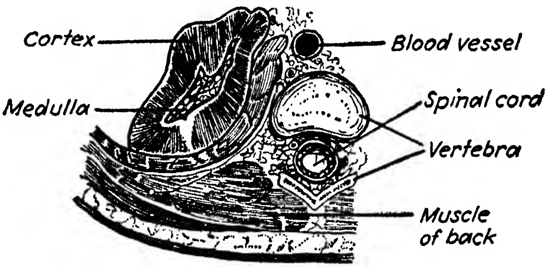

FIG. 43.—Cross section of the left adrenal gland from a newborn child. (*Adapted from Cunningham, Textbook of Human Anatomy, Oxford University Press.*)

with brain development; when it is small or lacking, the brain fails to develop.

Secretion and Function of the Cortex.—The internal secretion of the adrenal cortex has been isolated and named *cortin*. As might be supposed from its origin, the cortical secretion influences the early development of the reproductive organs. The cortex enlarges during pregnancy and lactation. Cortin, when injected into experimental young animals, seems to speed up sex development and maturity.

Cortical deficiency gives rise to a disease called *Addison's disease*, which is characterized by progressive weakness and debility, together with peculiar bronzing of the skin. Formerly this disease was invariably fatal, but it can now be arrested and perhaps cured by the timely administration of cortin, when this can be obtained. It has not yet been possible to synthesize cortin, and the isolation and manufacture of the extract is highly technical and expensive. It is said to require the cortical hormone from 150 beef glands to furnish one day's dosage.

One of the most important functions of the adrenal cortex is that of *regulating the balance between the sodium and potassium ions in the blood and the tissues* (see page 253). This balance is essential to normal osmosis through all cell membranes, and osmosis is basic in all cell chemistries (see page 41).[1]

Because of this function, in addition to treatment with cortical extract, cortical deficiency must be treated with a diet very high in table salt and low in potassium. Some mild cases respond to diet without the administration of cortin.[2]

It is reported that there may be a specific condition, known as *latent adrenal insufficiency*, characterized by excessive fatigue. An affected child may appear normal physically, but is unnaturally apathetic and disinclined to exertion and is easily depressed and discouraged, although not dull mentally. He is sleepy much of the time and hard to arouse in the morning. Such children should be noted by parents and teachers and brought under skilled medical observation, and never reproached for "laziness." (See pages 254, 255 for dietetic sources of sodium and potassium.)

The Adrenal Medulla.—The secretion of the adrenal medulla has been isolated and produced synthetically. It has several names: *adrenalin* (the proprietory commercial name), *adrenin,* and the official name *epinephrine.* The adrenal medullas are sometimes called the "brain of the autonomic, vegetative, or

[1] "Since sodium is the chief cation [positive ion] of the extracellular fluids and potassium the principle ion of the intracellular fluids, the distribution of these will, to a large extent, govern the distribution of body water. In the absence of the adrenal cortex or its life-maintaining hormone, the extracellular electrolytes increase by renal retention of potassium. . . . A direct consequence of this slowly increasing imbalance of ions on either side of the cell membrane is an upset in osmotic equilibrium and shift of fluid from extracellular to intracellular compartments." W. W. Swingle, *Symposia on Quantitative Biology,* Vol. V, p. 340, Biological Laboratory, Cold Spring Harbor, 1937.

[2] Reynerson, Edward A., "The Treatment of Addison's Disease," *Journal of the American Medical Association,* Sept. 3, 1938; "Advances in the Treatment of Addison's Disease," editorial, *Journal American Dietetic Association,* Sept. 3, 1938; "Treatment of Addison's Disease," editorial, *Journal of the American Medical Association,* June 17, 1939.

sympathetic nervous system" (see page 183).[1] The secreting medullary cells are the so-called "chromaffin cells," which are also found in the sympathetic ganglia elsewhere in the body. It seems that these ganglia, wherever found, also secrete adrenin and mediate in nerve impulses (see page 184). Adrenalin is released at the site of all sympathetic nerve discharges. Heightened epinephrine secretion produces the same effect as electrical stimulation of the sympathetic division of the autonomic nervous system (see page 177).

The blood contains normally about one part of epinephrine in twenty million. The medullas contain a hundred thousand times this much, stored as reserve. Under nervous stimulus, such as pain, fear, or rage, this is fed into the blood stream, whereupon the liver is stimulated to release glycogen (liver sugar), which provides quick fuel for the muscles. The senses of sight and hearing are quickened. The blood mass is redistributed, the bulk going to brain and muscle. More red cells are forced into the blood stream from the spleen and other blood-forming centers, thus increasing the oxygen-bearing capacity of the circulation. The total animal resources are made available for flight or fight, and exertions are put forth which at another time would be quite impossible. Invalids escape from burning buildings; the really furious small boy whips one twice his size. The adrenal medulla is sometimes called the "gland of emergency energy." The adrenal medullas doubtless are stimulated by the painful contractions of the uterus at the time of childbirth, and play a role in supplying energy for the last great expulsive effort (see page 356).

Epinephrine (adrenalin) is used medicinally to check hemorrhage and to raise blood pressure. Deficiency in adrenal function is associated with certain types of nervous exhaustion or neur-

[1] "Adrenin raises the conductivity, temperature, and capacity of nervous tissue and the adrenal medulla, while it has the opposite effect on the other tissues. This, it would seem, increases the difference in potential [electrical] between the different tissues. 'It would appear . . . that the medulla of the adrenal functions as nerve tissue; perhaps it is the brain of the vegetative system, its probable function being to charge up, to energize the vegetative system.'" George W. Crile, "New Chemical and Experimental Studies of the Interrelations of the Thyroid, Adrenals, and the Nervous System," *Journal of Endrocrinology*, January–February, 1929.

asthenia, mental depression, and mental derangement. In milder form, it shows as a "tendency to worry and weep." The outstanding symptom of general adrenal insufficiency is *fatigability*, a tendency to tire easily. There are, of course, many other possible causes of fatigability, and the condition is usually complex.[1] Since deficiency in adrenal activity produces or is associated with insufficiency in most of the other endocrines, the specific details of much of this effect are as yet uncertain.

Observers of child behavior are beginning to call attention to the probability of endocrine insufficiency as a factor in certain types of behavior, particularly the essentially ineffective types, such as the hypoadrenal types described.[2]

The Pancreas.—The pancreas is a gland of both external and internal secretion. The gland proper is a tongue-shaped organ about 10 inches long, lying behind the stomach (see Fig. 70). It secretes the well-known digestive fluids that are poured through the pancreatic ducts into the intestines. Scattered throughout the gland, however, are minute isolated masses of endocrine tissue known as the *islands of Langerhans*, which secrete the hormone *insulin*. Insulin is filtered into the capillaries and does not enter the pancreatic ducts.

Insulin is one of the regulators of sugar combustion in the tissues. When the islands of Langerhans fail to function, sugar

[1] "Functional hypoadrenia is frequently found in adolescents, and is marked by sensitiveness to cold and cold extremities, hypotension, weak heart action, anorexia [lack of appetite], anemia, constipation, asthma, and other manifestations, by hypersensitiveness, and by psychoasthenia [mental instability]. These patients are unable adequately to meet the demands of ordinary life. Fatigability is a manifestation of the condition, and exertion or sustained effort increases the adrenal depletion. They are emotional, crave excitement but are fatigued by excitement. Often clever students, their work is sporadic and superficial. Their enthusiams are intense but short-lived." E. B. McCready, *New York Medical Journal*, Vol. 128, p. 199.

[2] Lurie, Louis A., "Endocrinology and the Treatment and Understanding of the Exceptional Child," *Journal of the American Medical Association*, May 7, 1938; Collip, J. B., "Hormones in Relation to Human Behavior," *Harvard Tercentenary Publications*, 1936; Timme, Walter, "The Internal Glandular System in Relation to Childhood Inadequacy," *American Journal of Psychiatry*, January, 1925; "Gland Disorders Make Problem Children," *Science News Letter*, Feb. 28, 1931; Mateer, Florence, *Glands and Efficient Behavior*, D. Appleton-Century Company, Inc., 1935.

is not properly oxidized in the tissues, sugar appears in the urine, and the sugar-ratio in the blood is increased. This condition, known as *diabetes*, is now treated very successfully with regulated doses of insulin or, preferably, the new *protamin insulin*.

The Thymus.—Lying behind the sternum is a large, bilobed gland having cortex and medulla. The specific functions of the thymus are not yet entirely clear, and no hormone has been isolated. It seems to play a part in growth and nutrition, as it is largest during the most active period of growth and atrophies after puberty. The active thymus is said to contain a larger concentration of nuclear proteins than does any other animal structure. Nuclear proteins are essential in forming new cells, and hence are especially important in growth. The thymus shrinks markedly under starvation and malnutrition. Recent experiments in injecting successive generations of female rats with thymus extract produces increasing precocity in each generation.[1]

> After the fifth generation the young rats run about the cage when only 2–3 days of age, being as alert as normal rats of 16–20 days. Weaning is possible at 48 hours, after which they can nest for themselves and need no further parental care. They can swim at the third day. These rats do not become larger than normal at maturity but reach maturity in weight and size in about one-half normal time.[2]

What these spectacular findings mean in terms of human growth is still unknown, but there is no doubt as to the importance of the gland in childhood and no question that it does relate to growth.

The Pineal Gland.—This tiny gland, like the posterior pituitary, grows out of the interbrain, in this case the epithalamus (see Fig. 56), and contains both nervous and secretory cells. It has not yet been possible to isolate a secretion or to make conclusive experiments as to the function of the gland. Administering the gland to successive generations of rats, as is done with the thymus, produces sexually precocious dwarfs. Growth is retarded but development is speeded up. Cases are recorded,

[1] ROWANTREE, L. G., *Glandular Physiology and Therapy*, Chap. XXVI, The Thymus, American Medical Association Press, 1935.

[2] GORTNER, *op. cit.*, pp. 845–846.

associated with hyperpineal function in boys, in which the life cycle—childhood, maturity, and old age—was run with great speed and with very early death. Such children may mature sexually, grow beards, and converse in Latin at five or six years, but usually die of old age before twelve or thirteen. The pineal is here probably only one item of a complex disorder. There may be some essential balance between the pineal and the thymus in their urge and check on development, but the results of conclusive research must be awaited.

Other Hormones.—*Gastrin* is a hormonelike substance that is secreted by certain cells in the stomach. "This is taken for a joyride through the body. That part of it which finally gets back to the stomach stimulates the secreting cells and gastric juices (hydrochloric acid and pepsin) are poured out."[1]

Other reports indicate the existence of an *antianemic*, hormonelike substance in the gastric juice which is essential in blood chemistry. Deficiency is associated with *pernicious anemia*. This antianemic substance is stored in the liver, spleen, and kidney.[2] It is proposed to call this *addisin*.

The duodenum, the first section of the small intestine, probably secretes several hormones. It contains in its lining a mechanism for producing a *prosecretin* which turns into the hormone *secretin* when the stomach empties its acid contents into the bowel. Secretin, when it reaches the pancreas by way of the blood stream, causes the pancreas to secrete and release the pancreatic digestive juices.

Antihormones.—The mechanism of the precise adjustments of the endocrines to each other and to the body as a whole has challenged investigation. The fact that the body becomes refractory or immune to continued dosage and that there is a limit to the effects produced in all experimental work has led to the suspicion that there must be a source of *antihormone* or *hormone antibody* or *immune body*.[3] The *reticulo-endothelial*

[1] Hoskins, R. G., *The Tides of Life*, p. 299, W. W. Norton & Company, Inc., 1933.

[2] Morris, Schiff, and associates, "Endocrines from Gastric Juice," *Journal of the American Medical Association*, Jan. 21, 1933.

[3] "Hormone Refractoriness," editorial, *Journal of the American Medical Association*, Feb. 24, 1940.

system (page 133) is now believed to be the source of the antibodies which produce immunity to foreign protein antigens from disease germs and from other sources. There is now some evidence that the reticulo-endothelial system may further protect the body by producing, when needed, *antihormones*—perhaps one for every hormone.[1] Some advance has been made experimentally in immunizing animals against specific hormones.[2]

Acetylcholine.—It seems to be generally accepted that a hormonelike substance, *acetylcholine*, is liberated under nervous action whenever a parasympathetic nerve ending comes in contact with a muscle fiber (see page 184), possibly also at motor voluntary nerve endings,[3] and this may actually communicate the impulse to the cell. It has long been known that adrenin (epinephrine) performs a somewhat similar service in the case of the sympathetic nerves (see page 184). One speaker on the subject said, "As I speak to you, I have every reason to suppose that the muscle fibers of my tongue and my jaws are being activated by innumerable little charges of acetylcholine, fired at them, as it were, from the endings of the nerve fibers."[4]

Vitamins and Hormones.—There is an increasing tendency to compare vitamins and hormones and to speak of vitamins as "plant hormones," the chief difference being that hormones are manufactured within the animal body, while for the most part vitamins and provitamins are manufactured in plants and must be eaten as food (or as concentrates). However, the body does or may synthesize the fat-soluble vitamins A, D, and E, in the presence of provitamins.[5] It is becoming apparent that there are striking chemical similarities, relationships, and interdependencies between hormones and vitamins. Vitamin D and parathormone may be used somewhat interchangeably, and animals that have lost their parathyroids can be kept in health

[1] Gordon, Albert S., "The Relation of the Reticulo-endothelial System to the Anti-hormones," *Symposia on Quantitative Biology*, Vol. V, p. 419, Biological Laboratory, Cold Spring Harbor, 1937.

[2] Gordon, Kleinberg, and Charipper, "The Reticulo-endothelial System and the Concept of the 'Anti-hormone,'" *Science*, July 16, 1937.

[3] Gortner, *op. cit.*, p. 554.

[4] Dale, Sir Henry, "Chemical Ideas in Medicine and Biology," *Science*, Oct. 19, 1934.

[5] Mason, *op. cit.*, Chap. V.

by large doses of *viosterol*[1] (see page 264). Vitamin C (ascorbic acid), is found in the anterior pituitary (hypophysis) in the corpus luteum, the placenta, and in the adrenal cortex. Traces are also found in thymus, spleen, testes, pancreas, and thyroid.

Certain similarities appear between the chemical structure of some vitamins and corresponding hormones. Vitamin B_1 (thiamin chloride) has an insulinlike action and increases the oxidation of carbohydrates in the tissues. This is opposed by the diabetogenic hormone of the anterior pituitary (page 142). Vitamin A, it is now apparent, has a direct interaction with thyroxin and with the thyrotropic hormone of the anterior pituitary.

Growth Hormones.—Three specific growth hormones, *phytohormones*, known as *auxin-a*, *auxin-b*, and *heteroauxin* have been isolated from plants and seem to be responsible for plant-cell growth. The auxins are formed in root tips, buds, and rapidly growing parts of plants. Some use is already being made of commercial extract of auxins. Auxin is also found in human urine, although the significance of this is not yet known.[2] Numerous other compounds are being found to have auxinlike properties, among which are thiamin and female sex hormone.[3]

Most hormones and most vitamins are being found to be protein in character. "Some have even speculated as to whether there may not possibly exist one grand-master hormone, likewise a protein, which is responsible for life itself."[4]

The Organization Factor.—When any blastula (see page 94) begins to differentiate into a complex animal structure, one particular part of the embryo seems to exert a controlling influence in the spectacular movements and changes that take place in the apparently homogeneous cells of the blastula. Nobody knows quite what makes these movements happen or where the patterned force comes from. But already at the beginning of gastrulation the various regions have tendencies to behave in the appropriate way. If different bits of tissue are cut out and grafted back into other parts of the blastula, in early

[1] Murlin, John R., "Vitamins and Hormones," *American Journal of Dietetics*, June–July, 1938.

[2] Gortner, *op. cit.*, p. 862.

[3] Mason, *op. cit.*, p. 138.

[4] Gortner, *op. cit.*, p. 834.

stages, they develop as do the tissues surrounding the graft. If grafted later, they go on behaving in their own typical fashion, even in the wrong situation.[1] An eye may try to develop on the back, or an arm to grow out of the chest.

This center of directive force is called the *organization center;* it "is that part of the embryo with respect to which all the rest is organized."[2] The organization action seems to be due to a chemical substance, and it seems that organizerlike hormones from any group of animals will work in any other.[3] Naturally, it has not been possible to demonstrate this experimentally upon human or higher mammalian embryos, but doubtless the same factors obtain in higher embryonic development.

The chemical stimulus has been named the *evocator,* but it has not been isolated or analyzed. The region in which the evocator operates is called *the individuation field,* which fits the different parts of the embryo together to make up one single complete animal—the region in which there is a tendency to build up one complete embryo. If some material is taken away from or added to the individuation field, what is left will do its best to turn into one complete embryo.[4] Needham proposes to classify the organization principle as the *organizer hormone,* which apparently exists throughout the animal kingdom with no species-specificity. This organizer hormone apparently is fatty, lipoidal, or sterolic in character, somewhat similar to the large group of sterollike sex hormones and other compounds of biological importance, such as the fat-soluble vitamins (see pages 264–267), and it radiates its organization power from its specific center.

Summary.—Thus, one more, and perhaps the largest, chapter is added to the mystery story of living chemistry, which, however, will ever be continued thrillingly "in our next." The border lines between living and nonliving, between enzymes, hormones, and vitamins are growing dim and show increasing tendencies to disappear, leaving the magic panorama of life spread vividly before us in unbroken sweep.

[1] WADDINGTON, H. C., *How Animals Develop*, p. 42, W. W. Norton & Company, Inc., 1936.

[2] *Ibid.*, p. 69.

[3] *Ibid.*, p. 72.

[4] *Ibid.*, p. 95.

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New Words in Chapter XII

acetylcholine. A hormonelike substance released from nerve endings by the action of nerve currents.

adrenin (adrenalin, epinephrine). Synonymous terms for the hormone of the adrenal medulla. A substance released from nerve endings which is antagonistic to acetylcholine.

afferent. Conducting inward to a central part or organ. Afferent nerves—conveying sensation from organs to brain as opposed to efferent, conveying outward toward a part or organ.

association fiber. Nerve fibers without cells, conveying nerve currents from one neuron to another in the brain or spinal cord.

autonomic nervous system. Involuntary, autonomic, is applied to that portion of the total nervous system which operates below the level of consciousness.

cerebellum. A separate lobe of the dorsal part of the brain. It is concerned in the coordination of movements.

cerebrum. The hemispheres of the brain, in man the largest part of the brain, filling the entire upper portion of the skull. It is the part most concerned in the voluntary and conscious mental processes.

cephalic. Pertaining to or situated near the head.

chromaffin. Cells, found in connection with sympathetic nerves and ganglia, which have an affinity for chrome salts, staining brown or yellow.

commissure. Means of joining, *e.g.*, the tissue which joins corresponding right and left parts of the brain and the two halves of the spinal cord.

convolution. A rolling or coiling together. A winding or fold, as of something rolled or folded on itself; a coil, whorl, or sinuosity, as seen in the brain.

cortex. The outer layer or covering of anything—*e.g.*, of the cerebrum, within which are found the nerve cells active in the thinking process; the organ of consciousness.

efferent. Conveying away from a part, as impulses from a nerve center; opposed to afferent.

extrovert. "Turned outward." Applies to a personality that is actively interested in things external to himself; aggressive.

forebrain. The anterior of the three primary vesicles or divisions of the developing brain of vertebrates.

ganglion. A nerve center as (*a*) an aggregation of nerve cells forming an enlargement on a nerve or on two or more nerves where they join or separate; (*b*) a mass of gray matter in the brain or spinal cord.

hindbrain. The posterior of the three primary cerebral vesicles; also the parts of the brain (epencephalon and metencephalon) that develop from them. Sometimes restricted to epencephalon, the metencephalon being called *afterbrain*.

homeostasis. The complex coordination of physiological functions which maintain the very stable condition of the body.

hypothalamus. A division of the thalamus which lies near the pituitary gland.

intellection. Exercise of the intellect; cognition; also, a particular act of the intellect.

introvert (or **intravert**). "Turned inward." Applies to a personality that sees everything in relation to himself; secluded, sensitive.

medulla. The deep or inner substance or tissue of an organ or a part. Short for *medulla oblongata*—the lowest or posterior part of the brain, continuous with the spinal cord.

medullation. The process by which a nerve fiber acquires a medullary sheath or covering.

myelin. A soft, white, somewhat fatty material which in certain nerve fibers forms a thick sheath (medullary sheath) about the axis cylinder.

myelination. The process of acquiring a myelin sheath or covering.

nerve net. A primitive nerve channel in which the current may run in any direction.

neurilemma. The delicate outer sheath of a nerve fiber, the primitive sheath.

neuroblast. One of the embryonic cells from which nerve cells develop.

neurochromatin. Chromatin found in nerve cells.

neurofibrils. The axons which, taken together, form nerve trunks or fibers.

neuroglia. The supportive tissue that fills the interstices and supports the essential elements of nervous tissue, especially in the brain, spinal cord, and ganglia.

neuron. A nerve cell, together with its processes.

Nissl bodies. Deeply staining masses of neurochromatin.

optic thalamus. Either of the pair of oblong masses of gray matter situated on either side of the third ventricle of the brain.

parasympathetic. Applies to the cranial and sacral divisions of the autonomic nervous system which inhibit the visceral organs.

parasympathin. A synonym for acetycholine.

plexus. A network, especially of blood vessels or nerves.

pons Varolii. The structure that connects the cerebrum, cerebellum, and medulla oblongata.

postganglionic. Relating to nerve fibers leaving a spinal autonomic ganglion.

precocity. Quality of being precocious—developed more than is natural or usual at a given age. Premature development.

preganglionic. Relating to nerve fibers entering a spinal autonomic ganglion.

projection fibers. The axons leaving the brain.

pseudopodium (plural, **pseudopodia**). A temporary protrusion or retractile process of the protoplasm of a cell, as for locomotion or for taking food.

Purkinje cells. Large branched cells of the cerebellar cortex.

pyramids. Bilateral groups of nerve fibers connecting the motor areas of the cerebral cortex with the motor cells of the spinal cord.

reflex arc. An afferent nerve, a nerve center, an efferent nerve, and a muscle. Any complete nerve circuit.

solar plexus. A plexus of ganglia and nerves supplying the abdominal viscera.

sympathetic nervous system. Sometimes used as a synonym for the entire autonomic, vegetative, "old"—or "lower"— nervous system, but the term *sympathetic* is used by most writers to designate the middle division only of this system, the division which stimulates activity in visceral organs.

sympathin. A synonym for adrenin released by nerve endings.

tentacles. Elongated flexible processes, usually tactile or prehensile, generally on the head or about the mouth of a primitive organism.

CHAPTER XII

THE BRAIN AND THE NERVOUS SYSTEMS

While my voice proclaims
How exquisitely the individual mind
(And the progressive powers perhaps no less
Of the whole species) to the external World
Is fitted—and how exquisitely, too—
Theme this but little heard of among men—
The external World is fitted to the Mind;
And the creation (by no lower name
Can it be called) which they with blended might
Accomplish:—this is our high argument.

WILLIAM WORDSWORTH.[1]

The Integration of Energies.—We must keep the fact before us that there is no break in the interrelatedness of energies as they ramify from cosmic rays to atoms, worlds, galaxies; to colloid, virus, plant, and animal; to the highest thought of man. It is the thought of man and the mechanism of behavior and thought that is now to engage our attention.

We have looked at the evolution of protoplasm, the most complex mechanism yet to appear in nature for securing the precise, rapid, and delicate interplay of energies. We have seen special organic devices arise—organs, glands, enzymes, hormones, vitamins—all created to speed up and refine the transformation of latent energies into active, living energies. The end result, the human body, is a marvel of structuralized and balanced energies. In addition to these more strictly chemical mechanisms, a still more specific means of speeding up energy transformation is provided in the nervous systems,[2] and the animal still must get itself a brain—must become "beminded."

[1] *The Recluse*, by permission of Houghton Mifflin Company.

[2] "The nervous system at all times represents the complete unity of the individual more than any other system of organs in the body. That the individual is a unit in body and soul receives abundant confirmation from consideration of the structure and function of the nervous system. In this connection there is one fundamental idea which every inquiring person must

Does, then, man have a soul? No, he *is* a soul. Only when a living being gains the capacity to think, to reflect, to reason, to use language does it become a man. Man is a "minded" body.[1]

The growth and behavior of the child become intelligible, and consistent management becomes possible, only when we envision the mechanism of behavior. *We must have some sort of picture of what it is that is behaving!* Accordingly, we will here review the outstanding or important features of the evolution and of the structure of this mechanism as understood at the present time. Knowledge of the evolution of the nervous system and the brain is an essential item in this background of understanding, since the child recapitulates his phylogenetic history in behavior as well as in body. In order not to expect the impossible of him, we must in fairness to him consider at any point in his career how far he has climbed his phylogenetic tree.

The Rise of the Nervous System.—As root, branch, flowers, and fruit successively unfold, so do the reflexes, the mechanisms of emotive behavior, the mechanisms of consciousness and of reasoning, unfold in the phylogenetic drama of life—each growing out of what has gone before, and all integrated and interdependent at every stage of development.

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bear in mind. No matter how far we analyze the nervous system in terms of structure or in terms of stimulus and response, it always remains a completely unified reaction system." JAMES W. PAPEZ, *Eugenics*, February, 1931.

"But in many cases coordination must be rapidly achieved if the body is to survive. The higher we ascend in the animal scale the more urgent is the need for quick action. Muscular coordination in particular must become increasingly perfect. The speed of movement demanded is far beyond the power of any purely chemical regulating system. Animals, therefore, developed an intricate system of nerves capable of transmitting activity rapidly from one part of the body to another. Recent evidence has shown that even in nervous activity there are essential chemical links. The wave of activity in nerve must itself be a very complicated physico-chemical process. Instead of moving slowly through the blood, it passes swiftly along highly specialized fiber pathways, able to support a heavy traffic of impulses and directing activity to definite points in the body where local responses are needed." WILLIAM R. AMBERSON and DIETRICH C. SMITH, *Outline of Physiology*, p. 121, The Williams & Wilkins Company, 1939.

[1] PATRICK, G. T. W., *What Is the Mind?* p. 125, The Macmillan Company, 1929.

Very early in animal evolution we find in the simplest organisms areas and channels of protoplasm that are more sensitive than is the rest of the cell to the passage of electrical current. In the one-celled ameba there is a constantly shifting polarity (direction of electrical current), as pseudopodia are thrust in one direction or another, and there are vague paths of heightened sensitivity converging somewhat upon the nucleus (Fig. 44). Douglass says that these paths of heightened sensitivity constitute a primitive receptor-motor reflex.[1]

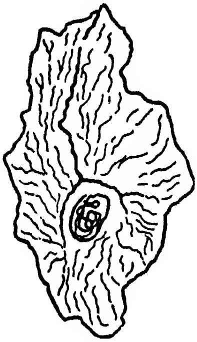

Fig. 44.—Diagram of an ameba showing radial reaction paths converging on the nucleus. (*Modified from Douglas, The Physical Mechanism of the Human Mind.*)

In Vorticella, a higher unicellular animal, a strand of contractile protoplasm runs from the bell through the stalk: there is a fringe of sensitive cilia about the mouth of the bell; slight stimulation of the cilia causes the bell to close and the stalk to coil in retraction from danger (Fig. 45). Here is a faint beginning of differentiation between sensory and motor reaction.

Fig. 45.—Vorticella: (*a*) expanded; (*b*) contracted. (*After Lane, Animal Biology, P. Blakiston's Son and Company, Inc.*)

The Nerve Net.—In jellyfish and certain polyps, a uniform network of sensitive protoplasm brings all parts of the body structure into communication (Fig. 46). Herrick says that this nerve net has a functional polarization (electrical) such that an excitation applied anywhere will be radiated in every direction according to the stimulus. The nerve net seems to consist of streams of electrolytic (see page 38) fluid protoplasm with nuclei at the nodes of the net but having no discoverable cell boundaries. Primitive as is this mechanism, it greatly increases the experience and range of activity of the animal over its evolutionary predecessors.

[1] Douglass, A. C., *The Physical Mechanism of the Human Mind*, pp. 39–40, E. S. Livingston, 1932.

The Nerve Ring.—In some medusae there is a condensation of part of the nerve net into a *nerve ring* running around the margin of the umbrella, or mouth, with processes running into the contractile tentacles, and a nerve net spread through the body structure. There is an axial gradient, or field, of heightened sensitivity running from the nerve ring toward the apex, a foreshadowing of the head-tail gradient (see page 389).

The Chain Reflex.—To play out several lengths of evolutionary thread, we shall now look at the nervous system of the segmented

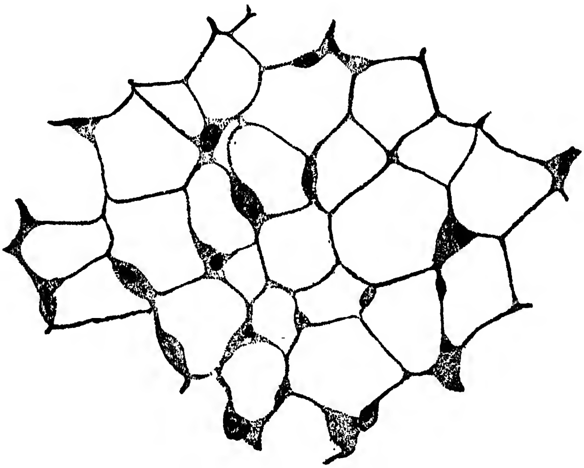

Fig. 46.—Nerve net of Hydra, greatly magnified. (*From Rogers, Textbook of Comparative Physiology.*)

earthworm. Here we find nerve cells with axons and dendrons arranged in a series of bilateral reflex mechanisms, one set for each body segment (Fig. 47). The nuclei at the net nodes have become *nerve cells*, which are grouped in *ganglia* (groups of nerve cells), from which *conduction fibers* extend to the muscle segments. *Sensory cells* on the skin covering the segment and also in the muscles, send fibers (axons) into a central or motor ganglion, where communicating or commissural motor cells send back fibers that complete a local *reflex arc* (see p. 179) or circuit between sensory and motor elements. Conduction fibers run longitudinally between the ganglia in these body segments over which sensory stimuli are transmitted headward and motor impulses are conducted tailward. This one-way conduction is facilitated by the interpolation of synapses or valvelike barrier membranes (see page 176) between the ends of the axons and dendrons (dendrites) where they communicate with each other.

The First Brain.—At the head of the earthworm several ganglia, possibly derived from the primitive nerve ring, fuse and form an exceedingly simple reflex brain, which acts as a determiner or switchboard in some of the general activities of the worm, although to a considerable extent each ganglion acts as a brain for its own segment. It will be noted that the anterior end of the

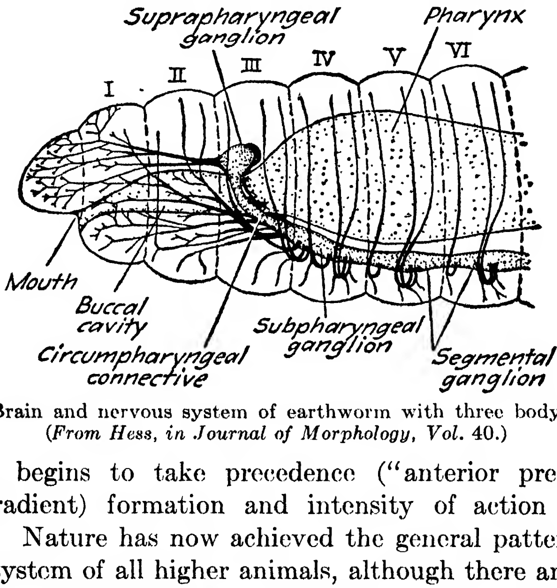

FIG. 47.—Brain and nervous system of earthworm with three body segments. (*From Hess, in Journal of Morphology, Vol.* 40.)

organism begins to take precedence ("anterior precocity"). Field (gradient) formation and intensity of action diminish tailward. Nature has now achieved the general pattern of the nervous system of all higher animals, although there are certain important modifications in vertebrates. That this is true functionally as well as structurally is shown by the fact that even the earthworm can learn. Yerkes taught earthworms to avoid an electric shock in a simple maze after 20 to 100 repetitions. That the centralization of control is imperfectly established at this stage and that the spinal ganglia are, in a sense, "little brains," is shown by the fact that after decapitation the worm still makes the correct turn.[1]

That the segments of the body are still under the primitive domination of the "whole" and that each cell has (as we have

[1] WELLS, HUXLEY, and WELLS, *The Science of Life*, p. 1127, Doubleday, Doran & Company, Inc., 1931.

seen in Chap. VI) a full set of traits or genes (but all controlled by an "organization factor" see page 160), is shown by the fact that the anterior segment develops into a new head with a new brain after the original head is cut off. (See page 63.)

From the first appearance of a primitive central coordinating mechanism to the highest type of human brain is a long, absorbing story, much too long even to be sketched here, except as its outlines appear significantly within the panorama of human development and specifically in the development of Our Child.

The Structural Units of the Nervous System. *The Nerve Cell and Fibers.*—When the blastula (see page 94) differentiates into the three embryonic layers, the cells of these layers develop into various tissues by passing through transitional embryonic stages (see page 97): *mesoblasts* form in the mesoderm and become muscle cells, *osteoblasts* arise which become bone, etc. Likewise, early in the formation of the human embryo (see neural tube, page 95) *neuroblasts* appear in the ectoderm along the path of the future brain and spinal cord and proceed to become *neurons* (nerve cells). The ectoderm is the outer cellular layer of the embryo, which comes in contact with the outside world, hence its early specialization into the nervous system which receives impressions from environment and communicates these to the interior. Neuroblasts are very small compared with mature nerve cells. It is believed that the full quota of cortical, or brain, cells—some ten or twelve billions, form very early in fetal growth. In fact, when mammals appear in evolution with the development of young within a placenta (see page 109), a sudden exuberance of organization and growth is bestowed by nature upon the organism, reaching its highest point in the miraculous growth of the nervous system.

Dr. Coghill's description of the appearance and development of the primitive nerve cells from the embryonic ectodermal matrix is exceedingly interesting.

The differentiation of one of these cells into a nerve cell involves the massing of the protoplasm, together with the nucleus, near the external limiting membrane [between the mesoderm and the ectoderm]. That part next to the membrane becomes the growing tip of the cell. It spreads out along the inner face of the membrane [much as an ameba creeps along a surface], first as a single process going out in only one direction. . . . Later the growing tip near the nucleus spreads in the opposite direction. . . . Eventually the ends also free themselves from the membrane and the cell becomes a neurone. . . . The growing processes of the cell have been forcing their way against the resistance of the indifferent epithelial cells or "doing work." It is analogous to a germinating seed. It is to be regarded as the dynamic unit of the nervous system before it becomes nervous in function.[1]

Nerve cells (neurons) develop two kinds of processes or nerve fibers called the *axon* (or *axone*) and the *dendrons* (or *dendrites*). Each cell has one axon, which is its *efferent* or outgoing fiber by which the cell performs its work, but it may have many *afferent* or incoming dendrons or dendrites, which bring stimuli to the cell. Also, the entire neuron has efferent or afferent properties, which are, as we shall see, particularly important in the cerebral cortex and certain other regions. Some of the nerve fibers are very long, *e.g.*, when the axons must reach from the spinal cord to the foot. The nerve cell may receive impressions from many sources by way of the dendrons but can act only through its one axon (which may send out collateral branches). The cell body of the neuron differs from other tissue cells in several particulars. In the first place, the child is believed to be born with the neuroblasts already formed for all the nerve cells he will ever have in brain or body. All other cells, such as muscle and bone, multiply by mitosis (see page 64) as the child grows. When a neuroblast

[1] COGHILL, GEORGE E., *Anatomy and the Problem of Behavior*, pp. 53–54, The Macmillan Company, 1929.

These observations of Dr. Coghill have been supported by others. Dr. Carl Caskey Speidel, who studied the developing nervous system of the living tadpole by a special technique, was able to follow the development of individual nerve fibers in the transparent tail fins of living tadpoles for periods of longer than a month. He says: "The growth cones [the "tips" of Dr. Coghill] travel through the tissues by slow ameboid movement, spinning the nerve fibers behind them. They are quite sensitive to their environment. Exploratory processes are being continually sent out and retracted."

These living, growing nerves sprout from the spinal cord and go directly to the muscle or sense organ they were destined to connect with the central nervous system, according to "some commanding purpose."

The *Science News Letter*, in reporting this, says: "The nerve traveled outward on its important journey much as though it were a whole animal in itself, a sort of very intelligent worm bent on getting where it should go." *Science News Letter*, Jan. 9, 1932.

once forms a nerve cell, that cell normally lasts and functions for the lifetime of the individual. Other tissue cells will be regenerated or replaced after injury, while, once destroyed, a nerve cell is never replaced, but it will grow new dendrites and axons if these only are injured and the cell remains intact. For this reason, doubtless, nature has protected the nerve cells by placing them entirely within the skull, the vertebral column, and within certain well-protected ganglia. From these entrenchments they receive sensory impressions and enter into the regulation of the muscles and glands and chemical activities of every sort.

The other feature peculiar to the nerve cell is its internal structure. We noted in Chap. VI that the catalytic protein nucleus of the cell is separated from its cytoplasm by an insulating lipoidal nuclear membrane, the "nuclear wall," and that active interplay between the electronegative nucleoplasm and electropositive cytoplasm takes place only under specific conditions of cell activity. In the somatic (body) cell the chromatin granules are confined to the nucleus, where they are active in the functions of the cell, particularly the division of the cell in multiplication. In the nerve cell, *which does not multiply itself*, the chromatin material, here called *neurochromatin*, seems to be employed in generating energy for nerve action. The nuclear membrane of the nerve cell is highly permeable, and constant interplay seems to take place between the nucleus and the cytoplasm. Within the cytoplasm also are quantities of this neurochromatin material, usually more or less diffuse in arrangement, even extending into the short dendrons, which seem actually to be pseudopodia of the cell cytoplasm (see Fig. 48*A*). When the cell is stained (and thus killed) (see page 59 for difference between living and dead cells), this chromatin matter clumps in masses that stain darkly and are called *Nissl bodies* (see Fig. 48*D*). It was formerly supposed that the Nissl bodies existed as such in the living cell.

In addition to these chemically active factors, *neurofibrils* run through the cell cytoplasm and extend into and form the axon and the dendrons (Fig. 48*C*). These apparently are activated or charged as they pass through the cell cytoplasm with its neurochromatin and as they come in contact with the nucleus. Under continuous cell activity with excessive fatigue, or under toxins of drugs or disease, loss of sleep, excessive pain, emotional strain or shock, the neurochromatin is not regenerated or replaced from the nucleus with sufficient speed to keep the cell in normal condition,

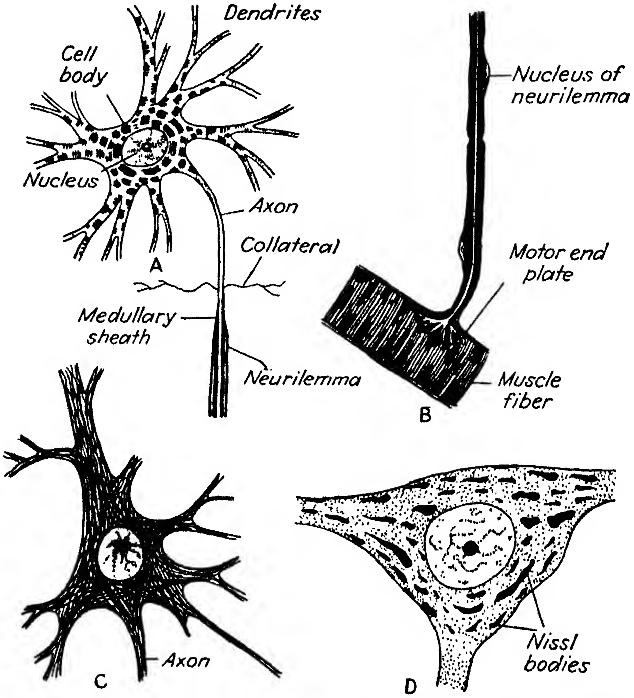

FIG. 48.—*A*, nerve cell showing axone, dendrites, medullary sheath, neurilemma, and ending (*after Wolcott*); *B*, end plate of a motor nerve; *C*, nerve cell from cortex of human brain, showing neurofibrils but not Nissl bodies (*from Morris, Human Anatomy, P. Blakiston's Son & Company, Inc.*); *D*, nerve cell showing axone, dendrites, and Nissl bodies (the neurofibrils ramify among the Nissl bodies, as in *C*, but are not shown in the picture) (*after Wieman*).

and cells killed and stained under such circumstances show Nissl bodies to be dim or absent.[1] Different kinds of nerve cells show characteristic differences in their neurochromatin or Nissl bodies. In sensory cells they are finely granular and evenly

[1] CRILE, GEORGE W., *Man, an Adaptive Mechanism*, The Macmillan Company, 1916; VON EULENBURG-WIENER, Renée, *Fearfully and Wonderfully Made*, The Macmillan Company, 1938; CANNON, W. B., *Bodily Changes in Pain, Hunger, Fear, and Rage*, D. Appleton-Century Company, Inc., 1928.

distributed. In motor cells they are coarser. There are said to be no Nissl bodies in the nerve cells of newborn infants.

The neurofibrils, on passing through the cell cytoplasm and, presumably, receiving impulses from the neurochromatin, are massed to form the *axon* or *axis cylinder*, and these in turn are bound together with others, like the insulated wires of an electric cable, to form *nerve trunks*. These fibrils are embedded each in a jellylike *neuroplasm*, and the axis cylinder itself is usually surrounded by the protoplasmic *neurilemma* and the fatty *myelin sheath*, which are supposed to act in the roles of nutritive mechanism and insulator, respectively (see Fig. 48*A*). While the cell body of the nerve becomes fatigued and uses up its definite energy potential and must be renewed by rest and food, the axon with its neurofibrils is believed from numerous experiments to be almost indefatigable. In other words, the battery may run down or wear out but the transmission wires lose their full conductivity slowly, if at all, while they and their insulation are intact.

The nervous mechanism is often likened to a telephone system with its receivers, central office, cables, branches, and "common pathway." The telephone wire, however, transmits both ways, as in the primitive nerve net (see page 169), while the nerve fiber transmits one way only. Often there are separate fibers for efferent (outgoing) and afferent (incoming) impulses enclosed within the same nerve trunk but separated by their insulating sheaths.

End Organs, or Receptors. The nerve substance is most economically distributed in the neuron, with a maximum surface of contact and transmission provided by the branching dendrons and the axon. This efficiency is further multiplied by having the ends of dendron and axon fibers ramify in expansions or *end organs* which still further increase the range of sensitivity and influence of the central nerve cell. The motor nerve fibers terminate in end plates in direct contact with muscle fibers (Fig. 48*B*, also Fig. 49). Some dendrons end (or rather begin) in a great variety of mechanisms for registering or reporting the character of the external world, some of which are supposed to be adapted for conveying one kind of sensation only. These include free nerve endings for pain and possibly special nerve endings for warmth and cold, pressure, muscle sense (proprioceptive sense), etc. It is not entirely clear as to whether nerve endings for pain are present in practically all tissues or whether all nerves can, under sufficient stimulus, register pain. In addition to the general sensory dendrons there are in very direct connection with the brain the specialized receptor organs of sight, hearing, smell, taste, and equilibrium.

The Synapse.—While impulses normally pass in one direction only in a given axon or dendron, strong excitation applied midway on a nerve fiber will be transmitted in both directions to the ends of the neurofibrils. Where the neuron comes in contact with another neuron through its axon-dendron processes, the excitation cannot be made to pass contrary to its normal direction. There is a barrier between neurons where their respective processes come in contact with each other which acts as does an electric switch, a radio plate-filament contact, or a valve in a tube, which will not permit fluid to flow backward. This one-way barrier is called the *synapse* (see Fig. 50). The synapse consists in some alteration of the protoplasm the nature of which is not understood. Wheeler says that the synapse functions as an electrical switch, "as well the first time as the last."[1] It seems possible that the synapse may be a specialized modification of one-way membrane such as separates nucleus and cytoplasm (see page 60).

Also of recent years there has been a growing opinion that synaptic transmission is accompanied by substances variously designated as *neurohumors, neurohormones* or *chemical activators,* which produced on one side of the synapse, pass across the minute interruption and stimulate the opposite side.[2] It thus appears that the exact role of the synapse in nervous and mental activity is not completely known, but obviously such a specialized mechanism as this must have important functions. One clear function is the multiple patterning of conduction of impulses made mechanically possible by the incredible number of synaptic (chemical or electrical) switches.

[1] WHEELER, R. H., and FRANCIS PERKINS, *Principles of Mental Development,* p. 350, The Thomas Y. Crowell Company, 1932.

[2] PARKER, G. H., "A Modern Conception of the Action of the Nervous System," *Science,* Oct. 11, 1940.

Whatever may be the character of the impulse which passes the synapse from one neuron to another, synapses may become fatigued or altered and lose in whole or in part and more or less permanently their specificity and power of transmission. They are susceptible to the influence of chemicals (drugs, such as nicotine or strychnine), and their action is affected by the vaguely understood neurohormones, adrenalin and acetylcholine (see page 184). The permeability of the many synapses in

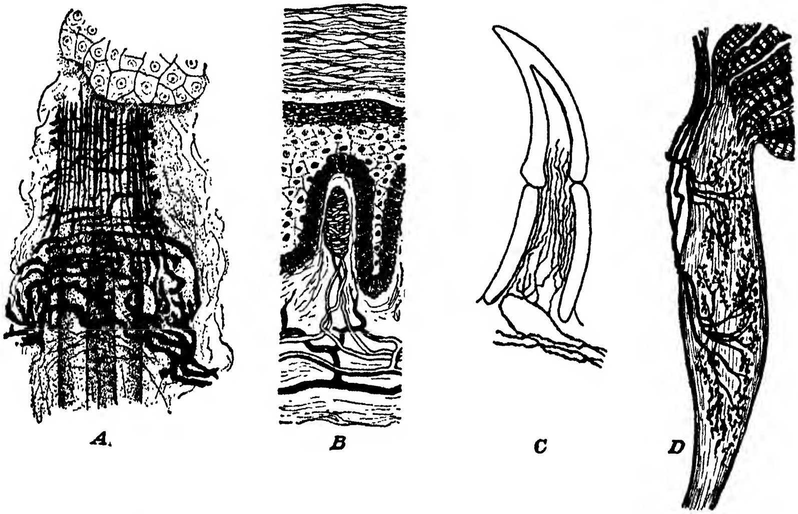

Fig. 49.—Varieties of nerve terminations. *A*, nerve endings about a large hair from a dog (*Herrick after Bonnet*); *B*, a nervous papilla from human skin (*Herrick after Cunningham*); *C*, nerve terminals in tooth of a fish (*Herrick after Retzins*); *D*, sensory nerve ending from muscle of a rabbit (*Herrick after Huber and DeWitt*). (*Modified from Herrick, Introduction to Neurology, W. B. Saunders Company.*)

neuron chains and probably also in the cerebral cortex must be of great importance, although some neuron chains seem to function without any apparent synaptic resistance.

The Nerve Impulse.—The nerve impulse is a wave of metabolic change the exact character of which is in doubt. Any stimulus—heat, mechanical, electrical, or chemical—releases the nerve impulse, but it depends not only upon the character of excitation but upon the place and manner of ending in the brain as to whether the excitations are registered as taste, sight, smell or sound. Nerve impulses generate electrical potentials. The speed at which these travel can be measured by special electrodes and galvanometers. As compared with the speed of a current passing through a nonliving conductor, the electrical potential on the nerve moves slowly and in discrete or wavelike volleys, which suggest the "hop along" of the ionization mechanism (see page 39). At the synapses and at all nerve endings, however, certain hormonelike chemical substances seem to be released —*adrenin* or *acetylcholine* (see page 158), as the situation demands. Whether the role of these is primary or secondary to the electrical impulse is not yet clearly determined.

Brain Waves.—The discovery that thinking and cortical action and even the state of consciousness, itself, generate electrical potentials that can be amplified and charted has opened an exciting field of study of so-called "brain waves," "brain potentials," or "Berger rhythms." The brain waves of electrical activity show an automatic, ever-present movement, known as the *alpha wave.* "The alpha rhythms probably underlie general consciousness and the emotive states."[1] Superimposed upon the basic rhythms are the *beta waves,* which reflect all the patterned excitations produced by afferent (environmental) stimulation. Apparently, it may soon be possible to recognize and study specific rhythms produced by hearing, seeing, etc.

In the *Normal Child Development Study* of the Department of Diseases of Children, of Columbia University Medical School, consecutive brain-potential records are being made of a series of children from birth. These are found to be as individual in character and pattern as are fingerprints, vocalization records, or any of the other numerous data being brought together in this extensive study. It is also becoming apparent that certain characteristic sequences of change in the brain potentials accompany the course of development. The changes in frequency and character of the alpha waves with age have been fitted into growth equations and otherwise formulated.[2]

[1] PAPEZ, JAMES W., "Cerebral Mechanisms," *The Journal of Nervous and Mental Diseases,* February, 1939, p. 155.

[2] WEINBACH, A. P., "Some Physiological Phenomena Fitted to Growth Equations," II, Brain Potentials, *Human Biology,* February, 1938; LINDSLEY, D. B., "Foci of Activity of the Alpha Rhythm in Human Encephalogram," *Journal of Experimental Psychology,* August, 1938, and "Brain Potentials in

The Spinal Cord and the Reflex Arc.—A reflex arc is the linking of afferent, receptor, or sensory impulses (stimuli) with efferent exciter, or motor, impulses to produce an effect. The simplest example is a multiple two-neuron circuit through the spinal cord. A slightly more complex type is represented (as illustrated in Fig. 50) when a commissural (communicating) neuron in the cord transfers the sensory (afferent) stimulus to the opposite side of the cord (and of the body) or to a higher or lower level of the cord, and either stimulates to action or inhibits the action

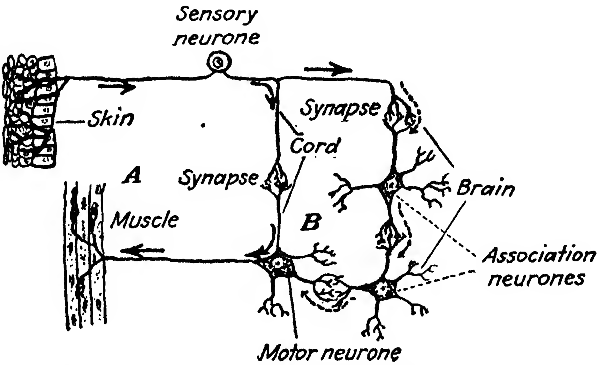

FIG. 50.—Reflex arcs. *A*, simple reflex through the spinal cord; *B*, the same impulse continued through the association mechanism of the brain after the muscle has been stimulated. (*Modified from Kirkpatrick-Huettner by permission of Ginn and Company.*)

of a motor (efferent) neuron on the opposite side or of another part. The sensory stimulus may be relayed over a variable number of communicating neurons to the head of the cord (medulla oblongata), or to the basal structures (the thalami) to be described, before it reaches completion in action through efferent motor neurons. Also, as will be seen, the autonomic nervous system is involved in much of the reflex activity of the body mechanism (Fig. 55).

Children and Adults," *Science*, Vol. 84, p. 354, 1936; DAVIS and DAVIS, "Action Potentials of the Brain," *Archives of Neurology and Psychiatry*, Vol. 36, 1936; SMITH, J. ROY, "The Encephalogram during Infancy and Childhood," *Proceedings of the Society of Experimental Biology and Medicine*, 1936, and "The Electroencephalogram during Normal Infancy and Childhood," *Journal of Genetic Psychology*, Vol. 53, 1938; JASPER, SOLOMON, and BRADLEY, "Electroencephalographic Analysis of Problem Children," *American Journal of Psychiatry*, November, 1938.

The Spinal Nerves.—Earlier in this chapter we have considered the evolution of the nervous system from ameba to the earthworm and to the earliest vertebrates, or up to the point at which nature hit upon the happy scheme of linking reflex segments or units into "chain reflexes," as seen in crawling worms, and the still happier scheme of welding these into the vertebrate *neural tube*, enclosed within the segmented spinal column, as seen in swimmers and walkers. Ultimate communication between brain and body is effected through the agency of 12 pairs of cranial nerves and 31 pairs of spinal nerves. Except for the two first pairs of cranial nerves—the olfactory and the optic—which actually are

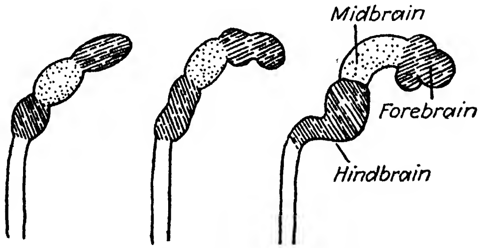

FIG. 51.—Diagram of the process of making the brain compact. (*Walter, Biology of Vertebrates, The Macmillan Company.*)

extensions of brain substance, the rest might have been numbered consecutively from 3 to 43.

Inspection of Fig. 52 shows that pairs of nerves emerge from between the vertebrae, as can be seen on the right. On the left of the diagram is seen, in black, one of the bilateral chains of ganglia that belong to the autonomic nervous system but that interlock with the posterior spinal nerves in the manner shown in Fig. 53.

It will be noted in Fig. 53 that the nerve cells (gray matter) of the cord are massed in the center ("the butterfly"), while the nerve fibers—receptors, connectors, and excitors (white matter)—surround the cellular core and run up and down and along the periphery of the cord, connecting by synapse with the dendrons of the centrally placed gray neurons. In general, the sensory, receptor, or afferent fibers whose cell bodies are in the spinal ganglia are massed in the posterior half of the cord nearest the surface of the body (see page 94), to form the dorsal, or *sensory*, tract. The motor, excitor, or efferent neurons are massed in the ventral (anterior) gray matter of the cord, while the autonomic pathway tends to be lateral. Communicating or connector

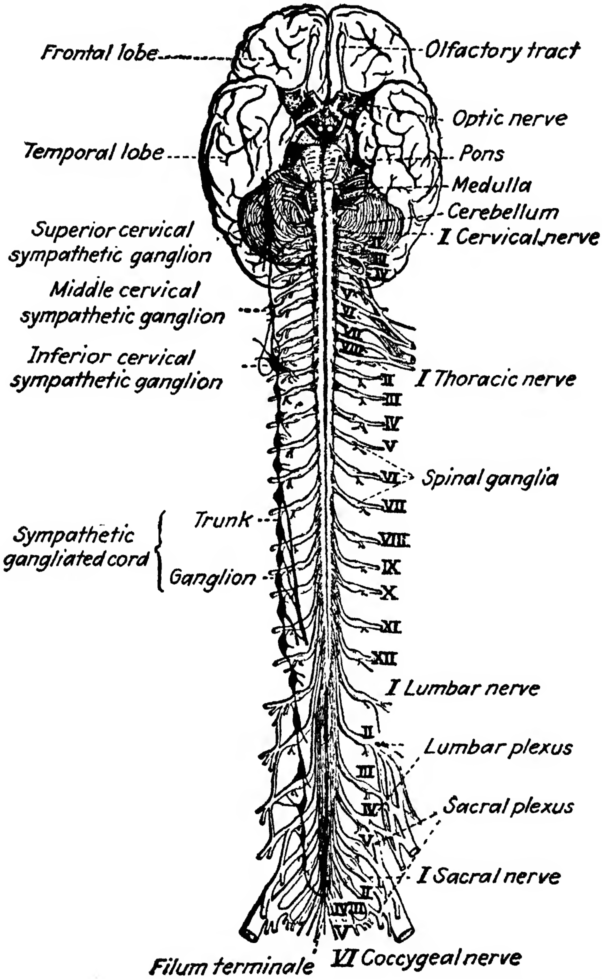

FIG. 52.—The human central nervous system, from the front, showing its connection with the cerebrospinal nerves and with the sympathetic nervous system (drawn in black on the left). (*From Herrick after Allen, Thompson, and Rauber, Introduction to Neurology, W. B. Saunders Company.*)

fibers are found at all levels of the cord and establish contact between neurons at the various levels and between the posterior and anterior parts of the cord. Effector or motor neurons may receive synaptic contact from many sensory neurons, a highly economical and efficient arrangement which integrates motor activity and enables the spinal cord to function as a "final common pathway (see Fig. 54)."

The spinal reflex mechanism maintains traces of its primitive segmented character, as is shown by the persistence of certain deep automatic reflexes, such as the knee jerk, ankle clonus, plantar reflex, etc., which cannot be controlled by will.

Although the spinal reflex mechanism in higher animals has become closely integrated with and subject to the autonomic and

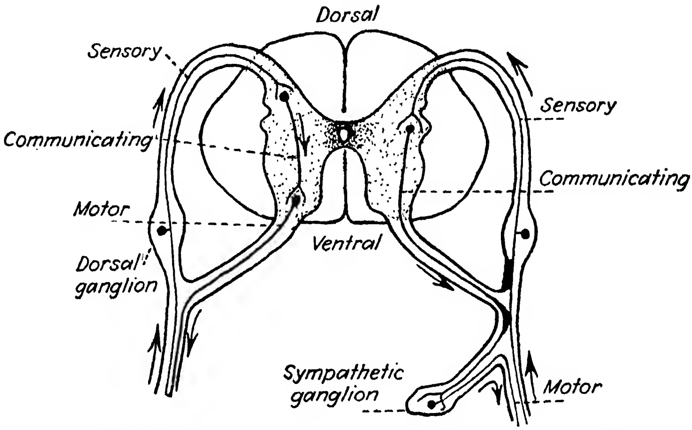

Fig. 53.—Diagram of a cross section of the spinal cord illustrating reflex paths in spinal nervous system. (*Modified from Walter's Biology of Vertebrates, The Macmillan Company.*)

cerebral levels and has lost much of the independence of the primitive segmentation, there are very deep automatic reflex patterns hidden in the mechanism. Amberson and Smith describe the complete decapitation of a dog under anesthesia, with the tying of blood vessels, inflation of lungs, etc. all done so carefully that the animal actually remains alive for hours or even days ("a spinal animal"), and while the time of reflex response is slower than normal, a good many innate patterned reflex responses do occur, such as walking movements, the scratch reflex, response to pricking or pinching, etc.[1]

This spinal nerve cable is another one of many examples of concentrated potency. It contains within its circular $\frac{4}{10}$ inch a

[1] Amberson and Smith, *op. cit.*, pp. 141–144.

central core of nerve cells occupying at least half of the given space. The gray core is surrounded by many millions of microscopic nerve fibers, long and short, reflex and autonomic, which serve to make the complicated integrations between all cells in

Fig. 54.—Diagram to show many sensory neurons making contact with a single motor cell of the ventral horn (final common pathway). (*Amberson and Smith, Outline of Physiology, The Williams & Wilkins Company.*)

the organs and members of the body and with the brain. And the entire cord, exclusive of enveloping membranes, weighs slightly more than 1 ounce.

The Autonomic, Visceral, or Vegetative Nervous System.—As the cerebrospinal nervous system evolves for the purpose of conducting and regulating the relations of the organism with its environment, a special nervous mechanism arises for the purpose of regulating the internal, vital, organic processes of the organs of the body with each other and with the cerebrospinal mechanism. We have seen the rise of opposing sensory and motor nerves and centers coordinated and functioning in the complex patterns of the cerebrospinal nervous system. The cells and fibers of the autonomic system are also of two opposing kinds, which break and check with great minuteness the action of the internal or vital organs and their relation with the cerebrospinal system. The action of autonomic nerves, however, differs from the definite, specific, positive-negative action of the sensory and motor cerebrospinal nerves. The autonomic system has two divisions, *which oppose each other as a whole* rather than by virtue of specific check or stimulation.

Autonomic nerves are for the most part gray, or unmedullated. *The autonomic nerve cells are found chiefly in ganglia and in organs and tissues, not in skeletal muscles, while the motor spinal nerves communicate with skeletal muscles and not with organs.* Autonomic nerves do not communicate directly with the cerebrum, and may act independently of cortical activity. Activity of one sort of autonomic cells—*the parasympathetic*—is, like that of sensory cerebrospinal nerves, always accompanied by the release of the neurohormone *acetylcholine* (*parasympathin*), while the activity of the nerves of the other autonomic division—the *sympathetic*—is, like that of the motor neurons, always accompanied by the release of *adrenin* (*sympathin*). The effect of acetycholine is fleeting, that of adrenin is longer continued. Autonomic neurons act upon the so-called "smooth muscle" in the walls of blood vessels, heart, lungs, stomach, intestines, etc. Each vital structure is supplied from both divisions, the action of each always being antagonistic to the other.

The parasympathetic division arises in connection with the cervical group of cranial nerves, and from the sacral group (see Fig. 55). The cervical parasympathetic nerves supply certain structures in the salivary glands, the thyroid, the involuntary eye muscles, also the smooth muscle of the heart, lungs, stomach, liver, pancreas, kidneys, upper intestinal tract, and blood vessels of the upper part of the body. The sacral parasympathetic nerves supply the involuntary muscles of the lower bowel and bladder, the sphincters of rectum and bladder, the reproductive organs, and the blood vessels of the lower trunk and extremities.

The nerves of the middle or sympathetic division of the autonomic system leave the cord by way of the thoracic and lumbar spinal nerves and largely duplicate the distribution of the parasympathetic nerves to glands, viscera, and blood vessels (Fig. 55). Also there are several *plexuses* (networks serving as relay sta-

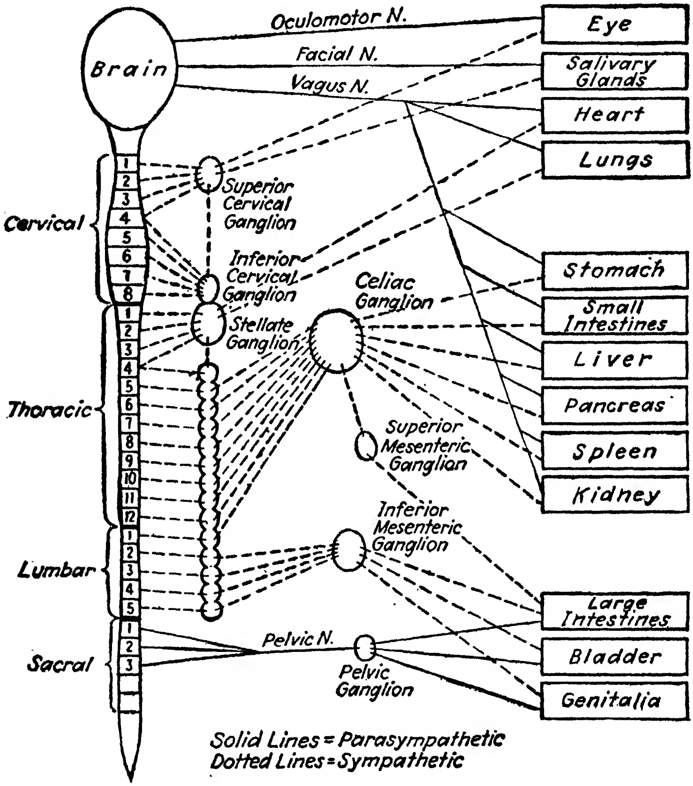

FIG. 55.—Scheme illustrating the distribution of the autonomic nervous system of man and the important plexuses. (*Watkeys, Daggs.*)

tions), notably the *solar* or *celiac plexus*, behind the stomach, and the *lumbar* and *sacral* plexuses, which consist of extensive networks of fibers and ganglia of both kinds of autonomic neurons, and which supply nerves to various organs.

The sympathetic nerves leave the spinal cord with the medullated (white) spinal nerves known as the *preganglionic fibers* (see Fig. 53). A short distance on either side of the spine, the autonomic fibers leave the nerve and enter a ganglion about the size of a pea (see black masses in Fig. 52). From this point the autonomic fibers emerge unmedullated as *postganglionic fibers* and proceed to their destination in a more or less remote ganglion, plexus, or organ, and out along the spinal nerves to the blood vessels and to the sweat glands of the skin. In addition to the afferent and efferent sympathetic nerves, there are communication fibers running from ganglion to ganglion, giving the ladder-like effect seen in Fig. 52.

The sympathetic division of the autonomic system operates in close association with the *adrenal medulla,* which secretes the well-known *adrenin, adrenalin,* or *epinephrine* (see page 153). It has long been known that many small masses of sympathetic cells are scattered throughout the body, and the adrenal medulla is sometimes called "the brain of the sympathetic system" (see page 154). It is a relatively recent discovery that adrenalin-like substance is generated wherever sympathetic nerve action occurs.[1]

The Autonomic Balance.—From what has been said, one might assume that adrenin always stimulates and acetycholine always checks visceral activity, but their synchronization is much less simple than this. It is not yet clear as to just how these hormones do operate or how the synapse operates, and there still remains much mystery as to what makes living protoplasm so different from dead protoplasm. One of the most weirdly complicated evolutionary adjustments is that of the balance between the sympathetic and the parasympathetic autonomic tissues (see Table III). This is partially explainable by the fact that the autonomic system is subject both to hormonal and to hypothalamic, or cerebrospinal, nervous control.

Specific cranial autonomic nuclei in the medulla and at the base of the brain exercise centralized control over the two divisions of the autonomic system and help in keeping the action of the two divisions synchronized. In Chap. XI, page 154, we read of the almost instantaneous adjustments made by the body in meeting emergencies and that, in lesser degree, the same adjustments go on continuously in meeting the stresses and strains of ordinary

[1] CANNON, W. B., and A. ROSENBLUETH, *Autonomic Neuro-effector System,* The Macmillan Company, 1937.

TABLE III.—ANTAGONISTIC EFFECTS OF SYMPATHETIC AND PARASYMPATHETIC DIVISIONS OF THE AUTONOMIC NERVOUS SYSTEM[1]

Organ	Effect of sympathetic	Effect of parasympathetic
Heart	Increases strength and rate	Decreases strength and rate
Lungs	Relaxes muscles in the bronchioles	Contracts muscles in the bronchioles
Blood vessels of		
Heart	Relaxes muscles	Contracts muscles
Skin	Contracts muscles	
Visceral organs and skeletal muscle.	Some fibers contract muscles, while others relax them	
Salivary glands and external genital organs	Contracts muscles	Relaxes muscles
Kidney	Contracts muscles and thus diminishes urine flow	
Glands:		
Liver, Pancreas, Tear, Salivary	....	Assists in producing or regulating secretion
Adrenals, Sweat	Mainly or exclusively responsible for secretion	
Stomach	Assists secretion of gastric juice	Assists secretion of gastric juice
Stomach and small intestine.	Slows or stops muscular contraction	Increases muscular contraction
Spleen	Contracts muscular capsule	Relaxes muscular capsule
Urinary bladder	Relaxes wall muscles and closes sphincter	Contracts wall muscles and opens sphincter
Eye	Dilates pupil	Constricts pupil and adjusts eye for near vision
Hairs	Contracts muscles and thereby erects hairs	

[1] AMBERSON, WILLIAM R., and DIETRICH C. SMITH, *Outline of Physiology*, p. 185, The Williams & Wilkins Company, 1939.

living. Life is perpetual adjustment of the organism to external and internal conditions. What is it that keeps the body temperature within the normal range of 98 to 99°F.; the blood volume and blood composition at incredibly stationary "norms"?[1] W. B. Cannon has given the name *homeostasis* to the total mechanism whereby living organisms do maintain their chemical integrity or "wholeness" and stability in the midst of constantly changing environmental conditions.[2] The coordinated action of the two autonomic mechanisms is an outstanding factor in this.

It is to be remembered that every vital tissue, organ, and structure of the body has contact with outgoing and incoming nerve impulses from the parasympathetic and sympathetic systems, and directly or indirectly with the cerebrospinal system. Because of the fine adjustments between these, an extreme degree of homeostasis or physiological stability exists during health and life.

The Autonomic Nervous System and Temperament.—Remembering that the general effect of adrenin is stimulating, it is easy to believe that an individual in whom the sympathetic or middle division is overactive will be a hyperactive, overstimulated person. During periods of "refueling" or digestion and absorption, the parasympathetic division is dominant, and the feeding animal likes to be quiet and inactive. It has been suggested that in some individuals there may be enough habitual dominance of one or the other mechanism to color the personality. Since a great many other factors enter into determination of the exceedingly complex total personality, the autonomic factor is not to be considered separately from every other external and internal factor of the situation.

The Brain and Its Parts.—By common consent the group of structures contained within the skull is called the *brain*. In the course of evolution these structures have become very complex, and the compact manner in which they are compressed within the protective brain case is a marvel of architectural planning.

[1] Cowdry, E. V., editor, *Human Biology and Racial Welfare*, Chap. X, The Integrative Action of the Vascular System, pp. 219–245, Paul B. Hoeber, Inc., Harper & Brothers, 1930.

[2] Cannon, W. B., *The Wisdom of the Body*, W. W. Norton & Company, Inc., 1932.

Figure 51 illustrates the initial folding back and forth in the fetal brain.

Although the brain is a thoroughly integrated organ, it is necessary, for clearness of description, to adopt some system of division. Most texts have presented the five divisions shown in the body of the diagrams in Fig. 63: myelencephalon, meten-

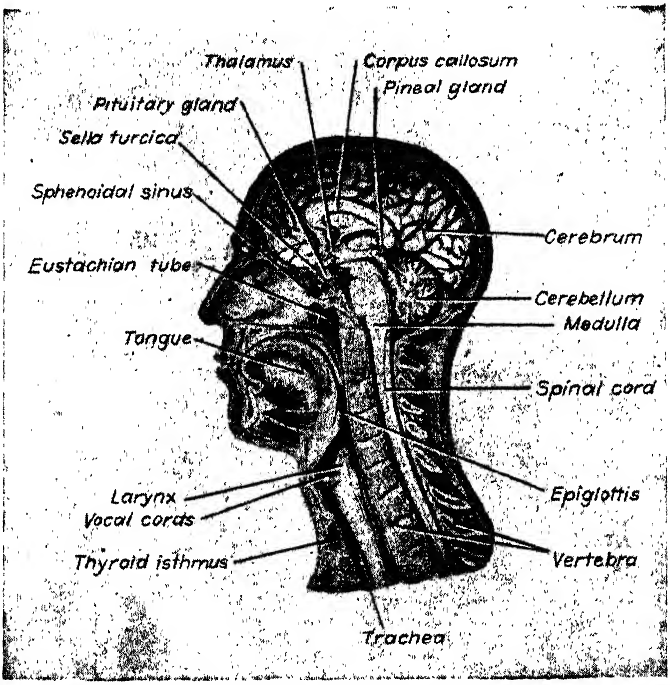

FIG. 56.—Median section of the head. (*Warren, Handbook of Anatomy, Harvard University Press.*)

cephalon, mesencephalon, diencephalon, and telencephalon. There seems now to be some disposition to condense these into four or into three divisions, and there are actually only two areas of major difference. The author has elected to discuss the structures as hindbrain (including myelencephalon and metencephalon), midbrain, and forebrain (including diencephalon and telencephalon).[1] Since only those parts will be described which

[1] BAITSELL, GEORGE A., *Human Biology*, pp. 259–262, McGraw-Hill Book Company, Inc., 1940.

seem essential to the construction of a more or less coherent story of human behavior, the student is advised, for more complete description, to consult recent texts on physiology, psychology, and neurology.

The Fiber Tracts.—The more complex the nervous system of an organism, the more numerous and important become the communicating fibers. At the base of the human brain are found exceedingly intricate bands, cords, and masses of fibrous connections between various cell areas. Indeed, neurological research is largely occupied in tracing the connections of the nerve cells of the various areas with each other. The *corpus collosum*

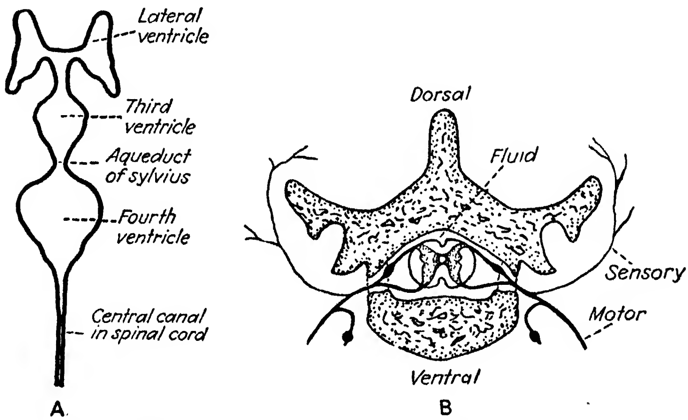

FIG. 57.—*A*, diagram of ventricular spaces in brain; *B*, cross section of a vertebra showing cord and fluid and passage of spinal nerves. (*After Walter, Biology of Vertebrates, The Macmillan Company.*)

is a conspicuous band of such fibers connecting the neurons of the two hemispheres of the cerebrum, making coordination and synchronization of action of the two halves possible. The fibers of the *corpus striatum* provide intimate connection between the gray areas of the basal forebrain and the central motor apparatus. Further mention will be made of specific aspects of the communicating mechanism.

Cerebrospinal Fluid and Meninges.—As the various nervous structures developed from the primitive neural tube, the tubal space was not completely obliterated, but persists in a series of communicating, centrally placed spaces known as *ventricles* (see Fig. 57*A*). The first two *lateral ventricles* are found within the lobes of the cerebrum; these connect by narrow passages with a centrally placed *third ventricle,* within the walls of which are found important structures of the basal forebrain. The third ventricle communicates by another narrowed passage (*aqueduct*) with the *fourth ventricle* between the *medulla oblongata* and the *cerebellum.* The fourth ventricle continues as the *central canal* in the spinal nerve cord.

The skull is lined with a vascular membrane called the *dura mater.* The brain and cord are covered with another closely applied vascular membrane, the *pia mater,* which conveys blood and lymph to the brain and cord. Between the *dura mater* and the *pia mater* is a third membrane, the *arachnoid,* leaving between the arachnoid and the pia mater a space, which is filled with the same cerebrospinal fluid as the ventricles and central spinal canal. Small openings between the fourth ventricle and the subarachnoid space provide passage for the fluid between the internal and external fluid-filled spaces. The cerebrospinal fluid is secreted by the chorionic plexus and is returned in the arachnoid to the venous circulation. It is thus apparent that the cerebrospinal nerve structures float, so to speak, in a sea of cerebrospinal fluid, which equalizes external and internal pressure and temperature, and to some extent enters into the nutrition of the delicate and highly specialized nervous tissue. Perhaps the chemical insulation provided by this arrangement is important also.

The Brain Stem (*Hindbrain*).—Looking again at Fig. 52, the central nervous system, we may say that the *brain stem* begins with the *medulla* and includes the *pons* and the *cerebellum.*

The Medulla Oblongata.—The medulla, out of which the spinal cord emerges, is, so to speak, the port of entry between the brain and the body. With the exception of the olfactory and optic extensions of the brain (see Fig. 52), every outgoing and incoming impression or impulse must pass through the medulla. The dorsal, ventral, and lateral fiber tracts of the cord pass through the medulla, some fibers connecting with autonomic nuclei in the medulla itself which automatically regulate the basic physiological reactions of breathing, circulation, swallowing, etc. Other fiber tracts cross and enter or leave opposite lobes of the cerebellum and help to regulate posture and movement. Still others reach the midbrain and communicate more or less directly with the gray areas in the midbrain and in the basal forebrain, some of which connect with the cerebrum.

The Pons (Bridge).—The pons is a mass of nerve fibers swung across the lower surface of the brain—chiefly, the cerebral fibers which synapse with communicating efferent fibers conveying motor nerve impulses from the cerebrum across to the cerebellar lobe on the opposite side, thus establishing cerebral control of movement. First and last, most nerve impulses are, at some place in the various fiber tracts, shunted from the side of origin to the opposite side, thus bringing the left side of the body under the control of the right side of the brain and vice versa, a curious arrangement, probably related to early swimming movements. The fibers of the pons constitute what is sometimes called the *cortico-porto-cerebellar tract.*

The Cerebellum ("Little Cerebrum" or "Little Brain").—The cerebellum is the striated (striped) bilobed structure seen in Fig. 52 on either side of and above the medulla. The wing-shaped lobes have their surfaces enormously increased by the familiar device of nature of wrinkling a surface into folds.[1] The gray cells are on the surface, the fibers or axons (white) on the inside. A cut section of a cerebellar lobe has a characteristic treelike appearance, to which the term *arbor vitae* (tree of life) was applied by early anatomists (Fig. 56). It is relatively large in active animals that swim, fly, or run and small in short-legged or mud-dwelling vertebrates. In man the cerebellum constitutes about one-tenth of the total brain weight.

The function of the cerebellum seems to be chiefly that of motor strength and coordination, particularly fine and rapid coordination, such as that involved in writing, musical performance, technical skills, etc. The cerebellum receives fibers from many cortical areas of the cerebrum by way of the thalamus, as is evidenced by the great increase in strength, speed, and skill that may on occasion result from conscious effort and exercise of the will. Every area or tract having anything to do

[1] "A flexible membrane is well adapted for making things. And so Nature has found; and accordingly extensive use has been made of this material; and cupping, folding, gathering, is the order of the day, as the embryo develops." C. B. Davenport, *How We Came By Our Bodies*, p. 247, Henry Holt & Company, Inc., 1936.

with stimulating, coordinating, or synergizing (bringing together to form a unity) any sort of movement sends fibers to the cerebellum.[1]

Not an inconsiderable part of the cerebellar function is the maintenance of general muscle "tone" or balance, the *proprioceptive sense*, and the regulation of body equilibrium and posture through delicate response to environmental stimuli. In the animal that must maintain his upright posture in opposition to natural forces of gravity, this muscle tone and postural balance are both complicated and important. This is accomplished, largely automatically and subconsciously, by constant interplay between the afferent and efferent impulses to and from body and cerebellum which never reach consciousness.[2]

The cerebellum is not ready for function at birth, hence the inability of the infant to coordinate any of his muscles. *It seems probable that the ability to walk and the urge to walk mark the functional maturation of the cerebellum.*[3]

[1] "The fundamental function of the cerebellum is the coordination of separate movements into the complexes necessary for the performance of special acts (synergia). . . . This synergic control seems to be effected in essentially the same way whether the movements are called forth reflexly or voluntarily." C. JUDSON HERRICK, *Introduction to Neurology*, p. 213, W. B. Saunders Company, 1922.

"The cerebellum has a dual mechanism for both excitation and inhibition which makes incredibly delicate reactions possible. It is the establishment of association paths and patterns between cerebral cortex and cerebellar cortex which constitutes training in motor skills. The cerebellum must be regarded as an essential part of this mechanism whose probable function it is to determine the rate of flow of excitor and inhibitor impulses into the various groups of muscles brought into action through its underlying reflex mechanism." JAMES W. PAPEZ, "The Human Brain," *Eugenics*, October, 1930.

[2] "In order to bring about this elaborate coordination to maintain correct position a constant checking up, or an adjustment to a large number of incoming sensory impulses, is necessary. Therefore we have the large bundles of fibers connecting the cerebellum with other parts of the central nervous system. Fibers from the portion of the brain receiving impulses from the eye, from the balancing organs of the labyrinth in the ear, from the medulla and from the spinal cord to the motor nuclei of the eye muscles are connected with the cerebellum. CALDWELL, SKINNER, and TIETZ, *Biological Foundations of Education*, p. 143, Ginn and Company, 1931.

[3] KOFFKA, KURT, *The Growth of the Mind*, p. 59, Harcourt, Brace & Company, Inc., 1928.

The gray cortex of the cerebellum is composed of several layers of cells. Those of the greatest evident importance are the *Purkinje cells,* found in a dense layer near the surface (see Fig. 58), which have excessively branched dendrites, making incalculable and incredible numbers of contacts possible for each cell. The outgoing axon pathway proceeds, by way of the pons and ventral spinal tract, more or less directly to specific muscles. It is thought by some neurologists that the cerebellum may be definitely mapped according to regions of specific control.[1]

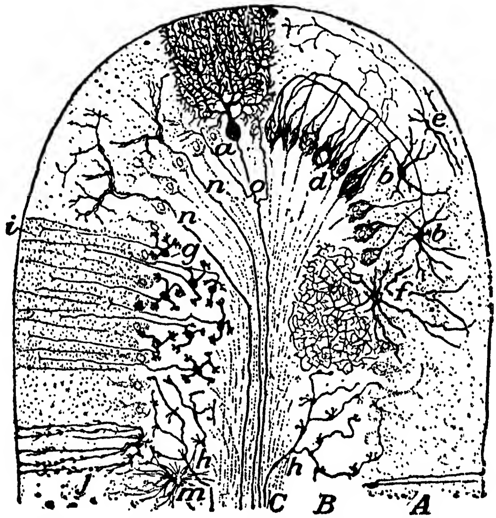

FIG. 58.—Diagram of the various cells found in one fold of cerebellum. A, a Purkinje cell. (*After Ramón y Cajal, from Histology, by permission of William Wood & Company.*)

The Midbrain.—Interposed between the hindbrain and the forebrain (as we have elected to name these parts) is a small, compact group of fiber tracts within the bands and masses of which are several gray nuclei (the *red nucleus,* the *corpora quadrigemina,* etc.) which serve as relay stations for certain nerve impulses on their way to and from the cerebral cortex.

In lower vertebrates, the midbrain was located near the end of the neural tube and was relatively important. In higher vertebrates, it constitutes a section of the elaborate highway of

[1] HERRICK, *op. cit.,* p. 211.

communication that spreads out between the medulla and the cerebrum. It is the origin of the third and fourth cranial nerves, which control the muscles of the eyeball.

The Forebrain.—The forebrain comprises those structures directly and indirectly related to consciousness, perception, feeling, thinking, and willing. The forebrain may be discussed with reference to its "older" parts (the diencephalon) and to its "newer" structure (the telencephalon) (see Fig. 63).

The diencephalon, or *interbrain,* consists of a number of gray cellular masses, nuclei, or areas which are neatly packed and distributed among the white fibrous bands and cords of the communicating pathways found within the cuplike space below and between the cerebral hemispheres, at the "base" of the brain.

In Fig. 56, representing a median section of the human brain, we may see this closely integrated, heterogeneous-appearing assemblage constituting the *basal forebrain,* together with certain structures that have already been discussed within these pages—the pituitary gland (see page 140), the pineal gland, (see page 156), and the structures of the brain stem (the pons, cerebellum, and medulla)—while the larger part of the picture is taken up with the convolutions of the cerebrum, next to be considered. These structures (*the archipallium, or old brain*) originally served to integrate the experience of the animal and were the site of consciousness and emotion. In higher organisms, these structures come under the direction and control of the secluded, exclusive aristocrat of the nervous system, the *cerebrum.* They fetch and carry and serve this dictatorial ruler, which sits in splendid but helpless isolation, unable to do anything for itself.

The basal mechanism is concerned with the *drives* of the organism, with its reactions to conditions that disturb its *dynamic equilibrium,* its *homeostasis* (see page 188), favorably or unfavorably. Behavior is a matter of perpetual oscillation about and within the essential *field of equilibrium* of the particular individual (see page 32). Centers, areas, or nuclei for accomplishing this have arisen at the anterior end of the neural tube (the spinal reflex cord) as the animal body has become increasingly more complex and its operation has required a more intricate switchboard—a more speedy and more selective control. In more strictly psychological language, *sensations* or purely physical and chemical alterations in the biochemistry of the body are registered centrally and become converted into *feelings* that these changes reported by the sense organs are good, bad, or neutral; feelings set off *tensions, drives,* or *emotions.* The *tensions* thus engendered are released or explode as *emotional expression,* or *behavior.*

All along the way from sensory end organ to cortex and back to motor response, short cuts to behavior are provided through reflex and association centers.

At each level are accumulations of neural gray matter which may produce functional response below its particular level. The

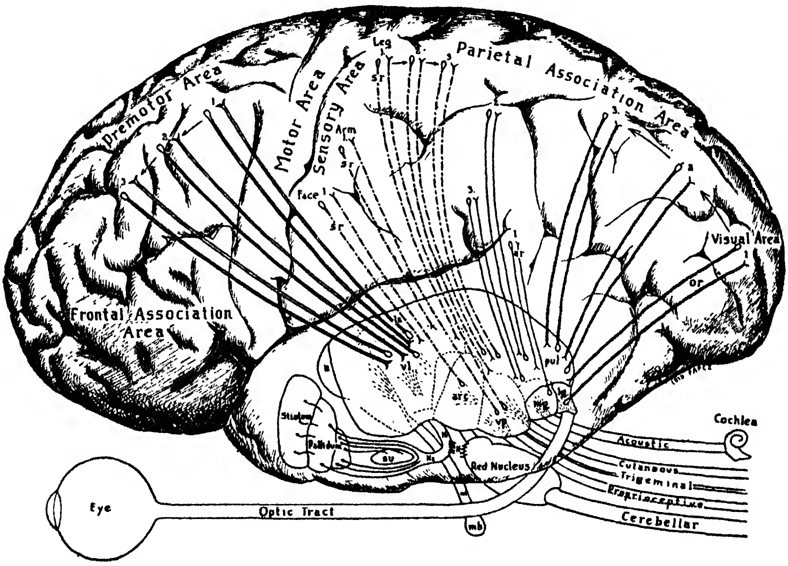

FIG. 59.—Diagram of sensory thalamic tracts and their belt-line connections with the cortex. (*Papez.*)

basal structures of perhaps the greatest significance in our attempt to understand the behavior of the child are the various *thalamic nuclei* found within and adjacent to the walls of the third ventricle of the brain (see Fig. 59). Because the *dorsal thalami* are paired and identical and function as one mechanism, it has become the custom to speak of them as "*the thalamus.*" The *anterior thalamus* (*hypothalamus* and *epithalamus*) is located at the anterior end of the third ventricle.

The posterior thalamus, or "dorsal thalamus" (including tributary ganglionic groups), provides "an amplifying and distributing level for the sensory systems." All the sensory pathways reach the dorsal thalamus: the optic, olfactory, auditory, gustatory, cutaneous, proprioceptive (internal muscle sense), and visceral (autonomic)—each reaches its own particular nucleus in the thalamus, from which association fibers convey the impression to other nuclei or to specific areas on the cortex.

Figure 59 is a diagram of the right thalamus and the right cerebral hemisphere, having the wall of the third ventricle cut away. It is known that association fibers connect the sensory nuclei with each other, and that association fibers connect the nuclei with the various areas of the cortex, while cortical projection fibers connect the cortex with the various thalamic nuclei and with motor centers (see Fig. 59). The cortical areas also associate freely with each other. This is the mechanism that provides a flexible medium of exchange between the organism and the environment for the correlation of experience. The interaction of thalamus with cortex "constitutes a unitary system for maintaining a dynamic vigilance under a variety of environmental conditions which affect the individual" and for "orientation and focalizing and for the organizational processes which deal with comprehension and elaborative thinking."[1]

The Anterior Thalamus.—The hypothalamus, with the epithalamus, receives messages by way of the cerebrospinal and autonomic fiber tracts from all tissues and organs of the body and from the other basal areas, and seems to act below the level of consciousness as a switchboard for the regulation of all physiological processes for the common welfare of the body. The hypothalamus is the mechanic who keeps the machinery in order so that the pilot (the cerebrum) may have his brain energies free to steer a flight across the ocean. In lower animals having little or no cortex or thinking brain, the hypothalamus plays a large part in integrating the total experiences of the animal in the form of emotional reactions, *i.e.*, the "fixating" or energizing of reactions for flight, pursuit, fight, etc. Survival is a matter of favorable integration of all organs and tissues of the body;

[1] Papez, James W., "Cerebral Mechanisms," *The Journal of Nervous and Mental Diseases*, February, 1939.

hence, the close association or identity between digestion, circulation, body temperature, etc., and that curious, centralized, overall reaction we know as *emotion* (something causing motion). Hence, the centralization of physiological direction and emotional reaction in one place—the hypothalamic region. In higher animals, *emotional experience* is mediated in the cortex, where it may be related to other experiences and either intensified or diminished before it reacts upon the hypothalamic centers to produce *emotional behavior.* Animals from which the cerebrum has been completely removed show exaggerated emotional behavior. The emotional behavior of a "decorticated" animal suggests a broken balance wheel; the machinery "runs wild." Some neurologists believe that there must be a sort of consciousness in

> the subcortical source of impulsive activity, a source of elementary but undefined dynamics associated with emoving, perceiving, comprehending, acting, and thinking, . . . the essential subcortical center for the differentiation of all the bodily processes which regulate the individual's disposition, affective life, emotional expression, and the development of personal traits.[1]

This may be considered as the "matrix" out of which specific behavior "emerges" (see page 76).

Papez and others think that complete emotional experience in higher animals distinctly involves the basal cerebral connections, and that the basal forebrain attains a "nascent consciousness," although quite devoid of specific sensory content.

Since emotional behavior is the rule in the young child, it is important to understand as much as is known concerning the mechanism of emotion and its relationship to the other mechanisms of behavior.[2]

[1] Presented by Papez as the ideas of Haskovec, in "Cerebral Mechanism," *Journal of Nervous and Mental Diseases*, February, 1939, pp. 152–154.

[2] "The term 'emotion' as commonly used implies two conditions: a way of acting and a way of feeling. The former is designated as emotional expression; the latter as emotional experience of subjective feeling. The experiments of Bard [removing both cortex and posterior thalamus], have demonstrated that emotional expression depends on the integrative action of the hypothalamus rather than on the dorsal thalamus or the cortex, since it may occur when the cerebral hemispheres and the dorsal thalamus are

Dr. James W. Papez has expressed the implications of this newer conception so clearly, we quote him at some length.

The hypothalamus and epithalamus do mediate emotional expression and are connected downward with the sympathetic and parasympathetic systems. However, the real super-mechanism for integrating the emotions forms a large part of the base of the forebrain. . . . This mechanism of "instinctive" or emotional behavior is superimposed on the more simple (innate) reflexly integrated mechanisms of the brainstem and the spinal cord. All emotional behavior, or social behavior depends in no uncertain way on this mechanism which regulates through the hypothalamus and the epithalamus, the sympathetic and the parasympathetic. Here is a complete hierarchy of closely integrated anatomical levels, as well as a remarkable physiologic integration of the emotions with bodily processes. This is the very core of inner life. . . . Much of early experience and child psychology rest on this emotional level of activity which might be called a bundle of instincts and nascent consciousness. . . . Emotions as experienced are not true sensations, they are properly called feelings or affects. Since they run parallel to sensory experience, emotion may be called parasensory experiences. In emotions it is the situation, internal or external, which is represented, the object is only a part of the total experience. In fact, objects as such may be wanting in an emotional experience. There are many moods, frustrations, elations, etc., which are not

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completely removed. For subjective emotional expression, however, the participation of the cortex is essential. Emotional expression and emotional experience may in the human be dissociated phenomena. Hence, emotion as a subjective state must be referred to the higher psychic level." JAMES W. PAPEZ, "A Proposed Mechanism of Emotion," *Archives of Neurology and Psychiatry*, October, 1937.

"There is evidence that at the base of the diencephalon [the hypothalamus] are located neural patterns responsible for emotional behavior, mechanisms capable of independent discharge but normally held in check by the cerebral cortex. At the same time the central cortex is the immediate site of emotional consciousness, and, as we have seen, emotional experience and emotional expression may be dissociated by disease or surgical intervention. But we know that thalamic processes are a source of affective experience, that bodily sensations such as are sometimes associated with emotion may be thalamic in origin. Well-established anatomical facts show that, with the possible exception of the olfactory, all sensory impulses are interrupted at the thalamic level [the posterior thalamus] before gaining the cerebral cortex. . . . . . There may be a regrouping of cortical impulses in the thalamus." C. L. DANA, "The Anatomic Seat of the Emotions," *Archives of Neurology and Psychiatry*, December, 1921.

objective. Emotional experience is a function of the archipallium [old brain] in contrast to sensation, perception, etc., which are functions of the neopallium [new brain].

Thus we find somewhat specific functions inhering in the different parts of the closely related basal brain structures. These are the mechanisms that are featuring largely in the newer theories of behavior. These provide the basis for the appearance and development of the thinking brain.

The Cerebrum, Telencephalon, "New Brain."—The cerebrum is nature's masterpiece up to the present time. The rudiments

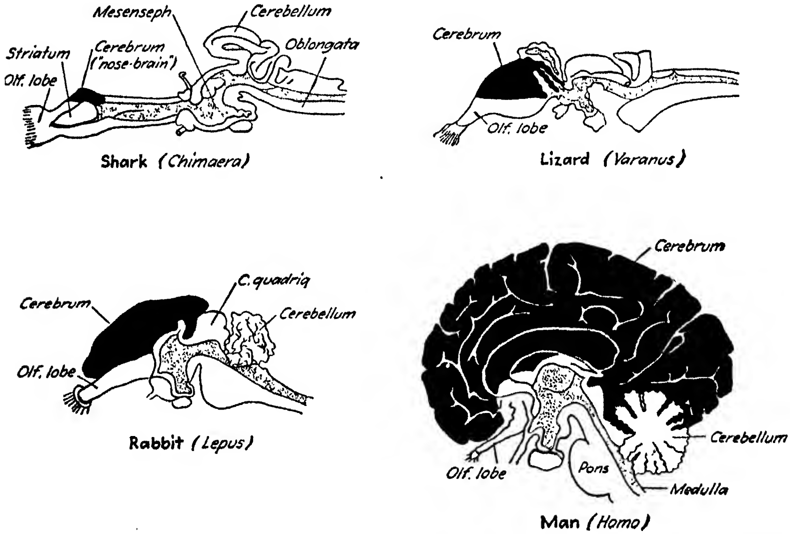


FIG. 60.—The evolution of the cerebrum (new brain). (*Adapted from Koffka after Edinger.*)

of the cerebrum first appear in fishes as an olfactory lobe ("nose brain") with a "mere prophecy of a cortex" (see Fig. 60). The dominance of the forebrain with its cortex over all other parts of the brain comes slowly from fishes to mammals. In mammals the cortical cerebrum rapidly overshadows the other brain structures and in man it has taken on enormous importance.

Fishes and amphibians have no well-defined cortex; reptiles possess a basal cortex, though it is limited in amount and of very primitive structure. They have no true neopallium. In the placental mammals the neopallial cortex is seen to be suddenly expanded in amount and elaborated in internal organization, while in man "the association centers of his cortex are magnified and in internal texture complicated in measure commensurate with his enlarged and glorified mental powers."[1]

Herrick further says:

> Throughout this series of progressively more complicated cortical patterns no fundamentally new structural features are added. The most highly elaborated cortex is made up of neurons of substantially the same sort as those of the rest of the brain. Anatomically, this progressive evolution appears to be wholly a matter of increase in number of neurons and gradual change in the structural arrangements by which they are physiologically interconnected.[2]

It is this structural arrangement in the higher cortex that is the important thing in sensation, perception, symbolism, retention, and in all higher activities.

The cerebrum is divided into two longitudinal *hemispheres* having their surfaces deeply wrinkled into *lobes* and *convolutions*, which are separated by *furrows*, or *sulci*. When the skull is opened, the cerebral portion of the brain is seen to resemble somewhat the bilobed kernel of an English walnut. If the two hemispheres are pulled apart, they are found to be joined at their bases by a dense mass of intercommunicating fibers called the *corpus callosum* (see Fig. 56).

The Cortex, "New Mantle" (Neopallium).—The essential element of the cerebrum is its surface layers of neurons and association fibers forming the *cortex*. There are several varieties of these cells, arranged in two general layers—the inner or *infragranular*, and the outer or *supragranular*. The cells lie within a dense feltwork of nerve fibers and supporting *neuroglia cells* (which are nonnervous in character, apparently a sort of living packing tissue). The convoluted surface of the cerebrum is covered with this cortical covering of gray nerve-cell tissue, which varies from 1/10 to 1/8 inch in thickness. It is said to cover a total surface, if spread out, of approximately 316 square inches, or 2½ square feet. Again we are reminded of the potency of small things. We are told that this magic fabric, some 16 by 20

[1] HERRICK, C. JUDSON, *Brains of Rats and Men*, p. 70, University of Chicago Press, 1926.

[2] *Ibid.*

inches square and $\frac{1}{10}$ inch thick, contains in the average individual at birth some 10,000 millions of undeveloped cells or neuroblasts (see page 171). Even so, these cells are not closely packed together; the greater part of the space is loosely filled with nerve fibers and neuroglia cells and blood vessels. *There is still plenty of room to grow.*

Neuroblasts are the seeds from which the functioning pyramidal and other cells grow. They may increase greatly in size with use. It is said that the cortices of highly intellectual persons have large pyramidal cells; also cells having very long axons are

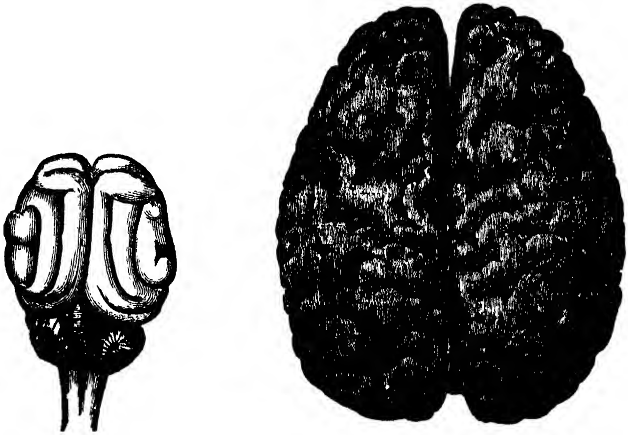


FIG. 61.—Comparative wrinkling of cerebral surface of cat (*A*) and man (*B*). (*Eddy, General Physiology, American Book Company.*)

larger than those having short axons. It is said that if these approximately 10,000 million cells were packed closely together in the form of a cube, with no interspace, the cube would measure a little less than an inch on each edge and would weigh a little over 13 grams—about $\frac{1}{100}$ of the total weight of the brain. *It is with these very cells, however, that we are at this instant trying to grasp the significance of their own structure and function.*

Let us look at Fig. 62, a classic picture by Ramòn y Cajal, the famous Spanish neurologist. It is a drawing from a magnified fragment of this $\frac{1}{10}$ inch from the brain of a human infant. If it paralyzes the imagination to try to conceive of ten billion cells packed into a cubic inch, let us struggle with the effort of computing the possible number of contacts or associations of each of these cells with the others within the cortex. In Chap. VII we saw the impressive list of figures resulting from the computation of possible millions of millions of combinations of 30 amino acids; the conclusion was that enough kinds of proteins might thus be created to account for all hereditary traits in all the genes, and all physiological functions throughout life. Shall we not conclude, when we have somewhat recovered from our stupefaction, that the cerebral cortex is a mechanism adequate to account for all experience, reasoning, memory, and thought? The growth and constant adaptation of these nerve cells makes possible learning, retention (registry), reproduction (recall or memory), etc. Although no one yet can explain the mystery of the conversion of chemical and electrical energy into thought, it seems reasonable to assume that the processes of mentation—including sensation, perception, symbolism, retention, thinking, and reasoning—are the product of the dynamics of these structures, and that enough contacts and combinations are possible between these cells by way of the association (intercommunicating) fibers to keep one thinking without undue repetition for the duration of an ordinary lifetime; indeed, no lifetime is long enough to begin to exhaust the possibilities in the way of new or creative cortical associations.

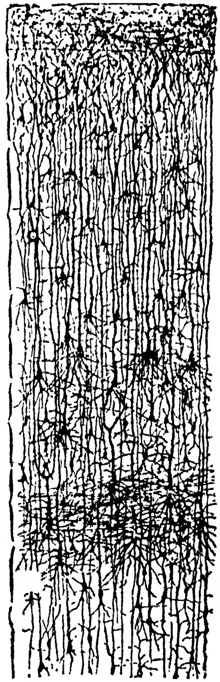


FIG. 62.—Section from the cortex of an infant, showing arrangement of cells and fibers—greatly enlarged. (*Ramón y Cajal, in the Proceedings of the Decennial Celebration of Clark University.*)

With the appearance of the cortex, the sensations, perceptions (object recognition), associative memory, and adaptive behavior become possible, and gradually dominate and largely replace reflex and instinctive and purely emotional behavior. The insect, which has nothing but reflex mechanism—no cerebrum or cortex—has a remarkable equipment of reflexes ready to use when it is born, but its nerve currents flow in set channels. Relatively little in the way of adaptative behavior or learning is possible. With such a flexible equipment for perception and retention as the human cortex, new combinations, contacts, and channels, even the maturation of new cells from neuroblasts, are forever possible —the newer science tells us—while life lasts.

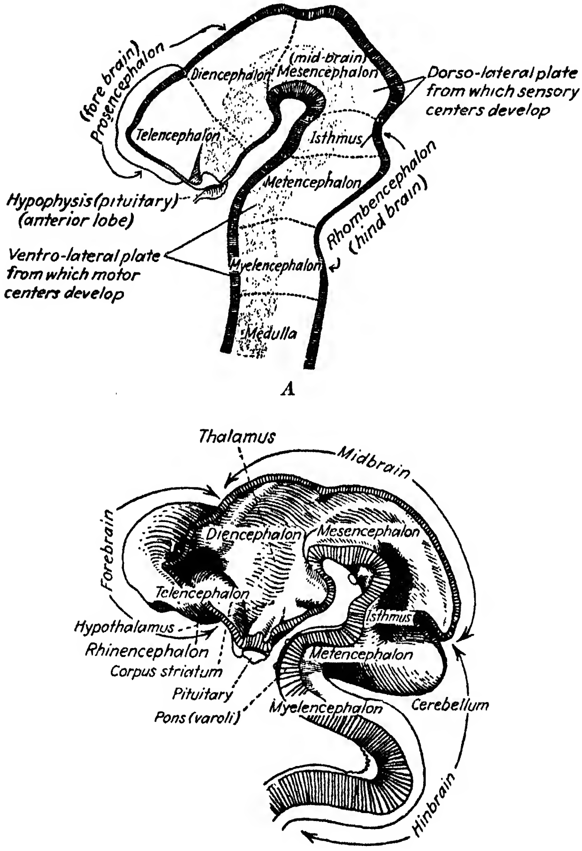


Fig. 63.—Two stages of developing brain. *A*, inner surface of a developing brain in a human embryo of about 4 weeks (*from Herrick, Introduction to Neurology, W. B. Saunders Company*); *B*, section of brain of fetus 3 months old (*modified from Toldt*).

The Brain of the Child.—We have just looked at the general structure of the brain and the nervous system and have briefly considered its history. We wish now to review what is known as to the way the human brain develops during prenatal life, infancy, and childhood—especially in what particulars, if any, the child's brain differs from the adult structure.

Dr. George E. Coghill of Wistar Institute, Philadelphia, watched the development of the brain in *Amblystoma* by precise and carefully controlled methods and tells us that centers of rapid differentiation (gradients or fields) appear first at the anterior end of the embryo. Three fields of acceleration make their appearance almost simultaneously during the early nonmotile stage of *Amblystoma*, each controlling the development of a respective part of the forebrain (see Fig. 63). Then:

centers of differentiation in the brain and spinal cord arise as centers of disturbance in a placid lake. The disturbance, however, is of greater intensity and amplitude in some centers than in others. The difference appears to be correlated with the orientation of neurons and the growth of conduction paths.[1]

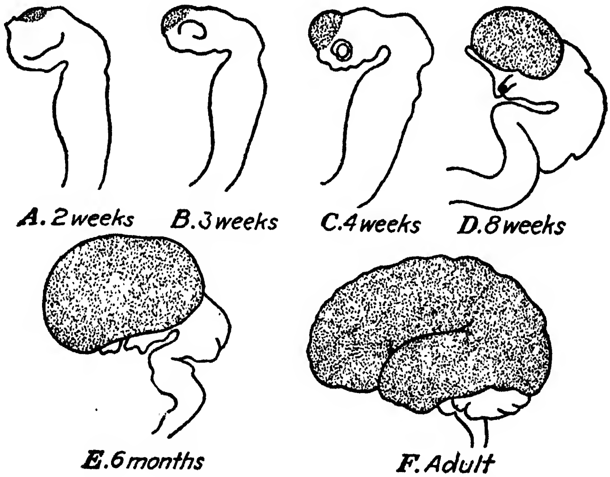


Fig. 64.—Development of the cortex in the human embryo. (*After Herrick, Neurological Foundations of Behavior, Henry Holt & Company, Inc.*)

We find Coghill's picture applies equally graphically to the embryonic growth of the brain and nervous system of the human infant. Nature in the development of the human embryo begins first upon her latest, most complicated, achievement—the brain and its extensions in the form of the nervous systems.

[1] Coghill, George E., *Anatomy and the Problem of Behavior*, pp. 68–70, The Macmillan Company, 1929.

The first appearance of structure is the neural tube (see Fig. 18). By four weeks of embryonic growth (see Fig. 85), when the entire embryo is approximately ½ inch in length, the neural tube already shows at its anterior end segmentlike flexures and areas of the permanent brain, and shows the ventral and dorsal plates from which motor and sensory centers respectively will develop.

The brain of a human embryo of five or six weeks shows close resemblance to that of fishes (Figs. 64 and 60).[1] At birth the cerebral cortex is still unfinished, the conducting nerve fibers are largely unmedullated, and the nerve cells are small, immature neuroblasts which have little if any neurochromatin (Nissl bodies) (see page 173). Lashley says that the transformation of neuroblasts into neurons continues for a long time after birth and that the development of behavior depends upon this and upon the growth and proliferation and myelination of nerve fibers, also upon growth in cell size and resultant modification in cell chemistry.[2]

Ramòn y Cajal is quoted by Herrick thus:

> The extension, the growth, and the multiplication of the appendages of the neurons, moreover, are not arrested at birth; they go on after that time; and there is nothing more striking than the difference between the nerve cells of the new-born and those of the adult as regards the length, number, and complexity of their ramifications. Doubtless exercise is not without influence upon these alterations, which are probably more marked in certain spheres of the brain of the cultured man. Lack of exercise, on the other hand, should evoke in the inactive spheres of both cultured and uncultured men those phenomena of resorption which have been observed during the embryonic period and which here come to expression as forgetting, etc.[3]

Herrick says the axis cylinders (nerves or myelinated fibers) of the cerebral hemisphere mature—*i.e.*, acquire their myelin sheaths, without which they cannot completely function—at various stages in the development of the brain, some of these

[1] Herrick, C. Judson, *Neurological Foundations of Animal Behavior*, p. 166, Henry Holt & Company, Inc., 1924.

[2] Lashley, K. S., *Foundations of Experimental Psychology*, Chap. XIV, Nervous Mechanisms in Learning, Clark University Press, 1929.

[3] Herrick, C. Judson, *Brains of Rats and Men*, p. 53, University of Chicago Press, 1926.

systems of fibers appearing before birth and some after birth. Flechsig formulated a law expressing the manner in which these nerves become ready for function, which is called "Flechsig's fundamental myelogenic law."[1] "The myelination of the nerve fibers of the developing brain follows a definite sequence such that the fibers belonging to particular functional systems mature at the same time." He also states that in the cerebral cortex there are two great functional classes of fibers: the *projection*

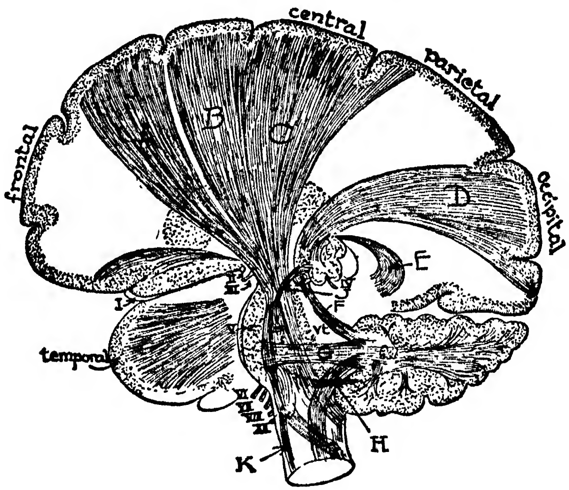


FIG. 65.—Schematic section of the human brain showing the projection-fiber tracts connecting the cerebrum and other parts of the brain and spinal cord. (*Hunter, Walter, and Hunter, Biology, American Book Company. Modified from Starr.*)

fibers, which carry excitations between the body and brain, and the *association fibers*, which intimately connect the cortical cells with each other (see Figs. 65 and 66). The projection fibers, he says, mature in advance of the association fibers. This would seem to explain the observed fact that children make the acquaintance of the world as experienced by their bodies some time before they reason much about their experience. Dr. Papez calls the projection system the "extrovertive mechanism" and says that it is the more primitive cerebral mechanism, dealing with reactions to immediate situations, while the association fibers constitute the "introvertive mechanism," which is

[1] HERRICK, *Introduction to Neurology, op. cit.*, p. 322.

later and more complex and is related to the higher cortical functions.[1]

Dr. Coghill believes that nerve cells, like seeds, grow according to their "inherent potentiality" and according to "a definite pattern," but that the direction of growth and their orientation with other structures depend upon such surrounding conditions as "metabolic gradients," "limiting membranes," and "vascularization." He tells us that the nerve cell is from the start more than a conducting mechanism; it is a dynamic system reacting to its environment after the manner of a living organism,

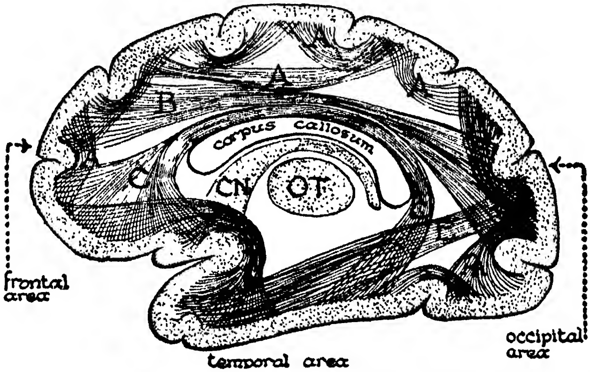


Fig. 66.—Schematic section of the human brain showing the association-fiber tracts. (*Hunter, Walter, and Hunter, Biology, American Book Company. Modified from Starr.*)

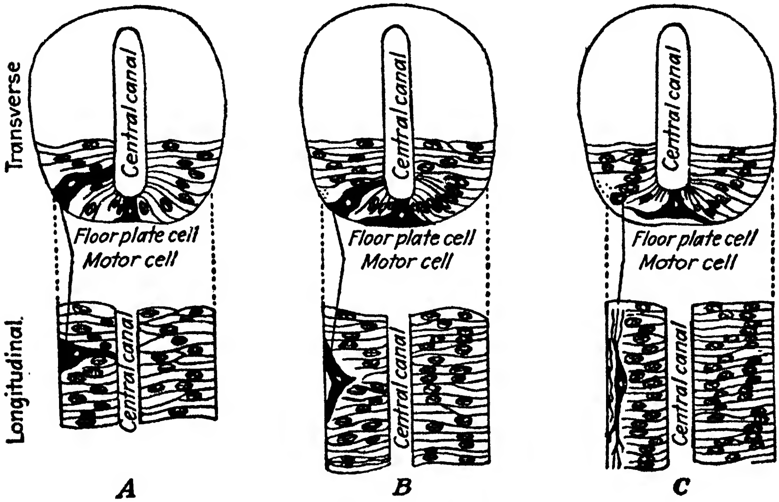
with "conduction" its accessory or secondary function (see page 171). He declares: "If it ever loses its potentiality of growth and differentiation we do not know when or where."[2]

It is well known that nerve cells when once destroyed are not regenerated or replaced (see page 173), but cortical cells, with their axons and dendrons, develop from neuroblasts and certainly grow in size, while the axons grow in length as the child grows. Indeed, the size of the pyramidal cells in the cortex is one index of mental activity; apparently they grow with use. Dr. Coghill shows that growth of the ends of the dendrons and axons—sometimes of microscopic dimensions—may make new contacts possible and have a tremendous effect upon behavior.

[1] Papez, James W., "The Human Brain," *Eugenics*, October, 1930.

[2] Coghill, *op. cit.*, pp. 84–85.

By the growth of terminals of nerve cells over a distance of less than one four-hundredth of a millimeter, the animal (Amblystoma) is transformed from one that must lie helpless where chance places it into one that can explore its environment in response to impulses from within or stimulation from without. . . . In a biological sense Amblystoma is certainly solving its immediate problem of survival by means of growth of neurons that are already functional conductors.[1]



Orientation of Neurons

FIG. 67.—Diagram of nerve cells in process of growth. Upper figures represent cross sections of the spinal cord; the lower figures represent longitudinal sections at corresponding levels. *A*, *B*, and *C* represent successive stages in the development of an embryonic epithelial (neuro-epithelial) cell into a neuron. (*From Coghill, Anatomy and the Problem of Behavior, courtesy of The Macmillan Company and the Cambridge University Press.*)

Langworthy says that "fibers and tracts become medullated in the order in which they have developed phylogenetically" (during evolution). It is probable that tracts become functional at the same time that they become medullated.[2]

How long the growth of dendritic terminals continues is not known, but this growth doubtless goes on as long as the brain and skull and body continue to increase in size; and it seems probable, as has been said, that microscopic extensions may continue

[1] *Ibid.*

[2] LANGWORTHY, O. R., "The Myelination of Tracts in the Nervous System," *Journal of Comparative Neurology*, Aug. 15, 1928.

indefinitely. We saw (page 202) that much of the brain space is actually occupied by fluid and loose supporting tissue; it would seem to be constructed to allow for the contingency of growth. It seems likely that neuroblasts become nerve cells and then increase in size, at least to some extent, in response to the dynamic demand of experience.

Dr. Coghill makes a very definite distinction between the basic neural structures, which are laid down *before function begins, in*

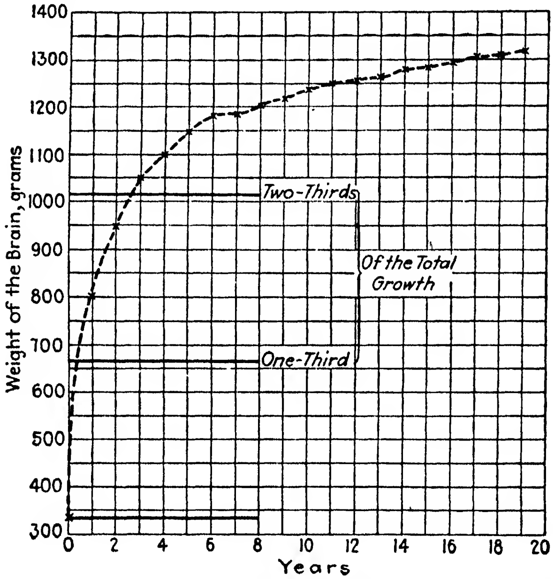


FIG. 68.—The postnatal increase in the weight of the brain. (*Karl Bühler, Mental Development of the Child, Harcourt, Brace & Company, Inc.*)

advance of excitation or experience, and the more sensitive or flexible extensions of these, which appear after function begins and *may be modified by experience*, and which, he believes, are susceptible of indefinite growth and extension through microscopic but significant increments.

Specific Cortical Areas.—Every human cerebrum exhibits in each hemisphere four major lobes (frontal, temporal, parietal, and occipital). These are wrinkled into definite *convolutions*. The convolutions have further smaller wrinkles or indentations (gyri), and it is the supposition that the greater the wrinkling, the greater the intelligence, since this increases the surface extent of "gray matter." Certain *areas* or convolutions on particular lobes are directly connected with specific parts and organs of the body through the dorsal thalamus and the spinal and cranial nerve paths. There are two deep fissures, one in the inner sides of each of the hemispheres—the *central fissures of Rolando*. The posterior surface of this fissure is the *sensory area*, receiving impressions via the thalamus (see page 197). On the front wall of the fissure is the specific *motor area* (see Fig. 59). An animal in whom a certain spot—the visual area—in the occipital lobe has been injured will be made blind, although the eyes may be perfect. Injury to a certain spot of the motor area on one side will cause impairment of movement of the arm of the opposite side. The center for the outflow of speech control and that for "handedness" are next to each other on the side controlling the hand naturally used in writing.[1] In older texts a pictured map will be found setting forth specific motor and sensory areas on the surfaces of the various convolutions and sulci of the cortex. Later experimentation shows that cortical activity is not so rigidly circumscribed in spots or areas as was formerly thought. The sensory tracts are less definite than are the motor tracts; in all tracts and areas association may take place with the greatest range and freedom. This spread of influence has come with the development and use of association fibers, which structurally differentiate the instinctive from the reasoning animal. For all impulses, incoming and outgoing, coordination with the entire cortex is necessary.

The Behavior Cycle.—We have seen the nervous system develop through growth and maturation. "Under the impacts of external forces," we see the behavior of the child unfold in similar manner.

The newborn infant uses little of his brain mechanisms above the medulla in the brain stem. His lower autonomic nervous system is taking care of the primitive physiological functions that clear through the autonomic centers in the medulla, *viz.*, breathing, sucking, swallowing, crying, etc. (see page 383). Eventually, certain reflexes begin to circuit through the cere-

[1] "There is considerable evidence that injury may result from forcing a left-handed child to use his right hand." Ira S. Wile, *Handedness, Right and Left*, Lothrop, Lee & Shepard Company, 1934.

bellum and descending tracts of the medulla and cord, and coordinated movements appear. The hypothalamus with its very primitive associative connections with the basal cortex, its associative connections with the other basal nuclei, and its circuit of "nascent consciousness" comes into function. The behavior of the young child is then strictly emotional behavior. *Even when sensations register in his cortex by way of the thalamic, sensory pathway* (see Fig. 69), *the child has no associative memories or previous experience by which to check his sensations* Of necessity, until he can accumulate experience, he must pass through a considerable period when he is a *thalamic organism.* He is controlled by the impulses and sensory impact of the moment; he has no past memories, therefore he cannot anticipate the future. He has not had sufficient repeated or sequential experience to acquire a sense of time. There are generous associative connections between the various nuclei of the thalamic interbrain, and the emotional life of the child is vivid, intense, and primitive.

As the projection fibers between the thalamic complex and the cortex become medullated and functioning, successive and repeated sensations or experiences register on the cortex as *situations,* and also *register cumulatively and leave traces, or memories.* Consecutive experiences create a sense of *time.* Each experience creates a *graded field of awareness* or response in the particular cortical area in which it is registered. Fields of perception that arise simultaneously and repeatedly tend to merge into one, become "associated," and give rise to *conditioned responses* (see page 223). Fields of cortical activity spread or travel through the cortical areas via association fibers. The child begins to be able *to compare, to associate, to draw conclusions, to reason.*

As all impressions reach the cortex by way of some of the thalamic nuclei, so all communications from the cortex to the external world must retrace a pathway through the thalamic region and the spinal cord before they can arrive at any expression in behavior. *There is a constant shuttling of afferent and efferent impulses between thalamic areas and cortical areas.* Papez has named the spot of impact of a sensation, or impression on the cortex, *the dynamic engram.* He compares the shuttling of messages and the traveling of associative "engrams" over the cortex to the electric sign on the Times Building in Times Square, New York City. On this band of solid light bulbs (the pyramidal cells in the cortex), an operator at an internal switchboard (the sensory and emotive nuclei) spells out a perpetually changing story of the daily news, which runs along the cortex from center to center.

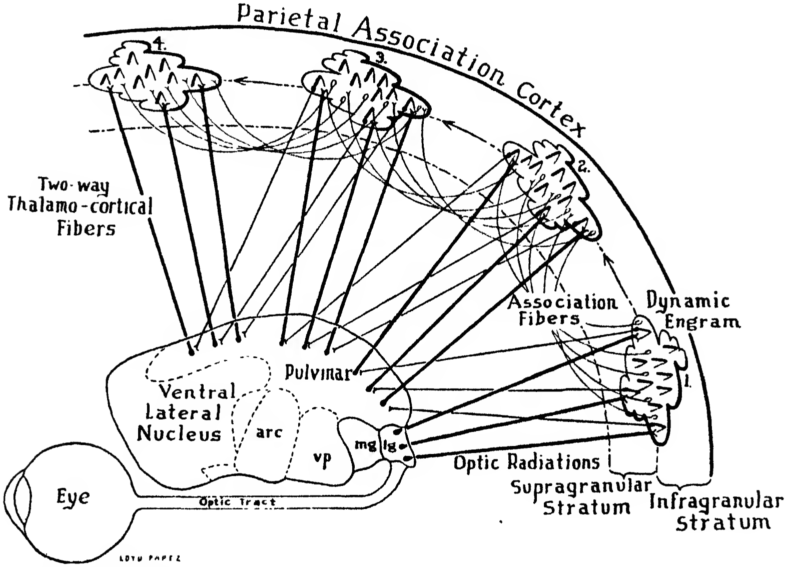


FIG. 69.—Diagrammatic scheme of the passing of the dynamic engram (the symbolic neural complex) from the thalamus (pulvinar) to the cortex, along the association paths and back to thalamus. (*Papez.*)

Even the simplest response by movement necessitates for its execution the mechanical, chemical and physical activities of a number of organs. With the rise in the animal scale, the body becomes capable of responding to increasingly complex external situations, and the nervous organization of the vital machinery, whose activity underlies these responses, becomes likewise of increasing complexity. Hence the intricate mechanism of the thalamic plexus for the coordination of the vital activities with the functions of the cerebral cortex.[1]

When an impression (engram) has been registered upon the cortex by way of the thalamus, that impression may encounter

[1] ROSSETT, JOSHUA, *The Mechanism of Thought*, p. 69, Columbia University Press, 1939.

other related memories or fields and become more or less modified before it reaches the point at which it is shunted back over efferent paths to the thalamus. In the thalamus, before the efferent impulse is shifted through the gateway of the medulla to have its effect upon behavior, it may be further modified, enhanced, diminished, or entirely suppressed. It may, on occasion, gather force in traversing the associative cortical paths and release a great amount of stored-up energy when it returns to the midbrain. In general, "*nerve impulses are, in this passage through the association systems, modified in correspondence with the person's previous experiences.*"[1]

It will be apparent that a great deal depends upon the accumulation of experience by the child. To expect of a child behavior in advance of his experience and in advance of the development of the behaving mechanism is a serious mistake. This is a common error in child management.

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[1] *Ibid.*, p. 80.

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New Words in Chapter XIII

cupidity. Eager desire, especially for wealth; avarice.

emotion. Any of the feelings of joy, grief, fear, hate, love, awe, etc; any of the feelings aroused by pleasure or pain, activity or repose, in their various forms, or the type of consciousness characterized by such feelings.

Gestalt. The name given to the school of psychology which bases its theory on the organismic philosophy.

goal. The objective sought in any directed effort.

insight. Mental vision, discernment, intuition. Act or fact of apprehending the inner nature of things.

instincts. Any inherited tendency, characteristic of a group or race of related animals, to perform a specific action in a specific way when the appropriate situation occurs.

intelligence quotient. The relation of the mental age to the chronological age.

monozygotic. Arising from a single fertilized egg.

natal. Native; pertaining to or dating from one's birth.

neonatal. Pertaining to the newborn; technically, in vital statistics, the first month of life.

psychic. Pertaining to the mind.

CHAPTER XIII

BEHAVIOR AND TRAINING

Behavior is always a total response and not limited to a specific muscle or organ. From the outset the individual confronts his environment as a whole. Reactions to stimuli are not limited to local parts but the entire individual is always involved in the response. Behavior patterns are thus generalized and not specific responses.

—JAMES W. PAPEZ.[1]

Behavior emerges basically from body dynamics which press the individual to action at the same time that they give rise to feeling states. . . . Perhaps we cannot describe accurately the role played by feelings in motivating and directing behavior, but we do know that they are close to the basic physiological processes which underlie all behavior.

—D. A. PRESCOTT.[2]

The Newer Concepts of Behavior and Training.—Modern science is making the care and guidance of a child a much simpler, happier, and more rational matter than ever before in educational history. All behavior is normal. The child behaves in the only way he can behave on a basis of his present developmental level and of his previous experience, and under the existing present situation. When one realizes this, he ceases to enter into conflict with growth and thus saves both the child and himself from useless frustrations and unhappiness. He realizes that he can influence development only by modifying the situation, and that when the situation is correct the child will continue to react in the only way in which he can react and will exhibit acceptable behavior, provided the adult is intelligent enough to accept behavior appropriate to the degree of maturity of the child, behavior that expresses, also, the particular personality configuration of the particular child. The adult must continually strive to recognize, to understand, and to meet the behavior phase presented by the child. This makes living with a child a perpetual challenge, a

[1] "The Human Brain," *Eugenics*, February, 1931.

[2] *Emotion and the Educative Process*, pp. 16–17, American Council on Education, 1938.

stimulus, sometimes a worry, but always a joy. One can never settle down to static rules or procedures.

Every day the child is a new child. Like Coghill's *Amblystonia* (page 209), during the night new increments of neural growth have made new behavior possible and inevitable. Each day the child sees a new world and greets it with a shout of joy. Happy is the adult who can see this fresh new world with the child and help the child to fit himself happily into it. Too often the adult strives to make the child see *his* world and demands conformity beyond the maturity of the child. Both adult and child are then bewildered and unhappy.

Instincts, Feelings, and Emotions.—Instinctive behavior is the structuralization of behavior that has occurred habitually in the experience of the species. Habit is the pattern of stabilized behavior that results from repetition of an experience in the life of an individual. Although it is not clear as to how acquired, or *habitual,* behavior becomes inherited, obviously it has done so (see Chap. VIII).

The most primitive and basic of the inborn action patterns is the instinct of survival, or the will-to-live. A fish, a fly, a rabbit, or a wild bird exhibits an instinct of survival that challenges the intelligence of man. Even a helpless newborn babe will try to withdraw from discomfort or pain and, if unable to do so, will struggle and resist. Through evolution this urge to survive became differentiated into a hierarchy of instinctive protective reactions grouping around food, sex, and safety, and resulting in the development of an autonomic nervous system, eventually heading up in the brain stem (the medulla) and in the midbrain (the thalami). Coincidentally, the chemical organs of flexible adjustment, the endocrine glands, appear. At the time of the appearance of the cortex in animal evolution the animal possessed marvelously intricate and effective ready-to-use reflex paths for *innate* behavior. With the rise of the cortex, the function of the thalamic structures has changed and they have become increasingly the servants of the cortex and less and less the switchboard of the instincts.

The newborn infant is a purely vegetative or autonomic organism. He is governed from his brain stem (see page 191). He has, ready to use, the survival instincts, or reflexes, of sucking, swallowing, crying, sneezing, urinating, and defacating. He has inherited a midbrain and archipallium (see page 195) which retains much of its instinctive function, but his body is, so to speak, not yet functionally connected even with the thalamus, much less with the cortex. Hence, his unique and prolonged helplessness. As discussed on page 212, the maturation of the behavior levels creeps along toward the cortex, and the child next becomes an *emotional* or *hypothalmic animal*, with increasing use of the primitive forebrain and gradual rise of the sense of self.

Emotional motivation is the mainspring of the child's life. This is at once the most dramatic and the most wonderful part of the brain. I know of nothing more important for child psychology and proper social adjustment of the child than the understanding of this great emotional fountain head of the child's activities. We rational adults are so prone to forget that it takes many years for the child to gain a rational attitude and control over its behavior. And in this long interim the child struggles along under [purely] emotional guidance which, if it could be again revealed to the adult, would be like a fairy story of dreams, impulses, yearnings, loves, hates, heroic achievements and frustrations. . . .

The higher forebrain, neopallium or neocortex ligated with the dorsal thalmus represents sensory consciousness, perceptions, symbols (dynamic engrams), and the whole category of total complexes (Gestalts and Gestaltings), retention, registry, learning by wholes (configurations), by differentiation, redifferentiation, insight, thinking, intelligence.[1]

While it is necessary for psychologist and neurologist to establish technical distinctions between the feelings, sensations, and emotions and their producing mechanisms, it will suffice for our practical use if we think of feelings and sensations as the affective incoming states which produce the effective outgoing state of emotion that motivates behavior.

The feelings—pleasant and satisfying or otherwise—constitute an aura or a field property of every constellation or field of experience. Feelings generate an energy drive or tension called *emotion* which creates *goals* and which struggles for release or relief in some form of action or behavior, and in some degree this spreads

[1] From unpublished writings by James W. Papez.

or diffuses throughout the total energy system that we call *the body*. "Emotion is an aspect of whatever the individual is doing at the time."[1]

The dorsal thalamus is so connected with the new cortex in the human brain (see page 213) that feelings and emotions are relayed to the conscious, or thinking, cortex. The function of the higher cortex is to pass judgment upon the situation in the light of associative memory, experience, and reason. The intelligent individual with a disciplined, well-developed cortex will decide whether or not it is judicious to give way to fear, anger, jealousy, or cupidity; and such an individual can, to a greater or lesser extent, control his instinctive and emotional impulses to run, fight, hate, or steal. In this he is helped or hindered by the behavior patterns or group instincts of the family, neighborhood, race, or country, which he has inherited, and with which he integrates from birth. Plant says we should judge the conduct of children in the light of the pressure upon them of the cultural pattern in which they live.[2]

The emotions of children should be respected. The way a young child feels about things is all-important. Children should be helped to develop right attitudes and wholesome emotional reactions. Repression is never constructive. Mere conformity may cover up devastating inner conflicts. "It *is* more important that a child should feel right than do right."

Cortical Behavior.—*Intelligence* is a term used to designate the total picture of cortical awareness, including the clearness of sensory impressions as registered in the cortex, the accuracy and speed of neuromuscular response, the activity of associative memory in establishing mental fields of reference, etc. There has been much study of the question as to whether each individual is born with certain definite capacities making up his basic *intelligence quotient* (the famous "I.Q.") or whether all mental capacities are subject to modification by experience. From what has been presented it would seem to be clear that the

[1] WHEELER, R. H., and FRANCIS T. PERKINS, *Principles of Mental Development*, pp. 207–208, The Thomas Y. Crowell Company, 1932.

[2] PLANT, JAMES S., *Personality and the Cultural Pattern, The Commonwealth Fund*, 1937; see also "The Emotions of the Child," *Child Welfare Pamphlet*, 58, University of Iowa, 1938.

structures created in embryo and fetus through the catalytic action of the hereditary genes will vary much, although keeping to the specific human pattern.

If it were possible to obtain a clear graph of this native or hereditary equipment, it would become possible from this basis to measure and evaluate learning and wisely to plan education.[1] The attempts to identify and measure natural or hereditary equipment have been many—the Binet, the Binet-Simon, the Terman, the Goodenough drawing tests, the Merrill-Palmer tests, etc. None of these is yet completely satisfactory, and the present trend is away from close comparative distinctions. Tests are given and the results are studied and found helpful in interpreting the individual, but psychologists and educators are becoming wary about attributing the results definitely either to heredity or to training and experience, since it is clearly impossible at the present state of human knowledge completely to separate these at any moment of the individual's life. As a means of making controlled observations that should be helpful in understanding natural and conditioned behavior, the intelligence tests are valuable. As bases of prediction as to future development, they have proved to be uncertain and even dangerous.[2] Especially, parents should not take pre-school and school entrance tests too seriously. No one should worry over a low

[1] "A real *intelligence test* is measuring an individual's will as much as his intelligence, his personality as much as his reasoning, his emotional life as much as his judgment. It is measuring the organization of his forces toward achievement, and the achievement is an expression of derived potentials. The achievement, however, not the potential, is being measured. As a psychological phenomenon this achievement is insightful response. . . . Thus the validity of any prediction, based upon a test, depends upon the constancy of the conditions under which the individual is maturing," R. H. Wheeler, and Francis T. Perkins, *op. cit.*, pp. 167–168.

[2] Wellman, Beth, "Our Changing Concept of Intelligence," *Journal of Consulting Psychology*, Vol. 2, 1938; Stoddard, George, "The I.Q. Its, Ups and Downs," *Educational Record*, Vol. 20, 1939; Wheeler, R. H., *The Science of Psychology*, pp. 171–178, The Thomas Y. Crowell Company, 1940; Anderson, John E., "The Limitations of Infant and Preschool Tests in the Measurement of Intelligence," *Journal of Psychology*, Vol. 8, 1939; Stoddard, George, and Beth Wellman, "Environment and the I.Q.," *The Thirty-ninth Year Book of the Society for the Study of Education*, Part I.

I.Q. or be too "set-up" over a high one. There is considerable possibility, even probability, of later change.[1]

Symbolism and the Conditioned Reflex.—One of the difficulties in any process of learning—a difficulty which is particularly acute in the case of the little child—is the fact that *all experience must be translated into symbols, something that stands for or represents the experiences.* Experiences cannot actually enter the brain; only symbols in the way of much-condensed and contracted words, signs, etc., carry associations by way of sight or sound and register on the cortex. The child must learn that the spoken word *box* represents or stands for a whole class of objects having a few common characteristics. Later he learns the written symbol for the spoken word and object *box.* The child must not only learn symbols for everything; he must learn the accepted, conventional symbols in common use by his associates—the particular language symbols used by his family. He learns that his associates will not accept his symbol of an eye or a hand as standing for an entire man (a type of symbolism likely to be employed by all children in their first attempts to draw). At the same time, the symbolism of using a part to stand for a whole underlies the *conditioned reflex.* In the conditioned reflex contiguous fields of experience tend to merge, as when eating, hunger, twelve o'clock, the noon whistle, the odor of food, and the dinner table form a unitary experience, any item of which may be a symbol of the whole and even touch off the appropriate physiological glandular secretion. The classic example of conditioned reflex is the flow of saliva and gastric juice when any familiar symbol relating to or associated with the eating situation is experienced.

The dynamic engram, which Papez envisions as the projection of experience upon the microscopic cells of the cortex, is a symbol of the objective, external experience itself (see page 213). The exact nature of the cortical symbol still eludes investigation, but any sensory impression is some sort of neural-action symbol—a

[1] McNemar, Quinn, "A Critical Examination of the University of Iowa Studies of Environmental Influences upon the I.Q.," *Psychological Bulletin,* February, 1940; Wellman, Skeels, and Skodak, "Review of McNemar's Critical Examination of Iowa Studies," *Psychological Bulletin,* February, 1940.

counterpart, or representation, of the color, the pain, or the cold of the objective stimulus.

It becomes a matter of importance, then, to assist the child in acquiring correct and useful symbols; important, also, to protect him from forming useless or false symbols, and acquiring conditionings that impede clear thinking and prevent his acquiring true knowledge of situations. To one child a blue uniform or a certain style of cap is a symbol of friendly protection; another child will scream with terror at the sight of a similar sort of uniform because he has been "conditioned" to regard the uniform as a symbol of force and cruelty.

The Psychology of the Whole.—It is more important than usually is recognized by adults that the child's first concepts shall be true and as complete as he is able to grasp. *The mind of the child tends to make a whole—a conditioned reflex—of every experience.* The whole may be a poor, distorted thing, could we but see how its imperfect and fragmentary symbols have fallen together to form an associative field, but he has done his best with what he had to make it of and, because he has a limited background of remembered experience for comparison, the distorted fragmentary concept seems authentic to him, and to him it stands for reality. The configuration psychologists tell us that closure, patterned grouping, organization, the emergence of the new from the old, is a fundamental compulsion in thinking, no less than in physical growth, heredity, crystal formation, or the grouping of a solar system.[1] The "configuration," the "whole," the "pattern," *is the reality,* and it is something different

[1] "This new psychology goes by the significant name of Gestalt psychology, which means in our language the configuration psychology, and is perhaps chiefly remarkable for its intimate connection with modern physics. For just as Einstein gave an impetus to physics by expounding the relative nature of space and time, so the champions of configuration psychology have been assiduously engaged in the attempt to demonstrate the relative character of our mental life, and have thereby imbued present-day psychology at large with renewed vigor." Paul Chatham Squires, "A New Psychology after the Manner of Einstein," *The Scientific Monthly,* February, 1930.

"Relativity Theory Reaches Psychology," Andrew Juhàsz, Report to International Congress of Psychology, *Science News Letter,* Sept. 14, 1929.

from the sum of its parts in thought as well as in physics and biology.[1]

According to this theory of learning and reality, learning takes place, not by practice, trial and error, or any other scheme for constructing wholes from parts, but rather by closure of factors to form a mental configuration. Insight may occur with the first trial, after any number of trials, or never, according to whether or not a consistent configuration or engram emerges on the field of cortical consciousness.

Drill is entirely useless except as an expensive way of seeking "configuration";[2] educational effort must be directed toward helping the child to acquire organic concepts of wholes. This somewhat resembles the old idea of "helping him to understand." The child eventually learns the alphabet because the letters suddenly click together as an idea, a whole, something out of which language is made. He grasps the symbolism. Up to that moment he struggles in vain with it as an instrument of communication, although he may recognize in each letter an interesting small unity, an isolated configuration.

Translated into terms of practical management in child training, *this means helping the child to obtain a complete concept and to see the whole of every experience (within the limits of his maturation). It is our duty to protect him against fragmentation in his mental life.* Fortunately the normal mind has a compulsion to complete its concepts. Consider the instinct of *curiosity* which

[1] Max Planck, who gave the world the quantum theory, says in *The Philosophy of Physics:* "Modern physics has taught that the nature of any system cannot be discovered by dividing it into its component parts, and studying each part by itself, since such a method often implies the loss of important properties between the parts. The same is true of our intellectual life. It is impossible to make a clear cut between science, religion and art. The whole is never equal merely to the sum of its parts . . . Looked at correctly science is a self-contained unit; it is divided into the various branches, but this division has no natural foundation and is due simply to the limitations of the human mind—which compels us to accept a division of labor. Actually there is a continuous chain from physics to chemistry to biology and anthropology and thence to the social and intellectual sciences, a chain which cannot be broken at any point save capriciously."

[2] Drill or repetition is useful *after a configuration is established* for the purpose of converting temporary into permanent gradients or habits, and for acquiring skills in performance via cerebellar coordination (see p. 192).

leads the child at certain levels of maturation to ask questions. The more alert, the more associated memories or configurations he has had opportunity to store, the richer his daily experience, the more question he will ask. And he will continue to seek information and ask questions until he completes his desired configuration or attains his mental goal, such as it is at the time. Such a child will have a mind stored with symbols. Recall and creation will come richly and quickly. Small symbols will bring elaborate associations to him. A small brown feather will be the symbol of a particular songbird and of its habits and history, because he has "experienced" such a bird.

It is the imperative duty of the adult to answer every question in terms of the child's understanding. The child is educating himself more completely than is possible by any formal routine of the schools, because he *knows*, while the adult can only *guess* when his configuration is complete. The energies of his developing organism are sensitively seeking equilibration with the energies of his environment. It has been said that a child would educate himself more completely and in half the time allotted by the school system if he could be permitted to follow unrestrainedly and within a normal environment the lines of his curiosity and interests, with an understanding adult at hand to interpret and inform and satisfy this natural intellectual curiosity. He will instinctively build for himself a complete mental structure. *He wants with desperate intensity to complete every experience to the extent of his capacity for understanding at the moment.*

It is more than probable that most child prodigies are examples of this sort of management. It is devastating to mind and personality to thwart, repress, and fragment the child's greed for complete experience. The practices of modern education are being leavened by the organismic philosophy. The nursery school is probably the most perfect example of correct educational technique in discipline plus freedom that we have at the present time. It is a matter of note that when preschool-aged children have progressive parents who try to follow this philosophy of education in the home and who do try to satisfy every inquiring interest of the child, *and who really converse with their children,* such children are showing unprecedented language development and precocity of interest and reasoning. Nursery-school children go into public school at a distinct advantage because of their enrichened opportunities for organization and extension of mental life.[1]

Interest as Indication of Growth.—As new fields of integration form in brain and mind they demand expression and exercise. This urge takes the form of *interest.* Interests are the indicators of maturity; they blossom in the personality as *attitudes or patterned interests.* Interest (feeling, emotion) catalyzes behavior in a manner completely comparable to the catalytic action of rennin or thyroxin (see page 41). The adult should take the interests of the child seriously. They never are haphazard or meaningless. Behavior enforced or imposed when there is lack of interest or when there is existing antagonism has the same result as mixing chemicals that have no affinity—they separate the moment one ceases to "stir" (if they do not actually explode). It is much more rational to add the catalyst.

The uselessness of premature stimulation has been shown by a number of studies of identical twins, in which one twin would be trained prematurely in some selected behavior, the other being not trained or even discouraged from the particular activity.[2]

In practically all instances the co-twin (the untrained control) has, when the indicated maturation level was reached, soon equaled the t-twin (the trained twin) in performance. One of the most carefully controlled and detailed of such experiments is that of Doctor Myrtle B. McGraw, of the Normal Child Development Study, which is being carried on within the Department of Diseases of Children of Columbia University. The detailed, controlled study was carried on for nearly two years following the birth of presumably identical twins and reported in *Growth, A Study of Johnny and Jimmy.*[3] The experiment was then terminated, followed by periodical observations and a further

[1] Kawin, Ethel, and Carolyn Hoefer, *A Comparative Study of a Nursery School versus a Non-nursery School Group,* University of Chicago Press, 1931; Van Alstyne and Hatwick, "A Follow-up Study of the Behavior of Nursery School Children," *Child Development,* March, 1939.

[2] Hilgard, Josephine Rohrs, "The Effect of Early and Delayed Practice on Memory and Motor Performances Studied by the Method of Co-twin Control," *Genetic Society Monograph,* December, 1933.

[3] McGraw, Myrtle B., *Growth, A Study of Johnny and Jimmie,* D. Appleton-Century Company, Inc., 1935.

report when the twins were six years old.[1] The findings of the study were checked against current observations of a large number of normal children. Dr. McGraw arrives at certain important conclusions, all of which tend to support the organismic theory. She discriminates between basic phylogenetic activities for which the mechanism is made ready in advance of function, such as walking, in which Jimmy, the co-twin, soon caught up with Johnny, the t-twin, and ontogenetic activities depending on functional development, such as roller skating, in which Johnny distinctly excelled. The two years of different environmental influence definitely affected the personality of the two children, particularly in shaping their respective "attitudes," or manner of individual responsiveness.

Imagination, Creativeness.—Bergson, whose philosophy of *creative evolution* has had a definite influence upon education thinking, says:

> Evolution is creative; in organic evolution as in consciousness the past presses against the present and causes the upspringing of a new form incommensurable with its antecedents. In the primitive impulse must be sought the solution of the problem of organic evolution.[2]

We have seen how patterns (engrams) form in the association fields of the cortex and integrate with former patterns, out of which spring new images, ideas, or configurations. The more cortical patterns, the more symbols there are, the more images or "imaginings" will arise out of cortical activity. In the little child all is imagining; he has no fund of critical experience by which to appraise images formed in his brain. All mental impressions seem equally vivid and equally valid to him. The experienced adult learns to evaluate the imaginings of his mind and think whether his ideas "will work." The creative work of the world in industry, art, letters, and science is first shaped in human imagination. One of the most delightful and one of the most critical phases of development in the child is that of

[1] McGraw, Myrtle B., "Later Development of Children Trained in Infancy," *Child Development*, March, 1939.

[2] Carr, H. Wildon, *Henri Bergson: The Philosophy of Change*, Dodge Publishing Company, 1911.

the rise and ascendency of imagination. New fields, new configurations arise out of all experiences of the child. Stories of imaginary events and pictures are to him exactly as vivid and authentic as are actual experiences, and all give him his mental palette with which to paint alluring pictures upon the canvas of his mind. It is as if the newly energized associative fibers of the brain were hypersensitive and were making random contacts all over the brain at once. Whatever mysterious process is involved in the stabilizing and maturing of the associative mechanism, the imaginative experiences at the time must be important and determinative in shaping the mental life.

Imagination, the child's most precious gift, should never come to be associated with fear or taboo, as occurs in the unwise handling of the so-called problem of imaginative "lying" (see page 590). To guide the child wisely in distinguishing the real from the imaginary without curbing creative imagination and to give the child rich, colorful experiences with which to paint his creative canvases is one of the supremely satisfying duties of parenthood and education.

Mental Discipline.—The greatest difficulty the young parents of the present have is that of distinguishing between liberty and license. Adults are prone to take what seem to them to be desirable patterns of behavior as objectives, and not knowing how to make these objectives desirable to the child, they try to achieve them by force. While the young child must learn to conform to the customs of his country through encountering unyielding but friendly situations, he need not be humiliated or abused. From the very first, the objective of self-discipline should dominate all training. *Early discipline is largely confined to the establishment of habits. What we are pleased to call "good habits" come through adaptation to environmental conditions which are reasonably invariable and which are good for the child.* A frequent difficulty is that the parents themselves are undisciplined, and that they do not set up an orderly frame of living designed to establish desirable behavior patterns.

Setting up a wholesome frame of living is the first duty of the parents. This should have been established before the arrival of the child (see page 8). For the child this frame of living covers the routines of eating, sleeping, elimination, rest, and play. The child who cheerfully accepts a regular daily schedule is already a disciplined child. In turn, the schedule must fit his organic needs and flexibly adapt to the constant changes in these needs, or the very fixity of the program may be highly detrimental and defeat its purpose. It is coming to be a question in the minds of some authorities as to whether the arbitrary and rigid "programs" with which our era of order was ushered in did not sometimes do more injury to growth than did the old, entirely programless method. It is not necessary, however, to go to either extreme. Orderly living can be easy living, even for the learning child.

The procedures essential to health and survival having become to a desirable degree automatic, and the survival habits having been established to the level appropriate to the age, parent and child are free to enjoy the daily miracle of unfolding awareness of creation. In this aspect of living the utmost possible freedom of activity should be not only permitted but safely arranged and encouraged.

It is of the greatest importance that the practices essential to optimum growth and health be crystallized in habits as fast as maturation makes this possible, in order that the body may become a servant of the mind, and not drag down and impede the creative spirit. Too often there is such continued confusion and conflict over the matters of the body—such eternal struggle over food, clothing, and sleep—there never comes freedom and quietness for the higher enjoyments of living. The parent who has a clear concept of the developmental sequences can guide the child from stage to stage of self-development and control, without excessive emotional tension and without establishing habits of conflict. Many parents are much more keenly aware of their own personal convenience than they are of the developmental needs of their young children. To them the child who interferes with adult conveniences is a "bad child." In this connection let it be said *there are no bad children—there are only bad (ignorant) parents.* Practical application of these principles will be made in later chapters.

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New Words in Chapter XIV

acidosis. A lowering of the alkali content or reserve of the body. When extreme, is called acid intoxication; treated by administration of alkali.

amphoteric. Affecting both red and blue litmus, acting as either acid or alkali.

appetite. An inherent or habitual desire or propensity for some personal gratification of body or mind. Desire for, or relish of, food or drink.

calorie. The amount of heat required to raise 1 kilogram of water 1 degree centigrade. When applied to food combustion in the body, it means the equivalent amount of oxidation or burning of food fuels in the tissues.

calorimeter. A "heat meter"; an apparatus for measuring the amount of heat produced within the body.

diuresis. Increase in the production of urine.

fatty acids. Acid components of fats which, when combined with certain alkalies, form soaps and set free glycerol.

galactose. A sugar prepared from milk sugar.

glucose. Grape sugar or dextrose.

glycerol. Same as glycerin; the part remaining after the fatty acids are removed from fats and oils by saponification.

glycogen. "Liver sugar," the form in which sugar is stored in the liver and muscle.

hunger. A craving or desire for food. A strong or eager desire.

metabolism. The sum total of chemical changes taking place in any living organism.

nutrition. The process by which food is assimilated by the body.

saponification. The conversion of a fat or an oil into a soap.

CHAPTER XIV

FOOD AND NUTRITION

The adult physical pattern is the outcome of growth along lines determined by heredity—but enhanced, dwarfed, warped or mutilated in its expansion by the influence of environment in the adventures of life. The food supply is often the dominating environmental influence. . . . Nurture can assist Nature. —H. C. SHERMAN.[1]

Any living organism perpetually integrates with environment through the process of *nutrition.* Activated by instinct or intelligence, the human being selects as well as he is able the chemical substances (foods) which the digestive mechanism has come to use to maintain the physical composition of the body at its individual chemical level and at approximately the "steady state" indicated in Table II, page 37. The body cannot utilize any elements as food other than those indicated in Table II as entering into the body structure (and traces of others which may yet be discovered to be essential). The process by which food chemicals, after undergoing digestive preparation, actually become converted into tissues and used in tissue function is called *metabolism.*

Nothing is of so much primary importance to any animal as is his food supply. He is literally what he eats; growth, survival, and behavior depend directly upon a balance in food supply that will make it possible for the body to function in growth and reproduction, and to function in behavior or work. It is exceedingly important that every woman be intelligent as to the nutritional needs of her own body during pregnancy and lactation, and highly necessary that she know the food needs of infant and child, and that she be versed in the techniques of food preparation and psychological management.

So important is food in relation to life, nature has created the powerful *instinct of appetite* and the *drives of hunger, thirst, and craving for air.* In a condition of perfect physiological and men-

[1] *Chemistry of Food and Nutrition,* p. 483, The Macmillan Company, 1937.

tal adjustment and an adequate food supply there probably would be quite perfect adjustment between hunger, food selection as dictated by appetite, and bodily need. Unfortunately, however, perfect adjustment seldom exists; and the conditions of animal evolution under which the human body evolved its structure and its metabolic needs, and met these needs out of its available primitive food supply, have rapidly and almost completely changed. Necessity, therefore, arises for reinforcing, at times even replacing, the instinctive drives of appetite and hunger with knowledge and intelligence—another assertion of cortical control over thalamic sensations (see page 221). During the eons of evolution of the human body and the digestive system, nothing was encountered in natural foods comparable to concentrated sugar or starch or alcoholic drinks or narcotic drugs. Therefore, the body is lacking in protective mechanisms for the rejection or control of these substances. The natural appetite is not keyed to the use of "unnatural" food concentrates, stimulants, and sedatives—as drugs or alcohol; therefore, it does not produce an automatic sense of satiety, as occurs with the eating of regular food. An artificial or conditioned adjustment may be made in the form of a permanent gradient or field of habit. The habit of ingesting substances that do not contribute to the well-being of the organism or that are foreign to the machinery of normal metabolism may be very detrimental, and "reconditioning" may be very difficult (see page 313).

Human Food Requirements.—Protoplasm arose by the process of evolution of colloidal carbohydrates and lipids (fats and lipoids) which came to be catalyzed by the nitrogen-bearing amino acids (as proteins) and by the minerals in the adsorbed sea water (see page 47). We therefore assume that food must contain *carbohydrates, fats, proteins,* and *minerals.* It took many millions of years to create living tissue and living organisms out of these elementary organic and inorganic compounds. Nature finally accomplished this through creating an infinite number of organic catalytic substances, such as enzymes, vitamins, and hormones, which accomplish with incredible speed chemical reactions that originally required long periods of slow change. Incidentally these catalysts all are made from unique combinations of the same 20 or more elements (Table II) found in the human body and also found in the original sea water within which life arose (see page 147).

Basal Metabolism.—The chemical action involved in the conversion of food into tissue and into tissue-function releases energy; as energy is released, a regulated amount of heat is given off. Since it is much simpler to measure heat than to measure the other varying energies of bodily activity, it has become the custom to measure the total body metabolism in terms of the heat given off under stated conditions. In health this measures the chemical activity necessary to keep the body at or near the normal internal temperature of 98.6°F. (36.8°C.) under varying conditions of activity, clothing, external temperature, etc. Body heat is measured in terms of a commonly used unit called the *calorie*, meaning the amount of heat from fuel combustion that is required to raise 1 kilogram of water 1°C., or 4 pounds of water 1°F. The amount of organic substance, living or nonliving that will produce this much heat when burned inside or outside the body has a value of 1 calorie. Foods have been analyzed and burned in the laboratories to determine how much of the various common foods is required to produce, when burned, 100 calories of heat. By animal experiments these findings have been translated into terms of body heat. One-hundred calorie tables of common foods are found in various texts and may be practically useful in estimating the total caloric value of a day's food consumption.

Basal metabolism represents the fuel consumption of the body when it is "idling along," merely existing. The blood is circulating, the lungs are breathing, evaporation from the skin is taking place, the body heat is maintained, the muscles are maintaining a certain tension or tone, even during sleep. The fairly regular utilization of food fuel by the body while at rest is called *basal metabolism.* Basal metabolism is measured by various sorts of mechanisms called *calorimeters* (heat measures). The normal basic metabolic rate has been computed for persons of various ages, weights, and builds and reduced to formulas which make it relatively easy to discover conformity with, or deviation from, normal in any given subject. It has been determined that fuel consumption while one is at rest and fasting is approximately 39.7 calories per square meter of body surface per hour for men, and 36.9 calories for women. Deviation is commonly expressed as per cent plus or minus compared with the normal basal rate. If a clinical report states that the basal metabolism of the individual is 10+ or 10− it means 10 per cent more or less than the expected or normal rate. An average-sized man lying at rest will normally require about 70 calories of food per hour merely to support basal metabolism. When sitting up, he will burn 100 calories per hour; all exertion greatly increases this rate.

The heat regulation of the body is yet a mysterious process, depending upon complicated interaction between circulatory, glandular, and nerve mechanisms (see page 198). It seems to be fairly certain that there is a heat-regulation center in the hypothalamus (see page 197). It is certain that the pituitary, adrenal, and thyroid glands participate in the heat regulation of the body through control of oxidation. The thyroid, in particular, is exceedingly active in controlling the oxidation rate and energy production. In thyroid deficiency, or hypothyroidism (see page 149), the body temperature and basal metabolism are markedly lowered. In hyperactivity of the thyroid the rate of basal metabolism is raised, sometimes as much as 100 per cent. The body is burning its own tissues. Any condition impairing general vitality may reduce the basal metabolism. Thyroxin (the internal secretion of the thyroid) is sometimes given medicinally to stimulate oxidation of food and thereby increase bodily energy and raise the basal metabolism (see page 309 for basal metabolism of pregnancy).

Classes of Foods.—Food substances may be classified as (1) those that supply energy (fuels)—the carbohydrates, proteins, and fats; (2) those that supply building material for tissues—the proteins and certain mineral salts; (3) the catalytic substances that instigate and regulate the chemical actions involved in building and operating the body structures—the minerals, vitamins, proteins, and water.

In Chap. V we read that oxygen, carbon, and hydrogen in their various compounds help form the colloidal framework and provide the fuels for protoplasmic activity. Hydrogen and oxygen form water, and the body is largely composed of water. Hydrogen and oxygen combine with carbon to form the limitless numbers of *carbohydrates* (starches and sugars). Combined in other proportions, C, H, and O form the *fat* fuels and the *sterols* (lipoids) (see page 60). With the addition of nitrogen, *amino acids* are formed, and these combine to form the very complicated dynamic molecules of *proteins* (see page 48). The rest of the mineral elements listed in Table II either act simply as catalysts or enter into the formation of structural compounds, such as calcium carbonate and calcium phosphate in bones, or, together with proteins, enter into the formation of new catalytic compounds, such as hormones and enzymes. Certain essential compounds of these elements, the vitamins, and provitamins, are formed chiefly in plants. Some 10 essential amino acids cannot be synthesized in the human body and must be obtained ready-made from food sources. It follows that to be able to identify the sources of the essential amino acids and of the vitamins is important.

Proteins.—Since all proteins are colloidal, and since colloid micelles will not pass through the minute seivelike openings in cell membranes (see page 60), proteins must be broken into their component amino acids within the digestive tract before protein foods can be absorbed into the circulation by way of the capillaries in the villi of the intestines. The digestion of the proteins is accomplished by the enzymes secreted by gland cells of the stomach, pancreas, and intestine (see page 127). In the stomach the enzyme *rennin* "curdles" (precipitates) milk protein and is particularly abundant and important in the stomach of the infant. The free amino acids released by the protein-splitting enzymes in the stomach and intestine filter through the intestinal capillary walls, enter the portal circulation that goes to the liver, then are carried by the blood in measured amounts to every cell of the body; the cells take out the particular amino acids (as well as carbohydrates, lipids, and minerals) required to build their individual and specific proteins, and carry on their specific activities.

Proteins (amino acids) are amphoteric in reaction, *i.e.*, able to combine either with acids or bases (see page 41). Proteins, therefore, act as buffers equalizing the excess of either acids or bases in the blood, and so help to maintain the blood at the fixed hydrogen ion concentration of pH 7.3 to 7.4 (see page 40). Amino acids not used by the tissues are split into a nitrogenous part which is excreted by the kidneys, and the remaining C, H, and O may, if needed, be burned as carbohydrate fuel or converted into fat and stored as reserve.

Protein Selection.—Since proteins make up the mass of all cell nuclei, all natural foods—plant and animal—must contain some protein; the amount in many plant foods, however, such as green leaves, starchy vegetables, in sugar, in fats, and in fruits, is negligible. Animal food, other than fat and gelatin—such as milk, eggs, flesh, and edible organs—contain all of the 10 indispensible amino acids and so are "complete," "adequate," or "have high biological value." Gelatin is a valuable protein food in its place, but it must not be depended upon as a complete source of amino acids. Seeds—such as beans, peas, legumes—and grains—such as corn and wheat—do contain some of the essential amino acids, but in such small amounts that it would be necessary to eat truly prohibitive quantities of these foods in order to obtain a desirable or even a maintenance quotient of amino acids.

For children, pregnant and nursing women, adolescents, and any individual undergoing increased metabolic demands, *milk is the one best source of complete protein.* Eggs, flesh, and edible organs are desirable sources when used in proper amounts.

Amount of Protein.—Only about 10 to 15 per cent (depending upon age and activity) of the entire food oxidation of the body assumes the form of tissue building and repair, any remainder being burned or oxidized to produce energy; yet the fact that we cannot identify and select with any accuracy the great variety of amino acids required by the millions of cell nuclei of the body makes it necessary to provide a margin of safety or surplus. Hence it is usually stated that 10 to 15 per cent of the total caloric intake should be selected from protein sources and some must contain the indispensable amino acids. The protein quotient, therefore, should comprise a liberal variety of foodstuffs in order to meet the varied requirements of all the body cells.[1] *There is need for relative and actual increase in protein during pregnancy, lactation, infancy, and early growth;* hence the emphasis on the value of milk as the simplest way to provide for this need.[2]

[1] Raymond Pearl is quoted by William A. Shaffer in the *Journal of the American Dietetic Association*, December, 1927, as stating that between the years of 1911 and 1918 the net human food consumption in America was carbohydrate 52 per cent, fat 34.5 per cent, protein 13.5 per cent.

[2] JONES, D. BREESE, Protein Requirements in the Light of Present

Carbohydrates: Sugars, Starches, Cellulose.—As has been said (page 46), the apparent source of all earth energy is the sun. Physiological energy, however, comes from the sun for the most part indirectly through the photosynthetic action of the chlorophyl in green leaves, which results in the creation of starches and sugars and cellulose—the *carbohydrates.* Since in nature these food factors in fruits and vegetables are accompanied by certain minerals and by vitamins, the human animal became adapted to these, and utilized them and required them all through the long stretch of evolutionary development. Man is just now learning through bitter experience that he cannot safely remove these catalytic substances from his diet.

All starches and the polysaccharids, or complex sugars, are—like proteins—colloidal. Therefore, starches and sugars must be reduced, before being eaten or in the process of digestion, to simple soluble sugars, such as glucose, galactose, etc. Carbohydrate, in the form of glycogen ("liver sugar," "animal starch"), is stored in the liver and in muscle fibers, approximately and usually about an equal total amount in both. The liver, regulated by the endocrines (see page 154), releases glycogen, again reduced to the form of glucose, into the blood stream as required to provide energy and at the same time keep the blood sugar at the very fixed concentration of 0.10 to 0.15 per cent. Under emotional strain, excessive ingestion of sugar, and disease (such as diabetes), this percentage may be greatly increased. The glycogen in the tissues is almost completely burned as fuel, being converted into carbon dioxide and water, with release of energy. The tissues burn (oxidize) carbohydrates and fats in certain proportions, and these can safely be substituted one for the other only within fixed limits. Both are essential.

Carbohydrate Selection.—Fruits of all kinds and certain vegetables—such as beets and carrots—honey, and sugar cane (as molasses) furnish the most desirable natural sources of sugar in the human diet.

Cereals, grains, seeds, tuberous and root vegetables supply the bulk of the *starches.* The starches are bland and nonirritating, and the prolonged digestive process required to reduce them to sugars tends to provide a steady supply of fuel and thus does not

Knowledge, *Food and Life*, pages 182–184, Yearbook of the U. S. Department of Agriculture, 1939.

suddenly overwhelm the sugar-regulating mechanism, a thing which may be brought about by the abrupt ingestion of a quantity of soluble sugar (such as eating a large amount of candy or other sweets).

Like sugars, the starches as they occur in natural foods are accompanied by important minerals and cellulose, and also by proteins and certain vitamins (see page 256). Among the starchy foods, those that provide a maximum amount of the important accessory factors are the whole-grain cereals and breads, and root and tuberous vegetables.

Cellulose ("Roughage").—All sugar and starch granules in nature are encased in insoluble wrapping or supporting carbohydrate substance, known as *cellulose.* Cellulose is softened by cooking and by the hydrochloric acid of the stomach and by other digestive fluids, thus releasing the soluble nutritive substances enclosed. Cellulose itself is not digested or absorbed (except to a limited extent in the lower bowel) and has little or no nutritive value. It is softened by heat in cooking—a fact which explains in part the increased digestibility of properly cooked foods.[1] Cellulose does have a distinct use, however, in providing loose bulk and thus rendering the food mass porous so that it may easily become saturated with the various digestive fluids. It thus stimulates the mucosa (lining) of the intestine in such a way that the wormlike peristaltic movement of the bowel is continuous. *It is highly important that the food mass be kept moving;* this is nature's way of securing complete digestion and preventing excessive fermentation and putrefaction.

Pregnancy imposes mechanical difficulties to this free peristalsis. It is, therefore, particularly important that the contents of the bowel should be correct in composition. Constipation commonly follows reduction in the cellulose content of the food. A common remedy for this type of constipation is agar (a dried sea moss), which provides nonirritating bulk, but which has no food value. Certain faddists use bran for this purpose. Many nutritionists and physicians now advise against the habitual or frequent use of bran, both because it may be irritating to the bowel, particularly in young children, and, in some cases, may

[1] MACLEOD and NASON, *Chemistry and Cookery*, p. 366, McGraw-Hill Book Company, Inc., 1931.

pack or adhere to the intestine, and also because it has little food value in itself and may only replace nutritious articles of food which might also provide roughage.[1] On the other hand, Dr. Rose, in an experiment with normal college women, found no injurious effect.[2]

The liberal use of fresh fruits, raw salads, whole-grain bread and cereals, leafy and root vegetables will incidentally provide an abundance of stimulating but nonirritating bulk and roughage.

Concentrated Sugars.—While they are readily absorbed, concentrated or crystallized sugars cannot be advantageously used for any considerable part of the carbohydrate quotient because they *are irritating to the membranes of the digestive tract* and they readily ferment and disturb the chemical balance in the intestinal laboratory. Concentrated sugar has a value in exceptional situations in which a quick supply of excess fuel is needed, as in athletic contests, or prolonged exertion under food shortage, as in marching or battle. Under normal conditions the digestive mechanism does not require and is not prepared to use to the best advantage carbohydrate in this form. Concentrated sweets *are habit-forming*, tending to create a craving for themselves rather than for other, more wholesome foods (see page 314). Concentrated sweets, because of their quick absorption, *dull the appetite* by creating a sense of satiety and may lead to an insufficient total food intake. Especially, concentrated sweets *have been deprived of the vitamins and minerals* and cellulose that accompany them in a natural state, and anyone who consumes these in excess is very likely not to obtain enough of these indispensable factors. *On the whole, a very limited use is made of sweets in any optimal diet, particularly the diet of pregnancy and of childhood.*

Amount of Carbohydrates.—Approximately 50 per cent of the total calories should be selected from carbohydrate sources. On account of the bulky character of carbohydrate foods, the apparent proportion is even greater than this. On the whole, a wide

[1] LUSK, GRAHAM, *Science of Nutrition*, 4th ed., pp. 51–52, W. B. Saunders Company, 1928.

[2] ROSE, MARY SWARTZ, MCLEOD, A. M., and others, The Influence of Bran on the Alimentary Tract," *Journal of the American Dietetics Association*, July, 1932; ROSE and associates, "Wheat Bran as a Source of Vitamin B," *Journal of American Dietetic Association*, March, 1932.

variety is advantageous. For various reasons a diet would not be well balanced in which the carbohydrate quotient was selected entirely from either fruits, grains, leaves, or roots. It is better practice to include some from each class in each day's diet.

Lipids (lipins). *Fats and Lipoids* (*sterols, etc.*).—Fats and fatlike substances in the body and in food have been classified by chemists under the term *lipids* or *lipins.* The fatlike substances are many—sterol, ergosterol, etc.—all of which are now grouped under the term *lipoids.* These are assuming increasing importance as biochemical research proceeds (see page 146). Lipoids are found consistently in connection with fats, and the food aspects of lipoids may be included with fats.

Fat constitutes the most highly concentrated source of energy in the body. Fats are composed of varying proportions of hydrogen, carbon, and oxygen (but relatively less oxygen than in the carbohydrates), which are liberated in the process of digestion in the form of fatty acids and glycerol. Apparently this is necessary for the purpose of straining the fat molecules through the intestinal wall. Fatty acids and glycerol are liberated in somewhat the same way as amino acids are liberated in protein digestion. The glycerol and the fatty acids are immediately recombined in the process of absorption and furnish a certain quota of the fuel for running the cell engines of the body and also form the various tissue fats. Fats digest slowly—a fact that somewhat equalizes the rate of supply of food fuel to the blood stream. Fat is filtered directly into the lymph vessels and carried directly into the venous circulation. The surplus is stored in the familiar form of body fat, or eliminated in the feces. The body uses the stored fat for cell fuel whenever the current fuel supply in food runs low. A moderate reserve of this nature is advantageous. An excessive amount results in disturbance of metabolic balance and in interference with the mechanical efficiency of tissues and organs, as in the case of a "fatty heart."

Imperfectly oxidized fats cause *acetonuria*, one type of *acidosis* (*ketosis*). The favorable balance between fat and carbohydrate is upset in diabetes, starvation, some fevers, and sometimes in the high-fat (ketogenic) diet frequently used in the control of epilepsy. Such conditions may exist incidentally in pregnancy; also, too much fat in the diet or the imperfect digestion of fat during pregnancy may lead to imbalance with the carbohydrates and produce vague toxemia or acidosis.

Fat Selection.—The most valuable fat is milk fat as found in whole milk, cream, butter, and full-cream cheese. It is easily digested and has the advantage of being a rich source of the fat-soluble vitamin A. It also contains a small and variable amount of fat-soluble vitamin D, according to the diet and irradiation of the milk-producing animal, and also contains certain essential fatty acids.

Animal and vegetable fats, such as suet, lard, olive oil, and corn oil, are valuable sources of energy, but are almost entirely lacking in vitamins. Butter substitutes have a variable vitamin A content according to the materials used in their manufacture. Before any compound is substituted for butter, its composition should be investigated, as a serious deficiency in fat-soluble vitamin A may result unless the deficiency is supplied from other sources.

Amount of Fat.—Approximately 30 to 35 per cent of the total calories should be furnished from fat. As fats are highly concentrated, this does not represent a large bulk. If a desirable amount of whole milk, cream, and butter are used, together with some vegetable salad oil, and the fat in meat and egg yolks is eaten, the requisite quantity will be supplied without the use of fat in cooking. The use of cooking fats to excess retards digestion and may cause active indigestion. Normally, starches are partially digested in the fundus of the stomach by the digestive ferment *ptyalin* in the saliva (this is one important reason for chewing the food thoroughly). If the carbohydrate foods are not thoroughly mixed with saliva, their digestion must take place almost entirely in the intestine. Since the salivary enzyme does not act upon fats, a coating of fat (as in pastry and fried foods) retards or prevents the action of ptyalin upon carbohydrates and also delays protein digestion.

Water.—The world was under water (sea water) when life began; it is little wonder that organic matter is composed largely of watery fluid, and that the chemistries of life take place only in the presence of water. Nothing more completely arrests and more seriously interferes with body functions than dehydration or reduction of fluid content in blood or tissues. We recall that ionization depends upon water as a solvent (see page 39). The mechanisms of the body for maintaining the water balance of the blood at a constant pressure and composition ("blood pressure") through the give-and-take of the lymphatic system, the slow or rapid filtration of urine, the reabsorption of water from the renal tubules, the manufacture of water within the body from recombination of H and O, all present one of the most intricate and delicately adjusted mechanisms of the many such found in the human body.

Water has great capacity for taking up and giving off heat, thus assisting in maintaining the constant temperature of the body. Dr. J. H. Kellogg likens the body to an internal-combustion motor with an automatic cooling device provided by the 2,000,000 sweat glands, which, he says, evaporate a quart or more of water each 24 hours. He says that, without this mechanism, cell combustion would raise the body temperature to 150°, which clearly would be fatal to life.[1]

The importance of water is shown by the large proportion of water found in living tissue cells. The more active the tissue, the higher the water content. The water content varies from 6 to 10 per cent for fatty tissues to 82 to 85 per cent for brain tissue, in which chemical and electrical changes must, obviously, occur with the greatest rapidity and facility. The total water content of the average body is about 65 per cent (see Table II). We have seen (see page 54) that one phase of protoplasmic colloidal structure is the fluid, or "bound water," "living water," or "cell water," within which the chemistries of life take place. Water is absorbed from the large and small intestines, and little or none from the stomach. It leaves the body through kidneys, lungs, skin, and bowel. In health and with a normal appetite and correct food habits, the balance between intake and output of water is fairly equal. When the outgo is increased by sweating, diuresis (excessive excretion of urine), hemorrhage, or diarrhea, the individual instinctively drinks more.

Water should be included in the diet and every would-be health adviser is prone to stipulate an arbitrary number of glasses of water that should be drunk daily. As a matter of fact, it is quite

[1] Kellogg, John Harvey, "The Body-cooling Mechanism," *Good Health*, June, 1931.

impossible for the ordinary individual to calculate his fluid intake in cooked foods, succulent fruits and vegetables, and beverages, and then to calculate the exact number of glasses of water required to bring his intake up to an stated amount. Granting that this might be done, it would still be necessary to know the loss from perspiration, breath, and urine in order to know what the total fluid intake should be in order to balance the output. A little thought will show that these two factors must vary from person to person and in the same individual from day to day and hour to hour, according to air conditions, activity, etc.

Although few people drink a distinctly injurious amount of water, it is highly probable that many who force themselves to drink the six or eight glasses stipulated by their favored authority may at times dilute digestive secretions, overdistend the stomach and bowel, and even impair appetite and enjoyment of food.

The following are rational rules concerning the drinking of water:

1. Do not make a fetish of drinking "so many" glasses of water daily.

2. Arrange to have palatable, fresh, cool water easily available at all times. If this is not done, one "puts off" drinking because of the effort involved and unconsciously curtails the day's total intake or does all the drinking at mealtimes, with consequent distension of the stomach and possible limitation of amount of food eaten.

3. One should cultivate a liking for water and a habit of drinking between meals. One good rule is to take a drink (more or less than a glass, as one relishes) on first rising in the morning, and at other regular and convenient intervals during the day.

If one chews the food thoroughly and makes a practice, as far as mealtimes are concerned, of drinking fluids chiefly at the end of the meal, after the food has been thoroughly mixed with saliva and gastric fluids, one may drink just as much or as little as the taste dictates without checking off the "seven glasses." It is true that the kidneys excrete daily, in the average normal individual, from 3 to 4 pints of urine. Adding to this the 1 to 2 pints of skin and lung evaporation, and remembering that two glasses equal a pint, it is easy to see that the average individual requires a rather large amount of total fluid intake. Any diminution in the daily amount of urine voided should be noted, as this often indicates that more water should be taken.

Minerals.—The mineral residue (ash) left from the combustion (burning) of organic substances will have acid, base (alkaline), or neutral reaction. About 16 minerals (see Table II) have been found in the ash of the human body. Actually, numbers of other "traces" have been found, but are not known to be necessary to metabolism. The functions of several that are invariably found still remain somewhat in doubt. The importance of the 13 or 14 that have been conclusively investigated becomes more apparent as nutritional science advances.[1] Some minerals become incorporated in the body structure—notably, calcium, phosphorus, and magnesium in the bones. Most of the minerals, however, are in solution in the circulating and the cell fluids and adsorbed to colloidal surfaces, and most of these are present as ions, positive or negative (see page 39).

So important are the minerals that special organs, such as the thyroid, parathyroids, and adrenal cortices, have been created for the purpose of assisting in the sensitive regulation of specific mineral metabolisms (see Chap. XI). Minerals also are closely involved in the activities of specific enzymes and vitamins.

The Acid-base Balance.—It has been stated (see page 40) that the hydrogen-ion concentration of the blood is kept at an incredibly fixed point (pH 7.3 to 7.4) of very mild alkalinity. This fixed reaction is necessary to the osmotic function of all the cells of the body, including the cells of the capillary walls. Contrary to popular belief, the buffer mechanism (see page 41) is so completely automatic and so weighted for emergency that it is almost impossible, with normal organs, to cause an appreciable shift from the norm toward acid or alkaline reaction of the body fluids by extremes in diet.[2] Acidosis is not likely to occur in any self-selected diet but may occur in the high fat (ketogenic) diet often used in the treatment of epilepsy, in some cases of diabetes, and in extreme food deprivation and in other pathological conditions.

[1] McCollum, E. V., "Recent Advances in Nutritional Research, The Mineral Elements," *Journal of the American Dietetic Association*, January, 1938.

[2] Tobey, James A., "The Question of Acid or Alkali-forming Foods," *American Journal of Public Health*, November, 1936.

It is unwise to place constant strain upon the buffer mechanisms, however, and there are many authentic reasons for selecting foods which leave both acidic and basic residues, one being that there is

TABLE IV.—ACID- AND ALKALI-PRODUCING FOODS

Acid-producing foods		Alkali-producing foods	
Foods	Total cubic centimeters of acidity over base per 100 grams	Foods	Total cubic centimeters of base over acid per 100 grams
Bread	2.7	Almonds	12.38
Bread, whole wheat	3.0	Apples	3.76
Corn	5.95	Asparagus	.81
Crackers	7.81	Bananas	5.56
Cranberries*	.....	Beans, dried	23.87
Eggs	11.10	Beans, lima, dried	41.65
Egg white	5.26	Beets	10.86
Egg yolk	26.69	Cabbage	4.34
Fish, haddock	16.07	Carrots	10.82
Fish, pike	11.81	Cauliflower	5.33
Meat, beef, lean	13.91	Celery	7.78
Meat, chicken	17.01	Chestnuts	7.42
Meat, frog	10.36	Currants, dried	5.97
Meat, pork, lean	11.87	Lemons	5.45
Meat, rabbit	14.80	Lettuce	7.37
Meat, veal	13.52	Milk, cow's	2.37
Oatmeal	12.93	Muskmelon	7.47
Oysters	30.00	Oranges	5.61
Peanuts	3.9	Peaches	5.04
Prunes*	.....	Pears, dried	7.07
Rice	8.1	Potatoes	7.19
		Radishes	2.87
		Raisins	23.63
		Turnips	2.68

From McLESTER, JAMES SOMERVILLE, *Nutrition and Diet*, pp. 479–480, after Sansum, Blatherwick, and Smith.

* The ash of these articles is alkaline in nature, but because of the sources of hippuric acid contained in them, they increase the acidity of the body.

greater certainty of obtaining all the important specific minerals, which are to be discussed. Table IV presents a list of common acid- and base-forming foods. It will be seen that a diet of bread, meat, cereals, and eggs would be strongly acidic and that a diet including milk and emphasizing fruits and vegetables will be basic. The *balanced diet* is selected from both lists. Concentrated commercial starches, sugars, and fats are so completely lacking in mineral content that they do not appreciably affect the acid-base balance.

Calcium, Phosphorus, Magnesium.—This mineral trio enters into the formation of the skeletal and dental structures, 99 per cent of the calcium in the body being in the calcium phosphate, calcium carbonate, etc., of the bones (87% of the skeleton is calcium phosphate). About 2 per cent of the bone mass is magnesium, as magnesium phosphate, but this constitutes about 70 per cent of the total magnesium in the body, most of the rest being in the muscles. The exact function of magnesium is not entirely clear, but in cases of magnesium deficiency in experimental animals, calcium and phosphorus are drained out of the bone tissue, growth ceases, and extreme nervousness appears.[1]

Calcium is soluble in acid medium; if the intestinal contents are unduly alkaline, as may result from taking too much sodium bicarbonate for indigestion, there may be insufficient absorption of calcium through the intestinal membrane, and undue elimination as insoluble soap.[2]

Phosphorus in the body is a widely distributed and important element. There are 14 ways known in which compounds of phosphorus function in the human body.[3] Phosphoric acid is a component of the nucleic acid in all nucleo-proteins which enter into the structure of chromatin, genes, and chromosomes in all cell nuclei (see page 50). Phospholipins are present in every cell (see page 244). Phosphoric acid enters as an intermedian in carbohydrate and fat metabolism. Such is the prevalence and activity of phosphorus, it may even "determine nutritional and evolutionary processes of nature on sea and land."[3] About 70 per cent of body phosphorus is found in the bones. It is excreted chiefly as urinary phosphates.

[1] McCollum, Day, and Kruse, "Studies in Manganese Deficiency in Animals," *Journal of Biological Chemistry*, Vol. 112, 1935.

[2] Von Eulenberg-Wiener, Renée, *Fearfully and Wonderfully Made*, p. 188, The Macmillan Company, 1938.

[3] Sherman, Henry C., *Chemistry of Food and Nutrition*, p. 251, The Macmillan Company, 1937.

Rickets.—As stated in Chap. X, page 118, the bones of the child become calcified, or mineralized, chiefly after birth. Delay in the incorporation of calcium, phosphorus, and magnesium in the cartillaginous and membraneous skeleton characterizes the disease known as *rickets* (see page 436). Failure of the skeleton to ossify normally in infancy may be due to lack either of calcium or of phosphorus, or to lack of the catalyzing secretions of the parathyroid (see page 151), or more commonly to lack of vitamin D (see page 264). A certain balance must obtain between calcium and phosphorus and magnesium, or none will fully function.

The 1 per cent of total body calcium which remains in solution in the blood plasma is highly important. The calcium ions balance the sodium and potassium ions in regulating heart action and are involved in nerve conduction, in blood clotting, and in other vital chemistries (see page 40). Low blood calcium produces nervousness, which, in children, may even cause tetany or convulsions. In rickets all the functions of calcium, phosphorus, and magnesium are more or less disturbed, and rickets is much more than a "disease of the bones." It is a highly complex constitutional disorder (see page 436). Calcium deficiency is said to be the most prevalent deficiency in the American dietary, and particular attention should be given to this point in any dietary at any age,[1] but particularly in childhood, pregnancy, and lactation.

Sources of Calcium, Phosphorus, and Magnesium.—The most important source of both phosphorus and calcium is milk. It is very difficult to secure an adequate daily supply of calcium for adult or child—but particularly for the child, who must have a surplus for growth—without the daily use of milk. This is one reason for the general agreement among dietary specialists at the present time that a pint for the adult and a quart for the child is generally necessary fully to protect the calcium-phosphorus needs of the individual. Green vegetables, seed vegetables, and some fruits also provide calcium of fairly good quality, but in such small concentration that one must eat prohibitive amounts of the specified foods to secure a regular and safe supply from such sources alone.

[1] Sherman, Henry C., and H. L. Campbell, "Influence of Calcium Intake," *Journal of Nutrition*, Oct. 10, 1935.

Phosphorus is found, likewise, in carrots, turnips, whole grains, in seed vegetables, in eggs, in milk, and in meat, fowl, and fish, also to some extent in leaves, nuts, and vegetables generally. Most protein foods (see page 239) are rich in phosphorus.

Magnesium is so generally present and is required in such small amount that there is no possible danger of shortage.

Amount of Calcium and Phosphorus.—While the minimal requirement for the average adult is about 0.45 gram of calcium (0.88 gram phosphorus), nutritionists seem to agree that it would be advantageous to use more. The Technical Commission of the League of Nations recommends 0.75 gram as a standard daily quotient. Sherman recommends this as a minimum and says that "improvements in nutritional wellbeing have resulted from successive increases of the calcium content of the dietary up to levels well over twice and more, probably at least three times the level of minimal adequacy."[1] The requirements of both minerals is greatly increased during all periods of growth activity, such as late pregnancy, lactation, and childhood. The requirement for pregnant and lactating women was fixed by the League of Nations Committee at 1.5 grams per day for calcium.

While there is not so much total phosphorus as calcium in the body, it is found in the more active tissues and has a more rapid turnover than calcium. The general American diet is not so likely to be deficient in phosphorus as it is in calcium. The League of Nations standard is 1.32 grams of phosphorus per day.

Iron, Copper, Manganese, Cobalt, and Zinc.—It has long been known that iron is essential to the formation of hemoglobin, the specific protein of the red blood cell which carries oxygen from the lungs to the tissues. It has more recently become known that iron cannot function without the presence of a minute amount of copper, also traces of manganese and cobalt and possibly zinc.[2] Red blood cells are formed chiefly in bone marrow (probably also in liver and spleen) and live about 6 weeks, after which they disintegrate. The reticulo-endothelial cells of the spleen (see page 133) split up the blood corpuscle, and the iron is in part used

[1] Calcium and Phosphorus Requirements of Man, *Food and Life*, p. 192, Yearbook of the U. S. Department of Agriculture, 1939.

[2] Rose, Mary Swartz, "The Place of Aluminium, Copper, Manganese, and Zinc in Normal Nutrition," *The Journal of Nutrition*, July, 1929.

again by the blood-forming mechanism. Iron and copper (probably cobalt and zinc) are stored in liver, spleen, and bone marrow to the extent required in the manufacture of the millions of red cells that are turned out each day. The role of iron, copper, manganese, and cobalt in oxidation-reduction substances other than hemoglobin, such as chromatin, may be important, and is under active investigation.[1] Zinc is found in the fetal liver and in breast milk; cobalt seems to be involved in hemoglobin formation. Manganese is found in all enzymes and is a potent catalyzer. The formation of hemoglobin depends upon the presence in the bone marrow of basic food substances—the proteins, fats, and carbohydrates—upon the presence of the minerals just named, and also upon the antianemic factor mentioned on page 157.

Amount of Iron.—Because of the limited storage and of the serious effect of even brief and temporary shortage, obtaining the daily quotient of iron in the food is exceedingly important. The total amount of iron in an average adult body is only about $\frac{1}{10}$ to $\frac{1}{7}$ ounce (3 to 4 grams), "not much more than there is in a shingle nail."[2] The daily requirement is about 0.015 to 0.0175 gram. This quotient is greatly increased (at least to 0.02 gram) during pregnancy, when the hemoglobin is forming in the blood of the fetus. Also, normally, a considerable amount of iron is stored in the liver of the fetus to carry the child through his nursing period, since there is almost no iron in milk (see page 309).

Sources of Iron.—Iron is found in green leaves, in egg yolk, in muscle meat, oysters, dried beans and peas, whole grains, and some fruits—such as figs, apricots, raisins, peaches, and prunes. Manganese, copper, and the trace minerals named are found so universally in food substances that there is no possibility of shortage in any diet adequate to support life.

Sodium, Potassium, and Chlorine.—Sodium and potassium ions balance the pans of the osmotic scale, sodium salts being concentrated in the fluids, potassium salts in the tissue cells. Potassium and sodium salts are important alkaline buffers which help to maintain the normal hydrogen-ion activity of the body fluids

[1] SHERMAN, *op. cit.*, p. 306.

[2] *Food and Life*, p. 198, Yearbook of the U. S. Department of Agriculture, 1939.

by neutralizing acid "wastes" (see page 41). Sodium exists in the body chiefly as sodium chloride, or "common salt." The "normal" or "physiological" saltiness of the body fluids, such as tears, sweat, and blood serum, is about that of ancient sea water. In health there can be little deviation from this. Too high concentration may produce edema (a boggy swelling) of the loose tissues. The acid salts from used sodium and potassium are chiefly eliminated in the urine. Sodium chloride is eliminated in sweat, and in excessive sweating with copious water drinking the sodium may be so reduced in the body fluids as seriously to interfere with cell osmosis, hence the popular advice to increase the use of salt during exposure to heat.

Certain glands in the stomach remove chlorine from the sodium chloride or other chlorides in the blood plasma and make the strong mineral (inorganic) acid hydrochloric acid, which performs useful functions in digestion (see page 127). Almost a tablespoonful (10 to 15 grams) of sodium chloride is excreted daily in the urine.[1] One of the hormones of the posterior pituitary (see page 142) participates in the regulation of salt metabolism, while one of the important functions of the adrenal cortex (see page 153) is the regulation of the sodium-potassium balance (see page 41).

Amount of Sodium, Potassium, Chlorine, and Salt.—Sodium-chloride metabolism is not yet completely understood, and there are as many empirical notions as to how much salt one should consume as there are concerning water drinking. There is, at present, no way of defining accurately the salt needs of the body. Since the body has adequate and flexible means of salt excretion through urine and sweat, there would seem to be more danger in shortage than in excess. However, the craving for salt is so compelling, shortage in intake is not likely to occur in any ordinary situation. Also, salt craving can become a habit, and it is certainly foolish and injudicious to "salt everything" to excess. Some treatises on diet in pregnancy recommend definite routine curtailment in the use of salt—advice which is based upon a former erroneous idea that there might be some connection between the dropsy of the uremic toxemias of pregnancy (see page 336) and the use of salt. It cannot be emphasized too strongly that no

[1] Von Eulenburg-Wiener, *op. cit.*, p. 190.

one, under any circumstances, should meddle with nutrition by deviating from the normal diet, particularly during pregnancy; and particularly should no one reduce salt intake without careful and complete instructions from a competent physician.

Potassium is abundant in most fruits and vegetables and provides the alkaline mineral that puts even sour fruits on the alkaline list in Table IV. Potassium is found next to the hull of whole grains and cereals. The free use of vegetables and fruits leads to increased craving for salt in order to preserve the sodium-potassium balance. There is little danger of potassium shortage except in a diet very low in minerals.

Iodine.—Iodine is a mineral found in sea water and, in less concentration, in inland water and vegetation. Iodine in the form of di-iodo-tyrosine, a constituent of the thyroid hormone, *thyroxin,* is necessary in the oxidation of fuels in the tissues (see page 148). The thyroid gland thus specifically regulates iodine metabolism in the tissues. There is increased need for iodine during heightened activity of tissues, as in pregnancy and growth. Iodine, through its regulation of oxidation, seems to enter into the control of general growth and specifically the growth and differentiation of the brain and sex organs. The most concentrated source is in sea foods. There should be sufficient amounts in local water and vegetation fully to protect the normal individual, unless iodine has been leached from the soil (see page 149 for "goiter regions"). The rather prevalent use of iodized salts may do harm in cases of hyperthyroidism or hypersensitiveness to iodine (see page 150).

Sulphur.—Sulphur is found in many amino acids; hence, it occurs in most proteins and plays an important role in oxidation. It also has a *detoxicating* action upon certain putrefactive products of food decomposition in the intestine. Sulphur, as sulphates, is excreted chiefly in the urine. There will be no sulphur shortage as long as the protein quotient in the diet is adequate.

Silicon is found in hair and nails and *fluorine* in the enamel of teeth. Both probably contribute to the texture and hardness of those structures, but the precise role and the importance of both are not yet fully established. Both exist plentifully in plant foods.

The Vitamins.—Vitamins are potent organic compounds which produce effects out of all proportion to the microscopic amounts of the activating substance involved. Certain vitamins resemble hormones in their reactions,[1] while others resemble enzymes;[2] and always their action is catalytic (see page 41). In fact the three groups of vital compounds—hormones, enzymes, and vitamins—reveal more and more relationship and interaction as investigation proceeds.

Although the members of each class differ greatly, chemically there are two general classes of vitamins: (1) the fat-soluble vitamins A, D, E, and K, which can be synthesized in the animal body from provitamins; (2) the water-soluble vitamins B_1 (thiamin), B_2 (riboflavin), and D (calciferol), and nicotinic acid, with their variable and increasing number of known derivatives. All of the water-soluble vitamins must be obtained directly, or indirectly as provitamins, from plant foods. Most of the fat-soluble vitamins can be synthesized in the presence of their specific provitamins. Most of the vitamins have been isolated in crystalline form and are available as synthetic compounds.

There is, at present, an effort to rename the vitamins, using appropriate chemical terms, as these become determined, in the place of letters and negative descriptive terms such as "vitamin B" and "antiberiberi."

Vitamin A ($C_{20}H_{30}O$)*, Formerly, the "Antixeropthalmic Vitamin."* Vitamin A is a complex alcohol synthesized in the liver of meat-eating animals from a provitamin, the yellow pigment *carotin* (or carotene), through the action of an enzyme, *carotenase.* Carotin is found in green and yellow plant tissues, in milk fat, and in egg yolk, in summer. Not all yellow plant pigment is carotin, and not all can be transformed to vitamin A. Vitamin A is stored in the liver to an extent dependent upon the amount of carotin or vitamin A in the diet.

The function of vitamin A seems to pertain specifically to the formation and mainenance of the epithelial lining of cavities of the body, particularly the mucous covering of the eyes, the

[1] MURLIN, JOHN R., "Vitamins and Hormones," *Journal of the American Dietetic Association,* June–July, 1938.

[2] "Relationship of Vitamins to Enzymes," editorial, *Journal of the American Medical Association,* July 2, 1938.

mouth, the throat, the respiratory passages, and the intestinal tract. It seems to function specifically in the photosensitive visual-purple layer of the retina. It may be that vitamin A functions indirectly through the trophic (nutritional) nerve supply to the tissues named.[1] Because deficiency in vitamin A is followed by infectious invasion of these surfaces, it was first thought that vitamin A must have some specific antiinfective or immunizing property, in particular, acting as a preventive of the eye infection known as xeropthalmia. While there may be some relationship between the immunity mechanism and vitamin A, this is not yet clearly established.[2] It seems now quite clear that vitamin A acts chiefly through maintaining healthy growth and function in these important membranes. Nature has made the normal mucous membrane almost impenetrable to disease microorganisms. Vitamin A is particularly important during pregnancy and the early years of active growth, when mucous membranes are being formed. Sherman says the susceptibility to infection of children at ten or twelve may depend on how they were fed before three.[3]

Deficiency in vitamin A produces changes (keratinization) in the mucous membranes which make them permeable to all disease germs—not specifically to xeropthalmia, as was formerly believed. In human subjects, this is shown in susceptibility to sinus, tonsil, and lung infections and to intestinal and genitourinary infections. If strong, resistant membranes are not formed during growth, the individual may be more or less susceptible to infections throughout life, regardless of subsequent diet. Abundance of vitamin A is advantageous at any age, however, in maintaining the optimum function possible for the individual. Deficiency in vitamin A reduces the photoelectric sensitivity in the visual-purple layer of the retina, causing the condition known as *night blindness.*[4] Keratinization (hardening) of the epithelial

[1] Mellanby, Edward, *Nutrition and Disease*, Chap. V, Oliver and Boyd, London, 1934.

[2] Sherman, *op. cit.*, p. 369.

[3] *Ibid.*, 1932 ed., p. 351.

[4] Isaacs, Jung Ivy, "Vitamin A Deficiency and Dark Adaptation," *Journal of the American Medical Association*, Aug. 27, 1938; Blum, H. F., "Visual Purple and Rod Vision," *Science*, Feb. 25, 1938; Hecht, Chase,

tissues of the uterus may cause failure in implantation and in development of the ovum, which is one type of sterility.

Amount of Vitamin A.—While the League of Nations has fixed an international unit of vitamin A requirement, it is impossible to be specific in terms of food as to the amount necessary to protect human beings against infections. The *Yearbook of Agriculture* for 1939 says, "The vitamin A requirement for a normal adult can be supplied by a daily allowance of a pint of whole milk, one egg, two ordinary-sized pats of butter and an average serving of leafy green or yellow vegetables.[1] In experimental animals the amount has been determined that is necessary for protection against infections, but Sherman says fourfold the maintenance ration is desirable in promoting vigor and length of life.[2] There is no evidence of injurious effects from eating excessive amounts. The safest plan is to consume generous amounts of butter, milk fat, and yellow and green vegetable foods daily.

There is evidence that the colostrum (the fluid secreted by the mammary gland before the milk flow starts, see page 371) is rich in vitamin A, young rats being fully protected under a vitamin A free diet, by the administration of human colostrum.[3]

Vitamin A and Mineral Oil.—Mineral oil is not a fat and is not absorbed through the intestinal wall; all ingested mineral oil passes out of the body in the fecal matter. Carotin and, to a lesser extent, vitamin A are soluble in mineral oil. There is considerable evidence that mineral oil mixed with the food contents of the bowel removes the carotin and carries it out of the body. If it becomes necessary to take mineral oil, it should be taken when the bowel is empty of digesting food. The Council on Foods of the American Medical Association advises strongly against indiscriminate dosage with mineral oil.[4]

SHALER, and HAIG, "The Regeneration of Visual Purple in Solution," *Science*, Oct. 9, 1936.

[1] *Food and Life*, p. 229, Yearbook of the U. S. Department of Agriculture, 1939.

[2] SHERMAN, *op. cit.*, p. 378.

[3] REPETTI, MARIO, "The Vitamin A Content of Human Colostrum," *Chemical Abstracts*, Sept. 20, 1937.

[4] *Journal of the American Medical Association*, editorial, Nov. 27, 1937; DUTCHER, HARRIS, HARTZLER, and GUERRANT, "The Assimilation of Carotene and Vitamin A in the Presence of Mineral Oil," *Journal of Nutrition*, Vol. 8, p. 269, 1934; ROWNTREE, J. J., "Effects of Mineral Oil upon

Sources of Vitamin A.—Vitamin A itself is found in liver and other edible organs, liver oils, egg yolk, and butter fat. Cod-liver oil and haliver oil are rich sources of concentrated vitamin A. (The synthetic vitamin D products, such as *viosterol*, contain no vitamin A.) Carotin, the provitamin, is found in most yellow and green vegetables, such as carrots, yellow corn, sweet potatoes, rutabagas (yellow turnips), the green part of edible green vegetables (the carotin is covered up by the green chlorophyl).

Vitamin B-B_1 ($C_{12}N_{16}ON_4S$), Aneurin, Thiamin Hydrochloride, Formerly the "Antineuritic" or "Antiberiberi" Vitamin.—The original water-soluble "vitamin B complex" has been separated into several definitely established vitamins and several others not so certain. It has been decided to retain the term *vitamin B* for *the thiamin hydrochloride fraction.* Thiamin hydrochloride contains nitrogen and sulphur. Vitamin B is synthesized in the bowel of cattle and certain other animals by bacteria that act in a way comparable to the nitrogen-fixing bacteria on plant roots, which transfer the nitrogen of the air to organic matter. Rats and other experimental animals kept on vitamin B deficient diet will devour their own feces in which vitamin B has been created by bacteria, thus more fully protecting themselves, and they may not show deficiency symptoms.[1] The animal body does not synthesize vitamin B within its tissues and, while it is possible or even probable, it is not definitely established that the human bowel actually contains nitrogen-fixing bacteria. "It is possible to conceive that microorganisms are the primary source of thiamin chloride in nature."[2]

The physiological actions of vitamin B are not entirely clear, but they seem to be concerned in all cell metabolism, notably that of the peripheral nerves and the brain; specifically, vitamin B seems to act as an intermediary in the carbohydrate metabolism in nerves and possibly in all cells.[3] It plays a role in glandu-

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Absorption of Vitamin A," *Journal of Nutrition*, Vol. 3, 1931; SHERMAN, *op cit.*, p. 378; *Medical Women's Journal*, editorial, January, 1931.

[1] VON EULENBURG-WIENER, *op. cit.*, p. 276.

[2] GORTNER, Ross A., *Outlines of Biochemistry*, p. 882, John Wiley & Sons, Inc., 1938.

[3] *Ibid.*, p. 880; *Food and Life*, p. 230, Yearbook of the U. S. Department of Agriculture, 1939.

lar activities, particularly those pertaining to digestion. Vitamin B is not stored to any extent; hence it must be obtained directly and constantly from food.

The importance of vitamin B in animal nutrition is best shown by what happens under deficiency. Extreme deficiency of this vitamin in birds causes *polyneuritis* with paralysis, which disappears miraculously on administration of the vitamin. Extreme deficiency of the vitamin in man and other animals is known as *beriberi*, a disease characterized by anemia, loss of appetite and strength, and marked inactivity of the digestive tract, with indigestion, arrest of peristalsis, and with constipation. Extreme deprivation is rarely encountered in this country; but much indigestion, anorexia (lack of appetite), constipation, and general dullness and fatigue, with lowering of resistance to infections of bowel and appendix, is believed to be due to lack of an optimal amount of vitamin B in the usual American diet.

Dr. Hoobler describes a child who is experiencing vitamin B deficiency as "a pale, undernourished, fretful, whiney, spastic [convulsive or spasmodic] infant who consistently refuses much of his food."[1] He says that nursing mothers require vitamin B in greatly increased amounts, even three to five times the regular amount. Thiamin hydrochloride (vitamin B) is being used successfully in the treatment of various forms of neuritis—particularly, the specific form of neuritis occasionally seen in pregnancy.

In experimental animals under vitamin B deficiency, peristalsis and digestion are more or less completely arrested, all interest in food is lost. Injection of vitamin B concentrate causes spectacular recovery within a few minutes or a few hours. Under prolonged deficiency, the pancreas, thyroid, adrenals, and sex glands undergo structural changes.[2]

Sources of Vitamin B.—Vitamin B is widely distributed in small relative amounts, and there is likely to be serious deficiency in the human diet only when there is disproportionate consumption of foods that have been deprived of vitamin B, such as white

[1] Hoobler, Raymond B., "Use of Vitamin B in Diets of Infants," *Journal of the American Medical Association*, Feb. 28, 1931.

[2] Rose, Mary Swartz, *The Foundations of Nutrition*, The Macmillan Company, 1938.

flour, concentrated sugar, starches, and fats. Milk is only moderately rich in vitamin B—one reason why children, even infants, should receive a variety of foods. The richest natural sources are brewers' yeast and whole grains retaining the germs. Lean meat, especially pork, water cress and other very green leaves are also rich in vitamin B. The free use of whole-grain breads and cereals, with a suitable amount of meat, together with an abundance of fresh vegetables, will safeguard the individual. Vitamin B is particularly important in the diet of persons ill from fevers or from disturbances of the digestive tract, and in the diet of nursing mothers.

Vitamin B_2, *Vitamin G, Riboflavin* ($C_{17}H_{20}N_4O_6$), *Formerly the "Pellagra-preventive" or "Antipellagra" Vitamin.*—The vitamin G fraction of the water-soluble vitamin B complex is a *flavin*, a class of yellow-green flourescent pigments[1] that exists widely in nature in numerous forms or combinations, such as lactoflavin, ovoflavin, etc., according to the special protein involved. The vitamin G flavin is known as *riboflavin*, the term that is now used to designate the whole group of flavin vitamins.[2]

It was formerly thought that riboflavin was an essential growth vitamin, deficiency in which produced arrest in growth, pellagra in human beings, blacktongue in dogs, and various skin lesions (dermatitis) in other animals. It has been conclusively proved that *riboflavin is not concerned with this phase of metabolism*, although the administration of liver, yeast, and wheat germ may produce dramatic improvement in cases of pellagra, since these substances contain also *nicotinic acid*, which is specific for pellagra (see page 262).

Riboflavin is a cataract-preventive substance for rats and, presumably, for human beings, although this is not yet fully determined. Under riboflavin deficiency rats develop cataract, lose their hair, and stop growing, but do not develop skin lesions.[3]

The flavins are brilliant yellow plant pigments that readily undergo oxidation reactions. Vitamin G, therefore, may play

[1] DANIEL, ESTHER P., and HAZEL E. MUNSELL, "Vitamin G.," *Publication* 275, U. S. Department of Agriculture, June, 1937.

[2] GORTNER, *op. cit.*, p. 899.

[3] DAY, DARBY, and LANGSTON, "Identity of Flavin with the Cataract-preventive Factor," *Journal of Nutrition*, Vol. 13, 1937.

an important role in cellular oxidation-reduction processes. For this reason it would be especially important for tissue which, lacking a blood supply, must depend upon such substances for the maintenance of cellular respiration, *i.e.*, oxidation and reduction. The lens of the eye is such a tissue. Under extreme deprivation, experimental animals develop great weakness, relaxed muscles with incoordination, digestive disturbances, and precocious old age. Riboflavin deficiency in man or in animals under natural conditions has not been reported, and there has not yet been time to determine the connection, if any, between riboflavin deficiency and human cataract.

Sources of riboflavin are milk, liver, and the growing parts of plants; it is found to a lesser extent in seeds and in meats. Sherman says that the riboflavin in mother's milk is of great importance in the development of the young.

Nicotinic Acid (C_5H_4NCOOH).—The third water-soluble vitamin related to the vitamin B complex is *nicotinic acid*, which promises to be the real *antipellagra factor*. The fundamental biochemical properties of dietary nicotinic acid seem to relate to enzyme action in the body.[1] Recent reports indicate that the same dietetic deficiency causes chick pellagra, the blacktongue of dogs, and human pellagra. Nicotinic acid effects remarkably speedy cure in all.

The richest sources of nicotinic acid are meat, milk, and yeast. Deficiency is likely to occur in low-cost dietaries unless these are very wisely planned.

Vitamin C, Cevitamic Acid, Hexuronic Acid, Ascorbic Acid ($C_6H_8O_6$), *Formerly "Antiscorbutic" Vitamin.*—This water-soluble vitamin seems to function in the development and maintenance of the *intracellular cement substance*, "the colloidal condition of intracellular substances," which holds together the endothelial cells of capillary walls, of bones, of peridental structures (gums), etc. It may exert an effect upon the catalytic activity of certain enzyme systems, apparently inhibiting the activity of particular enzymes.[2] Vitamin C may act as the hydrogen transport in tissue respiration. In extreme deficiency (Scurvey or Scorbutis), general immunity to infections is lowered,

[1] GORTNER, *op. cit.*, p. 909.
[2] *Ibid.*, pp. 889 and 890; SHERMAN, *op. cit.*, p. 434.

rheumatismlike joint pains occur, bone wounds heal slowly, bones become fragile, teeth easily decay, the gums (peridental tissues) fall away from the teeth and bleed and ulcerate, the dental sockets atrophy through disintegration of the intracellular cement, the teeth become loose and even fall out. Capillary hemorrhages occur under the skin. While definite scurvy is seldom seen in modern times, there is no doubt that much dental caries (decay) and general susceptibility to infection is due to varying degrees of deficiency.

Vitamin C is stored to the saturation point, beyond which there is prompt elimination, and the vitamin must constantly be supplied. All animals, as far as is known, with the exception of the guinea pig, monkey, and man, synthesize vitamin C from some unknown provitamin. That a provitamin is involved in vitamin C synthesis is suggested by the fact that dry grains and seeds contain no vitamin C, while the sprouts of the same seeds to which water only has been added will be rich in vitamin C.

Vitamin C is particularly important in pregnancy, lactation, and growth. Vitamin C may "preserve the characteristics of youth" through preserving the elasticity of the capillaries.

Sherman says that with vitamin C, like vitamin A, very large increase above the maintenance quotient is desirable.[1] There is no evidence of undesirable effects from excessive ingestion, possibly because of the lack of extensive storage in the body.

Sources of Vitamin C.—The chief sources of this vitamin are the succulent, actively functioning, growing parts of vegetables, the citrous fruits, tomatoes, raw fresh cabbage (not in stored vegetables), lettuce, raw onions, apples, young carrots, and bananas. Milk has more vitamin C than was formerly supposed, but not enough to be fully protective. Dry grain, seeds, muscle meat, and eggs are practically free from vitamin C.

Vitamin C is easily destroyed by exposure to oxygen and to air. It is quickly destroyed by cooking in air. Milks and vegetables processed in vacuum suffer little deterioration. Vitamin C may be synthesized from some unknown provitamin, as it is found in the adrenal cortex and in traces in other endocrine glands.

Vitamin D ($C_{28}H_{43}OH$), Calciferol, Formerly the "Antirachitic" Vitamin.—*Vitamin D* is the name given to the product of certain

[1] SHERMAN, *op. cit.*, p. 436.

sterols that have been activated by ultraviolet rays (see page 256). The sterol is the provitamin (see page 158) that is thus converted into the vitamin. A number of sterols can be so activated in plants and in animals, and at the present time no fewer than 10 so-called vitamins D are known. The sterol called *ergosterol*, which is extracted from yeast and from a fungus growing on ergot and rye, when irradiated by ultraviolet rays, produces the compound *calciferol*, the official vitamin D, which is now synthesized and is available in crystalline form.

Animals also have body sterols that may be transformed into vitamin D by exposure to the ultraviolet rays of sunlight or from ultraviolet lamps, such as mercury-vapor quartz or carbon arc lamps. In the human body a sterol, *cleidin*, seems to be produced by the sebaceous (oil) glands of the skin and, when activated by ultraviolet rays, is resorbed as vitamin D.[1] Ergosterol is also found in the natural oil of fur and it is supposed that animals secure vitamin D from licking their own irradiated hair.[2] Fowls are supposed to obtain vitamin D from preening their feathers with oil from the preen gland, which then becomes irradiated.

It thus appears that one may produce his own vitamin D through irradiation of his skin, or he may eat foods or take concentrates containing vitamin D, or calciferol. In the temperate zone, where sunlight is irregular, and in cities, where smoke intercepts much ultraviolet radiation, it is well to use both methods.

Vitamin D is critically important during the period in which the bones of the infant are actively calcifying (see page 251). No child is born with rickets, but in shortage of vitamin D a child may contract rickets during the first months of life (see page 264). Vitamin D, together with *parathormone* (see page 151) regulates the intricate metabolisms of calcium, phosphorus, and manganese in bones, nerves, blood, glands, and muscles, particularly during active growth.[3] Vitamin D is especially

[1] MURLIN, *op. cit.*

[2] AMBERSON, WILLIAM R., and DIETRICH C. SMITH, *Outline of Physiology*, p. 288, The Williams & Wilkins Company, 1939.

[3] BLUMBERG, SHELLING, and JACKSON, "The Production of Manganese Rickets in Rats," *The Journal of Nutrition*, Oct. 10, 1938.

important to the pregnant and the lactating woman, the growing child, and the adolescent.

The oldest known naturally occurring vitamin D is found in fish-liver oils, notably salt-water fish, and especially in the familiar *cod-liver oil.* It has been impossible completely to isolate or synthesize the natural vitamins from these oils. Although they seem chemically similar or even identical with calciferol, they are physiologically different. While calciferol is fully protective against rickets, it is generally considered to be somewhat less effective than the natural vitamin D of cod-liver oil, halibut-liver oil, and other salt-water fish oils. Certain natural foods containing proper sterols, such as milk fat, may be irradiated and thereby become protective.

Sources of Vitamin D.—While the actual amount of vitamin D in most human food is small or nil, some biochemists begin to suspect that the amount of food vitamin D has been underrated. Sherman says, "The very significant, though variable, importance of milk as a source of vitamin D has been only recently established."[1] It is becoming apparent that the tests for vitamin D "are of such drastic character" that they have resulted in reports that it is absent from various natural foods, such as green leaves, when it more probably occurs in small or moderate amounts.[2] The factor of uncertainty is whether or not given foods have actually become irradiated or activated, since the vitamin D content of foods depends so directly upon their irradiation. At best, it seems certain that an optimal amount of vitamin D *is not* supplied in the ordinary diet, particularly for persons who do not regularly expose their skins to sunlight or to ultraviolet lamps.

Egg yolk is a source second only to fish-liver oils, if the hens have had normal exposure to ultraviolet rays. Milk fat and some meats contain highly variable amounts of vitamin D. In many dairies vitamin D milk is now produced.[3] Irradiated

[1] SHERMAN, HENRY C., *Food Products*, p. 37, The Macmillan Company, 1933.

[2] SHERMAN, HENRY C., "Do Common Foods Contain Vitamin D?" *Journal of the American Dietetic Association*, January, 1936.

[3] NELSON, E. M., "The Determination and Source of Vitamin D," *Journal of the American Medical Association*, Aug. 6, 1938.

evaporated milk retains its potency for at least 2 to 3 years, showing no loss whatever during the first year.[1]

In addition to food sources, it is generally conceded that pregnant and nursing women and children living in the temperate zone should take cod-liver oil, haliver oil, or other concentrate; and especially that they should live in the open, with free exposure of all or part of the body to direct or indirect sunlight (sky shine).

Hypervitaminosis D.—Vitamin D is a powerful chemical compound and, of late, instances are multiplying in which *hypervitaminosis* has occurred with rise in the calcium and phosphate level in the blood, overcalcification of bones, calcareous deposits in the kidneys, heart, blood vessels, and bronchi.[2] Vitamin D concentrates, such as cod-liver oil, haliver oil, and viosterol, should be taken only under the continued supervision of a capable physician or nutrition specialist.

Vitamin E ($C_{29}H_{50}O_2$) *Alpha-tocopherol, Formerly the "Antisterility" Vitamin.*—The third fat-soluble vitamin is less well known than are vitamins A and D. It seems to be a sterol, and an alcoholic compound of high potency has been isolated and named *alpha-tocopherol.* In experimental animals, lack of vitamin E causes death and resorption of the embryo and, in the male, causes sterility. Little is known as to its role in human reproduction. E. V. McCollum reports one experiment in which 25 cases of "habitual abortion" were treated with wheat-germ oil, with the result (apparently due to the use of vitamin E) that 17 couples subsequently produced living children.[3] Vitamin E is so generally present in cell sterols there is no possibility of dietetic deficiency. It is especially rich in seed germs and in yeast.

Vitamin K ($C_{31}H_{46}O_2$), *Formerly the "Antihemorrhagic" Vitamin.*—One of the newest additions to the vitamin list is a fat-soluble, crystalline, colorless substance that is heat-stable, although it is rapidly destroyed by alkalies or sunlight, and seems

[1] KRIEGER, C. H., and H. T. SCOTT, "The Stability of Vitamin D in Irradiated Milk," *Food Research*, May–June, 1938.

[2] SHOHL, ALFRED T., "Physiology and Pathology of Vitamin D," *Journal of the American Medical Association*, Aug. 13, 1938; and PAGE, IRVINE H., *Chemistry of the Brain*, p. 37, Charles C. Thomas Publisher, 1937.

[3] MCCOLLUM, *op. cit.*

to be essential to the formation of prothrombin in the liver.[1] Prothrombin is one of the links in the chain of exact sequences involved in blood clotting. Brilliant results are being obtained in the treatment of the acute disease known as *hemorrhagic obstructive jaundice* with vitamin K. Blood clotting itself is not well understood, so a large and important field of research has been merely opened, with few conclusive results as yet. Vitamin K appears to be widely distributed in nature. Like vitamin B, it may possibly be synthesized in the intestines by bacteria.[2] In plants it seems to be confined to the green portion of such growths as alfalfa, spinach, carrot tops, tomatoes, oat sprouts, etc. It is found in soybean oil, hog-liver oil, etc., but not in appreciable amounts in fish-liver oils.[3]

Specific application of the principles of the balanced diet will be made in subsequent chapters on pregnancy, and the nursing and feeding of children.

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[1] "Vitamin K," editorial, *Journal of the American Medical Association*, Dec. 31, 1938.

[2] AMBERSON and SMITH, *op. cit.*, p. 289.

[3] SNELL, ALBERT M., "Vitamin K, Its Properties, Distribution, and Clinical Importance," *Journal of the American Medical Association*, Apr. 15, 1939.

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New Words in Chapter XV

ampulla. A saclike enlargement of a canal or tube.

anus. The lower opening of the digestive tract, through which the fecal matter is extruded.

broad ligament. A thickened fold of the peritoneum which contains and supports the Fallopian tubes and ovaries.

circumcision. The operation of removing part or all of the prepuce.

clitoris. An organ composed of erectile tissue, the analogue in the female of the penis; about an inch and a half in length.

Fallopian tube. The tube which, in mammals, conducts the egg from the ovary to the uterus.

fimbriated. Having a fringelike structure.

hemorrhoids. Livid and painful swellings formed by dilatation of blood vessels at the anus.

hernia. Rupture; the protrusion of an organ or part of an organ or other structure through the wall of the cavity normally containing it.

hydrocele. A condition in which the scrotum becomes filled with fluid.

hymen. A thin, crescentic or annular fold partly closing the vaginal opening in the virgin.

inguinal ring. A loose place between the muscles and ligaments of the groin.

interstitial. Of or pertaining to interstices; within tissue, specifically the interstitial tissue of testes and ovaries.

involution. The return of an enlarged organ, as the puerperal uterus, to normal size.

labia majora. The protective folds covered with hair on the outside which enclose the vulva.

labia minora. Two smaller folds located inside the space surrounded by the labia majora.

lactation. The period following childbirth during which milk is formed in the breasts.

mammae. The breasts or mammary glands.

mons Veneris. The prominence caused by a pad of fatty tissue over the symphysis pubis of a woman.

ova (singular **ovum**). The eggs or female sex cells.

oviduct. See Fallopian tube.

penis. The organ of copulation in the male.

perineum. The muscular mass lying between the vulva and the anus in the female and the scrotum and the anus in the male.

peritoneum. The serous membrane lining the abdominal cavity and covering most of the viscera contained therein.

phimosis. Narrowness of the opening of the prepuce (foreskin) preventing its being drawn back over the glans of the penis.
prepuce. The circular fold of skin which covers the end of the penis.
primordial. Primitive, or first.
puberty. The age at which the reproductive organs become developed, thirteen to sixteen years in boys, twelve to fourteen in girls.
rupture. Hernia; a tear or break of any organ or other of the soft parts.
sagittal. In an anteroposterior direction.
scrotum. The musculocutaneous sac containing the testes.
semen. A thick, yellowish white, viscid fluid containing spermatozoa.
sperm (spermatozoon). The male sex cell, or germ cell.
spermatozoa (singular, **spermatozoon**). The male germ cell.
subinvolution. An arrest in the normal involution of the uterus following childbirth, the organ remaining abnormally large.
testes (singular **testicle**). The male reproductive glands, normally present in the cavity of the scrotum.
tunica vaginalis. A layer of connective tissue continuous with the connective tissue in the abdomen, which envelops the testicle and the spermatic cord in the scrotum.
urethra. A canal leading from the bladder, discharging the urine externally.
uterus (womb). In female mammals an organ for containing, and usually for nourishing, the young before birth.
varicocele. A condition concerning the testicle in which it becomes filled with fluid following injury.
varicose vein. A chronically enlarged and distorted vein.
virgin. A female who has never had sexual intercourse.
vulva. The area between the labia majora.

CHAPTER XV

THE ANATOMY OF HUMAN REPRODUCTION

In the dark womb where I began
My mother's life made me a man,
Through all the months of human birth
Her beauty fed my common earth.
I cannot see, nor breathe, nor stir,
But through the death of some of her.

JOHN MASEFIELD.[1]

The Female Reproductive Organs.—The "essential" reproductive organs are the *uterus*, *tubes*, and *ovaries*, which form one connected structure and which are loosely suspended from side to side of the *true pelvis* (see page 119) by a fold of connective tissue called *the broad ligament.* The broad ligament is a continuation of the connective-tissue membrane called the *peritoneum*, which covers the intestines. It should be remembered that all abdominal structures are covered with peritoneal membrane, much as if one huge piece of tissue paper were used to wrap and separate, in its successive folds, a number of objects packed in a box. One such fold separates the bladder from the other organs; the broad ligament is really a somewhat thickened fold of this membrane. This arrangement is protective and tends to prevent one organ, if infected, from transmitting infection to other organs. It also serves to convey the blood and lymph vessels to the various structures. The uterus is further anchored by two cordlike *round ligaments* attached to the upper angles or "horns" of the uterus, which pass across the pelvis and come out through a loose place between the muscles and ligaments in the groin called the *inguinal ring* and are attached to the muscles and connective tissue that form the *mons Veneris.* The large nerves and blood vessels supplying the leg pass out of the pelvis between muscles and tendons below this ring. A loop of bowel is sometimes forced through the inguinal ring, producing what is known as *inguinal*

[1] *Selected Poems.* By permission of The Macmillan Company.

hernia, or *rupture*. The testicles of the male child pass through the inguinal rings into the scrotum some time before birth.

Several other ligaments anchor the uterus loosely to structures behind and in front. These ligaments are all somewhat elastic

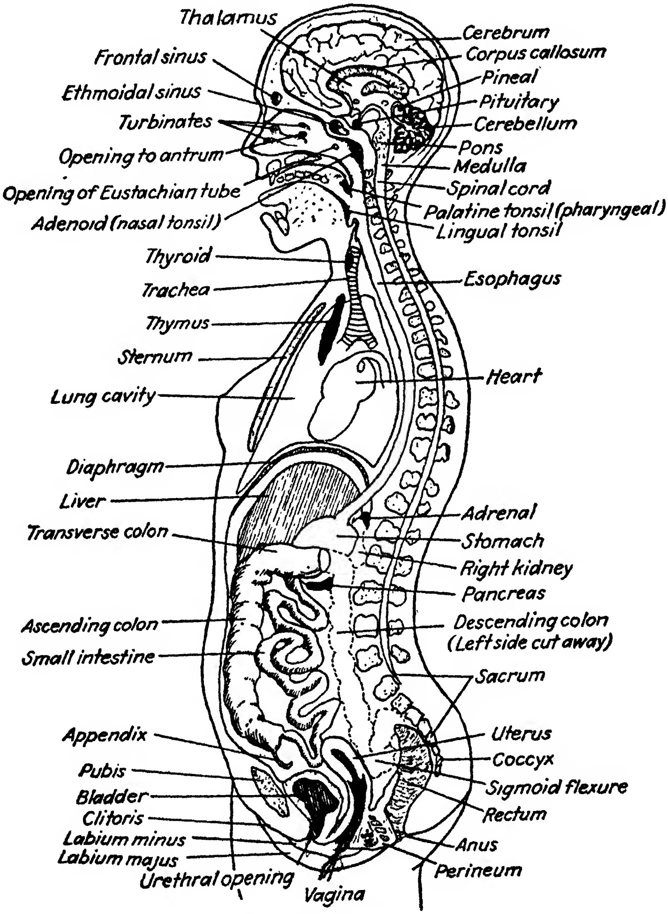

Fig. 70.—Median section of female body.

and become elongated during pregnancy to permit the uterus to rise into the abdomen.

Relation to Other Pelvic Structures. The Bladder.—The uterus and attached parts lie behind the urinary bladder (Fig. 71), from which it is separated by the broad ligament. The uterus normally curves toward the front and rests against the bladder. As the size and position of the bladder vary greatly, according to the amount of urine it contains, there is almost constant change in the relative position and curvature of the uterus.

The Bowel.—The *rectum* and *sigmoid* lie directly behind the uterus, and the loops and folds of small and large bowels closely surround the reproductive organs (Fig. 34). Constipation may interfere with free circulation and good tone of these organs, and may be a cause of painful menstruation; pressure of a pregnant or a displaced uterus may also cause constipation or hemorrhoids.

Blood Vessels and Nerves.—The trunks of the large spinal blood vessels and nerves branch and cross the pelvis on their way to the lower extremities. The pregnant uterus or a displaced uterus may press upon these and may cause swelling of the feet, varicose veins, muscle cramps, and hemorrhoids ("piles") (see pages 338–340).

The Uterus.—The most obvious of the reproductive organs is the *uterus* (commonly called the *womb*). This is the living nest in which the human egg passes its long period of incubation. It is a pear-shaped organ about 3 inches long, flattened from front to back, with the heavy end or *fundus* directed upward and curved toward the front of the body; the slender portion, the *cervix*, or neck, extends downward into the vagina. The uterus has a somewhat triangular cavity, with passageways leading from the upper external angles of the cavity into the Fallopian tubes. A larger passage through the *cervix* opens downward into the vagina (see Fig. 72).

The nonpregnant uterus is formed of a dense mass of highly elastic muscle fibers and weighs about 2 ounces. It is richly supplied with blood vessels but very scantily supplied with nerves. During pregnancy the uterus increases greatly in size and changes in shape. Just after the child and afterbirth (placenta) are expelled, the loose muscular sac contracts into a hard mass weighing about 2 pounds. During the 5 or 6 weeks following birth, the uterus returns to its former size and shape. This process is called *involution.* When return to normal is delayed and the uterus remains large and heavy, the condition is called *subinvolution.*

The Fallopian tubes or *oviducts*, commonly referred to as "the tubes," are tubelike structures each about as large as a lead without tearing the tissue, most modern obstetricians prefer to push the anaesthetic and clip the muscles, believing that a clean cut is preferable to an irregular tear and that it is more easily repaired.

The Breasts, Mammary Glands, Mammae.—The secreting structures of the breast (mammary gland) consist of grapelike clusters of glands which take substances from the blood and make them into milk. The milk flows through the twiglike *ducts* into the larger *ampullae* and is there retained until it is withdrawn by the mouth of the infant (Fig. 74). After lactation ceases, the glands undergo considerable atrophy.

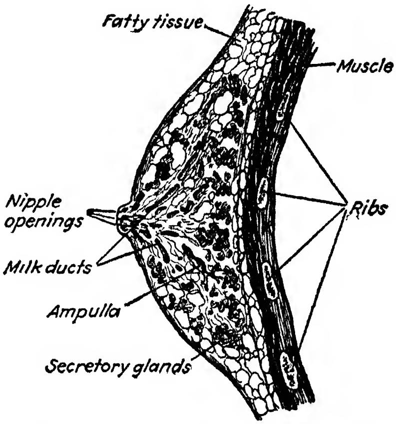

Fig. 74.—Diagram of the structure of the mammary gland.

As the mammary glands are situated at considerable distance from the reproductive organs, it has always been a mystery why milk should be secreted just when the baby was ready to use it. The discovery of internal secretions has cleared up this as well as many other "mysteries." The development of the breasts at puberty is stimulated by the internal secretion of the anterior pituitary and other glands. The changes in the breasts that are characteristic of pregnancy are especially stimulated and regulated by two glandular organs created for the duration of pregnancy only—the *corpus luteum* and the *placenta* (afterbirth) (pages 143 and 290).

The nipples are surrounded by a pigmented area, which darkens during pregnancy. Sometimes the nipples are small or even inverted or retracted. This condition should be treated during pregnancy, as it sometimes makes nursing difficult.

The Male Organs of Reproduction.—The male and female organs correspond part for part but differ in structure, and particularly in the fact that the male organs are carried outside the body while the female organs are inside. There is an appreciable difference in the internal temperature of the ovaries and the testicles, a fact which qualifies the behavior and duration of the life of the sperm in the uterus and tubes (see p. 287).

The scrotum is the sac of muscular and connective tissue that contains and protects the *testes.* It corresponds to the large labia in the female. It is highly elastic and contractile. If bruised or injured, it may fill with fluid causing what is known as a *hydrocele.* Male infants should be protected from pressure and irritation from tightly adjusted diapers. Older male children may injure themselves in sack swings and other injudicious sports.

The testicles (*testes*) are the essential reproductive organs in the male, corresponding to the ovaries of the female. Indeed, they originate within the pelvis and only "migrate" or leave it shortly before birth, when they slip through the inguinal rings and enter the scrotum. This is called the "descent of the testicle." Sometimes this descent does not occur until after birth. The testes are slightly larger than the ovaries, about 1½ by 1¾ inches. The testicle is filled with a very long coiled *seminiferous tubule,* within which the embryonic *sperm cells* develop as do the ova in the ovary. The tubules are surrounded with *interstitial cells,* which seem to have glandular function and may have something to do with stimulating the formation of the secondary sexual characteristics at puberty—the growth of hair, change of voice, etc.—and with maintaining sexual and mental vigor throughout life. The anterior pituitary, however, seems to play the major role in this (see page 145).

The sperm cells (*spermatozoa*) are developed in incredible numbers within some 1,500 feet of tubules in the testicle. When fully matured, the spermatozoon is one of the smallest cells in the body. The male child at birth is provided with millions of potential reproductive cells. After puberty these are maturing continually within the seminiferous tubules and are discharged at intervals from the testes through the *spermatic duct.*

The spermatic cord is formed by the time the testes descend. It corresponds to the Fallopian tube, or oviduct, in the female and contains the *spermatic duct,* blood and lymph vessels, and nerves. It is very long, extending from the testicle through the inguinal ring to the *seminal vesicles* behind the bladder, where the *spermatic fluid* is added. From the seminal vesicles the spermatic duct continues as the *ejaculatory duct* and carries the *seminal fluid* with the sperm cells through the *prostate gland*, where the duct joins the *urethra*. The fluid is discharged through the penis in *sexual intercourse* or in *seminal emissions*.

The Penis.—The male organ of copulation (sexual intercourse) is the penis, which is situated above the scrotum in the position corresponding to the clitoris in the female. This organ is com-

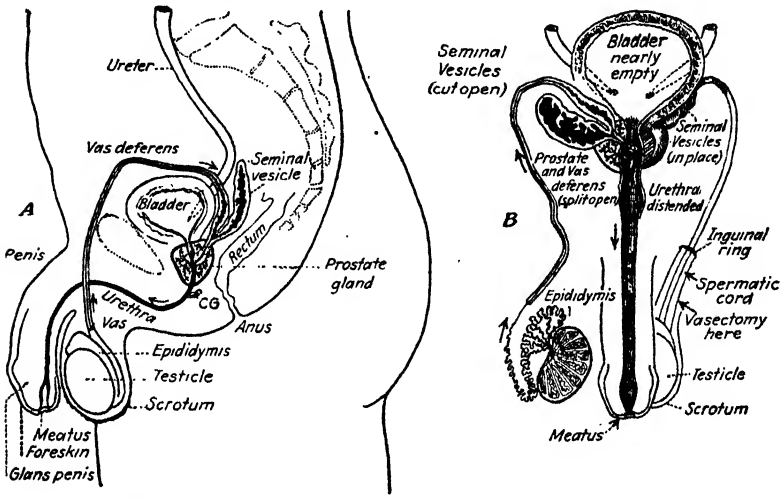

FIG. 75.—Male organs of reproduction. *A*, from side; *B*, from front (structures on the left laid open). (*From Dickinson and Bryant, Control of Conception, Williams & Wilkins Co.*)

posed of three cylinders of highly erectile tissue, one of which ends in the sensitive *glans penis*, the specific organ of sexual sensation in the male, corresponding to the *glans clitoris* in the female. The *urethra* also traverses the penis and conveys both seminal fluid and urine to the exterior.

The glans is covered and protected by the circular fold of skin at the end of the penis called the *prepuce*, or *foreskin*. This is normally very loose and elastic and easily slips back, exposing the glans. Sometimes the prepuce is adherent to the glans; sometimes the opening is very small, so small as to interfere with free discharge of urine. In this case secretions collect under the foreskin and become irritative. In the infant, fretfulness, wakefulness, and in extreme instances convulsions may result. In older children nervousness, irritability, masturbation (handling the genital organs), and impairment of nutrition result. Retention of urine may lead to toxemia. *Circumcision* (surgical removal of the excess tissue of the foreskin) is then indicated and, when needed, should be done as early as possible. Every male child should be examined at birth by the physician and, if this condition (called *phimosis*) exists, circumcision should usually be performed within a few days or a few weeks.

The foreskin of the male infant should be gently retracted and the glans cleansed with a bit of cotton at the time of the daily bath. This keeps the prepuce elastic and prevents irritative secretions from collecting about the sensitive structure.

The Origin of the Reproductive Organs.—We have seen that nature elaborated the scheme for the perpetuation of life that we see in human reproduction step by step over long ages of time as measured in human experience. We might expect to find some record of this in the embryonic development of the child, and surely enough we do (Fig. 76).

When the human embryo is only 2.5 millimeters long (1/10 inch, after 3 or 4 weeks of growth) *primordial germ plasm* can be distinguished in the ectodermal layer, which migrates to a certain center and proceeds to form the *genital fold* or thickening. At 12 millimeters (about ½ inch, at about 6 or 8 weeks) *the primitive genital gland* is formed.

While the centers or gradients from which the various reproductive structures are to come appear in rapid sequence, the organs remain indifferent sexually until between the second and third month of intra-uterine growth. During this month the embryo grows from about 1 inch to 1½ inches in length. There is a projection, called the *glans of phallus*, which in the case of the male will develop into the penis, and in the case of the female will become the clitoris.

Back of this is the "genital swelling," which, if the child becomes a male, will form the scrotum, or protective covering for the testes. If the child becomes a female, this will develop into the labia, or folds of protective tissue covering the open cavities which soon form between the vagina and bladder and the outer, world.

The essential organs of reproduction, the testes in the male and the ovaries in the female, arise from the same embryonic gradients or centers of growth, and in each sex the primordial germ cells containing the hereditary or germinal material become segregated

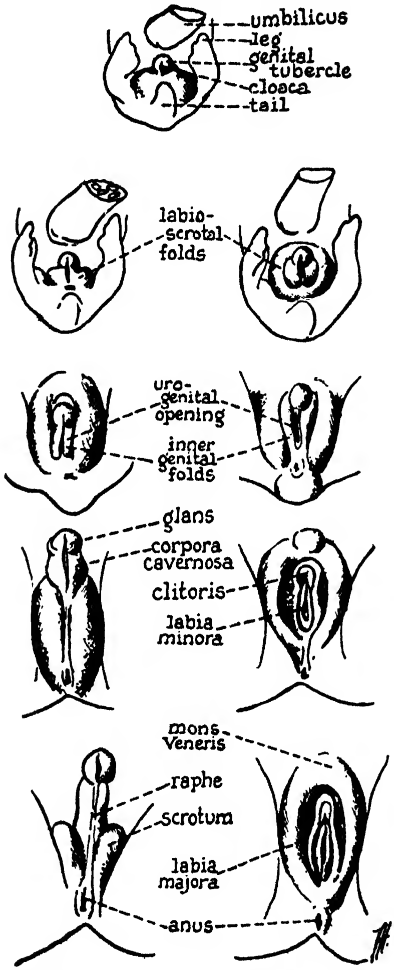

FIG. 76.—Embryonic differentiation of external genitalia. (*Walter, Biology of Vertebrates, The Macmillan Company. After Gray.*)

within these oval glandular organs. In the case of the male the testes migrate through the inguinal rings into the scrotum after about seven months' intra-uterine development, carrying with them a portion of the peritoneal covering known as the *tunica vaginalis.*

These few details are mentioned to show a little more of the experimental method of nature. She rarely produces an entirely new thing; she merely adapts and varies and develops the new from the old with incredible patience and precision.

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New Words in Chapter XVI

amnion. The innermost of the membranes that envelop the fetus in the uterus.

chorion. The outermost of the fetal membranes.

conception. See fertilization.

decidua. The altered mucous membrane of the pregnant uterus.

defecation. The discharge of excrement from the rectum.

ectopic gestation. Development of the impregnated ovum at some point outside the uterine cavity.

embryo. The newly developing individual from fertilization to the beginning of the third month.

fertilization. The union of the male sperm with the female ovum.

fetus. The unborn young from the third month till birth.

implantation. The attaching of the fertilized ovum to the wall of the uterus.

placenta. The organ of communication between the fetus and the mother.

placenta previa. The condition in which the placenta is implanted in the lower part of the uterus, obstructing the *os* more or less completely.

umbilical cord. The cord connecting the fetus with the placenta.

viability. The state of being able to live.

CHAPTER XVI

PREGNANCY

Seeing you round and full with ripening fruit of your body, in the sweet old way, the brave old way of women, I must sing and leap, and shout,—and I must kneel and pray, knowing you more than woman in this day of new creation, in this flowering spring of human fruitfulness. The gift you bring mocks the iron centuries that blast and slay.

You are the Race, you are the seeded Earth, you are the Torch that carries on the flame, and you are God made woman for a space. Now, as that inward glory lights your face, I, man, abase myself before your name and envy you the power of giving birth.

—CLIFFORD GESSLER.[1]

Ovulation.—Definite research is obviously difficult in matters relating to the functioning of human reproductive organs. It seems probable that normally only one ovum matures or ripens and escapes from an ovary during each menstrual interval. This is called *ovulation.* It is not known whether or not the ovaries alternate in action. It is known that a woman with only one, or even only a part of one ovary, may menstruate regularly and produce a normal number of children. The ovum ordinarily finds its way into the fimbriated extremity of the nearest Fallopian tube. Here it is propelled along by peristaltic action and by the wavelike movement of the cilia that line the tube, until, in the course of a number of days, variously estimated at from 3 to 7, it reaches the uterus.[2] The surface of the ovum is covered with adherent follicular cells (see Fig. 78), which are loose in attach-

[1] Courtesy of *Birth Control Review.*

[2] Extra-uterine pregnancy, or "ectopic gestation," may occur. Occasionally the fertilized ovum lodges in the Fallopian tube and never reaches the uterus. This is called *tubal pregnancy.* The ovum goes as far as it can in its development under its restricted conditions but never goes to full term. Sometimes it becomes a tumorlike mass and is removed surgically. Once in a very long time, fertilization occurs in the fimbriated extremity of the tube or in the abdominal cavity. This is called *abdominal pregnancy* and also may require surgical removal.

ment and do not interfere with the entrance of the sperm into the egg.

Fertilization, or Conception.—The normal and usual place for the meeting of the male and female cells is in the Fallopian tube. If sexual intercourse has recently occurred, live spermatozoa may be found in the vagina, in the uterus, and in the tubes.[1] Apparently a strong hormone attraction leads the spermatozoa to swim upstream, so to speak. When one of these meets an ovum and touches it, the nuclei of the two are powerfully attracted to each other and fusion occurs. At the instant the head of the sperm enters the ovum, the character of the surface of the entire cell becomes so altered that probably no other spermatozoon may penetrate the ovum. At least, only one unites with the nucleus (Fig. 77). The spermatozoon leaves its mid-piece and tail outside. The small male nucleus increases rapidly in size by absorption from the cytoplasm as it goes along, until by the time it reaches the nucleus it equals in size the nucleus of the egg. The nuclei fuse and shortly there is a new cell with 48 chromosomes, which at once begins to divide and subdivide, while the cilia lining the tube continue to propel it along toward the uterus, or "nest."

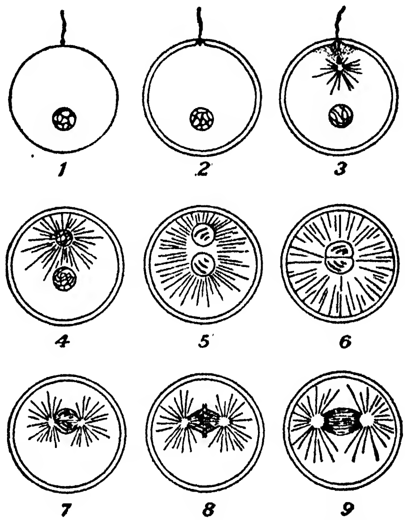

Fig. 77.—Diagram of fertilization. (*After Plunkett, Modern Biology, Henry Holt & Company.*)

Implantation.—By the time the fertilized cell reaches the uterus it has become a mass of cells perhaps as large as the head of a pin, depending upon how long it has been on the way. The uterus is vascular and soft under the stimulation of the follicular hormone (see page 143). Normally and usually the ovum comes to rest

[1] Some investigators believe that spermatozoa perish quickly within the vagina; others believe that they may, under some conditions, survive for some time.

within the triangular space in the body of the uterus.[1] Here it speedily sinks from sight, apparently having some digestive or enzyme action upon the uterine membrane (Fig. 78).

The Membranes. *The Amnion.*—Cell division goes on rapidly and soon the ovum presents the appearance of a delicate, transparent capsule, inside of which on the side of contact with the

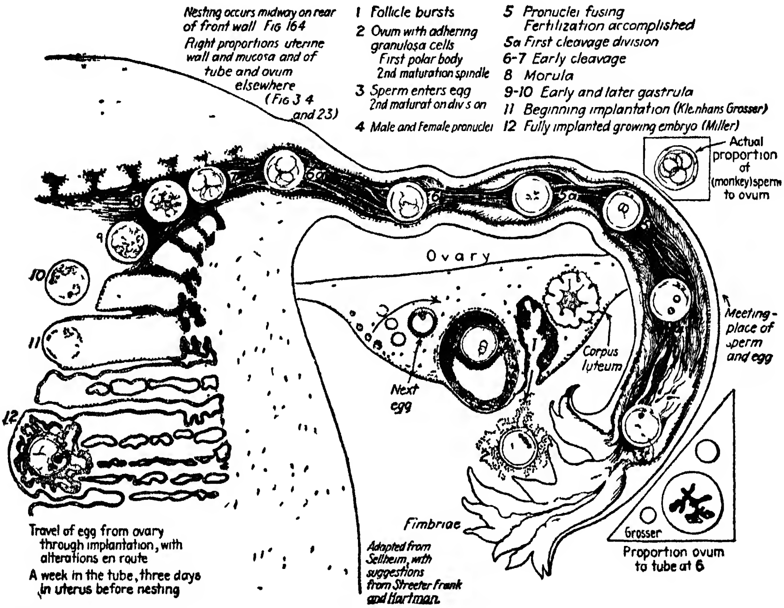

FIG. 78.—Journey of the ovum from the ovary to its implantation in the wall of the uterus. (*Dickinson-Elwyn, after Sellheim.*)

uterus appears a cell mass that is proceeding to develop into the embryonic child. This capsule is the first of the two membranes with which the embryo surrounds itself. It is filled with fluid and is called the *amniotic sac* or "bag of waters." The fluid, known as the *amniotic fluid*, is highly protective in that it equalizes pressure upon the embryo and permits it to have a

[1] Occasionally the fertilized ovum passes on to the cervix before it stops, and then lodges near or in the cervix. This may not be discovered until the time of birth, when the placenta is pushed ahead of the child instead of coming after, a condition known as *placenta previa* ("placenta before"). It will usually be detected by the physician during pregnancy, and he will know how to manage the complication when the child is born.

maximum freedom of movement. It is said that the fetus swallows amniotic fluid during the later weeks of intra-uterine life. Whether it does so accidentally or whether it thus obtains needed water and nutriment is not known.

The Chorion.—Very soon the amnion is surrounded by the second embryonic layer, which is known as the *chorion*. This is rough and shaggy and covered with villi, or fringelike projections.

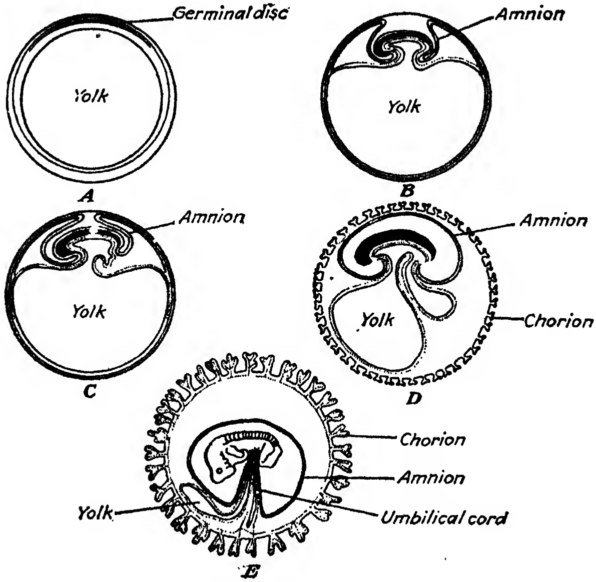

FIG. 79.—Stages in the development of the fetal membranes and cord. (*Modified from Edgar, The Practice of Obstetrics, P. Blakiston's Son & Co.*)

When the chorionic coat is pulled apart from the decidua and floated out in water it resembles a chestnut bur (see Fig. 82). On the side of contact with the uterus these projections sink like rootlets into the vascular uterine wall. As time goes on, these become more branching and rootlike, while the external surface becomes more smooth (see p. 80).

The Decidua.—When the cell mass sinks into the lining of the uterus, the lining folds over it in such a way that eventually the chronionic coat is covered with *two layers of uterine membrane*, called the *decidua*, which eventually fuse. The chorion closely interlocks with the inner decidual layer (Fig. 84).

The allantois (Fig. 80) is a rudimentary structure of considerable importance in certain lower animals; in the human however, it soon becomes incorporated in the tissues of the cord, and has little, if any, definite function.

The Cord and the Blood Vessels.—On the side of attachment to the uterus, the chorion develops within the villi, or rootlets, a mass of branching *placental blood vessels*, which are attached to the body of the child by means of the *umbilical cord* (Fig. 80). The cord, which may become 10 to 20 inches in length, has the thickness of a man's finger and conveys the three placental blood vessels—a vein carrying pure blood passively back to the fetus from the placenta and two arteries carrying impure blood from the fetal body to the placenta blood vessels (see page 291). There is no nerve tissue in cord or placenta and no nerve connection whatever between mother and child. This network of placental blood vessels ramifies through the villi of the chorion—which have sunk, root-like, into the vascular lining of the uterus—and divides into placental capillaries, which come to lie side by side with the uterine capillaries of the decidua and also lie in small "blood lakes." The placental capillaries join to form the vein that carries the pure blood back to the body of the fetus (Fig. 81). (It will be noted that "artery" and "vein" refer to structure rather than to the kind of blood carried.) *There is never any direct union of fetal and maternal blood vessels; exchange of nutritive and waste material is accomplished by filtration or osmosis between these two sets of capillaries.*

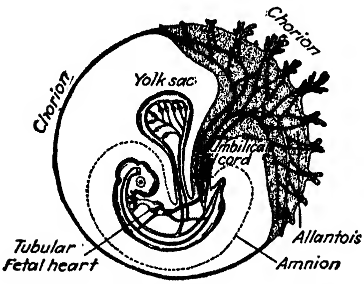

FIG. 80.—Diagram of placental circulation. (*Modified from Wilder, History of the Human Body, Henry Holt & Company.*)

The Placenta, or "Afterbirth."—These four membranes, two formed by the embryo and two by the uterus, form a sac about the embryo, very thick and full of blood vessels on the side that is attached to the uterus and relatively thin on the other side. This entire structure is called the *placenta,* or sometimes the *placenta and membranes.* The portion attached to the uterus is, at the time of maximum size, circular, about 8 or 9 inches in diameter, thin around the edges, and about an inch thick in the center, where the cord is attached (Fig. 84). While these struc-

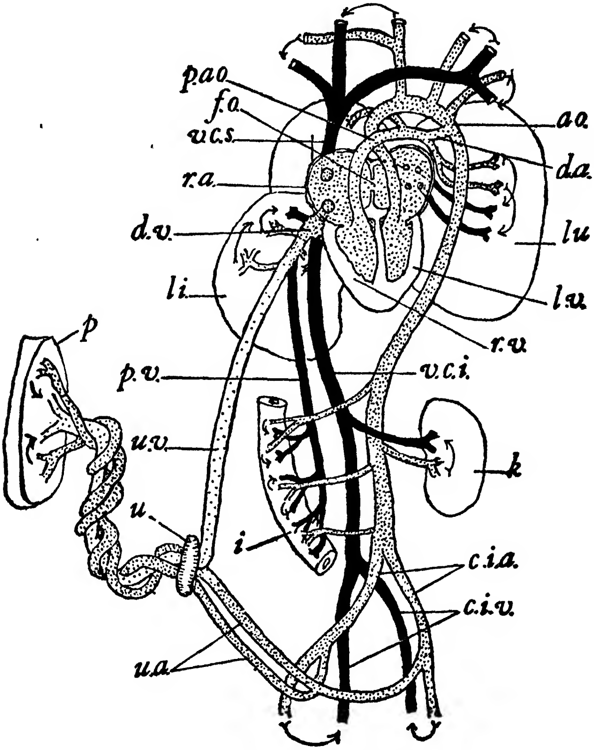

Fig. 81.—Diagram of fetal circulation. Vessels containing impure venous blood are shown in solid black; mixed blood by close stippling; pure blood by light stippling. *ao*, aorta; *c.i.a.*, common iliac artery; *c.i.v.* common iliac vein; *d.a.*, ductus arteriosus; *d.v.*, ductus venosus; *f.o.*, foramen ovale; *i*, intestine; *k*, kidney; *li*, liver; *lu*, lung; *l.v.*, left ventricle; *p*, placenta; *p.ao.*, pulmonary aorta; *p.v.* portal vein; *r.a.*, right atrium; *rv*, right ventricle; *u*, umbilicus; *u.a.*, umbilical arteries; *u.v.* umbilical vein; *v.c.i.*, vena cava inferior; *v.c.s.*, vena cava superior. (*Modified from Fig.* 169, *page* 329, *Wieman, Introduction to Vertebrate Embryology.*)

tures are forming, the fetus has developed its own heart and circulatory system, which is continuous with the placental circulatory system as just described, and eventually—at 3 or 4 weeks gestation—its heart begins to beat (see p. 129), and forces the pure blood received through the one umbilical vein from the placenta throughout its own very small and simple tubal structure, and forces its used blood out to the placenta through the two umbilical arteries (see Fig. 81). The fetal heart beats almost twice as fast as that of the mother. The scheme of fetal circulation may be said to resemble a "figure eight" in which the

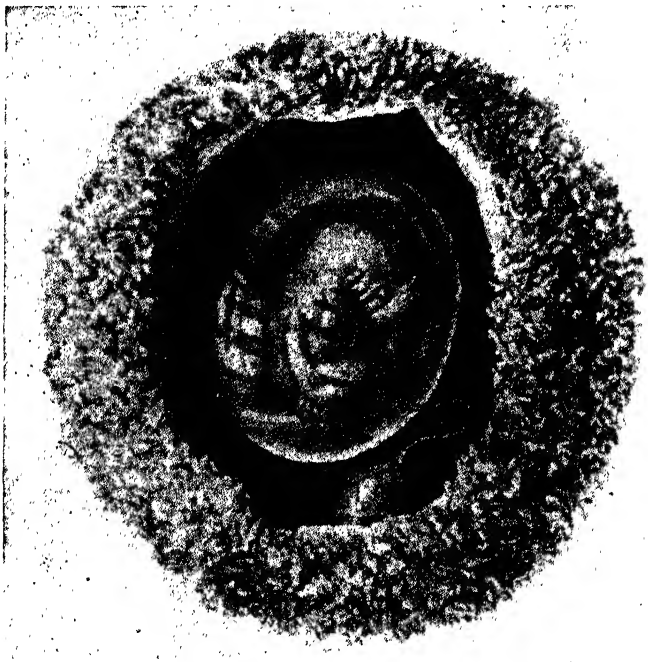

FIG. 82.—Chorionic sac opened to exhibit an 11-millimeter human embryo within its unruptured amnion. × 2. Small yolk sac still attached. (*Arey, Developmental Anatomy, W. B. Saunders Company.*)

large loop is in the child's body, the small in the placenta, while the cross is within the cord.

If the sap in the branches and leaves of a tree returned to the roots in complete circuit, the branches and leaves would represent the body of the embryo, the roots would correspond to the placenta, the soil to the uterus, while the trunk of the tree would play the role of the umbilical cord. Thus the human parasite feeds upon the bounty of the maternal hostess, somewhat as a fungus feeds upon a tree, or as a plant draws sustenance from the moist, warm earth through its branching rootlets. Under the stimulus of the changes wrought by the energizing action of fertilization of an ovum, nature has created an entirely new and remarkable organ, the placenta, which is interposed between fetus and uterus, between child and mother.

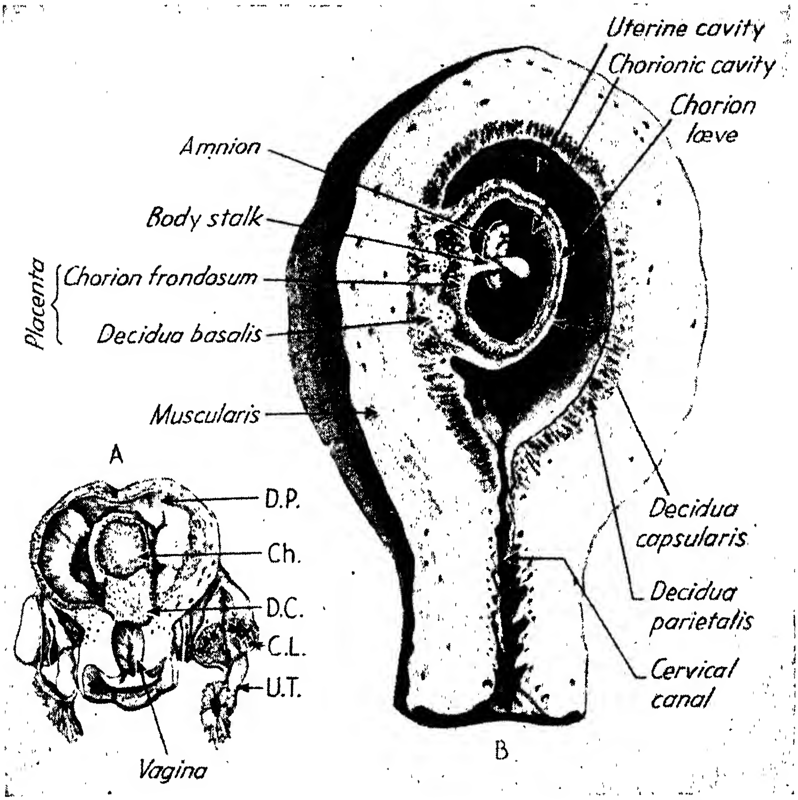

Fig. 83.—Relation of the chorionic sac to the deciduae.—*A*, gravid uterus opened at the fifth week, with the decidua capsularis reflected to show the chorion *in situ* (after Coste; one-third natural size). *B*, uterus of slightly over 1 month, in semidiagrammatic longitudinal section, to indicate the relations of the embryo to the deciduae (about natural size).

Ch., chorionic sac; *C.L.*, corpus luteum, ovary cut through *C.L.*; *D.C.*, decidua capsularis, cut and laid back exposing chorion; *D.P.*, decidua parietalis; *U.T.*, uterine (Fallopian) tube. (*Arey, Developmental Anatomy, W. B. Saunders Company.*)

Nutrition of the Embryo.—Small as is the human egg, provision is made for the nutrition of the tiny embryo, until it becomes attached to the uterine wall, by providing a small amount of *yolk*, a substance which is scattered through the cytoplasm of the egg and which becomes collected in the yolk sac immediately after fertilization. By the time that the placental circulation is fully established (see Fig. 84), the yolk is used up. The ovum also absorbs some nutritive substance and much water directly from the wall of the tube and from the mucous lining of the uterus in which it has become imbedded. From the time that the embryonic heart begins to beat the fetus rapidly becomes

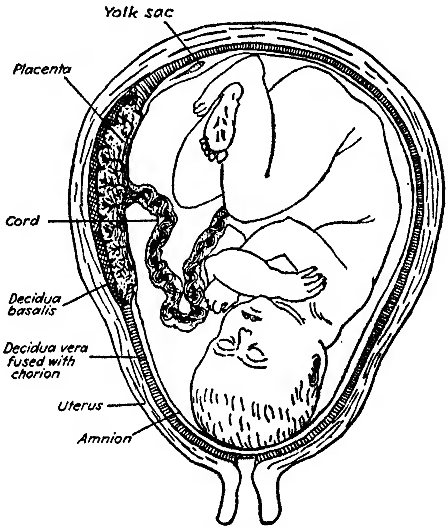

FIG. 84.—Diagram of uterus near end of pregnancy showing placenta, membranes, and cord. (*After Wieman, An Introduction to Vertebrate Embryology.*)

entirely dependent upon the mother's bounty by way of the placenta.

Signs of Pregnancy. *Probable Signs.*—It is sometimes a difficult matter to diagnose early pregnancy; even good physicians occasionally make mistakes. Ordinarily, however, when the following signs are present, they may be taken to mean that pregnancy has probably occurred:

1. Stopping of the period, or menses. In a healthy woman who usually menstruates regularly this is a strong indication that pregnancy exists. However, there may be other reasons for the temporary suppression of the menstrual periods.

2. Morning sickness. A sense of nausea or even vomiting when the stomach is empty or after the first food is taken in the

morning, when the digestion and health do not seem otherwise disturbed, is an experience common to from one-third to one-half of all pregnancies. When it appears along with the stopping of menstruation, it is fairly conclusive evidence.

3. Enlargement of the breast and darkening of the ring about the nipple. These changes usually appear along with the previous two signs and lend strength to the probability of pregnancy. It must be remembered, however, that a tumor in the uterus or other disorders of health sometimes produce all these symptoms, and that once in a long time all may occur without pregnancy. Sometimes, during pregnancy, the breasts may even excrete a small amount of fluid.

4. Visible enlargement of the abdomen. This is also one of the probable signs. It occurs at very different times and in different degrees in different women, depending upon posture, size of fetus, and amount of amniotic fluid, so that it indicates little as to duration of pregnancy.

5. Frequent urination. This condition is often present because the heavy uterus rests against the urinary bladder and prevents its usual expansion, also because there are congestion and irritability in the urethral tract.

6. Constipation. Pressure of the uterus upon the rectum may, for a time, make defecation difficult.

7. The gait of pregnancy. A woman walks differently during the later stages of pregnancy, leaning slightly backward and balancing herself with care because of the displacement of the center of gravity. This characteristic gait is sometimes called "the pride of pregnancy."

Positive Signs.—1. Quickening or feeling life. About midway in pregnancy, or at 4½ months, the pregnant woman usually begins to feel the fetus move. The contents of the abdomen are always in motion, however, and the muscles of the uterus have a slight rhythmic contraction in health. If a woman is a little nervous or strained over the matter, it is easy for her to think that a bubble of gas in the intestine is the movement of the child. Every now and then a woman who is not pregnant, and who has never been pregnant before and therefore does not know the sensation from experience, tells her doctor she is sure she has felt life.

2. Feeling the fetus move. When the physician or other person lays hands on the abdomen and actually feels and sees the child move, this may be considered as positive.

3. Feeling parts of the body. The physician can sometimes make out the head and various parts of the child's body definitely enough to be certain that it is a child and not a tumor.

4. Fetal heartbeat. When the doctor hears the fetal heartbeat through a stethescope at 4 to 5 months, there can be no longer be any doubt.

5. Laboratory tests. The blood serum or the urine of a pregnant woman when it is injected into experimental young animals causes increased growth and activity of the ovaries and uterus (see page 144). In case of certain diseased conditions, in some legal situations, when a long journey is contemplated, or when specific work is planned, early diagnosis is sometimes important. The specific character of the cells found in the vaginal secretions at different stages of the menstrual cycle and during pregnancy is a help in conclusive diagnosis. A skin test is also being tried (see p. 144).

Probable Date of Confinement.—The length of pregnancy varies in different women; it is, therefore, often impossible to compute the exact date of labor. Pregnancy, as indicated above, lasts on an average of 9 calendar or 10 lunar months, or 273 to 280 days. The usual method of estimating the date of confinement is as follows: Count back 3 calendar months from the first day of last menstruation and add 7 days. For example, if the first day of the last menstruation was Oct. 10, counting back 3 months would give July 10. Seven days added would give July 17 as the probable date of confinement. The English method of computing date of confinement may be preferred, *viz.*, add 40 weeks or 280 days to the first day of the last menstruation.

There is some evidence that the normal duration of pregnancy is 10 menstrual periods. Thus a woman menstruating every 26 days would expect her child to be born after about 260 days' gestation.

Since spermatozoa may live for an uncertain length of time in the female tract and since it is impossible to know the exact date of ovulation, it is difficult to be precise in computation, for the dates of coitus (sexual intercourse) and conception (fertilization) may not coincide (see page 6).

Maternal Changes.—The average, normal woman increases in total weight during pregnancy because of the added weight of the fetus with the placenta and fluids. She also usually increases somewhat in body weight because her metabolic processes are more active. She digests food more readily and has an increased appetite. The total increase in weight varies greatly, but it is usually 20 to 30 pounds.

The abdomen and the breasts enlarge, the center of gravity shifts, and during the later months of pregnancy a woman walks with characteristic precision and care; she throws her shoulders back to compensate for the heavy abdomen.

The sutures or lines of union between the bones of the pelvis soften somewhat during later pregnancy, thus allowing a very slight but important shift in diameters at the time of labor.

The pigment distribution in the skin is affected by pregnancy. The dark areola about the nipple becomes darker. As the abdomen becomes distended, streaks or striae appear, which sometimes remain as white scars after the birth of the child.

Sometimes irregular patches of dark pigment appear upon the face, and now and then upon the body. These almost invariably disappear after the child is born, sometimes before.

The uterus increases in weight from 2 ounces to 2 pounds at full term. Within 4 to 6 weeks following the birth of the child, it returns again to its original size and shape (involution).

The vaginal tract usually shows an increase of mucous secretion because of the generally increased physiological activity. The vaginal secretions are antiseptic in character. No douches or internal treatments should be used except under advice of a physician.

The sweat glands and the oil glands of the skin share in the general physiological speed-up and tend to increased secretion.

The endocrine glands also are increasingly active during pregnancy. When they are perfectly adjusted, the effect is a sense of increased vigor and exhilaration. When they are not perfectly balanced, a variety of nervous and mental symptoms may result, especially if complicated, as so often happens, with loss of strength through faulty diet and deficient sleep and rest, or with worry.

The metabolism in normal pregnancy shows certain significant changes, in that both nitrogen (protein) and minerals are stored in excess of the daily need. This is an important reserve for the approaching demands of labor and lactation, and more of these essentials should be included in the expectant mothers' diet (see page 309).

In general, a pregnant woman who is normal and follows a hygienic program should expect to feel well and more than usually vigorous and buoyant during most of her pregnancy. If she falls short of this, she and her physician should make every effort to discover the reason and correct it.

Stages of Development of Embryo and Fetus.—The first 2 weeks following fertilization of the ovum (egg) are technically known as *the period of the ovum.* During this period the egg is forming the germinal layers and the chorion is becoming embedded in the uterine wall—all preliminary to the formation of the embryo (see Fig. 79). From this time to the end of the second month, when the embryo begins to assume a "human appearance," is *the period of the embryo.* From two months to birth is *the period of the fetus.* Seven months of intra-uterine development bring the fetus to *the legal age of viability,* at which time the fetus may live if born prematurely, and from which time, in most states, physicians are required to report the birth whether the child is born alive or dead (stillbirth). At nine calendar or ten lunar months or, perhaps more exactly, ten menstrual intervals, *full-term birth* occurs.

Five Weeks.—At five weeks' development, the embryo is approximately 5 millimeters long (see 35 days in Fig. 85); the *neural groove,* which is to become brain and spinal cord (Fig. 18 *A*, *B*), is closed, forming the *neural tube* (see Fig. 18, *C*). The outlines of the brain are seen, nerves and ganglia are forming; the locations of the future special sense organs of sight, smell, and hearing can be identified; the heart (which has been contracting since three weeks of embryonic development) has increased in size and shows indications of its future auriculo-ventricular structure; along the region of the neural tube are seen segments (somata) that show where the vertebrae and spinal muscles will develop; the five branchial arches, or gill slits, are fully formed. The digestive tube is a closed hollow space extending the entire length of the embryo, anterior to the neural tube. At the upper end of it the mouth will eventually open in the tube and at the

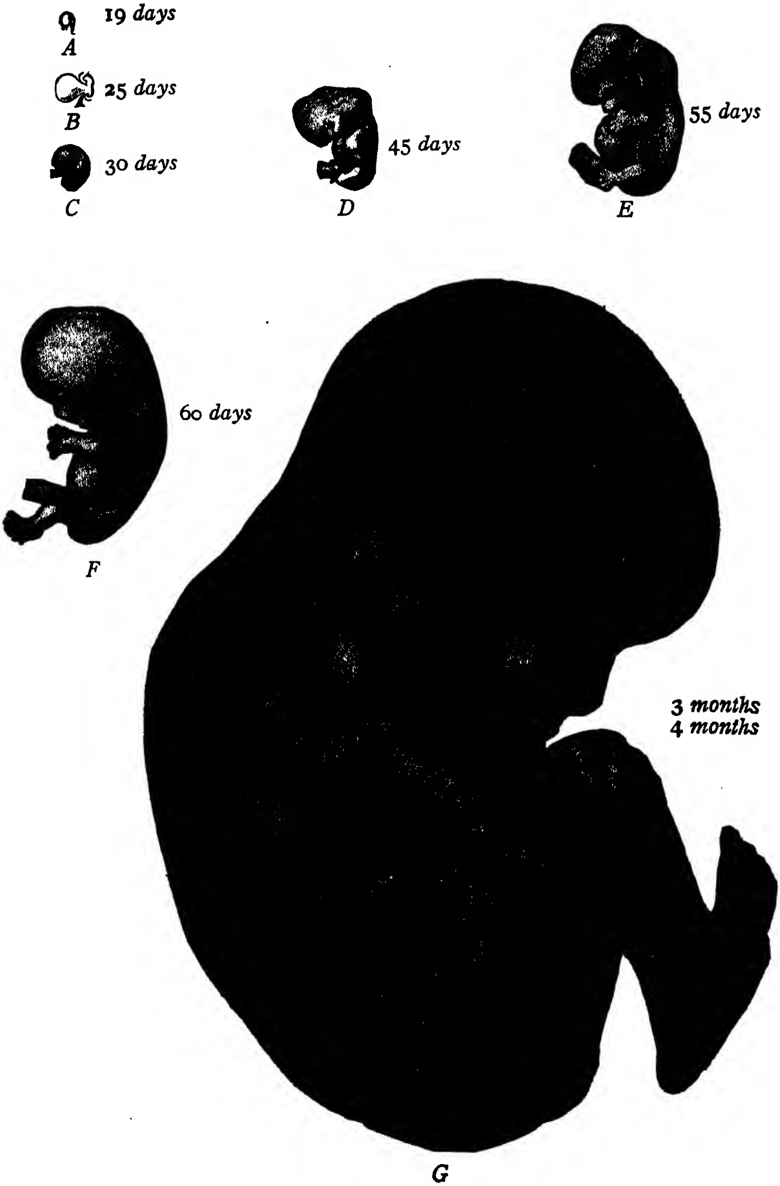

FIG. 85.—Human embryos of 3 weeks to 2 months (*His*), and fetuses of 3 and 4 months (*DeLee*). Natural size. (*Arey, Developmental Anatomy, W. B. Saunders Company.*)

lower end the anal opening will appear. The liver and the gall bladder, the stomach, and the lungs are beginning to develop. The limb buds are showing, and the tail is well developed. This is a great deal to compress within the tiny space occupied by the ovum at this period.

Eight Weeks.—By eight weeks, 25 millimeters—approximately 6 inches (see 60 days on Fig. 85), the embryo has straightened considerably; the face has developed, showing definite eyes, ears, nose, and mouth; and the head is approximately half the length and three-fourths the mass of the fetus. The branchial arches or gill slits have merged into a number of permanent structures; the tail is disappearing; the heart has four cavities with valves, and blood cells are forming in the liver; the extremities, with fingers and toes, are fully outlined. The stomach and intestines are completely outlined; the spleen, thymus, parathyroids, suprarenals, and pituitaries (hypophyses) are distinguishable. Muscles are forming, cortical cells begin to appear in the brain, and the fetus can make some movements. Both cerebrospinal and autonomic ganglia are forming. Hair follicles appear. The genital tubercle begins to differentiate into testicles or ovaries (see Fig. 76).

Twelve Weeks.—At three months, 68 millimeters (see Fig. 85), all structures mentioned have become extensively elaborated. Fingers and toes show nails; teeth are forming in the jaw; the soft cartilaginous skeleton is beginning to ossify in spots. Blood is formed in the bone marrow. The sense organs are progressing in the formation of their complicated structures.

Twenty to Forty Weeks.—In the period between five and ten months, the body gradually assumes "human" proportions. The head at birth is approximately one-fourth the length of the entire fetus. The legs still lag behind the arms in length and development. The fine fur (lanugo) mentioned on page 98 appears at about five months but completely disappears before birth.

Although the ovum doubles its size and weight at a more rapid rate immediately following fertilization than it ever will again, and the *actual rate of cell increase* gradually slows from that time until growth completely stops, *the actual mass increase* becomes compounded with each "doubling." Between five and ten months, the fetus doubles its length and increases its weight from 330 grams at five months (the mid-point of intra-uterine life) to 3,200 grams at birth—or approximately ten times. During this period the temporary teeth begin to show dentine and enamel, and the buds for the permanent teeth are forming; the tonsils and numerous other lymph glands and structures assume definite form. The testicles descend into the scrotum (page 280) at about seven months. Myelination of nerve fibers of brain and spinal cord is under way. Taste buds and gastric and intestinal glands are sufficiently complete to function if the child is born at seven months. The fetus at seven months is lean and wrinkled. The premature baby appears "old." By ten lunar months, more or less fat accumulates and the body contours round out. At birth, many bones are not ossified, many nerves are not yet myelinated (see page 206), and many glands function but incompletely. The sense of taste is the only special sense that is completely ready to function. Birth is only an incident in the long infancy and immaturity of the human child.

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CHAPTER XVII

THE HYGIENE OF PREGNANCY

Where the city of the faithfulest friends stands,
Where the city of the cleanliness of the sexes stands,
Where the city of the healthiest fathers stands,
Where the city of the best bodied mothers stands,
There the great city stands.

WALT WHITMAN.[1]

Professional Care.—The best protection a woman can have during pregnancy and childbirth is good care from a physician. Next to this comes intelligent personal care from a nurse and good help in her home.

The Children's Bureau of the U. S. Department of Labor has made many investigations and, after interviewing thousands of mothers and consulting outstanding obstetrical authorities, has formulated certain standards of professional care as necessary for the protection of the life and health of mothers and babies. These standards were set forth in an early bulletin issued by the bureau under the title "Prenatal Care," and have been reissued recently as a special bulletin.[2] Similar standards were confirmed by the Section on Medical Care, of the White House Conference.[3] In general all authorities now agree that every pregnant woman should receive the following attention from her physician. She should demand this care and should be willing, if financially able, to pay a fair price for it. It should be an obligation of society to provide this care for every woman. To safeguard the entrance of the child into citizenship should be the first duty of the state toward him; that it is coming to be so regarded is evidenced by

[1] "Song of the Broad-Axe," from *Leaves of Grass*, reprinted by permission of Doubleday, Doran and Company, Inc.

[2] "Standards of Prenatal Care," An Outline for the Use of Physicians, *Children's Bureau Publication* 153, 1939.

[3] *Prenatal and Maternal Care*, Proceedings of the White House Conference, D. Appleton-Century Company, Inc., 1932.

the expansion of the infancy and maternity program under the Social Security Act.

Early Consultation.—The best physician available should be consulted as soon as the fact of pregnancy becomes known; otherwise he cannot be expected to prevent complications. Both parents should have had medical and health examinations before marriage.

Standard Physical Examinations.—The physician should make a standard physical examination, including family and personal history of both parents, a thorough examination of heart and lungs, abdomen and pelvic organs, of the special senses, and all laboratory tests which may be indicated. In certain states the campaign against venereal disease has reached the point at which medical examination for syphilis is required of all candidates for marriage, and in 26 states specific tests must be made of all pregnant women.

Pelvic Measurements.—In the case of a first pregnancy the physician should make pelvic measurements to discover whether or not the diameters of the birth canal are normal. Some physicians take pelvic measurements in all new patients, whether or not they have previously borne children, since slight abnormalities may have gone undetected or unrecorded by the former physician.

Urinalysis, Blood Pressure, and Weight.—Once every month the expectant mother should take to her physician 6 ounces of fresh urine in a clean, scalded bottle. From the seventh month on, this examination should be made once every 2 weeks. When the urine is carried to the physician, he should take the blood pressure and weight. The reasons for this are discussed in Chap. XVIII).

Health Habits.—The physician will give advice as to diet, exercise, and other health habits, will insist upon dental care, and will usually suggest helpful and instructive literature.

Home or Hospital.—Every expectant mother must decide early whether she will be confined at home or go to a hospital. In towns or cities where good obstetrical hospital service is available, obstetricians are inclined to advise and even require that their patients go to a hospital. This economizes the doctor's time and lessens his responsibility, as the hospital staff will keep him correctly informed of the progress of the case. He is also sure of standardized nursing service with equipment and assistance for meeting emergencies. On the part of the mother and family, going to the hospital makes disruption of household routine unnecessary and does away with the trouble of making or purchasing supplies and equipment for confinement. On the other hand, the majority of the women of the world, even in our own country, do not have good hospital service conveniently near. If the hospital does not have a special obstetrical service, there is more or less hazard from general contagions. The small cottage hospital is likely to be anything but soundproof, and some women are disturbed by the unavoidable sounds and odors accompanying general surgery and other hospital work.

There is a suggestion of pathology about general hospitals which does not harmonize with our declaration that childbirth is, or ought to be, a normal, physiological phenomenon. Every possible care should be taken to prevent pathology or complications; but the normal, uncomplicated case needs only cleanliness, quiet, and proper food; and these can be provided in most homes.

In modern, well-managed obstetrical or "lying-in" hospitals efficient machinelike methods prevail. Both mother and baby are necessarily "Room I" and "Baby I" to nurses who must care for a considerable number of cases at once, and the general atmosphere is kind but quite impersonal.

A very common fear in going to a large hospital is that one's baby may be exchanged for another. There is now little danger of "mixing babies," as every hospital has a method of identification by means of metal name-necklace or bracelet, printed adhesive, or inked hand- or footprints similar to identification fingerprints (see Figs. 86 and 87).

Babies usually adapt themselves to the rigid routine and, by the time they leave the hospital, are started upon their habit training. Some mothers also fall in with the routine and impersonal character of the service more or less easily. Others, however, like better to occupy the center of the stage at home and enjoy the special attention of family and nurse.

Where there are older children, it is thought by some that they should have the educational experience of having a baby brother or sister born in the home—of course, being spared the actual witnessing of the mother's suffering. Besides, the question has been raised whether the father does not miss a rich spiritual experience and a proper vicarious share in the procedure if it takes place entirely out of the range of family contact. It is somewhat more intimate and less trying to be busy about the

FIG. 86.—Taking footprints of a newborn child. (*Acme Photo Service.*)

household than to pace a hospital corridor! It must seem more vividly to be his child if he does "stand by" during the ordeal and have some personal responsibility.

On the whole, the following conclusions may fairly be drawn: (1) Every woman who has any reason to expect a complicated or difficult birth should go to a hospital. (2) Any woman who cannot have intelligent, cleanly care at home or who cannot be made comfortable on account of inadequacies of housing or poverty should go to a hospital. (3) The woman who is healthy and who is enjoying a normal pregnancy may safely follow her own preference as to home or hospital care.

Household Help.—The expectant mother should begin early to plan for withdrawal from the work of the household. The life

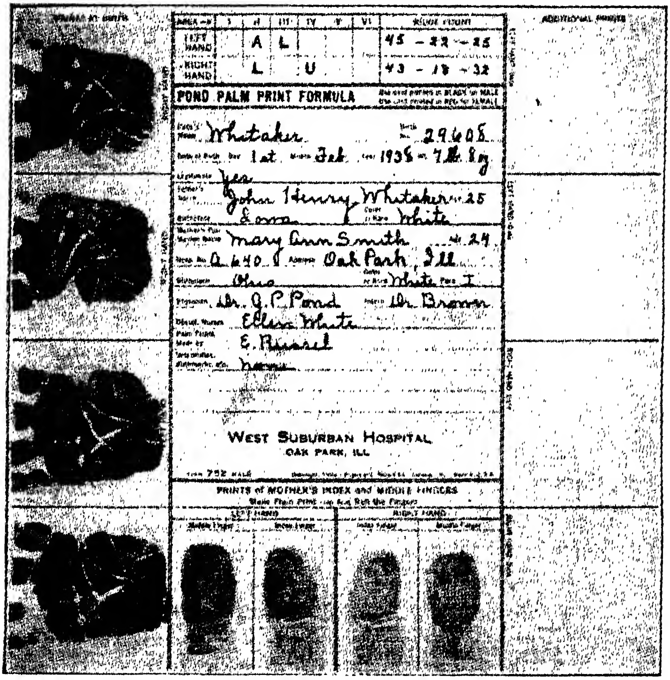

FIG. 87.—Complete palm-print record. Identification card of newborn babe. (*Physicians' Record Company, Chicago.*)

of the family should be systematized and simplified to the utmost and the various members of the family should be trained each to take certain responsibilities. They should do this early enough to relieve the mother more and more as time goes on. There will then be no sudden explosion of disorder at the moment above all others when order is entirely necessary.

If it is possible to have hired help, this help should be brought into the home and the routine adjusted in time to relieve the mother both mentally and physically, and to give her a chance to gather her mental and physical forces together before the onset of labor.

If it is not possible to have outside help, and the family, grandmother, or neighbor must do all that is to be done, the mother should reduce the work to the lowest possible terms by putting away whatever is not actually needed and in use, leaving the fewest possible things to require cleaning. Every member of the family should be trained not only to take care of his own things, but to do a little more, and the expectant mother should plan just what each one in the household is to do and just what the grandmother or the neighbor is to do. Such plans should be made in advance, so that no one will have to run to the mother when she is bedfast and ask where things are and how things are to be done. Even the ordering of food supplies and the general plan of the meals may be partially cared for some time in advance.

The Cost.—The rapid advance of medical science has made necessary long, expensive training followed by specialization. An increase in medical fees of every kind has accordingly become unavoidable. The situation gives the rich an unfair advantage in health protection. Free clinics, including prenatal and obstetrical clinics, have partly solved the problem for the very poor. Members of the great, self-respecting middle class are getting the worst of it. Young couples with small incomes must budget carefully in order to meet the cost of having and rearing a child.

One young couple conscientiously put by a sum sufficient to meet the expected expense. A serious and unexpected complication of labor made it necessary to call in a noted specialist, whose usual fee was $500. He cut the fee down to half that amount, in this case, but even so it took the strictest economy and monthly payments for a year to pay it. After the eleventh month the young father wrote gleefully to his parents, "One more payment and the baby is ours."

On account of variation in fees, living conditions, etc.,[1] it is impossible to make a strictly standard estimate of cost. The average middle-class family will have to make a budget covering

[1] Johnston, Sibyl W., "Cost of Maternity Care," *Hygiea*, May, 1939; Mark, Mary Louise, "A Professor Prices Babies," *Survey Graphic*, Jan. 1, 1930; and Boldt, Richard, "Cost of Obstetric Service to Berkley Mothers," *Journal of the American Medical Association*, May 17, 1930.

the following items. Unless a special nurse is employed in the hospital, there is little difference in cost between home and hospital care of similar adequacy. Taking a bed on a ward will somewhat reduce the hospital cost, and domestic service sometimes may be reduced below the estimate here given.

If Confined at Hospital	Costs
Service of obstetrician for eleven months, including regular urine analysis and frequent interviews, and postnatal supervision for 4–6 weeks.	$ 50–$100
Hospital delivery fee..........................	10– 20
Hospital room and floor nursing (10–14 days).....	50– 100
Layette and equipment for babe................	25– 50
Domestic service on return to home (2–4 weeks)..	20– 40
Miscellaneous...............................	15– 40
	$170–$350

If Confined at Home	Costs
Service of obstetrician.........................	$ 50–$100
Practical or trained nurse (2 weeks).............	40– 80
Domestic service (4–8 weeks)..................	40– 80
Layette, etc.................................	25– 50
Miscellaneous...............................	15– 40
	$170–$350

The Middle Western college couple mentioned on page 10 achieved excellent care for mother and baby on the following very modest budget. The mother returned to her college work when the baby was 3 months old, having hourly service only during her class hours, hence the small figure for domestic service.

Pregnancy and Puerperium	Costs
Physician.................................	$ 50.00
Hospital..................................	37.00
Layette and equipment..........................	42.00
Domestic service..........................	9.00
Supplies..................................	17.00
	$155.00
6 Weeks to 6 Months after Birth of Baby	**Costs**
Baby foods................................	3.35
Domestic service..........................	18.00
Supplies..................................	5.75
	27.10
	$182.10

The cost of maintenance of a child after it is born varies. It may involve high pediatric fees and expensive artificial foods, or in the case of the normal, breast-fed infant may be very little. Every child should either regularly attend a well-baby and pre-school clinic or be taken regularly to the family physician or a pediatrician. If the latter is the preferred method, or if there is no available health clinic, the pediatric fees must be considered. There is a tendency at present to regard a baby as a luxury. In any event, the cost of having a baby fairly balances the cost of a good victrola or a radio and still does not often approach the cost or upkeep of an automobile.

Diet during Pregnancy. *Amount of Food.*—During the first months of pregnancy the fetus is very small and the placenta is not large, therefore the new tissues do not make appreciable increase in calories necessary. During the last half of pregnancy the weight of the mother's body increases from 15 to 20 per cent (20 to 30 pounds) and there should be a corresponding increase in calories. A woman who usually consumes 2,400 calories daily will, by the end of pregnancy, be consuming 2,800 to 3,000 calories in order to maintain a normal basal metabolism (see page 237).

The Specific Food Needs in Pregnancy.—Food factors required in increased relative amounts during pregnancy are complete protein, calcium, phosphorus, iron, and iodine. There is need for relative increase of all the vitamins (see Chap. XIV). Extra protein will be required to build the new protoplasmic cells in fetus and placenta, also new uterine muscle fibers. Extra calcium and phosphorus will be required to build the supporting structures of the fetus, while iron must be provided for the manufacture of fetal blood and also for storage in the fetal liver of approximately 6 months' supply. Iodine is essential for the regulation of oxidation and for energy production. The vitamins are necessary for catalytic stimulus to all metabolism. The amount of complete protein, calcium, phosphorus, and iron should in later pregnancy be approximately double that of the usual diet.

The Balanced Diet.—The basis of the daily diet during the last months of pregnancy usually should be 1 *to* 1½ *quarts of milk daily, one egg,* and either *one serving of meat* or *one additional egg* or a *serving of cheese.* From this unit of her diet the expectant mother will obtain *complete protein,* from which to build the body of her child and maintain her own nutritional level.

From the milk she will obtain also calcium, phosphorus, and manganese (see page 250) necessary for supplying the bones, nerves, and blood of the fetus; and they will be in sufficient amount to make it unnecessary for the fetus to withdraw minerals from the mother's blood to the extent that her own tissues will be left depleted. From the milk fat, egg yolk, and full-cream cheese she will obtain the highly essential fat-soluble vitamins A and D. From milk, eggs, and meat she will obtain vitamin B. From egg yolk and meat she will obtain iron and sulphur and various essential "trace-minerals."

She will next require a liberal quotient of *whole-grain bread* and *whole-grain cereal.* These provide essential starch fuel and are among the best sources of vitamin B, the vitamin regulating appetite, nerve function, and digestion. From the portion next to the hull she obtains calcium, phosphorus, and potassium. Cellulose (roughage) is obtained from the hull. From the body of the seed she will obtain carbohydrate, some incomplete protein, and also trace-minerals and some vegetable oil. Retaining the hull and germ of grains and seeds immeasurably increases their nutritional value.

As the next essential we may place a liberal daily quotient of *fruits or juices containing vitamin C* (*see page* 262). A large glass (8 ounces) of orange juice or grapefruit juice or double this amount of tomato juice is desirable, together with some use of other fruits and of leafy vegetables, which contain variable amounts of vitamin C. Fruits contain also other vitamins, phosphorus, iron, potassium, sodium, and trace-minerals, as well as appreciable amounts of carotin and variable amounts of sugar.

Liberal daily use should be made of green, leafy vegetables. Such vegetables as cabbage, lettuce, celery, succulent "greens," spinach, cress, green beans and peas, and green pepper should be eaten raw or cooked in such a way as to conserve the mineral content. In green leaves we find one of the richest sources of iron, also carotin (the provitamin for vitamin A). Leaves contain, besides, cevitamic acid (vitamin C), thiamin (vitamin B), calcium, phosphorus, magnesium, iodine, and cellulose. *Leafy* *vegetables are indispensable in any diet—doubly so during pregnancy and lactation.*

Yellow vegetables and grains should be generously used; for instance, carrots, sweet potatoes, yellow corn, squash, and rutabaga. The provitamin, yellow carotin, is now known to be very essential in the synthesis of vitamin A. These are also rich sources of various minerals, of some of the other vitamins, of carbohydrate, and of cellulose (see page 256).

"After one has eaten what one should one may eat what one will." The rest of the calories may be selected from a wide variety of seed, root, and tuberous vegetables, fruits, etc.

Things That Should Be Avoided: Indigestible Food.—Almost every woman knows that certain foods are hard for her to digest, although other people seem to eat them with safety. It is foolish to take chances on upsetting the health during this important period by indulging in such foods. Warm, soft, or fresh breads should be eaten in moderation—not at all if there is any tendency toward indigestion. Thoroughly baked bread, toast, or zwieback, with heavy crusts, is better for the health and the teeth. *In general, fried, overcooked, undercooked, greasy, overseasoned, or very rich foods, such as pastry, rich puddings, soda-fountain concoctions, and candies should not be eaten.* They overtax the digestive system, crowd out essentials, and give little of value in return.

Manner and Time of Eating.—The pregnant woman should *eat very slowly and chew thoroughly.* This is the best way of preventing gas, "bloating," "water brash," "heartburn," "fullness," and other discomfort. It makes the work of digestion easier and more complete.

Women who suffer from nausea or find the digestion to be easily upset at this time, or who suffer from a sense of pressure and fullness, do better to eat sparingly at meals and take a light lunch midway between meals, with a glass of hot milk and a cracker at bedtime.

In general, the expectant mother should eat regularly even when she takes many small meals. The digestive system must have regular rest if it is to function properly. One should not develop the habit of "nibbling all the time," or eating much at one time and little at another. Even during the discomfort of the "morning sickness" one should try to adhere to a fairly regular scheme.

Mental Hygiene and Food.—Especially should a pregnant woman avoid thinking too much about her food and digestive sensations. She should be certain that she is pursuing a normal food program, then occupy her mind with other interests and avoid discussion of these subjects with her friends and sympathetic acquaintances. She will find that she feels more normal and enjoys her food more the less she dwells upon the matter.

Special Diets.—No pregnant woman should undertake to diet herself for the purpose of having an easy childbirth or to prevent increase in weight, except under definite instructions from her physician. Otherwise she runs a risk of doing serious injury to herself and her child.

Cravings.—Pregnant women sometimes crave pickles or chalk or other curious things to eat. This means that they have not been eating a well-balanced diet, or that some nutritional disorder indicating medical attention is present. Usually it means a lack of food rich in minerals and vitamins such as the mother's blood needs in special abundance at this time. As a rule, the trouble can be corrected by eating freely of fresh vegetables and fruits, especially leafy vegetables, and taking a full supply of milk and milk products, eggs, and cereals. These will supply the essentials which the baby is taking out of the mother's own tissues, and the loss of which is creating the craving.

Elimination. *Bowels.*—Regular movement of the bowels is essential. One thorough movement per day, usually soon after breakfast, is the general habit among adults, although children and primitive people tend to have a bowel movement after each meal, and occasionally a person is found who eats an easily assimilated diet and seems to thrive with a regular movement at intervals longer than the usual one of 24 hours.

A regular, well-balanced diet, with plenty of roughage, with regular exercise and a generally active life, with rest and sleep enough to maintain muscular and glandular vigor, with corrective exercises for relief of pressure, should insure regular bowel movements and make the taking of cathartics unnecessary. If assistance becomes necessary, the doctor should always prescribe, as he should not only know the condition but know exactly what his patient is taking.

Kidneys.—The elimination of waste through kidneys and skin is also important. If the woman is having three glasses of milk and five to seven glasses of water daily, besides the fluid content of fruit and vegetables and of cooked food, she should void not less than 3½ to 4 pints of urine daily. If at any time there should seem to be a lessening in amount, the urine should be saved for 24 hours (starting with the bladder empty), shaken, and measured, and the exact amount reported to the doctor, together with a sample for examination.

Skin.—Daily bathing, with vigorous rubbing of the skin and sufficient exercise, will insure active skin elimination. The pregnant woman may continue any form of bathing she has found to be agreeable. Cold baths, vapor sweats, hydrotherapy treatments, or any new or extreme experience should never be undertaken without the physician's knowledge and approval. An athletic, active woman may usually go on with cold baths, a moderate amount of swimming, hiking, or ordinary sports, not only without danger, but as a necessity in keeping physically fit, both through preserving muscle tone and in promoting active elimination.

Alcohol and Tobacco in Pregnancy.—The present social flair for smoking and drinking raises the important question as to the effects of these habits upon the health and the maternal competency of women. While much is being written upon these subjects, there is a dearth of precise, controlled scientific information as to the effect of these drugs upon normal body function, and still less seems to be known as to the specific effects upon germ cells and maternal function in pregnancy and lactation.

From what has been sketched in this text it will appear that the chemical unity of the body metabolism is an intricate and delicate affair, and that the intricacy and nicety of balance are accentuated during pregnancy by throwing the metabolic machine of the child into gear with that of the mother.

The habitual introduction of chemical substances which are foreign to the metabolic needs of the body, and which must, even under the most favorable circumstances, impose a burden of accommodation upon the physiological machinery of the expectant mother, is a matter that should receive thoughtful consideration.

In general, this statement applies to anything not comprised within the balanced diet here discussed: to the nibbling of sweets, to indulgence in soda-fountain products, to excessive use of tea and coffee, as well as to the habitual use of alcoholic drinks and tobacco. The following conservative statements will probably be accepted without question.

1. Each human organism (in common with all other organisms) has its own specific (as well as general) chemical and protoplasmic pattern, with its own dynamic equilibrium[1] or specific range of adaptation and limits of accommodation to unfavorable conditions and foreign substances, including drugs and chemicals having specific effects upon living protoplasm, such as alcohol and nicotine. Within the range of perfect accommodation these foreign substances probably have a minimum effect upon health and function. The body incorporates a regular minimum amount of them into its pattern or plan and goes along with little obvious disturbance as long as the amount is not increased and the use is regular. The morning cup of coffee, the glass of beer, or the after-dinner cigarette of the moderate user illustrate this.

2. When the range of perfect accommodation is exceeded and symptoms of interference with the metabolic balance of the body are produced, such as impairment of mental and physical coordination in the case of alcohol, or nervousness, tremor, and irregular heart action in the case of tobacco, or wakefulness in the case of coffee, *there can be no doubt that functional integrity of the body is impaired.* The degree of injury naturally may range from slight to severe.

3. The capacity for recovery, like the capacity for accommodation, varies from individual to individual, and the two do not necessarily correlate with each other. The body mechanism of one individual may accommodate to an extreme limit, but remain permanently impaired when accommodation is once broken by excess in the form of debauch. Another individual may be susceptible to the effects of drugs such as these under consideration, but show speedy elimination and repeated recovery. There

[1] Mitchell, P. H., *General Physiology*, pp. 188–189, McGraw-Hill Book Company, Inc., 1923.

is, however, in every human organism a limit to both accommodation and recovery, and every so-called "recovery" doubtless leaves a weakened mechanism.

4. *The habit-forming character of these substances, which is an essential characteristic, tends to create a craving which subjects the user to the constant danger of exceeding the limits of both accommodation and recovery.*

The Effect of Alcohol.—Alcohol has an affinity for nerve tissue; conditions within the nerve cells are modified in such a way that excitability is reduced. By partial paralysis of the vagus nerve (see Fig. 55) the respiration, heart rate, and oxygen consumption may be temporarily increased because "the brakes are taken off"; this is followed by depression of heart and of respiration, the body is forced to exist upon low rations of food and oxygen, and waste products are not removed at a normal rate.[1] The deadening of the defensive mechanisms of the body creates a sense of well-being, which is replaced by apprehensiveness, restlessness, and craving when elimination is complete.

The increase in incidence of errors in performance under the effect of alcohol is well known, as is shown by the prohibition of alcohol to athletes in training, to engineers and to workers in most industries.

Alcohol passes unchanged into the blood stream, where it is slowly oxidized, requiring from 7½ hours in habitual users to twice as long for habitual abstainers.[2] After moderate ingestion, alcohol is found in milk secretion[3] and alcohol passes from the mother's blood to the fetus by way of the placental circulation.[4] Nature safeguards the nursing infant by causing the milk glands to make up the milk formula, so to speak, from what is brought to the glands by the blood stream, and has endowed these glands with highly defensive mechanisms against injurious substances, such as drugs and disease toxins. Nevertheless, this defensive mechanism may be overwhelmed.

[1] Rising, Mary M., *Chemistry in Medicine*, Chap. VIII, The Chemical Foundation, Inc., 1928.

[2] Lusk, Graham, *Science of Nutrition*, p. 479, W. B. Saunders Company, 1928.

[3] *Ibid.*, p. 544.

[4] Stander, H. J., *Williams' Obstetrics*, p. 493, D. Appleton-Century Company, Inc., 1936.

It has long been accepted that alcohol is toxic to germ plasm. This is shown by high prenatal and early postnatal mortality when experimental pregnant animals are subjected to its influence. The general effect is to weed out weak germ stock. Several generations after the toxic generation, superior resistance and survival may be shown.[1]

On the whole, the pregnant woman would seem to have every reason for abstaining from the use of alcohol that obtains in the case of the athlete or the mechanic, and it would seem the part of wisdom to avoid ever contracting the habit of its use.

The Effect of Tobacco.—Tobacco contains the powerful narcotic poison, nicotine; carbon monoxide also is constantly present in tobacco smoke, together with poisonous aldehydes, ammonia, and irritative oils.[2] Both nicotine and carbon monoxide deaden sensibility—nicotine by direct action upon the nerves, carbon monoxide by displacing the oxygen of the red blood cells in the blood.[3]

There is much more absorption from "inhaling" tobacco smoke than from ordinary smoking. Inhaling tobacco smoke produces disturbances of blood pressure and heart action through injury to the nervous mechanism, and lowers the general resistance to infections, especially to mouth and throat infections.

Nicotine has been proved to lessen the milk secretion in the cat and the cow and probably in the human. Dr. Hatcher reports a case in which the woman smoked from 20 to 25 cigarettes daily and showed marked diminution of milk supply from the onset of smoking, with a trace of nicotine in the milk. Attention was first called to the case by the observed effect upon the child.[4] There are a few medical reports of instances of infants showing evidence of nicotine absorption, and there are a number of studies available relating to the general affect.[5] Sontag and

[1] Stockard, C. R., *Physical Basis of Personality*, pp. 159–161, W. W. Norton & Company, Inc., 1931.

[2] "Smoke Cigarettes Slowly," *Science News Letter*, July 27, 1929.

[3] "What It Costs to Smoke Tobacco," *Leaflet*, Life Extension Institute, 25 West 43rd Street, New York City.

[4] "Nicotine Affects Milk Secretion," *Science News Letter*, June 15, 1929.

[5] Mendenhall, W. L., *Tobacco*, pp. 44–46, Harvard University Press, 1930; Warring, J. J., "The Hygiene of Smoking," *Hygeia*, June, 1925; Editorial, *Journal of the American Medical Association*, June 25, 1925; and

Wallace, in 81 tests on five patients, announce that maternal smoking affects the fetal heart in the same way that the adult heart is affected.[1]

If a pregnant woman is a habitual user of tobacco, she should consult her physician as to the necessity or advisability of giving it up or reducing the amount. Above all, she must have the courage to face the situation and not rationalize herself into a conviction that she is experiencing no harmful results.

Exercise.—Exercise is the law of life. Regular activity is absolutely necessary to maintain muscular strength and the tone and vigor of the circulatory system and vital organs. One tends to become toxic or poisoned with one's own waste when confined to bed, or when taking too little exercise. The expectant mother who does not suffer from some complication that makes exercise injurious to her should lead an active life and keep herself fit and her muscles strong by regular, well-balanced work and exercise that will use every part of her body. She should not overuse any one part of the body, nor should she overwork. General housework affords good, all-round exercise if it is well planned and if it can be compassed within a reasonable number of hours. A strong, muscular woman who is accustomed to heavy work may even do washing, ironing, gardening, and other hard work up to the later weeks of pregnancy, always on condition that she feels no ill effects. Peasant women are sometimes taken in labor while working in the fields. Women who lead vigorous, outdoor lives have notably normal labors.

Work and Exercise Should Be Varied.—A woman should not sew continuously for a week at a time, nor should she clean house or make garden continuously day after day. She should either give a certain number of hours to each, every day, or she should at least alternate days of sewing with days of vigorous muscular work. A definite and regular amount of outdoor exercise should be taken every day. There is no tonic like fresh, outdoor air,

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HULL, CLARK L., "The Influence of Tobacco Smoking upon Mental and Motor Efficiency," *Psychological Monograph* 150, Princeton University Press.

[1] SONTAG, L. W., and R. F. WALLACE, "The Affect of Cigarette Smoking during Pregnancy upon Fetal Heart Rate," *American Journal of Obstetrics*, Vol. 29, 1935.

and sunshine is now classed as a health essential. The expectant mother owes it to her unborn babe to give him this chance for vigor. This means exercise for pleasure, not long shopping expeditions which produce fatigue rather than exhilaration. Sports that involve violent exertion or excessive reaching, such as tennis, or possibility of sudden hazard, such as swimming in rivers, the sea, or lakes, should be avoided.

Exercise for Women Who Do Not Work.—The woman who does not do her own housework, especially the woman who boards, keeps a maid, or lives in a small apartment, must take special pains to practice regular exercises, including deep breathing, arm exercises, and bending exercises to strengthen the back and abdominal muscles, and also to take daily walks in the open air.[1] All exercises should be begun rather gently if she has been unaccustomed to doing them. *At no time should violent or jerking exercises be attempted.* Contrary to popular opinion, a moderate amount of stair climbing is excellent exercise for any woman who is normal and healthy.

Cautions.—A woman will not cause the cord to become wrapped around the baby's neck by reaching over her head. Nature has prevented this by floating the baby in the bag of waters and by making the cord so long that it cannot be put on tension by anything that the mother may do. On the other hand, by overreaching or overstraining in any way, she may force the uterus to contract violently, thus causing miscarriage. Therefore, she should not reach, lift heavy loads, run, or do anything else *to excess.* She may, however, sleep with her arms over her head, take dishes from the upper shelf, or *do anything that will not cause a sense of strain.*

Traveling.—A woman may ride moderate distances in carefully driven cars or vehicles over smooth roads, but there is great danger of producing miscarriage through jolting or jarring if she is driven too fast or too far over rough roads. Touring involving fatigue should be avoided, also long railroad journeys, unless they are really necessary, because of the enforced interferences with regular habits and difficulty in securing attention in emergencies.

[1] Van Blarcom, Carolyn, *Obstetrical Nursing*, 2d ed., pp. 122–123, The Macmillan Company, 1929.

Sleep and Rest.—The pregnant woman should have an abundance of sleep, always in a comfortable bed and in a room with very fresh air or, better still, on a sleeping porch. *This means going to bed at such a time that she awakens fresh and rested in the morning.* In other words, she should "get her sleep out" every night. There is no danger that a normal person will sleep too much. Recent research in sleep shows that normal movements are hampered and that one sleeps less restfully with a bedfellow (see page 664). The pregnant woman will usually sleep better if she sleeps alone.

While pregnant, a woman should break her day's work with frequent periods of rest. She will accomplish just as much and will be less fatigued at the end of the day. During the first half of pregnancy there is downward pressure, and during the last half there is upward pressure. Both displace the center of gravity and make it fatiguing to stand continuously. If a woman's work is such that she must be on her feet a great deal, it is especially important that she drop flat on her back on a bed or a couch, or even on the floor, with her feet upon a cushion or a small box or the foot of the bed higher than her head, for 5 minutes every hour or two during her work day. A good rule is to relax every time the clock strikes. This will do much to prevent varicose veins and swollen feet and legs, and it will bring her through the day with much less fatigue (see page 339).

If her rest is unavoidably broken by young children, or if she must get up early and does not go to sleep readily at night, she must plan to take a nap after the noon meal. If she has other children, she can probably best do this by lying down while the toddler takes his nap.

It should be a matter of conscience with the expectant mother not to let herself become too tired or to lose sleep. Fatigue and loss of sleep poison the blood just as definitely as do disease or bad food. A good test is the way one feels in the morning. If she feels fresh and vigorous and ready for a new day, she has not overtaxed herself on the previous day. If she feels languid, dull, or tired in the morning, something is wrong; it may be her work, her sleeping regime, or her metabolism that is at fault—or it may be all three. She should try very earnestly to discover the cause and correct it.

Mental Hygiene and Recreation.—It is now known that emotion has a profound effect upon metabolism. While an expectant mother cannot "mark" her child, she may profoundly affect his well-being and her own by her mental and emotional attitude or experience. Bearing a child is the supreme experience in human life. Then, if ever, should a woman be serene, poised, and so uplifted that she does not react intensely to the petty frictions of life.

It is also known that body chemistry has much to do with one's emotional reactions and attitudes. It is far easier for anyone to be patient and serene when well fed and rested than when fatigued and undernourished. One should strive for a sane philosophy, not with the aim of producing a child prodigy, but in order to prepare a mother who will be an inspiring and understanding companion for the child. For the same reason, the expectant mother should discipline herself in self-control and courtesy, and never take advantage of "her condition" to indulge herself in selfish, complaining, egoistic attitudes toward her family and others. She must not "feel sorry for herself."

The pregnant woman should dress becomingly, groom herself attractively, and enjoy her customary social relationships, always short of excitement or fatigue. She should keep herself mentally normal.

Care of the Person. *Bathing.*—A daily morning sponge bath, shower, or quick plunge in a tub, followed by energetic friction with a rough towel, is most refreshing, stimulates the circulation, improves the appetite, and makes one less liable to take cold. The temperature of the water should be agreeable to the individual; tepid to cold is preferable. It is the wetting and the rubbing that do the work of seasoning and stimulating the skin. In addition to the morning rub, a warm soap scrub should be taken twice or oftener during the week, preferably at bedtime. It improves the complexion, and even the mind is more cheerful if one has a fastidious sense of bodily cleanliness and freshness.

Care of the Teeth.—The teeth should be carefully brushed twice daily, using unsweetened powder or paste or milk of magnesia, in order to counteract the tendency to acidity that is often present during pregnancy. As has been said, the teeth of the expectant mother should be under the observation of a dentist for the entire duration of pregnancy.

Care of the Breasts.—During the last 2 months of pregnancy special attention should be given daily to the thorough bathing of the nipples with soap and water, using a moderately stiff nail or flesh brush or a Turkish washcloth. This may be followed by cold application and massage with cold cream or oil. If the nipple is very small or inverted, it should be pulled out and shaped and rubbed in order that the baby may more conveniently grasp it. A breast pump may be used to draw out the nipple. A large-mouthed bottle, such as a milk bottle, may be rinsed with hot water and applied quickly over the nipple. The cooling of the air inside the bottle will cause suction upon the retracted tissues. Or an electric vacuum cup may be applied.

Care of the Abdomen.—The skin of the abdomen becomes stretched during the later stages of pregnancy, and sometimes breaks into striae or scars, which remain as a disfigurement. In some cases the muscles remain lax and soft after delivery, and it is said that the woman has "lost her shape." Something can be done to prevent both these effects of stretching by rubbing the abdomen every evening after retiring, or every day after the bath, with cocoa butter or cold cream or some other lubricant, but the effect is probably chiefly due to the rubbing. There is no virtue in the much-advertised applications for causing easy labor. If the muscles are greatly overstretched, a well-fitted muslin binder worn during the last month or 6 weeks of pregnancy will take some of the strain from these muscles (see Fig. 88).

Marital Relations during Pregnancy.—There is no accurate information as to the effect of sexual intercourse during pregnancy, but there seems to be a growing tendency on the part of obstetricians to advise against the practice.[1] Certainly it should be indulged in moderately and only at the desire of the woman; it should never be forced upon her. DeLee says that coitus during pregnancy, particularly during the first 3 and the last 3 months, is likely to produce abortion. He states that it aggravates any complications and may cause septic poisoning.[2]

[1] "Prenatal Care," Children's Bureau, U. S. Department of Labor, Washington, D. C., 1931.

[2] DeLee, Joseph, *Principles and Practices of Obstetrics*, p. 240, W. B.

Stander says that sexual intercourse should be completely forbidden during the last month of pregnancy on account of the danger of premature birth and infection.[1]

Clothing for the Mother.—There is no need for an expectant mother to make any radical change in style or material from her usual apparel. Most pattern manufacturers now issue patterns for maternity gowns that closely follow current styles. There are firms that specialize in the designing and manufacture of maternity gowns. It is no longer necessary for a pregnant woman to appear grotesque or to feel embarrassed on account of her appearance.

Underwear should be loose, and bloomer bands, garters, etc., should be nonconstricting. Unless well-fitting suspender supports can be achieved, it is better to wear "rolled" stockings or very loose round garters. The stockings should never be suspended from belt supports about the waist. Suspender supporters need to be well adjusted to the form, or the "pull" becomes annoying and causes discomfort.

Generally, shoes are the item of clothing most likely to interfere with comfort and freedom. Because of the probability of some swelling of the feet, shoes need to be larger than those ordinarily worn. Because of the shifting of gravity as pregnancy advances, shoes should have broad low heels to make walking erect as easy and safe as possible. Sport or business shoes or orthopedic or foot-form lasts should be selected. A pregnant woman should never change to high-heeled party shoes even for special occasions, as falls and muscle strain may very easily result.

Opinions differ as to the advisability of wearing maternity corsets. Every woman should follow the advice of her physician on this point, and should not wear anything of the sort of which he does not approve. No woman could be vain and selfish enough to impair the well-being of her unborn babe by the constriction of her circulation and of the activity of her child for the sake of appearance. Nature has omitted the ribs from the abdomen and replaced them by a remarkable arrangement of

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Saunders Company, 1930.

[1] STANDER, *op. cit.*, p. 281, D. Appleton-Century Company, Inc., 1936.

abdominal muscles (see Fig. 32), which should have been trained and developed in the growing girl for their very important service in childbearing.

Sometimes, unfortunately, a woman has such poor abdominal muscles and such bad posture that she cannot comfortably carry her child without the assistance of an abdominal support. A properly adjusted cloth binder is better than even a well-fitted

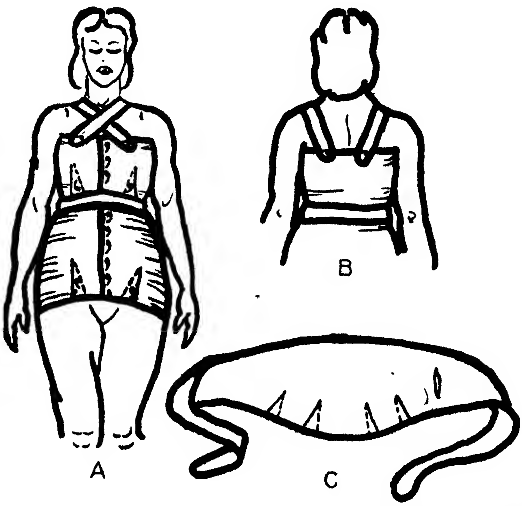

FIG. 88.—Abdominal and breast supports. *A* and *B* are straight pieces of cloth fitted with darts pinned with small safety pins. *C* is a fitted abdominal support.

corset, as it restricts movement and circulation less. A simple strip of heavy muslin may be fitted by pinching up darts with safety pins (see Fig. 88). If necessary, narrower strips of muslin may be pinned to the binder in the back, crossed, suspenderwise, brought over the shoulders and again pinned in front to prevent wrinkling and to secure the necessary upward support.

Sometimes during the last months of pregnancy the breasts become heavy enough to cause discomfort. A support for these also can be improvised, as shown in Fig. 88. If it is properly adjusted, there is upward support without pressure upon the nipple. A commercial brassière may be worn only if it gives upward support. Nothing that compresses the nipples and that does not contribute to comfort should be worn.

Clothing for the Baby.—The infant's first outfit may be simple and inexpensive, or it may cost a small fortune, according to the inclination and resources of the parents. In neither case should the helpless infant be made an object of display. Everything should be planned for his comfort and well-being alone. All garments should be simple in style, no matter whether made of fine or coarse material, and they should be easily washed and ironed. Maternal love can find expression in fine material and fine sewing if one can command these. It is a mistake for an expectant mother to spend hours of her own time in elaborate needlework when she would do a far greater service to her child by spending extra time in the open sunshine.

The number of pieces necessary will depend upon the frequency with which laundry work may be done. The following list assumes that diapers and underwear may be washed frequently—daily, if necessary—while the outside slips requiring more careful ironing may be washed once or twice a week.

1. Three abdominal bands torn from fine, firm flannel and not hemmed. A half yard of 22-inch flannel may have the selvages torn off, then be torn into three strips.

2. Three shirts, which may be bought or made. These should be of silk, silk and wool, or wool and cotton; if for a summer baby, they may be of cotton or linen mesh. The number 2 size is more practical than size number 1, as the shirts should be large enough to allow for the growth of the baby and for some shrinkage of material.

3. Three nightgowns, of outing flannel, wool flannel, or cotton or wool jersey.

4. Three dozen diapers of bird's-eye cotton, 20 or 22 inches wide, torn in lengths double the width and hemmed by hand or picoted to avoid stiffness on the edges. These should be laundered before using. A very practical diaper of tubular jersey, which is soft, absorptive, and easily laundered, is now on the market. Because of the ease with which these may be washed fewer are required. There are on the market commercial diapers that consist of several layers of unhemmed absorbent gauze; and various brands of paper throw-a-way diapers are now available.

5. Eight dresses of nainsook or Persian lawn or dimity, with no trimming on the edge of neck or sleeves.

6. Three or four petticoats of nainsook or flannel will be required.

7. The first cloak may be a sleeveless square fastened down the front and having a circle for the neck, to which a hood of the same or other material may be attached. It may be of eiderdown lined with silk, and it may later be refashioned into the first short coat.

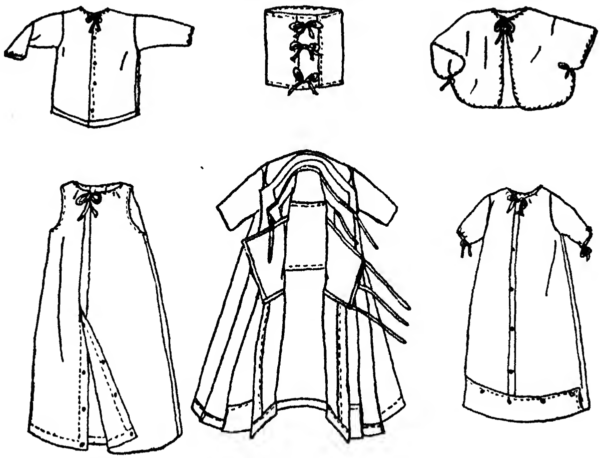

FIG. 89.—Telescoping garments: sewed-in sleeves. Designed by Dr. Josephine Baker, Bureau of Child Hygiene, Department of Health, New York City.

8. Three pairs of soft merino stockings, socks, or bootees. These should be large enough to allow generously for growth and shrinkage. Stockings having reinforced tabs for pinning to the diaper are to be preferred. Muslin tabs may be added, however. Some pediatricians disapprove of infants wearing anything upon the feet.

9. Carriage blankets according to taste and climate.

10. Two or three flannel nightingales or crocheted jackets are useful to have in case of sudden changes of temperature.

11. Three knitted sleeveless bands should replace the flannel bands as soon as the cord is fully healed.

The Style and Manner of Making. *The Telescope Layette.*—These patterns (see Fig. 89) were designed by Dr. Josephine Baker, formerly chief of the Division of Child Hygiene of New York City, and are so designed that the garments all open down the front and telescope one into another. After the infant is bathed and has had band and diaper adjusted, it may be laid in the telescope outfit, which may then be fastened at leisure

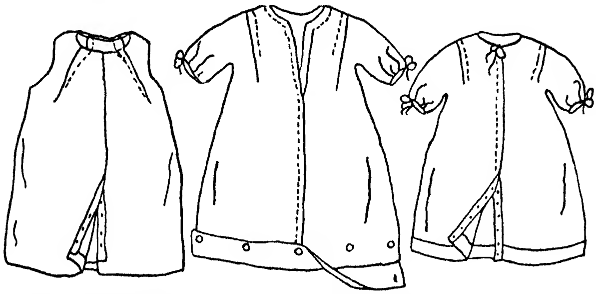

Fig. 90.—Front opening: kimono sleeves. Designed by Gertrude S. Hasbrouck, Bureau of Child Welfare, Wisconsin State Board of Health.

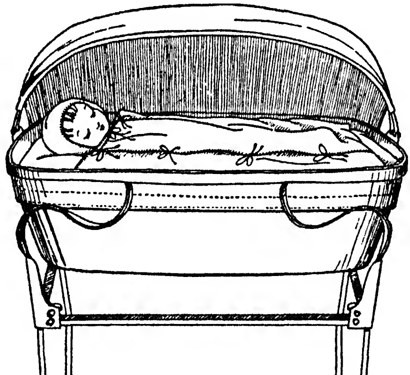

Fig. 91.—The first cloak. Also one type of folding bassinet suitable for auto travel. The side canopy protects child from dust and sun. The springs protect from jolting.

without further turning the child. The sleeves of this particular outfit are sewed in. There is much to be said for the kimono style of garment because of the absence of arm seams and the ease of making and laundrying.

The Wisconsin Layette.—The Division of Child Welfare of the Wisconsin State Board of Health has designed a telescoping outfit, with kimono sleeves and neck darts, which appears quite ideal. The darts permit easy adaptation to the growth of the child, as by ripping these one may keep the child wearing his baby clothes until they are worn out.

Some nurses and mothers prefer having all garments open in the back, as it is easier to keep them from becoming wet and soiled. In this case, the baby is dressed from the front.

In general, the neck and sleeves should be finished with soft hems or drawstring casings only. Any kind of trimming about an infant's neck is out of place. An infant's head is set squarely upon his shoulders; there is no room for lace. It only irritates the tender skin and is swallowed from sight under his (we hope) plump chin.

Nonwrinkleable tape may be used to adjust garments at neck and wrist. The garments may be closed by buttons, snaps, or tying tape, as indicated by time and preference. While the front, full-length closing simplifies the process of dressing the baby, it does increase the labor of making the clothes.

Shirts and nightdresses, if made at home, should have seams on the outside, in order to present a smooth surface to the delicate skin of the baby. Such seams look very well when neatly featherstitched on the right side. All garments are now made much shorter than formerly. A length of 18 to 20 inches is customary, except for nightgowns, which should be made quite long with a flap to button or snap, or a drawstring in the hem, in order to make certain that the child's feet will remain covered at night.

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CHAPTER XVIII

COMMON DISORDERS OF THE PELVIC ORGANS WHICH MAY AFFECT REPRODUCTION

A Woman

She had an understanding with the years;
For always in her eyes there was a light
As though she kept a secret none might guess—
Some confidence that Time had made her heart.
So calmly did she bear the weight of pain,
With such serenity accept the joy,
It seemed she had a mother love for life,
And all the days were children at her breast.

SCUDDER MIDDLETON.

Infection.—Soreness or tenderness in the abdomen between menstrual periods should always be referred to a physician. The right ovary sometimes becomes infected from an infected appendix. Pain or tenderness in either side may mean infected Fallopian tubes. Any condition of this kind calls for treatment. Neglect may lead to sterility or invalidism. The passage in the Fallopian tube through which the ovum must travel on its way to meet the sperm is very small: the scar tissue from even a slight infection of a tube may permanently close this passage and *make the union of two germ cells impossible.* The same thing may occur in the spermatic duct of the male. If both tubes or ducts are closed the individual is rendered permanently sterile.[1]

Displacements. *Cause.*—The uterus and the ovaries may become acutely displaced by a fall or other accident. Most commonly displacements are caused by bad posture, general lack of muscle tone, and habitual constipation in sedentary

[1] Surgical sterilization consists in "tying off" these tubes in either the female or the male, thus making fertilization mechanically impossible. Closing the tubes does not affect glandular function or sexual experience. Complete surgical removal of the ovaries or testes seriously disturbs glandular balance and is done only for the removal of malignant growths or because of other pathological necessity. After menopause the effect of removal is less pronounced.

women. Childbearing women who have unrepaired tears of the perineum or who suffer from subinvolution of the uterus are especially liable to have displacements. Displacements may be forward or backward, or simply a falling or lowering of these organs. The most common type is the backward displacement.

Symptoms.—Often no apparent inconvenience is experienced. A marked displacement may be the cause of sterility because the

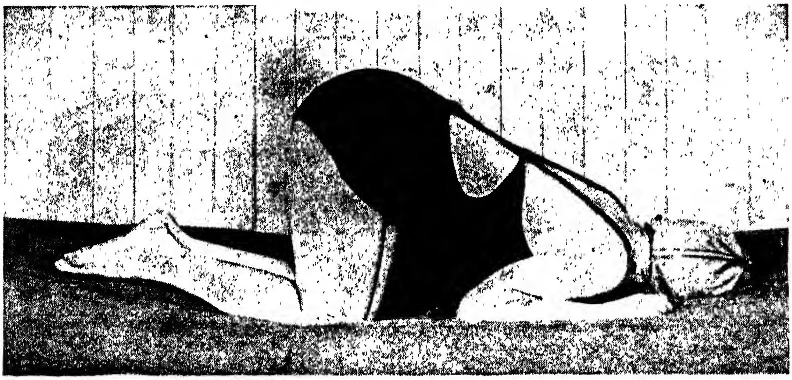

Fig. 92.—The knee-chest position.

passageway is closed to the spermatic fluid by the acute bend in the cervix. Sometimes acute pain is experienced, sometimes heavy dragging or aching sensations in the pelvis. Backache may or may not be present. Painful menstruation may follow acute displacement. Headache in the top of the head may be a symptom. Backward displacement may cause constipation through pressure upon the rectum.

Treatment.—An acute displacement can sometimes be corrected by taking the knee-chest position (Fig. 92) every night, faithfully, for some time, together with the Mosher exercise every morning (Fig. 93). If this does not give relief, a physician should be consulted. In all cases the fundamental thing is building up the general health. If good muscle tone can be restored, many cases recover spontaneously.

Syphilis and Gonorrhea.—Syphilis and gonorrhea are the so-called "venereal" diseases. They are usually contracted directly or indirectly through sexual intercourse with prostitutes. They may, however, be innocently contracted through kissing, through drinking after infected persons, from public toilets, from chains or handles of the various types of toilet flush, from public towels, etc. This rarely occurs, fortunately, since these germs die very quickly on exposure to light and air and contact must occur before there has been time for drying of the secretions.

Fig. 93*a*.—The Mosher exercise. Position *A*.

Fig. 93*b*.—The Mosher exercise. Position *B*.

However, everyone should be extremely careful to avoid touching anything which may have been *recently* contaminated.

Gonorrhea is the more common of the two diseases. Since it often makes both men and women sterile by causing inflammation of the tubes and ducts, it is sometimes called "the great sterilizer" (see page 329). Through infection of the baby's eyes while the child is passing through the birth canal, it may cause blindness. For this reason doctors and midwives in most states are required to put prophylactic drops in every baby's eyes soon after it is born. One drop of a 1 per cent solution of silver nitrate or other silver salt is commonly used. From one-fourth to one-third of all blindness was formerly caused by gonorrhea in the newborn. Because of the increasing use and effectiveness of prophylactic measures at birth this percentage has steadily declined until, accordingly to more recent institutional statistics, it is now only 4 to 9 per cent.[1] According to the report of the Committee on Conservation of Vision, blindness due to gonorrheal infection among new students in schools for the blind decreased from 28.2 per cent in 1906 to 8.5 in 1934. This infection is called *gonorrheal ophthalmia neonatorum*, or "gonorrheal sore eyes of the newborn"; it develops within 3 or 4 days after birth in untreated cases, and always destroys sight unless promptly and skillfully treated. Gonorrhea is rarely congenital (present as an active infection at birth), and it is not hereditary.

Gonorrhea may be transmitted from the husband to the wife or vice versa; infection of the tubes and ovaries may result, and often an operation becomes necessary. Some surgeons say gonorrheal infection of the tubes is the commonest cause bringing women to the operation table. No person with an active gonorrheal infection should marry. It is possible to cure gonorrhea but it takes a long time and very persistent treatment. Men and women may become careless or assume that they are cured before they really are, or they may put their faith in false "sure cures." In both sexes the germs may remain alive but inactive for variable intervals after all symptoms disappear. Therefore a careful examination is necessary to determine fitness to marry. Only experienced medical advice of the highest quality should be sought. There probably is no other human ailment in which the public is so victimized by quacks and charletans as by those proclaiming quick cures and sure cures for the venereal diseases.

Syphilis, when untreated, is the cause of many stillbirths (babies dead when born), many miscarriages and abortions, and also many congenitally defective children (defective when born). It produces many cases of blindness both at birth and during childhood in untreated cases.[2] The fetus may become infected in the uterus if the mother is actively syphilitic, in which case

[1] ROYER, FRANKLIN, "Syphilis and Gonorrhea as Causes of Blindness," *Journal of Social Hygiene*, March, 1931.

[2] *Ibid.*

it may be born with live syphilitic germs in its body. *This is congenital, not hereditary, syphilis.* Syphilis is sometimes said to be hereditary but this is not strictly true. The toxins of syphilis in the blood of an infected mother or father may actually injure parts of the germ cells before or after fertilization, and the child that develops from such an ovum will be a defective child, but may not have an active infection; or he may be both defective and diseased. In rare cases it is possible that the sex chromosomes of the fertilized and injured, but surviving, ovum may also be injured and defects, accordingly, may appear in the "third and fourth generation." To be strictly hereditary, syphilis would have to produce hereditable mutations in particular genes or gene groups. This probably never occurs.

The modern method of treating syphilis during pregnancy and infancy is highly effective if the condition in the mother is discovered in time. It is for this reason that most maternity hospitals and many obstetricians require all pregnant women coming under their care to have a diagnostic examination, including a Wasserman test. It is for this reason that the states are passing mandatory laws relating to the identification and treatment of syphilis (see page 303).

Every man and every woman applying for a marriage license should be required to show a physician's certificate of freedom from communicable or hereditary disease; or better still, an official medical examiner should determine the fitness to marry of all candidates for marriage.

Common Disorders and Complications of Pregnancy.—The majority of pregnancies are free from complications or pathology, and there are many more normal, fairly painless deliveries than is commonly supposed. Forewarned is forearmed, however, and one can successfully avoid danger only by being aware of it and intelligent as to the best method of meeting the various possible hazards of childbearing.

The Toxemias of Pregnancy.—*Toxin* is a general term denoting a chemical poison, and in this connection toxemia is used to refer to toxic alterations in the physiological chemistry of the body caused by disease processes, either infective or metabolic.

The grafting of an animal parasite (the embryo), with its foreign proteins, endocrine system, and placental rootlets, upon the maternal structure, the storage of nitrogen and the shift in water balance during the last of pregnancy, the increased load upon the mechanisms of elimination—the skin and kidneys—and upon the liver, all these processes necessarily involve rather radical physiological adjustment on the part of the host (the mother).[1] Nature usually takes care of this so fully that the expectant mother has in general, at least up to the later weeks of pregnancy, only a sense of increased vigor and well-being. Many women say, "I never feel so well as when I am carrying a child." One little immigrant woman interviewed by an agent of the Children's Bureau of the U. S. Department of Labor declared, "I was happy like a bird, I feel I could fly." DeLee says, "The woman may enjoy a permanent improvement in health from the stimulus of pregnancy."[2] In a certain number of cases, however, more or less disturbance of body chemistry occurs.

Since biological chemistry is itself a relatively new science, with such sentences as "the chemical changes involved in this process are not yet fully understood" occurring many times in every text, we are compelled to say that many of the actual chemical changes in the toxemias of pregnancy are only vaguely known.[3] Certain facts, however, are sufficiently established to serve as guides to hygienic conduct.

The toxemias of pregnancy until recently have been vaguely lumped together in medical literature under such synonomous terms as *uremic poisoning*, *uremia*, *Bright's disease*, *albuminuria*, *nephritis*, and *eclampsia*. Since the appearance of albumin in the urine, rise of blood pressure, and certain other symptoms usually are common to all these disorders, it was assumed that the kidneys were basically involved in all toxemias. It now appears that a rough classification can be made as follows: (1) the nausea and vomiting of pregnancy, (2) low-reserve kidney, (3) chronic nephritis, (4) eclampsia.[4] Certain important differences in these pathological conditions are now recognized,

[1] Stander, H. J., *Williams' Obstetrics*, p. 709, D. Appleton-Century Company, Inc., 1936.

[2] DeLee, Joseph, *Principles and Practice of Obstetrics*, 5th ed., p. 122, W. B. Saunders Company, 1930.

[3] *Ibid.*, p. 379.

[4] Stander, *op. cit.*, p. 710.

although no one of these is fully accounted for under our present knowledge of body chemistry.

The Nausea and Vomiting of Pregnancy (Morning Sickness).— This is a toxemia rather than a digestive disorder. The term is applied to a curious tendency of the stomach to reject food after eating, although there is commonly no aversion to food, and the woman may eat with relish a few minutes after vomiting. This experience occurs in about one-third to one-half of all pregnancies. It may exist in any degree from occasional slight sensations of nausea, especially with the first food taken in the morning (hence "morning sickness"), to extreme inability to retain food. When the condition becomes persistent and continuous it is called *pernicious vomiting.*

The cause has not been definitely established. The condition is supposed by some to be caused by the absorption of substances, possibly proteins, from the newly forming placenta; by others, to be of endocrine origin; and by still others, to be due to faulty carbohydrate metabolism.[1] The idea is advanced even that it may be an allergy caused by sensitization to the foreign protein of the sperm. The phenomenon usually occurs during the period of active formation of the placenta and tends to disappear entirely by the fourth or fifth month of pregnancy.

Although certain drugs seem occasionally to give relief, there is no known authentic remedy. Williams says there is a psychic factor in many cases and that for some "the first remedy tried gives relief."[2] There are women who seem to obtain temporary relief by chewing something pungent, such as preserved ginger or soda mint, after eating food. Mild cases can often be fairly well controlled by taking a small cup of black coffee or some other hot drink, with a bit of dry toast, some time before rising. Some women feel better and retain more nourishment if they eat many small meals and no large ones. Every pregnant woman should try to keep up her strength by eating easily digested food, such as peptonized milk, junket, buttermilk, jellied eggs, fruit juices, and vegetable extracts. Some specialists, assuming that carbohydrate deficiency is involved, advise the use of concentrated

[1] *Prenatal and Maternal Care,* Proceedings of the White House Conference, D. Appleton-Century Company, Inc., 1932.

[2] STANDER, *op. cit.,* p. 710.

carbohydrate foods in dry or solid form—such as ice cream, crackers, potatoes, cereals, macaroni—in small amounts every 2 hours.[1] Some advise carrying hard candies in the pocket for consumption when the feeling of nausea comes.

In general, little harm seems to result from the experience, and the discomfort can be philosophically ignored to a considerable extent. Taking the matter seriously aggravates the condition. Nervous women and women who worry about the fact of pregnancy are more liable to have this experience and to have it in an extreme degree. A primipara (a woman having her first child) is more likely to have morning sickness than is a multipara (a woman who has borne children). Working women, who "do not have time to pay attention to their feelings," seem to suffer the least.[2]

Low-reserve Kidney, Albuminuria of Pregnancy, the Kidney of Pregnancy.—During the last third of pregnancy the kidneys may prove inadequate in the discharge of their functions. The first sign is the appearance of albumin in the urine; abrupt gain in weight from defective osmosis, which causes fluid to collect in loose tissues; and a moderate rise in blood pressure. Usually the woman has some headache and a general feeling of illness, and she may notice some edema (dropsical swelling) of hands and feet. If promptly detected, the condition practically always clears up under a brief rest in bed with appropriate diet. It seldom leaves any permanent damage and is not especially likely to recur in subsequent pregnancies. If neglected, it may result in permanent damage to the kidneys. Of all the toxemias of pregnancy, the low-reserve kidney accounts for approximately a third.

Chronic Nephritis (Bright's Disease, Albuminuria, Uremia).—This disease, common to any age and to both sexes, may, therefore, occur in pregnancy. Nephritis occurs in several forms, but the kind usually complicating pregnancy is the so-called "chronic" type. In most cases, it is believed, the kidneys have been damaged prior to pregnancy by scarlet fever or other infection, leaving them unable to carry the increased work

[1] LEVENTHAL, M. L., "Diet in Pregnancy," *Journal of the American Dietetics Association*, June, 1931.

[2] DELEE, *op. cit.*, pp. 110, 267, 370.

imposed by pregnancy. This type may persist after the birth of the child and is very likely to recur with each subsequent pregnancy and to become progressively worse. There are degenerative changes in the kidneys but none in the liver. The symptoms vary according to the extent of damage to the kidneys. *Again, the very first symptom may be rise in blood pressure and albumin in the urine.* Edema (dropsical swelling) accompanied by abrupt gain in weight may occur, as well as any or all of the following symptoms: general fatigue, headache, and particularly disturbance of vision ("floating specks before the eyes"). In extreme cases there may be coma (deep unconsciousness) and death. Usually birth occurs without serious complications, but the nephritis may continue indefinitely.

Pre-eclampsia and Eclampsia.—Occasionally, though rarely, in the late months of pregnancy, in primipara as a rule, there may be sudden and very high rise in blood pressure, much albumin in the urine, often serious disturbances in vision, decrease in amount of urine, intense headache, general depression. There may be sudden difficulty in breathing, pain in the region of the heart, and intense pain in the head. The woman may go into convulsions (*eclampsia*). If repeated convulsions occur, both mother and fetus are likely to die. If labor is induced at once, there is commonly no recurrence of the attack and the child, if it has reached 7 months of development (age of viability, see page 298), will probably live.

Eclampsia was formerly supposed to be a possible acute phase of any toxemia, but it is now believed to be a specific condition involving the liver primarily, and the kidneys secondarily.

Occasionally, but not often, eclampsia will recur in subsequent pregnancies. Usually all symptoms subside as soon as the uterus is emptied. The shock to the metabolic system may lead to the later development of nephritis or acute yellow atrophy (a disease of the liver). A case of eclampsia should remain under medical care for some time.

Prevention in all the toxemias consists in constantly watching the urine, blood pressure, and weight during the entire course of pregnancy, particularly during the last 3 months. Early treatment at the appearance of the very first warning is practically always successful. Occasionally, however, in spite of the utmost watchfulness, the metabolic machinery does collapse and acute eclampsia strikes like a bolt out of the blue, even though the doctor has not been guilty of any carelessness. Fortunately, this occurs very, very rarely. Probably, in all such cases, there has been an unsuspected weak spot in the metabolic machinery. A woman who puts herself under the care of an up-to-date physician need have no worry or apprehension. There is more likelihood, by the law of chance and according to statistics, that she may be run over on the street than that she will have eclampsia.

Digestive Disorders.—*Increased acidity* of the gastric contents may cause regurgitation of acid fluid after eating. This is variously called *water brash, heartburn*, etc. All bread should be toasted or well dried and eaten very slowly. Greasy food—especially fried food—is likely to disagree. Eating very slowly and chewing with great thoroughness will minimize this discomfort. Frequent eating in small amounts usually creates less discomfort than regular full meals.

Flatulence (Gas in the Bowel).—Bacterial action normally creates fermentation and gas in the bowel. During health, gas does not accumulate in sufficient amount to be noticed. Pregnancy may cause retention because of pressure and the shift of organic relationship of the abdominal contents, or because of constipation, which may also cause increased bacterial activity. The fermentation of sugars, when they are taken in excess in sweets and pastries, and the eating of greasy or fried foods or any food of slow or difficult digestion will often cause or aggravate this difficulty.

Treatment consists in correcting constipation, selecting foods with extreme care, masticating carefully, with a full amount of exercise to encourage peristalsis, and the improvement of general tone and vigor. Lactic acid bacilli tend to antagonize the gas-forming bacteria; therefore, the use of buttermilk, natural or artificial, or Bulgarian bacillus tablets, or sauerkraut juice, which has a high lactic acid content, is sometimes recommended.

Pressure Complications.—Large blood vessels and nerves come down the spine, branch, traverse the pelvis, pass through openings in the pelvic bones and between the muscles of the groin, and supply the lower extremities. All blood in the lower extremities must flow through the veins "uphill" and against gravity in order to reach the heart (see Fig. 37). When the growing fetus, because of bad posture or poor muscle tone in the mother, presses upon the veins and nerves, certain complications may result.

Varicose Veins.—The pressure of the developing child upon the large veins in the pelvis through which the blood must pass from the extremities to the heart sometimes causes engorgement of the superficial veins of the legs and thighs. The pull of gravity aggravates this, hence the condition is worse in the evening than in the morning. Taking the knee-chest position every night (see Fig. 92), sleeping "on the face" as long as this is comfortable, sitting with the feet upon another chair, or lying with the feet or hips upon a pillow, gentle massage of the limbs, stockings supported from the shoulders, all help to make it as easy as possible for the venous blood to get back to the heart. Bandaging with roller bandages of muslin, elastic, or flannel, or with adhesive bandages, will give some relief when the veins become very large. Wearing a well-fitted abdominal support will also help this condition. Varicose veins are more likely to occur in certain endocrine disorders. A woman who always stands correctly and has good muscle tone and good circulation is less likely to have this complication.

Swelling of the feet may be caused by the same pressure in the pelvis that produces varicose veins. Instead of the veins enlarging, fluid (serum, lymph) leaks into the tissues and causes a dropsylike condition. The physician should be told at once of the appearance of this symptom, as it may be a sign of sodium-potassium imbalance or else a forerunner of uremic poisoning, instead of being caused merely by pressure. The same things may be tried for relief as are described above for varicose veins.

Hemorrhoids (*piles*) are caused by the same conditions that produce varicose veins and swollen feet. They are literally *varicose veins in the rectum*, which is a highly vascular, sensitive organ. Treatment by a physician should always be obtained if possible. The bowels must be kept especially open and free, and enemas of soapsuds or oil may be used to make the bowel movements easy. Carbolated Vaseline, zinc-oxide ointment, or any simple healing salve will tend to allay the irritation. Relief from pressure should be obtained by use of the corrective exercises described for displaced uterus (see page 329). Constipation and continued sitting aggravate the condition.

Muscle Cramps, Neuritis, Neuralgia.—Some women suffer from violent cramps of the muscles of the limbs during the later months of pregnancy. When muscle pain occurs only in the legs, it may be caused by pressure on the large nerves of the pelvis, which lie side by side with the blood-vessel trunks. Sometimes toxemia may also play a part and cause pain in other nerves as well as those of the feet and legs. If the fetus withdraws calcium from the mother's blood rather heavily during later pregnancy, if her food does not completely meet the need of both mother and fetus, she may experience nervousness, neuritis, and muscle cramps (see page 251). Deficiency in vitamin B may lead to nerve pains (neuralgia, neuritis). In such cases the administration of vitamin B concentrate sometimes gives prompt relief. Women who have bad posture and relaxed abdomens and who are on their feet a great deal are especially liable to suffering from muscle cramps. When the cramp occurs, vigorous rubbing, or rather kneading, of the muscles over the bones with the palm of the hand, as one mixes bread, will give the quickest relief. If a woman is subject to cramps after going to bed, she may help to prevent these by taking a hot foot bath and rubbing the muscles well before retiring.

Constipation.—Any tendency toward constipation is aggravated by pressure of the enlarging uterus upon the bowel. Corrective exercises and careful diet will minimize this tendency. The attending physician should prescribe all laxatives used.

Frequent urination results from pressure upon the bladder, also from congestion of the urethral membrane. The bladder will not contain the usual amount of urine; hence, more frequent emptying is necessary.

In general, any tendency to pressure complications should be promptly treated. Special attention should be given to all aspects of daily hygiene. The woman should take the Mosher exercise in the morning and the knee-chest exercise at night (see page 330), *always with the knowledge and approval of her physician.* If it is necessary for her to work hard or to be on her feet a great deal, she should form the habit early in her pregnancy of lying down with her feet elevated for a few minutes every time the clock strikes during her working day. She will get just as much done and will come through her day with less fatigue and pressure discomfort because of this simple procedure.

Local Disturbance. *Leucorrhea.*—There is an unusual amount of mucous discharge during the first and last months of pregnancy, caused partly by pelvic pressure and partly by the general speeding up of all secretory processes. When not excessive, this serves to keep the vaginal cavity clean and sterile. There is nothing to be done except to keep the parts very clean by bathing with soap or soda water. If the discharge becomes very great, or becomes yellow or green or odorous, the physician should be consulted, as it may indicate an infection, which should be promptly treated.

Pruritis.—Itching of the external parts is sometimes annoying. It is likely to occur in women who are nervous and who suffer from insomnia. Excessive leucorrhea may also cause itching. Anything that improves the general condition will act favorably upon this. Local applications of soda water, carbolized Vaseline, menthol, or peppermint water will give temporary relief. Bathing the parts frequently with cold water will also relieve.

Bleeding during Pregnancy.—Bleeding during pregnancy always indicates that something is wrong and should be promptly reported to the physician. It may indicate that miscarriage is about to occur, or that the afterbirth has grown in the wrong place (placenta previa, see page 288). A slight bleeding, if neglected, may result in serious hemorrhage. The woman should go to bed and keep strictly off her feet until her physician has seen her. No one should neglect this, thinking that she is menstruating even though pregnant, as it is doubtful if this ever occurs.

Miscarriage, Abortion, and Premature Birth.—The terms *miscarriage* and *abortion* are both used to apply to the loss of a child before the seventh month of intra-uterine life; miscarriage (technically) applying to the premature loss of an embryo, abortion to the loss of a fetus (see page 298). As a matter of fact, both terms are used by both laity and physicians to designate any premature loss of the product of conception. After the seventh month a child, though born prematurely, may live, under favorable conditions. If born between the seventh month and full term, it is said to be a *premature birth,* or if born dead, a *stillbirth.*

Miscarriage is especially likely to occur during the second and third months of pregnancy, because the placenta (afterbirth) is not firmly attached to the uterine wall until toward the fourth month. During this period loss of the fetus is especially likely to occur at what would be the regular menstrual periods. For this reason a pregnant woman should mark these periods on a calendar and remember to be particularly careful not to overexert or become too tired, or to have marital relations at these times.

Causes.—Anything that loosens the attachment of the placenta to the uterus may cause premature loss of the embryo or fetus. Causes may be *mechanical* or *chemical.* Mechanical separation may be brought about by anything that produces a sudden or forcible contraction of the uterine muscles. A fall, a shock, a fright, heavy lifting, overexertion, particularly sudden exertion, sexual intercourse—any of these may cause this unfortunate accident.

Chemical causes may be classified as follows: (1) *Toxins* produced in the mother's body by diseases, such as smallpox, influenza, and syphilis. Children's contagions are sometimes brought home to the pregnant mother by the school children, and she may thereby forfeit the life of her unborn child. (2) *Chemicals* that may be taken into the body. Drugs, such as cathartics, may cause contractions of the uterus when the bowels "gripe," and thus cause miscarriage. Most stimulant cathartics act on involuntary muscle and may coincidentally affect the involuntary muscle of the uterus. There are certain drugs that are used with criminal intent to produce this effect, all of which are very dangerous. Women have been known to go to physicians for medicine to relieve constipation or backache or "bladder trouble" without saying that they were pregnant or that they at least suspected that they were. This is taking a risk and is an injustice to both the woman and the physician. Any doctor or dentist consulted by a pregnant woman should be told of her condition. (3) *Diet* lacking in vitamins or minerals such as vitamin A or E and manganese. Lack of these may cause premature loss of the child, although there is small likelihood of such shortage in any ordinary diet. Vitamin A is essential to the formation and function of the placenta (see page 258) and to the implantation of the ovum. (4) *Imbalance in internal secretions*, particularly failure of corpus luteum and placenta to inhibit the pituitary, or deficiency in the follicular hormone or progestin is also a possible cause. (5) *Some abnormality in the ovum.* The ovum from which the fetus develops may be abnormal in some respect and never have the capacity for complete development. This is now thought to be the most frequent cause of premature loss of the fetus.[1]

Symptoms of Miscarriage.—Bleeding is usually the first symptom of threatened miscarriage. This is caused by the loosening of some of the "villi" or "rootlets" which attach the placenta to the walls of the uterus (see page 290). A little oozing may accumulate behind the placenta and finally force the whole mass loose.

If bleeding progresses to the point that the uterus begins to contract to expel the mass, which is now unnatural and irritating, the whole process resembles a miniature labor or childbirth.

Treatment.—The first and most important thing is for the woman to go to bed at once and remain there, with no exertion whatever, until her physician has seen her. If she is promptly treated, pregnancy may go on to full time.

If violent hemorrhage sets in, the arrival of the doctor should be hastened with all speed. The hips may be raised on a pillow and cold applications used low on the abdomen. The foot of the bed should be raised upon a chair. All napkins and discharges should be saved for the doctor's inspection in order that he may examine the embryo and determine the duration of pregnancy, and see whether the membranes are expelled intact.

The patient should not raise herself up or exert herself in any way while the bleeding continues; she should lie absolutely quiet until the physician has pronounced it safe for her to get up. She must not even get up to urinate or to move the bowels, and after severe hemorrhage should even be fed and turned.

After a miscarriage a woman should remain in bed for 10 *days and receive the same care as if she had had a normal childbirth.*

[1] STANDER, *op cit.*

More ill-health follows miscarriage than childbirth, largely because women do not commonly realize the importance of taking care of themselves. The reason full time should be allowed for physiological adjustment following premature interruption of pregnancy is that the rhythmic glandular clockwork which has been wound and "set to go" for 10 menstrual periods is thrown out of gear. Involution of uterus and return of mammae to normal may take some time.

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If I Am to Be a Mother

If I am to be a Mother,
I must know where the wood nymphs dwell,
And the names of the dew drop fairies,
The trail to the elfin dell;
I must learn what moonbeams are made of,
And be sure that the night's abode
Is a valley of silver clouds
That you reach by a star dust road.

If I am to be a Mother,
I must search and never be still
Till I find every beauty and sweetness,
And cup my hands to their fill
In each brook and each quiet water
Till I have found their peace;
I will take in my heart their singing
And never let it cease.

If I am to be a Mother,
I must know what is sorrow, and pain,
And feel what it is to be humble
And then to be brave again;
I must find love in its fullest,
Radiant ecstasy,
Treasure the days of unbounded youth
That they may keep me free.

And when I have learned these secrets,
I must know the wisdom of men;
From life's own lips I shall take it,
Finding its truths, and then—
I know that I shall be ready
To cherish a life that is new,
And I shall be, God willing,
A Mother such as you.

ELINOR DAY. *Anthology of Student Verse for* 1930, Los Angeles High School.

CHAPTER XIX

PREPARATION FOR THE BIRTH OF THE CHILD

The Waiting

So much is there to vision now . . . so much
To ponder while my road draws surely near
Its ending—its beginning. Let no fear
Harass the slow, prophetic hours! I touch
These small, enchanting garments . . . and a song
Is somewhere wakened, like an echo tossed
Against the very sky but never lost—
Never forgotten . . . Now I shall be strong.
I shall find certain courage given through
The strength of him I love—who shares with me
This pulsing miracle that is to be.
How strange—of all we ever dreamed or knew—
Of all our world—to claim so large a part,
Oh, little thing that stirs beneath my heart!

CATHERINE PARMENTER.[1]

If the baby is to be born at home, the supplies should be prepared at least several weeks in advance of the determined date, both because the mother should have fewer duties as she becomes heavier on her feet, and also because of the relative uncertainty of all computations of prospective date of parturition. The mother should consult her nurse and her physician in regard to the list of supplies that she is to prepare and the method of sterilizing.

Equipment for Confinement.—If it is left to the mother to prepare all the necessary equipment, she should have the following things on hand in addition to regular household provisions for illness:

1. Several packages of *sanitary pads*, such as are commonly used during menstruation.

2. A pound of *surgical cotton* for the small "wipes" and a small package of *sterile gauze* for dressing the cord.

3. If the *abdominal binder* is to be worn, two should be torn from heavyweight muslin, about 16 by 40 inches, or longer if the

[1] *Babies—Just Babies*, May. 1933.

woman is large. If an abdominal support has been worn (see page 323), this may be adapted to the new use.

4. A *small, soft blanket* with a square of old linen inside for first receiving the baby.

5. A generous supply of *hand towels*—at least 1 dozen—should be sterilized and put away. The new diapers may be sterilized and used, if the family supply of linen is too small to permit the convenient withdrawal of this number.

6. *Two or three hand basins or washbowls; two pitchers or extra teakettles* for holding hot and cold sterile water; one *slop jar, bucket,* or *foot tub* for receiving waste.

7. *Safety pins in three sizes, shears, nail brush, soap, and newspapers.*

8. For *delivery pads,* a piece of quilted mattress padding or table felt 2 yards long may be purchased and cut into two or four pieces and bound. These may afterward be thoroughly laundered and used for the baby's bed. Or the pads for protecting the bed may be made from a square of cotton batting "tacked" between layers of cheesecloth. These may be made ½ to 1 yard square, and two will be sufficient. In an emergency, pads may be made of many layers of newspapers basted or pinned between muslin and then thoroughly ironed on both sides with a very hot iron.

Sickroom Equipment.—From the home medicine cupboard the following things will be used: bedpan, irrigating or enema can or fountain syringe, rubber sheet or square of oilcloth, sterile Vaseline, sodium hypochlorite (Dakin's solution), lysol or other antiseptic solution, clinical thermometer.

Some surgical supply houses and mail-order firms now sell complete outfits for confinement already sterilized and sealed in compact packages. Naturally one pays for the processing and packing, but saves her own time and effort.

Preparing Supplies.—From an old sheet pieces should be torn suitable for pinning the following into packages as soon as they have been sterilized: three sheets, each wrapped separately; three pillowcases in one package; six packages of two towels each; 12 to 15 packages of four sanitary pads each, two nightgowns or pajamas, wrapped separately; one pair of long loose stockings, which may be wrapped with one of the gowns; four small or two large pads, wrapped separately, for protecting the bed during delivery.

Pledgets or "wipes" (if furnished by the mother) are made from either gauze or cotton loosely shaped into a mass the size and shape of an egg. The raw edges of the gauze are tucked in; if cotton is used it is shaped and twisted into a rather firm, round mass. There should be a generous supply of these for wiping away blood and discharges and for use in the daily cleansing of the parts. Usually the physician brings his own supply. If cost must be considered, or if an emergency occurs, wipes may be made from small pieces of soft old rags, sterilized by ironing.

Small pledgets are made by picking off and shaping small bits of cotton and dropping them in a pint glass jar or other closed container which has been boiled. These are useful for washing the nipple before and after nursing, and for cleansing the baby's eyes in making the daily toilet. Swabs are made by winding bits of cotton about the ends of toothpicks.[1] There should be a jelly glass full of these for the baby's nose, ears, and navel.

Sterilizing Supplies.—It is extremely important that everything coming near the mother during and following labor should be surgically sterile. Everything should be prepared and sterilized several weeks in advance of the expected date of confinement. Should the mother live near a hospital, her nurse may be able to have the supplies sterilized at the hospital. If the mother must be responsible for this, there are two possible methods that may be used in the home: ironing and steaming, which will here be described.

Ironing.—As large a table as is available should be selected and padded all over with a clean blanket or quilt. This should be completely covered with a freshly laundered sheet. The iron should be scrubbed with soap and water, especially the handle. A freshly ironed towel may be folded for a handle holder. All the supplies to be sterilized are placed on a chair or table at one side. The operator puts on a freshly laundered dress or large apron, scrubs the hands thoroughly with a brush,

[1] To make a toothpick swab stick the end of a toothpick into the cotton and wind off enough to cover the end; wind the top edge of the cotton firmly about the wood to prevent the cotton slipping off. *Make certain the cotton extends well beyond the end.*

soap, and hot water. She should take several rows of pins from a paper, place them in a dish and bake them in the oven.

She should then proceed as follows. First, she should run the iron over the entire table in order to sterilize the working surface. She should then iron the pieces of old sheet that are to be used as covers, and pile them on the back of the table. Then she should iron the towels, and as soon as two have been ironed, pin them up in one of the pieces of sheet as if it were wrapping paper, making a neat package, and so on until all the articles designated above have been ironed and pinned up, remembering to bury all but the head of each pin in the package. *She should use an iron as hot as can be used without scorching, and rub it over and over each article, ironing it several times on each side.* She should arrange that there be no interruption while doing this, and should *not touch anything whatever except the iron and the supplies.* When it is all done, the supplies will be arranged in a neat pile of packages on top of the table. She should then fold the ironing sheet over the whole thing, pin it compactly, and put it away until needed. She should not open this package for any reason whatsoever. The nurse will open it at the time of confinement. This sterilizing should be done two or three weeks before confinement is expected.

The gauze or cotton pledgets, swabs, safety pins, and everything that cannot be sterilized by ironing should be placed in glass jars, covered jelly glasses, or other suitable containers that have been boiled, covers and all, and have been dried with dry heat. When filled, the containers should be placed in an oven and kept at a low baking heat for an hour.

Steaming.—The Children's Bureau of the U. S. Department of Labor, in a pamphlet on *Prenatal Care,* 1931, gives the following directions for sterilizing supplies:

Wrap the sanitary pads, towels, and the sponges in packages of six each, and the remainder of the gauze squares in muslin and fasten with common pins. Put these packages and the muslin bags (five containing the cotton pledgets, the other the four cord ties and four gauze squares) into a pillowcase. Use a large wash boiler with a cover. Put water into it to a depth of six inches. Suspend the pillowcase containing the dressings in a hammock made from a towel or a piece of muslin (the hammock must not touch the water). Attach the ends of the hammock to the handles of the boiler. Wrap a cloth around the cover so that the cover will fit tightly. Steam an hour. Dry in the oven or in the sun by pinning the bag to a clothesline. Repeat the process the following day. Dry thoroughly. Put the pillow case away, unopened, until the articles are needed. If these articles have been sterilized more than a month, they must be sterilized again. The mother's nurse or the public-health nurse will explain to her the details of preparing and sterilizing these supplies.

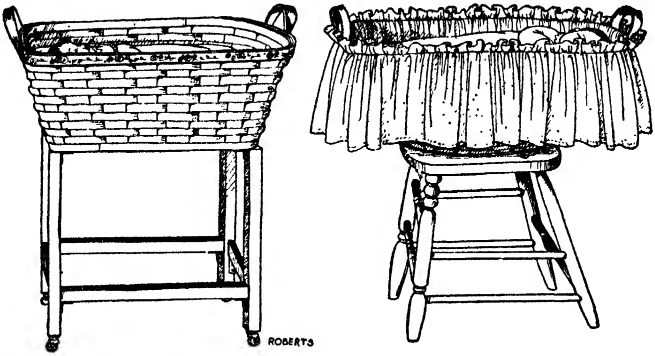

FIG. 94.—Two homemade bassinets. (*Department of Home Economics, University of Kansas.*)

Nursery Equipment. *Bed or Bassinet.*—A new clothes basket or splint delivery basket makes an ideal bed for the first 6 months. This may be nailed to the seat of an old chair without a back or mounted by a clever father upon a framework with casters. If so desired, the whole thing may be painted and made very attractive by appropriate decoration. A fitted pink or blue rayon lining that may be removed, with a wide flounce of dotted Swiss around the edge, makes a bassinet dainty enough for any baby. It is desirable to have the basket attached to a firm support of suitable height for convenience and safety, as an active infant—in his efforts, at four months or so, to turn himself over—may tip over a loose basket. A pillow may be carefully crowded into this basket to give a smooth, flat surface slightly higher at the head end. A head pillow is then unnecessary. A piece of rubber sheeting should be placed over the pillow. After the mother gets up she may use the rubber sheet from her own bed. A thin mattress should next be made by folding a piece of the table felting or quilted mattress padding, previously used for delivery pads, as mentioned, or even a piece of clean old quilt, to fit the basket. This gives the smooth, firm surface desired, keeps the baby from contact with the rubber, and is easily washed and renewed. Four small blankets may be made by tearing a soft old woolen blanket into quarters and binding or crocheting the edges. Attractive crib blankets may be purchased at very little cost. Four small sheets can be torn from an old thin sheet and hemmed.

For the Bath.—An enameled infant's bathtub or small foot tub will be required, or one of the numerous cleverly arranged commercial folding tubs. Two large, soft bath towels, if not found in the family linens, may be made from wide diaper cloth, or from soft, absorbent Turkish toweling. Four washcloths may be made of outing flannel or bird's-eye, or from an old, soft towel.

An Enameled Tray.—This should hold Castile or other mild soap in a celluloid box or small dish; fine talcum powder; boric-acid solution, boiled and strained through cotton; a tube of sterile Vaseline or other lubricant; a small jar of applicators or swabs made of toothpicks wound with cotton; a package of sterile dressings for the cord; small and large safety pins; a medicine glass for holding the sterile solution.

A Bath Table.—If the tub is not provided with a shelf for equipment, a folding sewing table may have the legs sawed to make it a convenient height for holding the bath things while the mother sits in the low chair. This may be painted like the bassinet if desired. A folded cotton blanket or a heavy bath towel should be provided for the top of the table. The wardrobette illustrated on page 352, provides a shelf for holding the tub, with small shelves above for equipment.

A Low Chair without Arms.—The legs of any chair may be sawed off and the chair painted to match the bassinet, or a low sewing rocker makes a very comfortable mother-and-baby chair.

Miscellaneous.—Other supplies include a drying rack for the diapers and bath things; drying frames for stretching the woolen stockings and shirts; a hot-water bag with flannel cover (the family bag may be scrubbed and cleaned, and fitted with a dainty cover in honor of this service, or a small bag may be purchased if desired), or an electric pad may be used on low heat; and finally, a reliable scale for the weekly weighing.

A Room for the Baby.—From the very start, some corner or room should be set apart for the orderly arrangement of the baby's belongings. These should be placed so as to require the fewest motions possible in performing the necessary operations involved in care of the infant.

From the day of his birth some part of the house should belong to the child. Theoretically he has a legitimate claim upon an

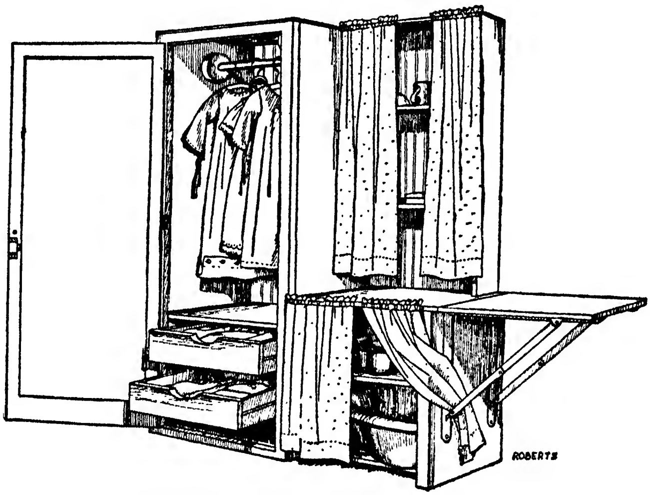

FIG. 95.—The wardrobette. (*Department of Home Economics, University of Kansas.*)

adequate space for his needs and practically it is much easier to give it to him than to struggle forever with disorder and conflict of interests.

Furniture.—The nursery should be properly lighted, heated, and ventilated. It may be small or large, upstairs or down, according to circumstances. It should, of course, be so located that the mother may easily see what is going on without too much effort. The furniture may be very simple: made at home by the father; bought piece by piece at secondhand stores and decorated according to some consistent plan; or purchased new if finances permit.

The wardrobette here illustrated (Fig. 95) was made by a neighborhood carpenter. It could, however, be constructed by any father or uncle who had had manual training. It is designed to comprise the chief article of furniture for the personal use of the child from birth to adolescence and is appropriate to a situation in which space is limited. The shelves for holding the infant's toilet equipment may be replaced by a mirror for the five- or six-year-old. The bathtub may be replaced by books and playthings, and the drop leaf affords useful space for play or study.

The child should have chairs and tables adjusted to the various levels of his growth. Fortunately, he finds many uses for his outgrown furniture, so it is not a matter of discarding them when it becomes apparent that he needs a larger chair and table. Because the child will need to have several of these, they should be inexpensive, and homemade when possible. The further adaptation of the child's room to his growing needs will be discussed later in the text.

CHAPTER XX

THE BIRTH OF THE CHILD

The Blessing of the Beds

Make the bed,
And make the bed,
The sheets are smooth
And the blankets spread.

Back and forth
Round the bed we go,
I and the child
I do not know.

If it should be
A son I bear,
May he be wise
And kind and fair.

Or if a girl-child
It should be,
May the blessings on
Her bed be three.

The first bed
Is the marriage-bed,
May Joy and Tenderness
Stand at its head.

And when in child-bed
She shall lie
May Victory
Herself draw nigh.

And when at last
Comes the third bed,
May Peace bend down
Above the dead.

Ah, Love! ennoble
With thy breath
Bride-bed, birth-bed
And bed of death!

Make the bed,
And make the bed,
The sheets are smooth
And the blankets spread.

ELIZABETH COATSWORTH.

The Approach of Labor.—Many young women approaching their first confinement are disturbed by vague fears and forebodings. They have heard many conflicting reports as to the suffering involved and they may even wonder, in moments of depression, whether a baby is actually worth the price. It is true that childbirth sometimes involves acute suffering, and the hours of waiting are almost worse to endure than the period of actual pain. However, there is no human suffering that is so promptly and completely forgotten, and no weariness from which one so quickly and completely recovers as the pain and fatigue of childbirth. If the woman is well nourished and in good physical condition, she usually wakens from her nap "feeling quite like herself" and eager to enter upon her new maternal estate.

Dorothy Canfield thus describes the second confinement of her heroine in *The Deepening Stream.*[1]

On the stormy day in December, when Matey lay down on her bed, shuddering in the onset of labor-pains before the birth of her second child, she saw out of the window the old beech tree, stripped to the boles, magnificently glorying in the battle with the wind and snow. She faced her own battle with a new heart. The present, anguish that it was, dwindled to its proper place in the great perspective. She remembered with pity the faltering panic of her first confinement. The pains were as great now but she was so much greater.

"No, no! Adrien," she cried to him, seeing him turn white at an outcry of hers . . . "It's worth it!"

He turned paler than ever, his face transfigured by love and by shared suffering.

Oh, wonder and glory of life that could bring such moments, thought Matey, bracing her soul against the old beech tree as a new rage of pain swept over her. This too was part of the banquet spread before the living.

The approach of childbirth should bring the expectant parents together in tenderness and communion of spirit. This can come only if the expectant mother has the "great perspective" which brings the courage and serenity that is appropriate to the mystic occasion of the birth of a new soul, hostage to immortality, out of one's own body. Fears may be conquered only by filling the mind so full of visions and activities and interests that there is no room for anxious anticipations.

The Physiology of Labor.—The exact cause of labor is still a matter of speculation. DeLee says:

Why should the uterus, which has carried the ovum for so many months, suddenly violently expel it? Nature certainly recognizes the right moment for the expulsion, since it is almost always accomplished at a time when the child is best able to carry on extrauterine existence and before it has become too large to pass safely through the parturient

[1] CANFIELD, DOROTHY, *The Deepening Stream,* Harcourt, Brace & Company, Inc., 1930.

canal. Why labor should occur on the completion of ten menstrual cycles is unknown.[1]

The most generally accepted explanation is that of alteration in the endocrine balance.[2] It is known that the corpus luteum degenerates during the last weeks of pregnancy, thus removing its restraining action on the pituitary. It is known that the posterior pituitary produces a hormone, *pitocin* or *oxytocin*, which causes specifically contraction of the uterine muscles (see page 142). The pain of childbirth also stimulates the adrenal medulla with the production of "emergency energy" (see page 154). When we consider that the placenta, being a short-lived, temporary organ, begins to become a "foreign body" and an irritant to the uterus, we get a picture of another of nature's many perfectly timed, intricate, physiological mechanisms.

The bringing forth of the child is variously called *labor, travail, delivery, accouchement, confinement,* and *childbirth.* Labor may be said to be divided into two periods: "insensible labor" (the French call it *travail insensible*) and the period of painful contractions. The first period begins with the return of the child from the abdomen to the pelvis. The second period begins with the first regular, painful contractions of the uterus.

The Signs of Approaching Labor.—The first or insensible period shows several phenomena which may be recognized and may indicate to the mother that her pregnancy is drawing to a close; however, many women never notice them and are suddenly aware only of the later symptoms.

"Lightening."—Two weeks or longer before labor the child starts on his journey to the outer world and begins to settle down into the pelvis. The woman's shape changes, the upper part of the abdomen becoming smaller and the lower becoming larger. She breathes more easily and feels lighter, but walks with greater difficulty. She is likely to have a return of constipation and frequent urination, owing to pressure such as she had before the child rose out of the pelvis at 4½ months. The process of stretching the muscles and ligaments and getting ready for the

[1] DeLee, Joseph, *Principles and Practice of Obstetrics*, 5th ed., p. 120, W. B. Saunders Company, 1930.

[2] Stander, H. J., *Williams' Obstetrics*, p. 307, D. Appleton-Century Company, Inc., 1936.

birth of the child really starts at this time. When women say that they were in labor only 1 hour or 2 hours, the truth is that the downward journey of the child had taken place so gradually and painlessly that they had not been aware of it, and were conscious only of the expulsion of the child. This is as it should be.

"False Pains."—Irregular and occasional contractions of the uterus occur during the entire period of pregnancy. As labor approaches, however, these become strong enough for the woman to become conscious of them. They may be more or less painful but are likely to be merely "griping" or "drawing" in character. Sometimes the woman will be conscious of these for from 1 to 4 weeks before labor. If they are only occasional and occur at irregular intervals they are called *false pains.* It is well to report these to the nurse and the doctor, however, in order that they may hold themselves in readiness for service.

"The Show."—During pregnancy the mouth of the uterus becomes plugged with mucus. When the birth canal begins to enlarge or dilate for the passage of the child, this plug of thick white mucus tinged with blood comes away, usually 24 to 48 hours before the birth of the child.

The Stages of Labor.—The second or conscious period of labor may last from a few minutes to many hours according to the relation between the fetal and maternal structures, the mother's vigor and organic competency, etc. This period is commonly divided into three stages.

The First Stage of Actual or Conscious Labor Is That of Dilation. This covers the period required for the complete stretching of the cervix of the uterus ready for the child to come out of it and pass through the vagina and pelvic outlet. This stage is characterized by contractions of gradually increasing frequency and severity. The woman may be conscious of these for from 12 to 20 hours, although the time frequently is much shorter, particularly in multipara.

True labor pains usually begin with more or less painful contractions coming on every 10 or 15 minutes, gradually increasing in frequency and severity until they occur every 1 to 3 minutes. It is usual to give some anesthetic if they are severe. Between pains a woman usually feels quite comfortable and may even sleep. The first stage lasts longer in a primipara (a woman who is having her first child) than in a multipara (a woman who has borne one or more children).

Breaking of the Bag of Waters.—One of the reasons dilation of the birth canal may progress so painlessly is that the contractions of the uterus force the soft amniotic sac ahead of the child. The pressure finally becomes so great that the placental membranes are ruptured and the amniotic fluid escapes in a rush. If this occurs too soon, the canal must be dilated by the head of the child, a condition known as *dry birth.* Such labor has been supposed to be longer and more painful than normal. Recent research, however, seems to indicate that a dry birth is not necessarily severe.[1] The breaking of the bag of waters should mark the end of the first period; the cervical canal should now be fully dilated and continuous with the vagina.

The Second Stage of Labor, or the Period of Expulsion.—This is the name given to the period required for the child to pass from the uterus, through the vaginal opening and the outlet of the pelvis, into the outer world. The pressure of the head of the child upon the rectum causes a feeling of urgent necessity to empty the bowel. The woman now "bears down" and thus assists the progress of the child. The stretching of the perineal muscles is the most painful part of the entire experience, and the woman can, by courageous cooperation, materially assist nature and shorten the period. Anesthetic of some kind is usually given during this stage, which may last from a few minutes ("one pain" or "two pains") to 1 hour or longer.

The Third Stage, or Expulsion of the Afterbirth.—The expulsion of the child is followed by a short period of rest, lasting a few minutes, after which the uterus again contracts vigorously and expels the placenta.

Afterpains.—The uterus when emptied should contract rapidly into a round, hard mass about the size of the child's head, which can be felt through the abdominal wall. This is nature's way of stopping the bleeding of the surface from which the afterbirth was separated. If the muscles in the wall of the uterus do not fully contract, the woman may have a *post-partum hemorrhage.*

[1] King, Arthur G., "Newer Concepts of Dry Labor," *Journal of the American Medical Association*, Jan. 20, 1940.

The nurse should occasionally feel of the abdominal wall during the first 24 hours. If the uterus should flatten out, she should grasp and knead it until it again contracts into a hard lump. Also, when the child nurses, the uterus contracts; hence the child should be put to the breast regularly from birth. The contractions are sometimes more or less painful, and are called "after-pains." Occasionally they are severe enough to require medical relief.

Preparation for Labor.—If delivery is to take place in a hospital, the doctor should be kept informed of the onset and progress of all symptoms, and he will indicate when the transfer should be made. The mother's bag containing her toilet necessities and the baby's clothes should be prepared early. If the doctor is not in close touch with the situation, the woman should go to the hospital at the first appearance of definite labor pains, and it is safer to go as soon as "the show" appears. If she lives at a distance from the hospital and must make a journey by train or automobile, she should avoid risk by going to the hospital as soon as "lightening" is definitely recognized, since precipitate labor may occur especially under the excitement and exertion of a trip.

If delivery is to take place at home, the doctor must be kept closely informed from the onset of "lightening" until he appears, to take charge of the situation. Certain preparations should be made for delivery of the child. The nurse should arrive early and put things in order. Emergencies do arise, however, and the family may need to have quarters and equipment ready. The room to be used should have been thoroughly cleaned and kept in order for some time. Places should have been found for things, ordinarily in the room, which will not be needed. The belongings of other members of the family should be removed. For 2 weeks this room is to belong exclusively and absolutely to the mother. If necessary, the nurse and the baby may also share it. It is much better, however, for the nurse and the baby to occupy an adjoining room. When labor begins the birth chamber should receive a final setting in order. The woodwork and furniture should be wiped with a clean, damp cloth; it should be a completely dustless room. The light should be put in order, and a strong extra light made ready in case it should be necessary to deliver the baby at night. The heat and ventilation should be carefully arranged.

The baby's blankets, first clothes, bath equipment, the boric-acid solution for its eyes, the Vaseline, oil, or cold cream for its first greasing, may all be laid out in an adjoining room, or wherever the nurse plans to give the baby its first bath.

The supplies listed on page 346 should be arranged upon small tables conveniently accessible to the doctor. The bowls and pitchers should be washed with hot soapsuds and wiped all over with a piece of gauze wet in an antiseptic solution.

A couple of teakettles (borrowed, if necessary) should be filled, brought to boil, then, with a plug of sterile cotton put in each spout, set aside to cool. It is easy to secure hot sterile water quickly, but it should not be forgotten that cold sterile water also will be required.

It is well to have the family instructed as to the regulation of fires, keeping water hot, preparing a lunch for the doctor and nurse if labor lasts through the night, etc.

Making the Bed.—A mattress pad or folded quilt should be placed over the mattress, then the lower sheet is spread and folded under at the corners. Unless the sheet is large enough to tuck under at least 12 inches all around, it should be pinned to each corner of the mattress underneath with large safety pins, several stitches being taken with each pin so that it will not tear either mattress or sheet. It is very important that the mattress coverings should remain firmly and smoothly in place.

Across the middle of the bed a piece of rubber sheeting or oil-cloth is placed, which should have been wiped on both sides with an antiseptic solution. This is covered with a sheet folded over crosswise (the "draw sheet"), which is drawn well under the mattress. The patient's hips should rest about on the middle of this sheet. It is much easier to change the draw sheet often than it is to change the sheet covering the entire mattress. Since this is the permanent bed upon which the mother will lie at the termination of delivery, it should be protected with one of the sterilized sheets (see page 347), which will be slipped out from under the mother at the end, leaving her on a perfectly clean, permanent bed. The pads for protecting the bed will be placed over the top sheet as required. The pan or jar for waste may be or else replaces it with a sterile short gown, such as the jacket of a pajama suit. She then places the patient on the bed with the sterile pads under her and the sterile sheet over her. The nurse should now put on her the stockings that were sterilized and pinned up with one of the gowns. When delivery is imminent, the mother will be placed crosswise, as shown in Fig. 96.

Every person entering the room or assisting in any way should wear a large, clean apron or a sterile sheet. The proper way to use a sheet for an apron is as follows: Hold the sheet up so that the middle crosswise crease will drop from chin to feet of the person who is to wear it. The sheet is folded over at the top so it will just clear the feet at the bottom. It is then brought smoothly around under the arms and the upper corners crossed in the back and brought over the shoulders and pinned to the front; that is, the right upper end of the sheet is pinned to the sheet in front of the left shoulder, and the left upper end in front of the right shoulder. This can be done in such a way that part of the sheet falls over the sleeve and arm. When properly adjusted, it allows one to move around as freely as if wearing a real apron.[1]

As soon as the baby's head is born (see Fig. 97), the nurse should quickly wipe the mucus from the mouth with a bit of sterile gauze and wash each eye with a separate piece of gauze wet in boric-acid solution. When the baby is released from the terrific squeezing to which he has been subjected in the birth canal, unless he has been overcome by deprivation of oxygen, by pressure, or by too much anesthetic, he gasps, draws his first full breath, and tells the world what he thinks of his chilly reception on being precipitated from a temperature of 99° to 100° within his mother's body into one of 75° or 80° in the delivery room! If the baby is slow in responding to the situation, he must be made to breathe by artificial respiration and stimulation.

As soon as the cord is cut the nurse should cover it with a piece of sterile gauze; she then wraps the baby in a soft piece of old linen or toweling inside a warm blanket and lays it on its right side in a warm, safe place, while she helps the doctor with the mother.

[1] Sherbon, Florence Brown, *The Family*, p. 388, McGraw-Hill Book Company, Inc., 1937.

She again tidies up the patient somewhat, places her in a comfortable position, and allows her to rest until time for the afterbirth to come away, when the contractions of the uterus start up again for a few minutes.

FIG. 97.—Birth of head, mouth appearing over perineum. (*Stander, Williams Obstetrics, D. Appleton-Century Company, Inc.*)

The nurse now gives the baby a little further attention, looks it over carefully to see if it is normal in every way, and shows it to the doctor for confirmation of her judgment. The doctor will now drop the prophylactic silver preparation into the baby's eyes (see page 331), after which the nurse will anoint it thoroughly with oil, Vaseline, or cold cream, to soften the sticky, cheesy coating with which most babies are covered when born. She again wraps it up and makes it comfortable until after the mother is entirely through and settled to rest. Usually the baby goes promptly to sleep as soon as he is warm.

Repair of Tears.—When the perineum is torn or clipped during the delivery of the child, the physician will sew up the tear before the nurse adjusts the dressing. The patient should be placed crosswise of the bed, and a very good light will be needed. The nurse will cleanse and prepare the parts as directed by the physician. It is very important that all tears, even small ones, be repaired as soon as they occur, thus saving ill-health and hospital and surgeon's fees later. The matter is not difficult, as the woman has usually had some anesthetic, and the parts are sterile and are going to be kept surgically clean for the period of healing anyway.

After the afterbirth has been delivered and the doctor has pronounced everything finished, the nurse quickly sponges off the exposed parts of the body, removes soiled pads, places a sterile dressing over the vulva, adjusts the binder, and pins the dressing to it, back and front. She places a hot-water bag at the mother's feet, gives her some hot milk or other nourishing drink, adjusts light and ventilation, and lets her take a much-needed rest. The mother will usually go quickly to sleep, and a great peace falls upon the household!

The duties of the physician at the time of the birth of the child may be summarized thus:

1. Care of the mother. The doctor should be present at least during the second stage of labor and should exercise scrupulous care as to cleanliness and asepsis. He should exercise good judgment in the use of anesthetics, instrumental assistance, etc. He should examine the afterbirth to make sure that no fragment remains in the uterus. He should see that the uterus contracts properly. He should repair any tears of the perineum.

2. Care of the child. He should see that the child breathes properly. He should examine the child for defects. He should see that the cord is properly tied and dressed. He should put prophylactic drops in its eyes and turn it over to the nurse. Before he leaves the house he should fill out a birth certificate.[1]

[1] The father should follow up the matter of registering the birth of his child and see that the birth certificate is actually filed with the local and state registrars of vital statistics. The laws of our own and other countries are full of age requirements. Legal evidence of citizenship and of age may be necessary at any time during the life of the individual in order to enable him

Birth

Just when each bud was big with bloom,
And as prophetic of perfume,
When spring, with her bright horoscope,
Was sweet as an unuttered hope;

Just when the last star flickered out
And twilight, like a soul in doubt,
Hovered between the dark and the dawn,
And day lay waiting to be born;

Just when the gray and dewy air
Grew sacred as an unvoiced prayer,
And somewhere through the dusk she heard
The stirring of a nested bird—

Four angels glorified the place;
Wan Pain unveiled her awful face;
Joy, soaring, sang; Love, brooding, smiled;
Peace laid upon her breast a child.

Annie R. Stillman.[1]

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to travel, to inherit property, to enter professions, to marry, or in order to determine criminal liability, age of entering and leaving school, etc. A busy physician, although under legal penalty, in most states, for failure to register a birth, may neglect actually to send in the certificate after it is made out; hence the parents should follow up the matter later.

[1] *The Willows Magazine.*

"Where have I come from, where did you pick me up?" the baby asked its mother.

She answered half crying, half laughing, and clasping the baby to her breast;—

"You were hidden in my heart as its desire, my darling.

You were in the dolls of my childhood's games; and when with clay I made the image of my god every morning, I made and unmade you then.

You were enshrined with our household deity, in his worship I worshipped you.

In all my hopes and my loves, in my life, in the life of my mother you have lived.

In the lap of the deathless Spirit who rules our home you have been nursed for ages.

When in girlhood my heart was opening its petals you hovered as a fragrance about it.

Your tender softness bloomed in my youthful limbs, like a glow in the sky before the sunrise.

Heaven's first darling, twin-born with the morning light, you have floated down the stream of the world's life, and at last you have stranded on my heart.

As I gaze on your face, mystery overwhelms me; you who belong to all have become mine.

For fear of losing you I hold you tight to my breast. What magic has snared the world's treasure in these slender arms of mine?"

RABINDRANATH TAGORE,
from *The Crescent Moon*,
The Macmillan Company.

CHAPTER XXI

THE PUERPERIUM

A woman when she is in travail hath sorrow, because her hour is come; but when she is delivered of the child, she remembereth no more the anguish, for the joy that a man is born into the world.[1]

Organic Changes.—The period required for the return of the uterus to its normal size and position, called the *puerperium,* usually requires 5 to 6 weeks. Rapid absorption of the extrauterine tissue takes place, a new lining is formed, and the large overstretched muscular sac weighing about 2 pounds becomes again a small compact organ weighing about 2 ounces. The supporting ligaments and the relaxed abdominal muscles also regain their tone and contract to their original size. By the seventh to the tenth day the uterus has usually returned from the abdomen to the pelvis and can no longer be felt above the symphysis pubis. Some physicians determine the time of sitting up by this, permitting a woman to sit erect as soon as the uterus is no longer palpable above the pubis.[2] This shrinking of the uterus is called *involution* (see page 274). Involution proceeds more rapidly in women who nurse their children, as the mammary hormone seems to have a stimulating effect upon the uterine tissues. While the uterine structure is undergoing this reduction the supporting ligaments are contracting, and the adjacent tissues of vagina, bladder, and bowel are recovering from the prolonged pressure, distortion, and congestion.

Duty of the Physician.—The attending physician should pay just as strict attention to the puerperium as to the pregnancy. He should consider it his responsibility to see (1) that the milk flow is successfully established; (2) that the mother leaves her bed and becomes adjusted to her daily routine safely and happily; (3) that the pelvic organs have returned to normal size, relation, and condition. No matter how normal the situation seems

[1] John 16:21.

[2] Stander, H. J., *Williams' Obstetrics,* p. 478, D. Appleton-Century Company, Inc., 1936.

to be, he should make a thorough pelvic examination when the baby is from four to six weeks old. Also, many obstetrical specialists now include in the contract a thorough physical examination for mother and babe when the baby is three months old, particularly when the medical supervision is not transferred to a pediatrician. The doctor should visit the mother and the babe every day until nursing is fully established. If everything is all right, he may then make a call about every other day until the mother leaves her bed. Where the distance prohibits this service, the woman should, if possible, go to the nearest hospital for confinement, or to the home of a relative or friend near her physician.

The Lochia.—The bleeding from the small blood vessels ruptured by the separation of the placenta, mingled with mucus and sloughed-off uterine lining, form a discharge called the *lochia*, which changes in color from red to brown and then to yellow. It gradually lessens, entirely disappearing when involution is complete. The odor is slightly musty or "meaty," but not offensive. If the odor becomes offensive or puslike it should be called to the doctor's attention.

Weight.—The new mother should return, during the puerperium, to about her normal, prepregnant size, certainly to not less than her normal weight. Some women remain a little heavier ever afterward, and most women are somewhat heavier during lactation, but lose some weight when the baby is weaned. Other women lose weight during nursing.

Confinement in Bed, "Lying-in."—It is customary for a primipara to sit up about the ninth or tenth day after the birth of the child, get into a chair within the next day or two, and dress and leave her room about the fourteenth day. Multiparas having no complications shorten this program by sitting up about the seventh day and dressing on about the tenth day.

These rules do not fit all cases. Vigorous peasant women scarcely go to bed at all, while women who are not vigorous and generally strong may need 2 to 3 weeks of absolute rest, especially if a satisfactory milk supply is to be secured. If perineal repair is made, a longer stay in bed is necessary. In general, there is a tendency on the part of many obstetricians to encourage greater freedom of movement than formerly. Some permit uncomplicated cases to get up to the bedside commode after the milk flow is fully established, and have their patients well propped up in bed to eat almost from the start, believing that better drainage of the uterus is hereby secured, as well as quicker return of abdominal muscle tone. Indeed, many women feel quite ready to get up after 2 or 3 days of rest. This is inadvisable on account of the weight of the heavy uterus upon the relaxed ligaments, which may cause "falling of the womb," "bearing down," and "subinvolution."

Lactation.—During the first 48 to 72 hours, the breasts secrete a yellowish, watery substance called *colostrum,* which is exactly adapted to the digestive capacity of the infant and meets his needs. It acts as a laxative, clearing the bowel of meconium, and supplies some protein, vitamins, and sugar. It also contains antibodies which protect the infant, to some extent, against early infections (see page 258). About the third day the milk glands begin to function, and the breasts fill up with a rush. The activity of the milk glands is stimulated by the sucking of the child both before and after the flow starts. The secretion of milk normally continues from 9 to 12 months, and may sometimes be prolonged from 18 to 24 months if the child is not weaned.

The Hygiene of the Puerperium: Care of the Mother. *Quiet.* The first need of the mother after the strenuous experience of labor is quiet. As has been said, she should be given nourishment; left in a fresh bed, with feet warm, air fresh, light adjusted; and then be permitted to rest until she spontaneously awakens. During the lying-in, and indeed, during the entire puerperium, she must be protected from excitement and fatigue. When the baby has been born at home and the mother has many accessible relatives and friends, there is sometimes created a situation calling for diplomatic finesse, since not every well-wisher knows the sum total of the demands the day may bring to the precious strength of the object of affection. *It is often important and necessary to have the doctor instruct the nurse exactly as to the number of callers, the length of the calls, and the time of the calls that his patient's condition permits.*

Diet.—For the first 3 days, or until the milk flow is successfully established, the diet should be nourishing but easily digested, beginning with fruit juices, milk, and milk drinks for the first

12 to 24 hours, and adding toast, eggs, milk soups, cereal, vegetables, and fruits as the appetite of the patient returns. Some obstetricians do not limit the food intake even at first. Dr. Bacon says if the woman "is hungry and wishes a hearty meal immediately after labor, there is no reason why her wish may not be gratified."[1] After the milk flow starts and immediate danger of infection is past, the patient may rapidly return to the diet of pregnancy as outlined in Chap. XVII. She must now literally "eat for two." Her need for calcium, phosphorus, and protein is increased even over that of pregnancy. This is shown by the fact that nursing mothers as well as pregnant women tend to show negative calcium and nitrogen balance.[2] As in pregnancy, the child tends to take his requirement from the mother's blood, leaving her depleted if enough for both is not supplied from her food. Fortunately, cow's milk supplies the increased need in both calcium and protein. Not less than 1 quart per day will usually be required. Some women will require as much as 2 quarts daily to maintain their calcium balance and preserve their own tissues. There is a greatly increased need for thiamin (vitamin B) (see page 259) both for appetite and for stimulating the function of the digestive glands and protection of the nerves (see page 340).

The appetite is usually increased, sometimes to a voracious degree, some women consuming as much as 4,000 to 5,000 calories per day. Of course common sense must be used in such a case, or the woman may accumulate excessive weight and fat. Ordinarily in a woman who is healthy and active and who eats regularly and chews her food thoroughly, the appetite is a fairly safe guide as to the proper amount to be eaten. She should eat a balanced and varied diet, and in event of doubt should analyze her diet for 1 week (see page 237).

She need have no fears that particular foods will give the baby colic. Whatever agrees with her will agree with the baby, except in the rare condition of protein sensitization (see page 412).

The mother's food during pregnancy and lactation is the baby's food. She should not forget this for a moment. He has nothing

[1] Bacon, Charles S., *Obstetrical Nursing*, p. 238, Lea & Febiger, 1924.

[2] Wilson, Charles A., *Third Conference on Research in Child Development*, Part II, p. 254, National Research Council, Washington, D. C., 1929.

out of which to build his bones, teeth, muscles, and brain except the food elements that she gives him from her own blood stream via the mammary glands, with the addition of certain protectives, which will be named later.

Urination.—If the woman is unable to void spontaneously, the doctor usually catheterizes the bladder at the end of labor, leaving it empty. Sometimes the new mother uses a bedpan for the first time following the birth of her child. The unaccustomed position and the general relaxation of all ligaments and muscles may make it difficult to void urine. If urine has not been passed before 10 hours after the birth of the child, the fact should be promptly reported to the doctor—sooner than this if there is any distress or discomfort. The amount of urine will depend in part upon fluids taken, but should be more than usual on account of the great amount of broken-down proteins from the uterus which must be excreted from the system. If there is difficulty in urinating, the nurse may try the time-honored expedients of having the patient listen to trickling water, putting hot water in the bedpan, and applying heat to the region of the bladder. Bacon permits a patient to assume a kneeling position in bed over a small basin held by the nurse, believing everything should be tried before catheterization.[1]

Bowels.—If the bowels have been properly emptied at the onset of labor, it will not be necessary to have a movement until about the morning of the third day after. Many physicians give a mild laxative on the evening of the second day. After the third day there should be a regular, daily movement, preferably soon after breakfast and before the bath. The use of a small soapsuds enema or a suppository is usually permitted by the physician for a few days until a regular habit and familiarity with the bedpan are established. The time of giving and the kind of laxative used will be indicated by the physician.

Air, Light, and Warmth.—The mother should occupy a light, well-ventilated room, the quietest and most pleasant in the house. Sunshine and fresh air are necessary to both mother and child. The temperature should be kept at not over 70°, and 65° to 68° is usually better. It is debilitating to lie in a warm, close atmosphere. The old method of keeping mother and child in a hot,

[1] BACON, *op. cit.*, p. 233.

dark, stuffy room, to prevent them from becoming "chilled," was the surest way in the world to make them highly sensitive to cold. This idea doubtless arose from the fact that childbed fever begins with a chill. It was natural to assume that exposure to cold caused the fever.

Both mother and babe must be kept warm, of course, but this must be done with warm, lightweight blankets and artificial heat, if necessary, rather than with heavy covers or hot, stale air in the room. In warm weather all windows should be freely open; in cold weather, unless the house is air-conditioned, a good method is to have all windows down from the top; a little crack left at the top at all times makes sure that the air in the room will not be stagnant and that it will be constantly changing from the top, where the hottest, stalest air is always found. *Good air is moist, cool, and moving.* The mother and the babe may be protected from a direct draught by some kind of screen. A blanket over two chairs or even a clothes-drying rack or an open umbrella does very well. The room need not be darkened except while the mother naps. However, the eyes of both mother and babe should be shaded at all times from direct light.

The Mother's Bath and Bed.—The mother should have a sponge bath every day, and have a fresh gown daily—or at least two gowns, one for night and one for day. The bed linen should be changed often enough to keep it neat and fresh; the bed should be smooth and orderly at all times. The hair should be combed daily and, if long, braided in two braids. It rests both body and mind of the mother to have her bed and person neat and clean and her room attractive and pleasant.

Abdominal Binder.—It is a traditional custom to pin a wide strip of muslin snugly about the body after childbirth, in the belief that the abdomen will thus be helped to return to normal shape. There is difference of opinion as to the use of the abdominal binder. Some physicians think it may cause rather than prevent displacements of the uterus, since it tends to press the uterus backward as the woman lies upon her back. Fixing the muscles tends to retard the return of tone and contractility. Some physicians object to the use of the binder while the patient is in bed, but permit its use when a woman first gets up, in order that the relaxed muscles may have some support while recovering their tone and shape. Most physicians permit its use for at least a few days after the birth because of the comfort and support it provides. The best plan is for every woman to consult her physician in regard to this and follow his advice. If the binder is used, it should be applied smoothly, pinned with safety pins placed closely together, and fitted with pinned darts (see Fig. 98).

Care of the Genitals.—The genital region should be kept sterile at all times, since infectious matter may find its way into the uterus (which is somewhat like a raw wound after the separation of the afterbirth) and cause childbed fever. The nurse should scrub her hands with soap, hot water, and a brush before waiting

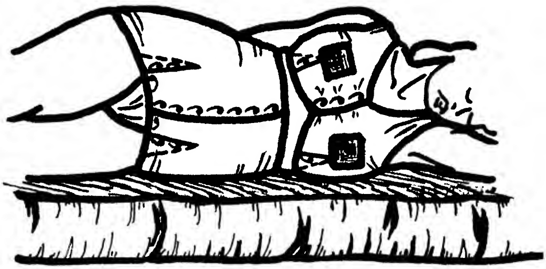

FIG. 98.—Abdominal binder, vulvar dressing, and nursing brassière.

on the mother. Every time the parts are uncovered for urination or bowel movement, all dressings should be dropped on an open newspaper. Before clean dressings are put on, the parts should be cleansed with sterile pledgets of gauze or cotton dipped in boiled water or an antiseptic solution. Each pledget should be thrown on the newspaper as used, and never dipped in the solution a second time. The anus (opening of the bowel) should first be cleansed, then the labia. The hospital method is to cleanse the anus, then rinse the other parts by pouring the solution from a sterile pitcher. When stitches have been taken, this method should always be used. After the parts have been made perfectly clean, a fresh, sterile pad should be applied. The newspaper containing the soiled dressings should be burned at once.

Exercises.—Bed exercises to restore tone and vigor to the various muscles of the abdomen and back are now commonly advised,[1] and are much more effective in restoring the "shape"

[1] DeLee, Joseph, *Obstetrical Nursing*, pp. 203–205, 7th ed., W. B. Saun-

of the abdomen than is the binder. These exercises should be undertaken only under the physician's advice. Excellent illustrations from photographs are found in *Getting Ready to Be a Mother* and in *Obstetrical Nursing,* both by Van Blarcom.[1] These exercises are also illustrated in Fig. 99.

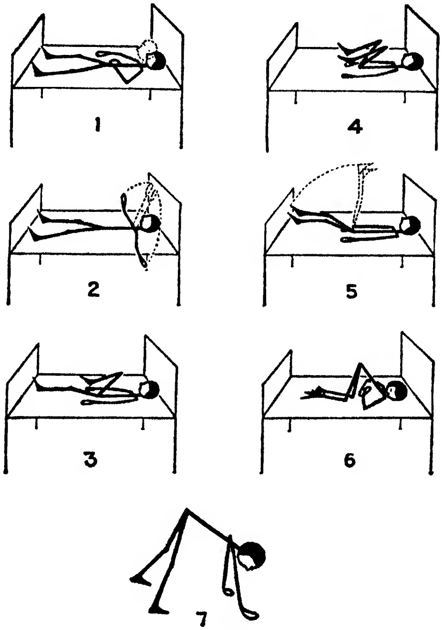

FIG. 99.—Bed exercises.

Hygiene of the Puerperium: Care of the Baby. *The Baby's First Bath.*—The water should feel pleasantly warm to the bare elbow of the nurse. If a bath thermometer is available, the water should test about 98° to 100°. The nurse spreads over the bath table a bath towel covered with a soft linen towel. She carefully wipes off the grease, carrying with it the cheesy covering of the skin. She keeps the baby's body covered except for the part under attention. She should first wash and wipe the baby's face and head, taking care not to get soap in the eyes.

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ders Company; SAMUEL R. MEAKER, *Mother and Unborn Child,* pp. 166–170, The Williams & Wilkins Company, 1927; BACON, *op. cit.,* pp. 264–266.

[1] VAN BLARCOM, CAROLYN, *Getting Ready to Be a Mother,* The Macmillan Company, 1940; also, *Obstetrical Nursing,* The Macmillan Company, 1929.

After washing each part she pats it dry, taking special pains to dry each fold and wrinkle of the skin. Sometimes the doctor will advise that the baby be cleansed only with oil at first and not bathed in water. If the baby is not in good condition, this is always advisable and may be continued for several days. Oil cleanses the skin very well and conserves the body heat of the child.

The Cord.—As soon as it is cut, the nurse dresses the cord by cutting a hole in a pad of sterile gauze, which she slips over the stump and covers with another piece of gauze. She bathes the baby and applies the band without touching or exposing the cord, if possible. If it has been exposed, she sponges the cord with alcohol or other antiseptic, dries it carefully with dry, sterile gauze, applies a fresh dressing, and adjusts the baby's band. Grease or salve or powder of any kind should never be put on the cord.

To adjust the band it is placed under the baby, lapped smoothly in front, and pinned with small safety pins placed closely together, beginning at the bottom. It should be pinned to fit the shape of the body, and fit without wrinkles; at the same time it must not be tight. On a plump, round baby it is sometimes necessary to pinch up little darts at the lower edge and fasten them with small safety pins, placed closely together.

If the cord is dry and sterile when dressed, and if it can be kept dry, it should not need to be redressed until it comes off, at the end of 6 or 7 days. The baby must not be put in a bath until the cord drops off and the stump has healed. Of course it must receive a sponge bath every day. If there should be any discharge from the cord, it must be redressed, and this condition should be reported to the doctor. After the cord drops off, a pad of sterile gauze will be kept over the stump until it is entirely healed, when the pinned band will no longer be necessary. It is advisable to put only band (shirt, in cold weather), diaper, and nightgown on the baby for the first few days.

The First Nursing.—The baby should be put to both breasts for a few minutes as soon as the mother has had a sleep and feels rested and ready. When the baby is brought to nurse, the nipple should be washed with boric-acid solution or boiled water and dried with sterile cotton. The mother should turn on one side and have a pillow thrust firmly against her back for support (see Fig. 100). If it is not desirable to have her turn completely on her side, the baby may be placed on a pillow so that she will not have to twist her body. The nipple and the breast should be kept dry and clean and covered at all times with a clean, sterile cloth or gauze, which may be held in place with adhesive strips laced together (see Fig. 101), or by the brassière (see

FIG. 100.—Nursing the baby in bed.

Fig. 98). Common clothing, dust, hands, etc., always contain pus germs. It is very easy for these to set up activity in the very small abrasions in the tender nipple caused by the vigorous squeezing of early nursing, and to cause infection. As much care should be taken with the breasts during the lying-in period as with any surgical wound.

The sucking of the child causes the uterus to contract, thus helping to prevent hemorrhage, and it stimulates the milk glands to activity. It is also desirable to call the nursing instinct into action reasonably soon, for it sometimes fades through delay. In some hospitals it is the practice to give even the boiled water with a teaspoon or a pipette to avoid the possibility of conditioning the baby to the bottle before he learns to nurse the breast. While there is no urgency in the matter, it is desirable to put the baby to the breast as soon as the mother is fully rested, and then quite regularly every 4 to 6 hours afterward (as directed by the physician), except during the night. *The baby should receive nothing except breast milk and warm boiled water at any time without orders from the attending physician.*

For the rest, the newcomer will require only warmth from loose, porous, lightweight woolen coverings, and quiet. He requires time to make his adjustments to the new order, and he spends his first hours or days somewhat as he has been accustomed to spend them—in warm and dreamless sleep.

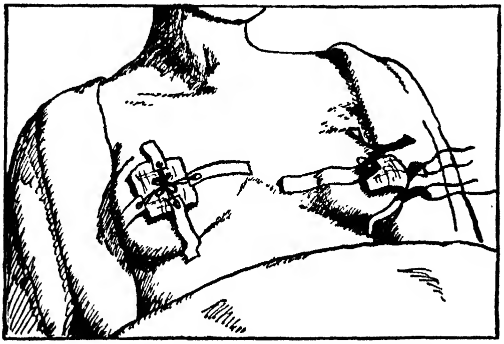

FIG. 101.—Proper care of the nipples.

Complications of the Puerperium. *Post-partum Hemorrhage.*—It has been stated that the uterus, when emptied by the birth of the child, contracts like an overstretched rubber bag. This is nature's way of stopping the bleeding when the afterbirth comes away from the wall. The nurse should watch that the uterus does not relax while the patient is asleep or resting, as violent hemorrhage may set in. The nurse can usually arrest hemorrhage by grasping the uterus through the lax abdominal wall and kneading it rather vigorously. If it does not then draw up, a cold, wet cloth or a piece of ice may be rubbed over this part of the abdomen. (The body of the patient must be kept warm.) Putting the baby to the breast will nearly always make the uterus contract.

While the physician is coming, the foot of the bed may be raised by placing a chair or some other piece of furniture under it until the feet of the patient are considerably higher than the head. The baby should be kept at the breast and the nurse should continue kneading the uterus through the abdomen. If promptly and persistently carried out, these measures will rarely fail. In very extreme cases the vagina may be firmly packed with strips of sterile gauze or loops of sterile bandage.

Puerperal Septicemia, Septic Infection, Puerperal Fever, Childbed Fever.—Septic (pus) germs of many varieties are practically omnipresent.[1] They are unable to penetrate unbroken skin or mucous membrane, but they grow with great readiness in living tissues if they gain entrance and if the patient's immunity is low. The inside of the uterus immediately after the separation of the placenta is a very favorable place for the growth of septic germs. This is the reason why so much emphasis is placed on having everything that comes near the vaginal entrance absolutely sterile.

Even though the doctor may be scrupulous about his own hands and instruments, the nurse may be careless in assisting him or may fail to use sterile vulvar pads or to keep these parts surgically clean, and germs may gain entrance after labor is ended. Any member of the family having a sore throat or any eruption or sore should keep strictly out of the mother's room. The immunity of the woman may be low because of her diet or general condition, and she may have foci of infection elsewhere in her body, in teeth, appendix, or sinuses.

The symptoms appear suddenly about 3 or 4 days after delivery. The patient complains of chilliness or has a chill, she complains of tenderness in the lower abdomen and feels ill, and her temperature rises. The attack may subside within a few hours or days in mild cases, or it may terminate fatally within a few days in severe streptococcus infection. In other cases it may drag along in a subacute form for a number of days, with subsequent recovery. Occasionally septic material from the uterus lodges

[1] The most virulent type of infection is from the *streptococcus hemolytica*, the germ that causes fatal blood poisoning, scarlet fever, erysipelas, and streptococcic sore throat. Some success is reported from the use of streptococcus serum and even scarlet-fever serum in puerperal cases. The new drug, *sulfanilamide*, seems likely to prove a specific in the treatment of all streptococcus infections, including puerperal fever.

in a vein of one leg, causing "milk leg" (*phlegmasia alba dolens*). The leg affected swells, and septic fever may occur.

The infection may travel up the Fallopian tubes and, by shutting off the tiny passages with scar tissue, render the woman subsequently unable to become pregnant. It may reach the ovaries, or even the peritoneal lining of the abdomen, causing peritonitis, which is always serious and often fatal.

In spite of modern progress, childbed fever still leads on all lists as the chief cause of death among all causes related to pregnancy and childbearing (see page 302). Skilled, modern obstetrical service and clean, intelligent nursing are even yet available to a relatively small number of the women of our country. Puerperal fever very rarely occurs in hospitals or where modern nursing and medical care exist.

The situation will change in the degree in which women generally become intelligent and informed as to the importance of skilled care during the entire period of pregnancy and the puerperium. When women know what to expect in the way of medical and nursing care and become willing to go early to a thoroughly qualified physician and pay adequately for the service, and when women citizens become aroused to such realization of the situation that they see to it that no woman is forced to risk the life and health of herself and her child because of poverty—when these things come to pass, childbed fever and toxemia will move from the top to the bottom of our mortality tables.[1]

[1] KRUIF, PAUL DE, *Why Keep Them Alive?* Harcourt, Brace & Company, Inc., 1936.

CHAPTER XXII

THE NEONATAL MONTH

Development is always dynamic and never discontinuous. It is, therefore, impossible to separate one period of development sharply and completely from any other period of development. The fetal period is continuous with the neonatal, the neonatal with the preschool, and this in turn with the school period, pubescence, adolescence, and adulthood. Indeed, the biologist goes still further. He does not even separate senescence from immaturity. Some of the most penetrating studies of growth and development have emphasized the fact that senescence and rejuvenescence are relative terms and that both processes may go on at the same time in one individual. As Child puts it, "The age changes in the organism are merely one aspect of Werden and Vergehen, the coming and passing away which make up the history of the universe."

—ARNOLD GESELL.[1]

The Newborn Infant. *If Premature.*—Birth is only an incident in the developmental career of the infant. If born too soon, he completes his postnatal development in much the same manner in which it would have occurred *in utero.* If postmature or delayed birth occurs, the child goes on maturing in the uterus and when born behaves like a child of two weeks (or whatever the interval). Gesell finds that children born prematurely are retarded in their behavior reactions and remain retarded for a definite period of time according to the degree of prematurity.[2] Shirley reports a study of the development of 63 babies having birth weights under 5 pounds which shows that babies with birth weights under 4 pounds are retarded by a month or more through 18 months of postnatal development, while those of 4 or 5 pounds birth weight overtake the control group by 9 months.[3] Melcher found that 42 healthy prematures reached normal size and proportions by 5 months but were retarded in postural control up to 18 months.[4]

[1] *Mental Growth of the Preschool Child,* The Macmillan Company, 1925.

[2] *Infancy and Human Growth,* Chap. XV, The Mental Growth of the Premature Infant, The Macmillan Company, 1929.

[3] SHIRLEY, MARY, "Development of Immature Babies during their First Two Years," *Child Development,* March, 1938.

[4] MELCHER, RUTH T., "Development during the First Two Years of

Physical Development.—The average infant at birth weighs a little more or less than 7 pounds and measures a little more or less than 20 inches. The circumference of his head, chest, and abdomen will be about the same and will be a little more or less than 13½ inches.[1] The arms and legs will be approximately the same length, in fact, the arms may even be longer than the legs. The trunk is approximately the length of the legs, while the head measures one-fourth of the total body length (see Fig. 166). The skin is red, but the average, normal, full-term infant is no longer wrinkled (see page 301). The infant retains the hunched-up fetal posture for some days. The fists are clenched. He tastes, but apparently he neither sees nor hears.

The transition from the uterus to independent existence is sometimes drastic. Goodenough says the hazards of being an infant under 1 month of age are double the hazard of being a soldier in the first World War.[2] This applies specifically, however, to cases in which the prenatal nutrition is poor, or in which infection exists in the mother's body, or in which birth is prolonged or difficult or complicated with the use of forceps or heavy anesthetic. In uncomplicated labor, with normal development of the fetus, the neonatal mortality is negligible. In fact, neonatal death rarely occurs in the service of modern obstetricians or in modern lying-in hospitals.

Behavior.—The human infant is born with a certain amount of behavior equipment, prepared and made ready in advance of function. Of all living young things, he is the most meagerly equipped with ready-to-use action mechanisms. The most elaborate behavior machine in the known universe, he lies in almost complete helplessness, awaiting the further completion of his structure through cell differentiation and the myelination and extension of nerve fibers (see page 211).

When the child is born, his autonomic mechanism is functioning, as is shown by the facts that his circulatory system is adjust-

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Children Prematurely Born," *Child Development*, Vol. 8, 1937.

[1] HOLT, L. EMMETT, JR., *Holt's Diseases of Infancy and Childhood* (see p. 21 for measurements at birth), D. Appleton-Century Company, Inc., 1934.

[2] GOODENOUGH, FLORENCE L., *Developmental Psychology*, p. 127, D. Appleton-Century Company, Inc., 1934.

ing itself to heat and cold through vasomotor constriction and dilation, and that his digestive system with its secretory glandular mechanisms is in fairly complete operation (see page 410). He can suck, swallow, sneeze, yawn, digest, urinate, and defecate. His sense of taste is the most actively functioning of all the senses and is fairly acute, accepting sweet and salt and refusing bitter and sour. The eliminative mechanisms—kidneys, bowels and skin—are abruptly thrown into gear with birth, and the entire subcortical, kinetic machine is removed from the placental shop where it has been under construction, placed upon its own base, and with the release of the respiratory button, so to speak, it enters upon its trial run as an independent organism.

The first behavior reaction of the newborn child is the so-called "birth cry." This marks the turning of the switch that diverts the circulation into new channels (see page 363) and releases the vocal mechanism that has so mysteriously been made ready for function. The stimulus to the birth cry is, in part, the release from the rather terrific intra-uterine pressure of the last stages of birth. This sudden release of pressure in itself causes the mouth automatically to open, thus admitting air over the vocal cords into the collapsed air passages and lung cells just as air rushes into a vacuum. The cessation of the placental circulation causes accumulation of carbon dioxide in the blood, which may act as a stimulus to reflex action. The inflation of the lungs, together with the impact of the relatively cold air upon the body surface, effects drastic and sudden adjustments in pressure and suction within the blood vessels.[1]

Random movements of the head, arms, and legs occur in much the pattern of the intra-uterine movements. Many observers think that these resemble swimming movements and attach recapitulatory significance to them. Dr. Myrtle McGraw of the Normal Child Development Study of Columbia University made a carefully controlled study of the behavior in water of 42 infants as recorded by motion picture and by notes. She reports:

> . . . The manifestation in the newborn infant of a rhythmical, coordinated, reflex movement simulating the aquatic movements of other

[1] "The body assailed by eyes, ears, nose, skin, and entrails all at once, feels it as one great blooming, buzzing confusion." William James.

newborn mammals suggests functional evidence of the phylogenesis of man. The maturation of the central nervous system is reflected in the sequential changes of aquatic behavior as well as in other types of neuromuscular activity common to the human infant. It is interesting that developmental changes in swimming behavior correspond in

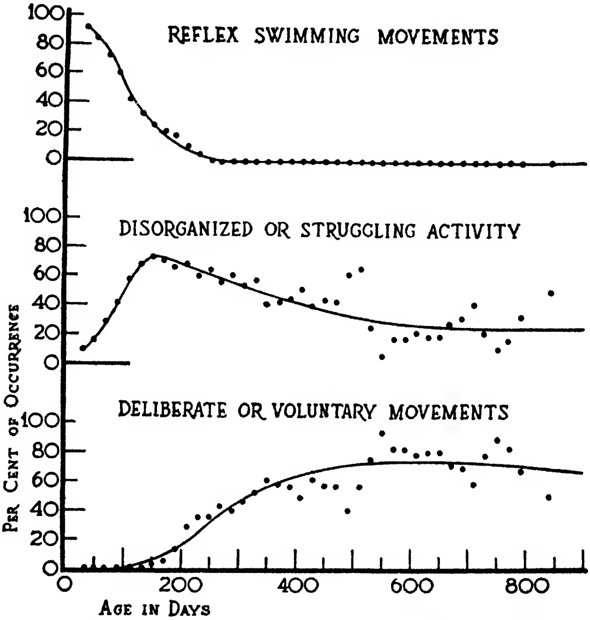


FIG. 102.—The incidence of three phases in the aquatic behavior of infants. (*Myrtle B. McGraw, Journal of Pediatrics, October*, 1939.)

chronological order to the major phases of other behavior patterns which also appear to be of phylogenetic origin.[1]

The pupils in the eyes of the newborn react to light. The knee-jerk (patellar reflex) is present. In most newborn, if the bottom of the foot is stroked, the toes spread and the great toe jerks upward (the Babinski reflex). This is considered significant, since the normal reflex, when the spinal reflex arc for this region is complete and intact, is for the toes to curl under. Within the first year the Babinski reflex normally disappears, showing that maturation of the centers has occurred, and it is never to be seen

[1] McGraw, Myrtle B., "Swimming Behavior of the Human Infant," *American Journal of Pediatrics*, October, 1939.

afterward except in the case of certain nervous disorders affecting the part of the spinal nerve cord in which this reflex center is found.[1] Recent observations under strictly controlled conditions show considerable irregularity in occurrence of the Babinski reflex,[2] and apparently in some instances it may be incidental or accidental, or maturation of the reflex arc may have occurred

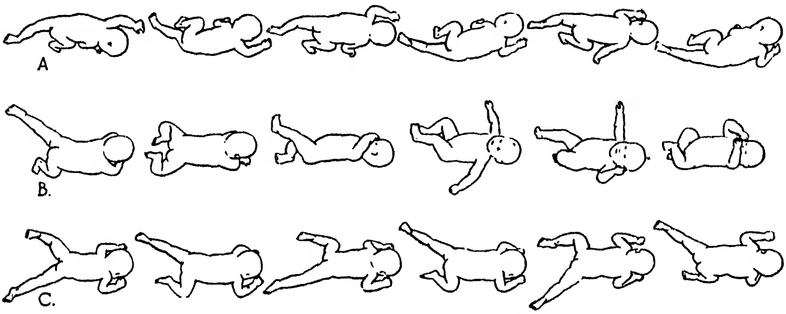


FIG. 103.—Line drawings representing three phases in the development of aquatic behavior of the human infant, corresponding to Fig. 102. *A*, reflex swimming movements; *B*, disorganized behavior; *C*, voluntary or deliberate movements. Traced from movie films. (*Myrtle B. McGraw, Journal of Pediatrics, October*, 1939.)

before birth in those instances in which the Babinski reflex never is seen.

If a rod is held under the toes, the toes curl round it but without much grasping force. If a rod or an adult forefinger is held within the palm of the hand, the fingers grasp it strongly, and the normal infant will suspend his entire weight from this support for several seconds or even minutes (see Fig. 104). Doctor McGraw, in a study of the suspension grasp of 91 children from birth to 7 years, finds a parallel between this and the swimming behavior (page 384). The phylogenetic-reflex period, 1 to 4 months; the transitional, 4 months to 2 years; the deliberate or voluntary period, from 2 years on. The infant, if laid upon its face, will turn its head to one side to enable it to breathe, and some

[1] WAGONER, LOVISA C., *The Development of Learning in Children*, pp. 54–55, McGraw-Hill Book Company, Inc., 1933.

[2] JOHNSON, BUFORD J., *Child Psychology*, Chap. III, Infant Responses, Charles C. Thomas, Publisher, 1932.

[3] MCGRAW, MYRTLE B., "The Suspension Grasp of the Human Infant," *American Journal of Diseases of Children*, October, 1940.

infants will even raise the head momentarily from the table. Mrs. Blanton observed certain infants who could turn over reflexly from face to back "almost from birth."[1]

If the nose is held, defensive, slashing movements of the arms occur, during which they may be directed with some force against the offending hand. If one leg is held immovable by a

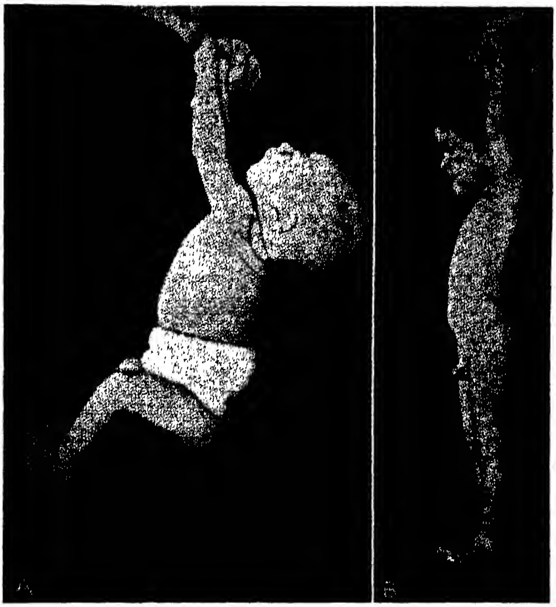


Fig. 104.—Photographs showing posture of children during suspension grasp behavior: *A*, reflex suspension of newborn infant; *B*, voluntary suspension of older child. (*Myrtle B. McGraw, Americal Journal of Diseases of Children, October*, 1940.)

hand against the knee, the other leg will kick violently, also *apparently* a defensive effort to remove the restraint.

Considerable attention is being given, at the present time, to the early *startle pattern* or *Moro reflex.* It is well known that, on sudden forceful stimulation, any organism experiences more or less complex involuntary reflex movement, or "startle." It is a comparatively recent discovery that this complex reflex, like every other sort of behavior, has a definite and characteristic pattern, which is determined by the normality and by the degree

[1] Blanton, Margaret Grey, "The Behavior of the Human Infant during the First Thirty Days of Life," *Psychological Review*, Vol. 24, 1917.

of development of the organism. In the infant the startle pattern, called the *Moro reflex,* is strongest during the first 90 days, during which time the brain cortex functions little, if at all, and definite cortical pathways are not yet established. The Moro reflex floods the autonomic system with energy and causes violent defensive reflex movements of the entire body. Between 90 to 120 days, as myelination of nerves proceeds (see page 206), these movements become greatly diminished and somewhat controlled, and by 210 days the startle pattern becomes much modified and assumes mature form.[1]

Miss Shinn reports that her niece evidently felt the difference between light and dark on the first day, turning toward the light. She thinks this is a pure reflex (phototropism), just as a plant turns toward the light. There was no evidence of seeing, she says, during the first fortnight. The eyes did not wink at passes made toward them, and the eye movements were not well coordinated. She says that her niece gave no evidence of hearing until the third day, when she was startled by the tearing of paper and other harsh noises.[2]

Watson and others believe that the child at birth shows fear of loud noises and of falling. More recent observers believe the reaction of acute discomfort interpreted as fear in these situations is really due to the violence of the stimulus rather than to its specific character, *i.e.,* the impact of the sound and the jolt of the drop actually cause physical pain, or at least acute internal organic disturbance.[3]

The tactile response of the newborn is fairly acute. A light stroke upon the cheek will provoke sucking, and a light stroke

[1] McGraw, Myrtle B., "The Moro Reflex," *American Journal of Diseases of Children,* p. 54, 1937; and *Growth, A Study of Johnny and Jimmy,* D. Appleton-Century Company, Inc., 1935; Hunt, Carney, and Landis, "Moro and Startle Reflexes," *Psychology Review,* May, 1938; "The Startle Pattern," *Journal of the American Medical Association,* Sept. 16, 1939.

[2] Shinn, Millicent, *The Biography of a Baby,* Houghton & Mifflin Company, 1900.

[3] Pratt, Nelson, and Sun report that, in the investigation of the responses to external stimuli of healthy infants during the first two weeks of life, they found no evidence of fear, rage, and love, nor even of the defense reactions reported by other investigators in this field. Pratt, Nelson, and Sun, *Behavior of the New-born Infant,* Ohio University Press, 1930.

upon the sole of the foot will produce typical plantar or Babinski reflex. The pain response, however, is not well developed at birth. Sherman reports that the infant gives no response to the single prick of a needle until some 18 hours following birth. Incidentally, the face is much more sensitive than the feet. Minor operations, such as circumcision, can be performed during the first few days without anesthesia.

Sherman's description of the appearance of behavior reactions tallies strikingly with the observations of Child, Coghill, and others as to head-tail gradients or "cephalic precocity" (see page 169) in experimental young animals.

The average number of stimuli necessary to produce a response is at all ages smaller for the face than for the legs. Sometimes infants less than six hours of age do not respond at all to as many as ten needle pricks on the legs. After five days every normal infant responds to a single needle prick on the face but until about the seventh day there is no response to a similar painful stimulus applied to the legs. . . .

. . . a biological explanation may also be given. Physiologists have shown that in many organisms metabolic activity, or the process of chemical change in living cells, is greater in the anterior than in the posterior end of the body. Increased irritability and rate of conduction of impulses accompany this increased metabolic rate. We have seen how, in the evolution from simpler to more complex animal forms, the anterior end began very early to assume dominance over the rest of the body.[1]

Experience as Training.—We have seen that life is ever a process of adjustment of the organism between internal and external conditions. Our child has been reacting to environment from the instant of his conception. The conditions of his prenatal life, however, were so ordered by nature as to be preeminently favorable to the development of his innate pattern, with minimum interference or necessity of adjustment to the very stable situation in his mother's womb.

With the birth of the child, however, external conditions become abruptly and enormously complicated. Both development and behavior begin to be affected in a highly variable manner by experience. The infant becomes, all at once, dependent

[1] SHERMAN, MANDEL, and IRENE CASE, *The Process of Human Behavior*, pp. 69–71, W. W. Norton & Company, Inc., 1929.

upon the knowledge or caprice of adult human beings for the management and control of his experience.

The newborn infant seems to have a relatively undifferentiated state of development, in which patterns of organization arise and are evidenced by his behavior. Pratt, Nelson, and Sun, who worked for several years on an elaborately controlled study of newborn children, state in their conclusions:

> The infant at birth represents an organism in which differentiation has proceeded to the point where there are many effectors and many receptors. Its behavior, however, is generalized, that is, stimulation of almost any group of receptors by almost any kinds of stimulus will lead to a response in almost any part of the organism. The reaction tends, however, to manifest itself most strongly in that part of the organism which is stimulated, and from there spreads out with decreasing frequency and intensity to the other segments of the body. This does not mean that the activity within any given segment is well coordinated . . . The new-born infant is equipped with quite a number of reflexes, but the degree of specificity and their significance seems to have been unduly exaggerated. For the most part these reflexes are vegetative (autonomic) in character, and even the others are in no way peculiar to human beings.
>
> Even within the first two weeks one may observe a restriction of the generalized reactions as indicated by . . . an increasing specificity in the reactions to stimuli.[1]

Irwin designates the first behavior as "mass activity," and notes the fact that the various stimuli all tend to produce general bodily movement.

> In seeking for an explanation of mass activity in new-born babies, it is here suggested that it probably lies in the immaturity of the nervous system. Our own view is a conservative one, set forth in the statement that the human infant during the first ten days is dominantly, although not entirely, a thalamic [autonomic] organism.[2] (See pages 203–219.)

Dr. Mandel Sherman reports that numbers of observers, such as students of psychology, nurses, and medical students, were

[1] Pratt, Nelson, and Sun, *op. cit.*, p. 208.

[2] Irwin, Orvis C., "The Amount and Nature of Activities of New-born Infants under Constant External Stimulating Conditions during the First Ten Days of Life," *Genetic Psychology Monographs*, July, 1930, p. 78.

hopelessly at variance in interpreting the cries and also the motor behavior of infants born in a certain hospital. The infants were subjected to needle pricking, dropping 2 or 3 feet, restraint of movement, and to hunger. The experiments were performed behind a screen, which was quickly withdrawn. From 9 to 15 different causes for the reactions to these four stimuli were named by the various observers, with no unanimity even among the nurses who were familiar with the infants. Dr. Sherman concluded that "most persons judge the emotional behavior of the individual in terms of the stimuli which have produced the reactions . . . rather than upon differences in overt behavior."[1]

Development during the Neonatal Month.—We have considered the relatively meager equipment of the newborn infant and have found that the reason for his great helplessness is chiefly the unfinished state of his nervous system. During the neonatal month he develops both physically and mentally at a rapid rate.

Dr. Gesell, who classifies development under the following heads—motor control, language, adaptive behavior, and personal-social behavior—describes the developmental norms for the age of one month as follows:

Motor development: (*a*) lifts head from time to time when held to the shoulder; (*b*) makes crawling movements when laid prone on a flat surface; (*c*) lifts head intermittently, though unsteadily, when in this prone position; (*d*) turns head laterally when in the prone position.

Language: (*a*) gives definite heed to sound; (*b*) has differential cries for discomfort, pain, and hunger.

Adaptive behavior: (*a*) stares at window or at massive objects; (*b*) gives visual heed to conspicuous moving objects; (*c*) gives transient visual regard to a red ring; (*d*) retains definite hold of the ring when it is placed in the hand.

Personal-social behavior: (*a*) makes tactually perceptible postural adjustments when taken up; (*b*) shows selective regard for the face.[2]

Miss Shirley, in her study of the motor development of 25 babies from birth to 2 years, reports that "all of the babies

[1] Sherman and Case, *op. cit.*, Chap. V, p. 142.

[2] Gesell, Arnold, *Infancy and Human Growth*, p. 128, The Macmillan Company, 1928.

went through almost the same series of reactions in approximately the same order." Their earliest reaction when they were in a prone position was turning the head to free the nose for breathing. During the first month most of them became able to lift the head so that the chin was free.

Miss Shirley records that newborn infants assume the fetal posture with knees hunched up, arms flexed, and hands close to chin, but that most infants have outgrown this stage within 3 or 4 weeks.[1]

Miss Shinn in her classic record of the development of her young niece says regarding the early behavior of her subject:

> Sensations had from the first the quality of being agreeable or disagreeable. The baby could not wish, prefer, and choose, for she had not learned to remember and compare; but also could like and dislike. And this was shown plainly from the first hour by expressions of face . . . A look of content or discontent, the monotonous cry, and vague movements of limbs, head, and features—these are the limits of expression of feeling in the earliest days. . . .
>
> Out of the new-born baby's dim life of passivity the first path was that of vision. I noticed about the end of the second week that her eyes no longer wandered altogether helplessly, but rested with a long and contented gaze on bright surfaces they chanced to encounter. . . . It was not active looking, with any power to direct the eyes, but mere staring; when the gaze fell by chance on the pleasant light, it clung there. But something must have come to pass, that it could stop and cling to what gave it pleasure.[2]

Miss Shinn regards this passive staring as the beginning of power to control muscular movements, and says that from the beginning of staring, irregular movements of head and eyes began to decline. During the fourth week Miss Shinn records what has the appearance of a conditioned reflex. She says her niece, when crying with hunger, would hush as soon as she was taken in the arms in the position usual to nursing.

Miss Bryan of the psychological laboratory of John Hopkins University observed in the maternity ward of the University of

[1] SHIRLEY, MARY M., *The First Two Years*, Vol. 1, Postural and Locomotor Development, p. 46, University of Minnesota Press, 1931.

[2] SHINN, *op. cit.*, Chaps. III and IV.

Maryland Hospital a number of children for 10 days following their birth. Miss Bryan describes the cries as becoming well differentiated during that period. She says, "The first cry may be entirely reflex but thereafter it very soon has the appearance of learning and of functioning as the expression of desire as well as emotion," and relates that infants as young as three days would cease crying on being lifted out of bed, before their wants had been given attention. Hungry babies when lifted up and placed back in their baskets would remain quiet with wide-open eyes for a time in apparent expectation of "the completion of the satisfaction of their wants which as such could only be ascribed to learning."

Miss Bryan's observations show that the eyes of newborn infants react to light within the first 5 days, and while an occasional infant will fixate a light or a bright or white surface for a period of time, the average infant does not follow a point of light with its eyes during the first 10 days.

She says that the average newborn infant gives evidence of hearing between the third and the seventh day, although not all respond to whistle and bell until after the first week. "Some infants give the appearance of listening to ordinary talking or crooning before the tenth day."[1]

The day after the child was one month old Miss Shinn tested her niece with a lighted candle and records that she followed it when it was moved slowly, and turned her head far backward to follow it.

Miss Shinn noticed an "awakening look, an access of attention, wonder, or intelligence" on the face of the baby at about the close of the first month of development, which indicated to her that a marked step in development had occurred. She advises all observers of infant behavior to watch for this significant sign.

Just before she was a month old came an advance in hearing. So far this sense had remained little more than a capacity for being startled or made restless by harsh sounds. I had tested it on the twenty-third day, and found that the baby scarcely noticed the sound of an ordinary

[1] Bryan, Edith S., "Variations in Responses of Infants during the First Ten Days of Postnatal Life," *Child Development*, March, 1930.

call bell unless it was struck within about six inches of her ear and suddenly and sharply at that; and on the twenty-sixth day she showed no sign of hearing single notes of the piano, struck close to her, from the highest to the lowest. But the next day, at the sound of chords, strongly struck, she hushed when fretting with hunger, and listened quietly for five minutes—her first pleasant experience through the sense of hearing. . . .

The first smile that I could conscientiously record occurred the day before the baby was a month old, and it was provoked by the touch of a finger on her lip; and a day or two later she smiled repeatedly at touches on her lip. The day before she was a month old, also, when her lips were brought to the nipple, she laid hold upon it with them—the first seizing of any sort, for her hands were still in their original helplessness, waving vaguely about at the will of the nerve currents.[1]

Margaret Curti describes the development of Ann at the age of four weeks thus:

When she is held, talking alone, without caressing, produces jolly grin, lips and eyes forming half-moons. Smile sometimes quite crooked! Cooing at such times is first noticed this week. Follows with eyes and head the face of a person talking and moving in room. Enjoys bath greatly, kicking and making little sounds.[2]

Irwin says vocalization in crying or cooing is only a feature of the mass activity at this early stage of development.

Vocal sounds frequently are components of mass activity. That is to say, new-born infants under ten days rarely make a sound unless it is accompanied by overt body activity. The only exception seems to be faint throat sounds such as gurgling. Crying accompanies mass activity. In the adult, crying, is generally limited to certain muscle groups of the thoracic, throat, and mouth regions. In the new-born, as has been suggested, when crying occurs, the head rolls, the mouth is opened wide, the body twists, jerks, bends, and is thrown about, the arms slash, and the legs kick. It is therefore suggested that crying probably is a component of mass activity.[3]

Neonatal Training.—As we consider the achievements of our month-old infant we are impressed with the fact that he is

[1] Shinn, *op. cit.*, Chaps. III and IV.

[2] Curti, Margaret Wooster, *Child Psychology*, p. 34, Longmans, Green & Company, 1938.

[3] Irwin, *op. cit.*, p. 68.

"learning." Out of the undifferentiated "matrix" or "ground" of consciousness, the baby has come to be aware of the "qualities" of light and sound and mass; and of comfort in the way of softness, warmth, and freedom of movement. He has begun to react to total situations, such as the bringing of his bottle or being picked up for nursing or changing of a wet diaper, and to sense a vague, general satisfaction in the bodily contact and nearness of a protective human being, and shows agreeable response to change of position.

In the light of the contributions of biological research to our understanding of child development we can imagine that we see completion of reflex arcs through corresponding increments of growth extending infinitesimal but important contacts between nerve and brain mechanisms.

The very common observation that infants of a few days or a few weeks of age cease crying when picked up and that they apparently "cry to be taken up" needs further careful research. It is not consistent with the accepted descriptions of the brain and nerve development of the infant at this age to assign to him deliberate purposeful action involving complex cerebral associative memory. *Desire* is scarcely a proper term to apply to a nonintelligent organism. The more rational assumption would be that the infant is more comfortable in arms than he is when lying down, and it would seem to be more reasonable to try to find out why he prefers arms to his bed, råther than to enter into disciplinary conflict with him at this tender age.

Since not all infants do show this particular behavior reaction, it seems reasonable to assume that the fault lies in the situation rather than in the planned behavior or innate perversity of the child. Watson and many other writers on child management assume that the infant has become "conditioned" to his mother's arms and "established a habit" of being taken up. If this be true, we still have to analyze the factors entering into this new association field. What makes the process of being taken up so satisfying to the infant? Response to warmth and softness is not the entire reason, for the child stops crying when he is lifted but not fondled, and the arms in question may be less soft than his bed. Fatigue, muscle tire, heat from the bed, irritation from clothing, restricted movement, and nervous irritability from too much handling, all may be factors in the situation. Simply picking up the child breaks tension, however, whatever causes it, and may account for the cessation of crying, which is promptly resumed unless the discomfort is relieved.

The fact that the infant who is normally vigorous, whose food and feeding intervals agree with him, and who, therefore, has no internal disturbance, who has not been subjected to excessive and unnecessary handling, and whose movements are not hampered, seldom manifests this behavior problem, should make us cautious about adopting the "let-him-cry-it-out" policy. There certainly should be a very careful and minute study of each total situation with an attempt at better adjustments to the physiological needs of the particular child. This study should also include careful research on the part of child-development specialists to determine the actual effect of prolonged crying and discomfort upon the plastic nervous structure of the young infant.[1]

Adjustment to a schedule is the major training problem of the neonatal period. This means that both mother and baby do some adapting—it seldom is a matter of laying off a rigid conventional schedule and having the baby adapt to it at once. It is a matter of observation that a normal infant will tend to accommodate himself to any regular schedule of feeding and care which provides for his physiological needs and renders him comfortable, but he is likely to require some time for this. This is the reason why babies formerly thrived on 2-hour feeding schedules and now thrive on 3- and 4-hour schedules, largely at the caprice and preference of the attending physician. Almost any baby will, after a time, obligingly learn to start the day at either 6 or at 7 A.M. to suit the convenience of the family, provided that the rest of his schedule is so adjusted that he is made comfortable during the remainder of the 24 hours. He must be given time to make the complete 24-hour shift.

The first item of training, therefore, is the adaptation of schedule to baby and baby to schedule. This is easy or difficult in the first place according to how well the schedule does meet the needs of the child and how regularly and consistently the nurse and the

[1] McLeod, Ruth Peck, "Shall We Let the Baby Cry It Out?" *Hygiea*, January, 1939.

mother carry it out. As stated earlier in the chapter, temporary conditions may require temporary adjustment in any program; complete inflexibility may be as detrimental as irregularity.

The adjustment of the schedule to the baby requires nicety of judgment and intelligent observation on the part of both physician and attendant. Under correct conditions of warmth, quiet, bodily freedom, and good air, the normal infant will adjust to his feeding schedule within a few days if the schedule meets his needs. *Continued crying on the part of a neonatal infant should not be ignored.* The fact that many infants survive prolonged periods of active protest against conditions does not justify the assumption that "it is the nature of babies to cry," and that "it will do him no harm to cry," or the still more dangerous assertion that "it is good for them to cry."

It was stated in standard baby books, a few years ago, that after one had made certain that pins did not prick and that the baby was dry, he should be left to cry it out, provided that he did not cry for "longer than one to two hours at a time." This is not only inexcusable cruelty but presents the possibility of serious neglect of conditions that escape recognition by the untrained parent.

It cannot be stated too emphatically that babies do not cry continuously "for exercise." Young parents are in the right when they take prolonged crying seriously and demand that the doctor try to find and remove the cause. Some infants—even vigorous, normal neonates—go through a period of initial physiological adjustment of the mechanisms of peristalsis, secretion of digestive fluids, establishment of normal intestinal flora (the bacteria essential in normal intestinal chemistry), etc. These infants may have brief but violent paroxysms of crying some time after each feeding, regardless of food or method. Even after the most careful efforts on the part of the doctor to correct the situation, there sometimes seems to be little to do except to "worry along" until the infant outgrows the difficulty.

Any crying infant should be under a doctor's observation, but parents should not become fussy or hysterical if it seems impossible to relieve the situation at once, if only the infant does not lose weight or appear ill. Especially, they must not permit themselves to handle the infant, walk the floor with him, and give way to agitation. Neither should they shut the door and leave the helpless child alone; too many accidents can happen to a struggling infant.

Frequently, the cause of early crying is the fact that the food is not satisfactory as to quality or quantity. One infant who had cried almost continuously for 6 weeks went to sleep as soon as the second pediatrician, called by the exhausted parents, had merely filled his stomach by adding a supplementary bottle to the breast feeding. Another infant was kept rigidly on a 4-hour schedule because he never completely emptied his bottle. Although he did not gain in weight, and although he cried vigorously from 30 to 40 minutes before each feeding, it did not occur to the doctor that this particular child could not hold enough food to last him for 4 hours.

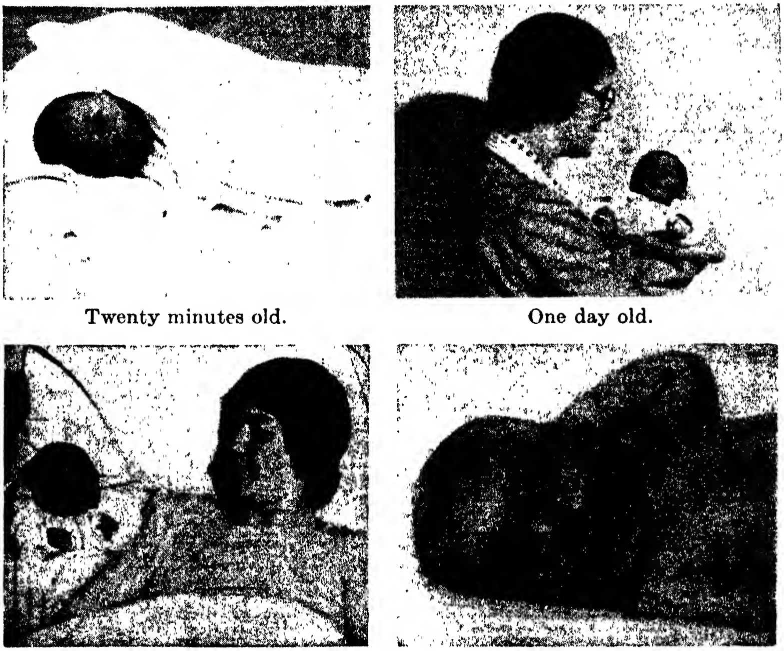
The adjustment of the feeding schedule is of primary importance in the habit formation, conditioning, nervous organization —in short, the training of the newborn child. Nutrition is his outstanding need for the growth and completion of his body, including his brain and nervous system.

Apart from food, the neonatal infant needs quiet, body warmth, and especially bodily freedom. The transition from the uterus to the conditions of the world should not be too abrupt. The intelligent nurse or mother will try to "follow the lead" of the child's behavior and provide him with quiet and softness and warmth for his body during the days in which he is going along with very much his prenatal program. He should be handled with gentleness and carefully protected from artificial stimulation and unnecessary handling.

There are individual differences among infants in responses made during the first ten days. In some cases responses expected on the second day do not appear even by the tenth day. For some infants the sucking movements are slowly established and only by reinforcement of the lip stimulation. Other things being equal such as nutritional state, freedom from physical defects and infections, and external conditions, it would seem that differences in structure of the organism, including the nervous system, would determine such variations from expected behavior. . . . The early formation of habits, by gradual selection from the characteristic diffuse activity of the infant of specific responses to particular situations, is shown by the majority of the studies.

The implication of these findings for guidance in child development merits special consideration.[1]

Summary.—We see in the newborn child the most helpless, unfinished young creature in all nature. Normally he leaves his mother's body as soon as his machinery of growth becomes able to function, *i.e.*, when he is able to taste, swallow, digest and



Twenty minutes old. One day old.

Four days old. One month thirteen days old.

FIG. 105.—The neonatal month.

assimilate food, and eliminate waste. He can withdraw from pain and cry from discomfort. He can breathe and can sneeze to protect his breathing passages. He has urges to move his body as a whole but cannot move any one part separately. He cries all over, sucks all over. He is only vaguely aware of environment. His cerebrospinal nervous system is developing from head toward feet (cephalocaudad) in the general pattern

[1] JOHNSON, BUFORD J., *Child Psychology*, pp. 120–121, Charles C. Thomas, Publisher, 1932.

of his fetal growth. His senses of pain, of sight, and of hearing are poorly developed at birth.

Nature has developed the brain and the vital organs within the protective but restricted space of the placenta and the uterus, has kept the arms and legs at a minimum size; indeed, at birth they are quite useless rudiments. He probably has no specific emotional reactions or differentiations, and his social communication is solely through the very efficient medium of the undifferentiated cry.

By the end of the neonatal month a marked amount of development and differentiation has taken place. The infant is like, yet unlike, other human infants. He reacts to environment in predictable ways, yet he already shows a personality of his own. He projects his own dynamic field upon the composite domestic situation. From now on there must be continuous mutual adjustment of child to situation and situation to child. The parents are going to need both wisdom and perspective if they succeed in doing this wisely and well. The child, even at one month, needs a variety of experience in exposure to light, sound, and touch. He is already making the acquaintance of his environment. He already is taking on "education" in the way of adjustments to his world. He is already a personality to be studied and, above all, to be respected.

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"You merry little roll of fat."
The Bacchante to Her Babe

. . . .
Sprite, you are love, and you are joy,
A happiness, a dream, a toy,
A god to laugh with,
Love to chaff with,
The sun come down in tangles gold,
The moon to kiss, and spring to hold.

There was a time once, long ago,
Long—oh, long since . . . I scarcely know . . .
Almost I had forgot . . .
There was a time when you were not,
You merry sprite, save as a strain,
The strange dull pain,
Of green buds swelling
In warm, straight dwelling
That must burst to the April rain.
A little heavy I was then,
And dull—and glad to rest. And when
The travail came
In searing flame . . .
But, sprite, that was so long ago!—
A century!—I scarcely know.
Almost I had forgot
There was a time
When you were not.

So, little sprite, come dance with me!
The sun is up, the wind is free!
Come now and trip it,
Romp and skip it,
Earth is young and so are we.
Sprite, you and I will dance together
On the heather,
Glad with all the procreant earth,
With youth and hope and life and love,
And joy thereof—
While we are part of all, we two—
For my glad burgeoning in you!

So, merry little roll of fat,
Made warm to kiss and smooth to pat
And round to toy with, like a cub,
To put one's nozzle in and rub,
My god to laugh with,
Love to chaff with,
Come and dance beneath the sky,
You and I!
Look out with those round wondering eyes,
And squirm, and gurgle—and grow wise!

EUNICE TIETJENS, from *Body and Raiment*, by permission of and special arrangement with Alfred A. Knopf, Inc., authorized publishers. From *Poetry*.

CHAPTER XXIII

THE BABY'S FIRST YEAR: FEEDING AND CARE

Getting Acquainted.—There is no more joyous human experience than getting acquainted with a new baby, when the parents permit themselves to enjoy him and do not take him too seriously. This means that they will inform themselves as to approved care, lay out a carefully planned regimen, and proceed to treat him as a personality and with the same casual consideration with which a wise host treats a valued guest.

To express this in terms of "field philosophy," the parents during their married life should have succeeded in consolidating the "fields" of their two personalities into one harmonious domestic unity, an integrated field within which each still maintains his own orbit, his own axis of individuality, as electrons and protons spin on their own axes within the unity of the atom. A new field force is now brought into the "physical system" of the family. The entire set of goals, tensions, interests, habits, dynamics is altered by the advent of a small but powerful individual. An entirely new setup emerges—a new *field contour of the family. A new molecular configuration is formed* as definitely, and by the same laws of integration, as when two atoms of hydrogen unite with one atom of oxygen to form water. The three personalities must form an organic whole; new qualities will ever emerge as each personality grows, and continual adjustment or integration is necessary.

In the imagery of the atoms, the electrons of each personality must keep in their orbits, otherwise individuality disintegrates and atoms fly apart, but the valence electrons of each must link into the valences of the rest (see page 36) or there will be no formation of a really organic family structure; there will be only a loosely combined "mixture" (see page 29).

The core force, the master nuclear energy of *affection,* promptly determines the first field properties of the new order. Each day's situations must be met by the parents with wide, farseeing perspective. Family groups organized upon these intrinsic principles are those that endure and grow and live above petty conflict, that develop a sturdily centralized domestic life able to withstand the inevitable frictions and trials inherent in any living.

The modern science of human development tells us that every act of a child is significant; therefore we will not chide the parental pair if they do spend much time watching the marvels of his growth. We want them to do this happily but quietly, without ever making him too much aware of their studious observation.

The poem placed at the beginning of this chapter was selected because it expresses the spirit of a parenthood that receives the child as a joyous companion, rather than as an object of anxious sentimental solicitude.[1] We hope the parents of the child who is the object of our study are going to find him a perpetual adventure, an unfolding romance, "continued in our next" from day to day.

Budgeting the Baby into the Day.—The first real temptation to worry, and probably the first cloud upon the joys of parenthood, comes when the trained help leave the young parents to their own devices. Under ideal conditions the mother gets about and assumes her regular duties only as fast as strength and inclination dictate. Sometimes, however, she comes back from the hospital and finds no one but herself to run the household and to do the necessary work, or, if she is confined at home, the nurse and household help may soon be dispensed with because of the cost, or leave because they have other engagements, and thus a critical situation arises. *Baby must have regular care and abundant breast milk, which depends directly upon the food, rest, mental attitude, and sleep of the mother.* Very radical adjustments may be necessary in both personal and family schedules in order to accomplish this. The baby must be budgeted into the

[1] Eunice Tietjens (Mrs. Cloyd Head) writes: " 'The Bacchante to Her Babe' was written in spirit of revolt against what seems to me the unhealthy attitude so many mothers have towards their babies . . . . p.s. The 'sprite' of this poem is now married." (Mrs. Head, of course, does not mean that the baby is to be considered literally "a toy" in the sense of a "plaything," but rather in the sense of something to be fully enjoyed.)

days' routine, and the mother must make out a work schedule so planned and systematized that every necessary activity will have its time and place, and also so arranged that she herself will have regular and sufficient rest and sleep.

The Baby's Schedule.—The items of the schedule will depend upon the family breakfast hour and other meal hours, the number of breast feedings per day, and other variable factors. For an average family which has breakfast at 7:30, lunch at 12:30, and dinner at 6:30, and where the baby is on a 3-hour feeding schedule, in which the mother does all the work for a five-room house or apartment except the weekly cleaning and heavy laundry, the average daily schedule would probably run somewhat as follows:

6:00 A. M.	Nurse baby while in bed.
6:30	Rise, bathe, dress, prepare breakfast.
7:15– 7:30	Eat breakfast.
7:30– 8:30	Do morning kitchen work, plan meals.
8:30– 9:00	Prepare bath, bathe baby.
9:00– 9:20	Lie down and nurse baby.
9:20–10:00	Tidy up rest of house, make beds, etc.
10:00–10:30	Wash baby's diapers and other clothes.
10:30–11:00	Read mail, get out of doors.
11:00–12:00	Prepare lunch, also dessert and vegetables for dinner.
12:00–12:20	Lie down and nurse baby.
12:20–12:30	Put lunch on table.
12:30– 1:00	Eat lunch.
1:00– 1:30	Clear table and wash dishes.
1:30– 3:00	Rest, make afternoon toilet, wheel baby out of doors, go to market, etc.
3:00– 3:20	Lie down and nurse baby.
3:20– 5:00	Varied employment—ironing, sewing, gardening, calling, etc.
5:00– 5:45	Prepare dinner.
5:45– 6:00	Prepare baby for night.
6:00– 6:20	Lie down and nurse baby.
6:20– 6:30	Serve dinner.
6:30– 7:00	Eat dinner.
7:00– 7:30	Father and mother wash dishes.
7:30– 9:00	Evening pleasures.
9:00– 9:30	Prepare for bed; nurse baby.

The diaper should be changed when necessary. The baby should also be offered water several times during the day, and his position changed occasionally. The very young baby sleeps most of the time, so there really is little to do for him except the routine items mentioned. As he grows older and becomes active and playful he will require more attention.

According to the above schedule, 2 hours are required for six 20-minute periods of nursing. If the mother lies down in a relaxed position, as she should, this total of 2 hours' rest will conserve her strength greatly. In addition to this time, at least another 2 hours will be consumed with the baby's bath, laundry, changing diapers, etc. If time is spent in wheeling the baby out, this must be added. However, the only excuse for this is that the mother herself gets out into the sun and air. As far as the baby is concerned, the buggy or baskets may, and should, be placed in a favorable spot on porch or lawn without waiting for the mother's leisure.

Mrs. Lucille Rust of the Kansas State Agricultural College has made an investigation of the time actually consumed in the care of infants under one year of age, all of whom were receiving modern standard care. She found the average daily time spent by the mother and helpers in the care of these infants to be 5 hours and 20 minutes, averaging less for younger than for older children, while the fathers included in the investigation spent a total average of 18.6 minutes per child per day. She found the number of times diapers were changed averaged eight—oftener for young infants. The younger mothers spent more time than mothers having other children.[1]

The above schedule does not make unreasonable demands upon the time or strength of any normal, healthy woman. The period of strain is the first day and the first week when this new routine is getting under way. The new mother feels tense and possibly worried lest she should not be able to meet the needs of the situation. She becomes too tired the first day; this reacts upon the milk flow; the baby is not satisfied and frets. Neither mother nor babe sleeps well and the next day is made difficult. The mother has less appetite and the baby more, a situation which may go on piling up fatigue for the mother and nutritional upset for the baby if the cause is not recognized and the proper adjustments are not made. *All of this can be much more easily prevented*

[1] Rust, Lucille Osborn, *A Time Study of Infant Care*, unpublished thesis, Kansas State Agricultural College, 1925.

than corrected. The new father is usually willing and anxious to be helpful during the first days of adjustment, and he will usually be glad to get the breakfast. The dishes may all be scraped and covered and left until evening, when "Father" will help do them. Usually a high-school girl can be secured to assist after school. She can do the baby's washing and help with the dinner and the dishes. The regular schedule of the baby and the mother's health must have the right of way, but this must not entail confusion and disorder and the piling up of work and worry for the future.

The adjustments of the first week of the mother's return to her daily activities determine in the great majority of instances whether or not the baby will be a good baby. He will be a good baby and a healthy baby if he is placed upon a schedule that is perfectly adjusted to his own individual needs and if nothing is permitted to interfere with the rhythm of this schedule after his organs, nerves, and glands have set themselves, like well-adjusted clockwork, to the regular program.

Breast Feeding.—With very, very few exceptions, every mother *can* nurse her baby. With almost no exception, every mother *should* nurse her baby. The few instances in which the mother is so out of health that she cannot or should not nurse her child are rare. In rare instances the mammary hormones (see page 144) fail to stimulate normal functioning of the milk glands and occasionally this occurs in well-developed, healthy women who are anxious to nurse their babies. Artificial feeding should certainly never be resorted to without explicit orders from the attending physician.

Reasons Why Every Mother Should Nurse Her Child.—(1) The sucking at the breast stimulates the uterus to contract, prevents hemorrhage, makes the uterus return more rapidly to normal size, and causes it to drain effectively and thoroughly. (2) The mother who nurses her baby will be less likely to have pelvic trouble and premature return of menstruation. (3) Nursing a child is one of the richest spiritual experiences that come to any woman, and no normal woman could wish to miss it.

Reasons Why Every Baby Should Be Breast-fed.—(1) Mother's milk is the one and only food prepared by nature for the exact and particular needs of the human baby. *No perfect substitute* *has yet been devised.* (2) *Mother's milk is always sweet and clean* and cannot become contaminated in any of the dozens of ways in which artificial food may become unsafe. (3) *It is always the right temperature.* (4) *It belongs to the baby. It is his food* prepared by nature at this time for his special, personal use. No mother who realizes what she is doing will take the one rich, right, and suitable food out of her baby's mouth and substitute an uncertain imitation if it can be avoided. (5) *More bottle-fed babies die in proportion than do breast-fed babies.* This is not so true in the case of modern pediatric feeding, but even the best specialists have many problem cases because of the difficulties entailed in successfully replacing breast milk.

Feeding during the First Three Days.—The baby's stomach and bowels are not ready for milk for several days after it is born. The mother's breast contains fluid (*colostrum*) which is just what the baby needs to clean out his digestive tract and make it ready to digest milk. Colostrum contains protein globulin and is rich in potassium and sodium chloride; it contains less sugar and fat than does milk. It contains all of the known vitamins, and is believed to contain some protective antibodies.[1] It is a serious mistake to give the baby anything else except a little boiled water before the milk flow starts, unless ordered by the physician. Nature has made no mistake in delaying this for 2 or 3 days.

Before the milk flow starts, the baby should be put to the breast regularly every 4 to 6 hours during the day, as directed by the physician. If mother and baby rest well, it need not nurse at all at night; surely not more than once. Dr. Wayne Rupe says, "Put the newborn baby to the breast within 4 to 6 hours following birth and every 4 hours thereafter."[2]

Causes for Delayed or Insufficient Milk Supply.—Delayed or insufficient flow of milk may be due to (1) severe labor and delayed convalescence; (2) worry, loss of sleep, nervous excitement; (3) too hard work before confinement; (4) getting up too soon and working too hard after confinement; (5) insufficient or improper diet during pregnancy and lactation; (6) glandular imbalance. Rest, quiet, sleep, and careful feeding will overcome the effect of all these causes in most cases.

[1] Holt, L. Emmett, Jr., *Holt's Diseases of Infancy and Childhood*, D. Appleton-Century Company, Inc., 1936.

[2] Rupe, Wayne, *Lectures on Pediatrics*, University of Kansas, 1928.

If the lying-in mother does not have proper rest, sleep, or food, so that her body can manufacture good milk, sometimes nature protects the baby, and the tired, undernourished mother makes good milk, but becomes run down and loses weight and strength herself. Sometimes nature protects the mother and takes the shortage out of the baby's milk supply. Either situation is a tragic mistake. Sometimes the opposite situation occurs, and the mother overeats in an excess of zeal and in a conscientious endeavor to carry out everybody's suggestions as to what she should eat and drink. She naturally develops indigestion, as a result of which she cannot eat. The rest of both mother and babe is broken; everything is upset; the flow of milk slackens; the baby is fretful and loses weight. It may appear to the family or even to the doctor that artificial feeding is indicated. Every effort should be made to restore the milk oroduction to normal before resorting to the bottle.

The young mother often makes too hard work of caring for herself and her babe. She needs only to practice the simple general laws of health, including regularity, a balance in sleep, exercise, and food; *to keev serene and turn a deaf ear toward neighborhood council!*

Other Causes for Failure to Nurse a Child.—Other reasons why a mother may not succeed in nursing her child include (1) sore breasts, (2) inverted nipples, (3) the baby's refusal to nurse, (4) milk disagreeing with the baby. The first and second causes may be prevented, in part at least, by proper treatment of the nipples before confinement and at the beginning of nursing (see page 321). If the nipples do become excessively tender and the baby sucks vigorously, it may be necessary for a short time to withdraw the milk with a breast pump and give it to the baby in a bottle or with a medicine dropper. During the first 3 days of life the time of each nursing should be limited to a few minutes. The baby should not draw on an empty breast, as this bruises it unnecessarily. A nipple shield is sometimes successfully used when the nipple becomes sore. This is a mask made of rubber, lead, or glass, which fits over the nipple and protects it somewhat from the terrific squeezing of the baby's sucking muscles. These, any mother will agree, are the strongest muscles in its body. The nipples should be kept clean, dry, and sterile (see page 377).

If the baby refuses to nurse, it may be the fault of the attendant. The baby will practically always nurse if put to the breast promptly and regularly. The nursing instinct is very strong at birth, but it may fade if not used. If a baby has not been put to the breast reasonably soon after birth or if he is given a bottle before the breast, it is sometimes difficult to teach him to nurse. Squeezing a few drops of milk from the nipple will sometimes bait him to grasp it. Giving the baby sweetened water or other liquid before placing him at the breast may be the cause for his refusal. One child who preferred the formula that had been given him before he was given the breast was tricked into accepting the nipple by wetting it with the formula. Very rarely it happens that a baby is born tongue-tied and cannot nurse. If there is any suspicion that he cannot nurse rather than that he will not, he should be examined by the physician.

If the Milk Disagrees.—As to the fourth reason for failure to nurse the baby, it is very, very seldom that a mother's milk disagrees with a baby for more than very temporary reasons, such as indigestion, anger, nervous excitement, etc., on the part of the mother, or still more rarely, in case of actual illness of the mother. Nature protects the baby in many wonderful ways, and one of these is that the mother's milk remains unchanged through many kinds of severe illness. Very rarely the mother's milk may lack proper balance in protein, carbohydrate, or fat. The child's symptoms and the analysis of the milk will clarify this, and adjustment of the mother's diet will usually correct it.

Sensitization.—Once in a long time a baby is "sensitized," or "allergic," to some protein in the mother's diet. In such a case the infant will have colic or rash every time the mother eats certain foods. It is now possible to determine whether sensitization exists and which article of food it is that is responsible—eggs, beef, berries, or other allergens. When this condition exists the indigestion or rash will be promptly relieved by omitting the harmful article from the mother's diet. The matter is one for careful medical diagnosis. No mother should experiment with her diet or that of the child.

Intervals between Breast Feedings.—The doctor should always be asked how often the baby should be fed, from the time the milk flow comes. A weak, delicate baby will need to be fed oftener than a strong one because it cannot take so much or digest so much at one time. When the baby is hearty and strong, most physicians recommend feeding not oftener than every 3 hours, and some advocate 3½- to 4-hour intervals from the start. Occasionally even a healthy, vigorous infant cannot take or hold enough food to last for 4 hours. He will take all he wants but will fret and act hungry before the expiration of 4 hours. The feeding interval should then be shortened.[1] No baby should be fed oftener than once during the night, and many do well with no night feeding from the outset.

A good 3-hour schedule is 6, 9, 12, 2, 6, 9. One feeding about 2 A.M. may be necessary for the first 6 or 8 weeks. At about the age of eight weeks or before, a well-fed infant ceases to waken at the usual time. If it wakens later, it can usually be tided over until near the 6 o'clock feeding by having warm water from a bottle. A few mornings will be needed to make the complete adjustment. The night feeding may usually be dropped and the interval between the feedings gradually lengthened until at six months the schedule is 6, 10, 2, 6, 10.

Length of Time at Breast.—Much positive advice has been given to the effect that no baby should be permitted to nurse longer than 20 minutes at a feeding. As a matter of fact, few things require more common sense and careful judgment than this, and each baby should be individually studied. As a rule, if the 3- or 4-hour period is observed the baby should nurse as long as he wants. If he has not been spoiled, he will be the best judge as to when he has had enough. There is so much difference in the rate of flow of milk, size of nipple openings, and nursing grasp of the child, that it is manifestly unjust to say that all babes should nurse for the same number of minutes. The child should be kept awake and busy and not permitted to sleep or idle at the breast. As a matter of fact, it seldom takes a normal child 20 minutes to fill his stomach. Usually he will be satisfied within 10 minutes.[2] If he clings to the nipple for 20 minutes he is not satisfied, and it should be determined as to whether or not he is getting a sufficient amount of milk.

[1] HOLT, *op. cit.*, p. 137.

[2] "The Duration of Breast-milk Feedings," Editorial, *Journal of the American Medical Association*, Jan. 13, 1923.

Most physicians now favor longer intervals between feedings and longer periods of nursing than was customary a few years ago. *But this must be carefully adapted to the individual child.* It must always be remembered, whatever the interval, that the baby must be fed regularly and that its stomach must have some rest between every two feedings.

Water is as important as food. Cool (not cold) boiled water should be offered to the baby between feedings at least twice per day and, in very hot weather, between every two feedings during the heat of the day.

How to Nurse the Baby.—The busy mother should always lie down to nurse her baby. The baby should be placed so that he can breathe easily and not be crowded. The mother should have a pillow against her back and utterly relax (see Fig. 100). *Twenty minutes of absolute rest every 3 hours will do much to conserve her strength.* If the mother sits, she should use a low, comfortable chair. A pillow on the lap enables a woman to sit up straight and without strain while holding a baby at the breast.

How to Tell How Much Milk the Baby Is Getting.—The baby may be weighed just before and just after each nursing for one full day, on a scale that weighs accurately in ounces and fractions of an ounce. Each amount should be recorded and all added together. An ounce of milk by measure weighs about an ounce. The total amount should be approximately the same as that allowed for artificial feeding, on page 695.

The Baby's Toilet. *The Bath.*—The baby should be bathed at a regular time daily. Just before the second feeding is usually the most convenient time. He may have a daily tub as soon as the navel is healed.

A foot tub, an infant's bathtub, or an oval dishpan may be used, with a folded towel over the bottom to keep the baby from slipping. Many mothers now use one of the several folding "bathanettes" on the market; these are convenient and take up little space. A low table is more convenient than the lap for handling the baby, although some mothers prefer to handle the baby on the lap. If the table is used, the right end of it should be padded with a heavy bath towel or some other soft pad. If the mother is right-handed, the tub is placed on the left end of the table. If the mother finds it more convenient to handle the baby on her lap, she should wear a rubber apron and spread a large bath towel over her lap, having the tub placed on a stool, a chair, or a low table in front of her. On a chair or a stool near by is placed the toilet tray or basket, containing soap, boric acid for the eyes, Vaseline for the nose, cotton pledgets, the glass of sterile cotton swabs on toothpicks, talcum powder, etc. On the drying rack, also near by, should be hung the baby's washcloth, face towel, and clean clothes. The toilet of the head should be made first, then the toilet of the genitals and navel. Small bits of sterile cotton or gauze should be used and discarded as used. In the male child the foreskin should be retracted and secretions gently removed. In the girl child the labia should be separated and the parts cleansed with cotton.

Care of Eyes, Nose, and Ears.—The baby's eyes should be cleansed with pledgets of cotton or sterile gauze wet in boric-acid solution or boiled water. *A separate piece is used for each eye and then thrown away.* The eye should be wiped from the inner corner toward the outer corner, without forcing it to open. *The baby's nose should be let alone* unless there is some discharge or inflammation. Then the nostrils are cleansed very gently with small, sterile cotton swabs wound on toothpicks, or twisted pledgets of gauze or cotton dipped in sterile Vaseline or oil. The cotton must extend well beyond the end of the toothpick and the swab should not be large enough to require force in inserting it in the nostril. *Force must never be used, and no preparation other than plain sterile oil or Vaseline should be put in an infant's nose without a doctor's orders.* Infants sometimes show undesirable reactions to nasal preparations containing menthol, eucalyptus, and other drugs that are used with benefit by adults and older children. It should also be remembered that powder may be accidentally inhaled with disastrous and sometimes fatal consequences. The baby should never handle the powder can.

The external ear should be cleansed very carefully with a toothpick swab or cotton pledget dipped in clean water and then dried with a dry bit of cotton. *One should never attempt to cleanse the* *inside of the ear canal.*[1] *The inside of the mouth should never be touched except under instructions from the doctor.* Nature keeps the mouth of the nursing infant sweet and clean. To force one's finger about the delicate tissues is certain to cause irritation and can do no possible good.

The face is gently washed with a very soft cloth and thoroughly dried. It will seldom or never be necessary to use soap on the face. The scalp is next soaped and rinsed and dried very thoroughly but gently. The baby's scalp should be bathed daily, as sebaceous secretions easily collect and form the so-called "scale," or "cradle cap." If scale should occur, sterile Vaseline may be rubbed on at night and shampooed in the morning. Scale should never be combed off, for this irritates the scalp and may provide entrance for infective germs. If this treatment does not suffice, the physician should be consulted, as a scalp infection may be present. The hair, if any, may be arranged with a soft brush and an infant's comb.

Next, the body is soaped. The mother then takes the baby on the left arm, letting the buttocks rest on the palm and the back and head rest on the forearm and lowers him gently into the water. With the right hand and a washcloth she washes off the lather, then places the baby on the wiping towel, folds this over him, and pats him dry. She should then take plenty of time to go over his body, gently drying every fold and wrinkle, even between toes and fingers. This will do more than any other one thing to prevent chafing.

The mother may massage the baby's body by rolling or kneading the flesh with the palm of the hand. The wrists should be loose, the movement even and gentle. If this is properly done, the baby will thoroughly enjoy it. It stimulates the circulation and tends to make the infant more resistant to taking cold. The child should lie and kick in the open air before the bath and

[1] A doctor should be consulted immediately if the baby shows any sign of trouble with eyes or ears. It is better to do this many times for simple troubles than to neglect a serious condition once. To go through life with defective sight or hearing because of early neglect is a terrible experience.

A doctor should also be consulted—a specialist if possible—if the baby does not breathe freely and easily through its nose. This may mean enlarged adenoids, even in very early infancy.

before dressing and for as long and as often at other times as it can be made convenient. In fact, summer babies need scarcely to be dressed at all.

Powder should be used but sparingly, if at all, except in very hot weather. A very little good powder may be used, but no more than can be rubbed in. Loose powder should never be left in wrinkles, since this is irritating.

The region of the anus should be bathed and dried after every bowel movement. If there is any redness or irritation, a little

FIG. 106.—The diaper should be folded square and put on so that it will give perfect freedom. (*Courtesy Kansas State Board of Health.*)

"sweet oil," Vaseline, or other lubricant should be applied after the parts have been bathed.

Dressing the Baby.—To dress the baby, adjust the diaper, shirt, and stockings. Pin these together so that they will be smooth, but not tight, and also so that they will stay in place and not wrinkle and draw. The diaper should be folded square or oblong, never three-cornered (see Figs. 106 and 107).

If the garments open only part way, place the skirt inside the dress, run the left hand through from the bottom to the neck; lift the baby in the crook of the right arm and slip his body, feet first, into the dress through the neck if it is large enough, grasping his feet with the left hand, then putting the arms into the sleeves as they come to them. Never put garments on over a baby's head if it can be avoided, and never force sleeves on by bending the arm backward. If all garments open down the front, telescope everything on the table, lay the baby on them, and fasten them (see Fig. 89). If all garments open in the back, telescope them and put them on the baby with a single movement, and turn him once to fasten them.

Fig. 107.—(*a*) Baby with improperly adjusted clothes. (*b*) Baby with diaper, knitted band and stockings properly adjusted. (*Courtesy Kansas State Board of Health.*)

The Baby's Bed. *The Baby Should Sleep Alone from the Very Start.*—It is both dangerous and insanitary for a baby to sleep with an adult. It is much better to place the baby in a common clothes basket on a chair by the side of the mother's bed if a bassinet has not been provided (Fig. 108). At about six to eight months the baby outgrows the bassinet and it is better to use a child's bed. This may be large enough to be used until the child is ready for a youth or an adult's bed.

To Protect the Baby on Cold Nights.—Half of a woolen blanket may be sewed to make a square bag. A round hole is cut in the center of one end for the neck, the middle of the front is cut, and

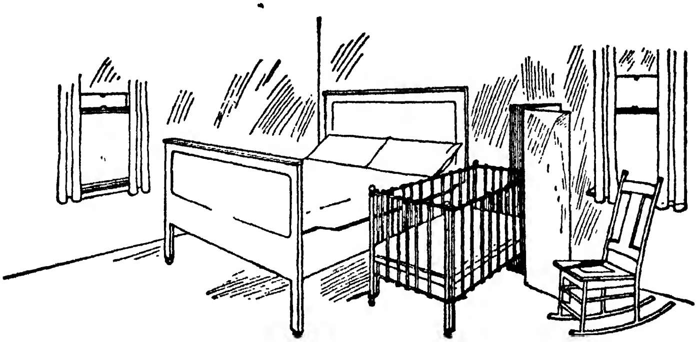


FIG. 108.—Proper arrangement of mother's and baby's beds. (*Courtesy Kansas State Board of Health.*)

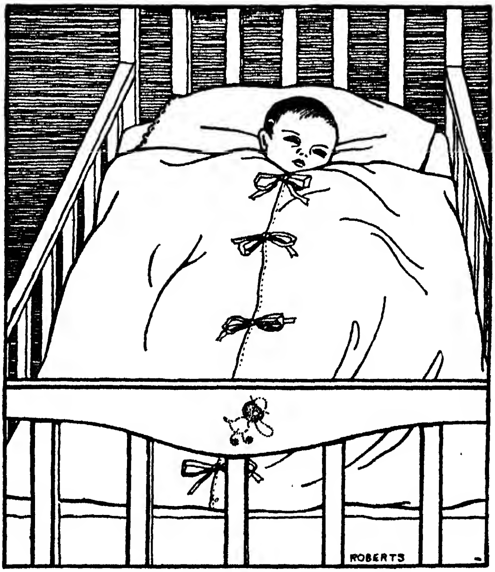


FIG. 109.—Infant in sleeping bag.

all edges are bound. It may be tied with strings, fastened with a zipper, or pinned with safety pins. It should be very large, so that the baby can move his arms and legs freely and turn as he likes.

After his night toilet is made he is tied in this sleeping bag. If the room becomes very cold, a hood should be put on *when it begins to get cold, not before.* In extremely cold weather a folded blanket may be spread over the basket, the baby placed, sleeping bag and all, in the middle; the blanket is folded over this *loosely* and pinned at the shoulders with safety pins. *Never "tuck in" a child of any age so tightly that he cannot turn or move freely. Children will not kick off the covers if they are free and comfortable.*

Changing Diapers at Night.—During the first few weeks of life, or during illness, there should be a warm place where the baby may be taken to have its diapers changed, although it need not sleep in a warm room. If the mother must get up during the night, her comfort and safety from exposure make it necessary to keep the night temperature from dropping too low. After the feeding is regulated, the infant's bowels should not move at night. During cold weather it may be better to place extra diapers *under* the baby to absorb the urine, and not expose it to have wet diapers removed during the night. However, a child who awakens when wet and demands a change from the start is less likely to become a "bed wetter." He may be more trouble at first, but he will be less trouble later. The mother must decide upon her policy in the matter according to heating conditions in her house and the exposure entailed to the child and herself.

Sleeping Habits.—Usually the new baby sleeps almost all the time. It should be wakened regularly to nurse during the day. In a short time a habit will be formed and most of the time the baby will awaken and demand food with almost clocklike regularity, provided the feeding interval meets his needs. If he does not nurse regularly, he will not get food enough during the daytime and will have to nurse at night. It is very important that the mother should have unbroken sleep; therefore, great pains should be taken by the nurse before she leaves to have the baby trained to feed regularly during the day and sleep at night, and the family should cooperate in this.

As soon as possible, according to the weather and other conditions, the baby should be put out of doors for his daytime naps. He should be dressed exactly as if he were to be taken downtown or elsewhere. The buggy is permitted to stand outside while he sleeps. He may be in the sun for part of the time (see page 437), when the weather is not too hot. *Always shade the eyes from direct light and shield the child from wind and dust.*

The Baby Is Not a Plaything.—The interest of family and friends naturally centers in the wonderful new baby. Everyone wants to hold him. After he begins to take notice, everyone loves to make him laugh, and some persons will even thoughtlessly tickle or shake or otherwise excite an older baby for the pleasure of hearing its violent laughter. *This is all wrong and must not be permitted.* Little babies need to have the position changed often, and they may be occasionally carried from place to place for changes of scene and variation of experience. As babies grow older they should be quietly amused and provided with an abundance of occupation. From the age of sitting and creeping, babies enjoy romping play, *but violent play or tossing or shaking should never be permitted, and tossing in the air is dangerous.*

The Baby's Bowels.—The first movements (*meconium*)—dark-colored and of a smooth, viscid consistency—are made up of the material that has accumulated in the bowel before the baby is born. The bowel movements turn yellow soon after milk feeding starts, and should have a smooth, mushy consistency. During feeding adjustments, however, unassimilated particles of fat or curd may appear temporarily in the stool of a perfectly healthy infant. At first the bowels may move after every feeding; the normal baby usually has from two to four movements in 24 hours, although some very early lessen these to one. The important thing is that there shall be regular and sufficient elimination of food waste. A baby who is fed regularly, sleeps regularly, and is bathed regularly soon comes to have regular bowel movements. It is very important that approximate regularity should early be established in this respect.

Training.—At six to eight weeks, a mother may begin conditioning the infant in this respect, and many modern mothers begin almost from birth. Small vessels can be purchased wherever crockery or toilet articles are sold. The mother warms the vessel, holds it on her lap and places the baby over it in such a way that he is comfortably supported in the crook of her arm. By doing this regularly during or following the early morning feeding, or following the feeding after the bath, and again after the evening feeding, 12 hours later, it will become increasingly possible to eliminate soiled diapers. Careful watching and scheduling of the normal urinations will later make it possible to reduce the number of wet diapers. A child who is thus accustomed to being dry and clean will be far less likely to become a habitual bed wetter and will be a more comfortable, sanitary, and satisfactory child.

Training in the use of vessel and toilet should be limited to regular practice on the part of the mother and never made an issue with the

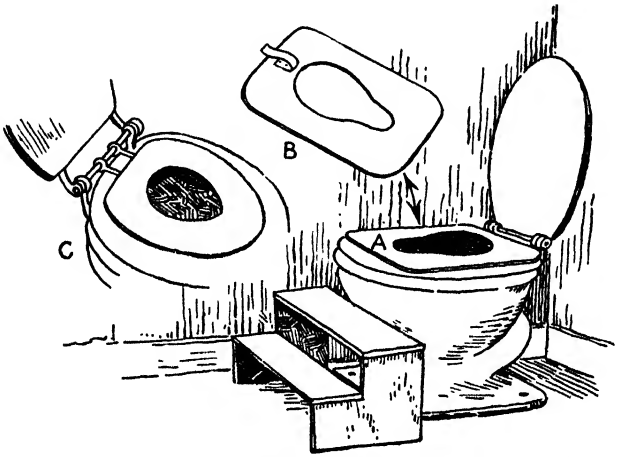


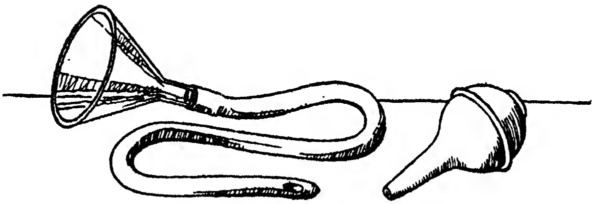
FIG. 110.—Two types of homemade toilet seats. There should be two steps in order that the small child may support his feet comfortably.

child. Actually, it is the mother who is "trained." The sphincters controlling the urethra and anus are activated by autonomic nerves only at first and only later, toward the second year, become supplied also with functioning voluntary nerves. Autonomic nerves can be conditioned in regularity, but it is stark and useless cruelty to try to force voluntary control before the mechanism for it is matured. Voluntary control naturally and easily follows where regular autonomic habits have been established. When the infant is old enough to sit comfortably for some time he may be placed, at the time of expected bowel movement, upon a small toilet chair, or upon a special seat attached to the regular toilet (see Fig. 110). He should not be forced to sit too long upon the toilet and thus establish negativism.

Signs of Bowel Trouble.—Undigested milk curds, fat globules, mucous clots or shreds, greenish or watery stools, or too frequent stools indicate indigestion or infection. The infant who is being conditioned to artificial feeding may have a period of adjustment during which the stools are not normal in color or texture. The physician should be kept closely informed of all symptoms, and the mother should ask for very explicit directions. The treatment for an older child is immediately to stop giving milk if the condition is acute, or to reduce the amount if the symptoms are not severe. Most pediatricans permit one teaspoonful or more of milk of magnesia, not to be repeated without orders. All the cool, boiled water the child will take should be given him. One might suppose that fluids should be withheld because of the watery feces. This is actually an indication for giving fluids, as dehydration of the tissues is occurring and may be extremely serious. If the discharges are irritating, an injection of 1 pint of warm, boiled water in which one level teaspoonful of salt and ½ teaspoonful of soda have been dissolved may be used. This should be very slowly and gently given. After each movement of the bowels, the anus and the buttocks should be washed with soap and water, patted dry with a soft cloth, and anointed thoroughly with Vaseline, lanolin, cold cream, or sweet oil. If the condition is not improved within a few hours, or if fever occurs, a physician should be consulted at once.

Constipation.—When a breast-fed baby becomes constipated the mother should carefully regulate her own diet by eating an abundance of laxative food and drinking plenty of water. The baby should be given boiled water 30 minutes or so before several successive feedings. A constipated baby is often given an ounce of thin, strained oatmeal gruel before one feeding each day. Some pediatricians give sorghum molasses or dark Karo in teaspoonful doses. Increasing the amount of orange juice regulates the bowel action of some children. Prune juice is sometimes given for its laxative effect. The physician should be consulted as to these measures.

Immediate Relief for Constipation.—A child who has missed having his regular movement should have the colon emptied before being put to bed, in order to prevent the nervous reflex irritation resulting from the presence of foreign substance in the sensitive rectum, which tends to disturb sleep and rest at any age.[1] For the small infant the oil enema is the best first aid. A soft rubber ear syringe or infant's syringe may be used, or, better still, a soft rubber catheter the size of a small lead pencil, with a small funnel fitted into the open end. Two to four ounces (according to the size and age of the child) of olive oil, sweet oil, refined cottonseed oil, or any salad oil, is placed in a cup and the cup set in hot water until the oil is warm. The infant is placed on its left side with its knees drawn up on its abdomen. The syringe full of the warm oil is very gently and slowly injected into the bowel; the diaper is held over the anus for a moment or two



Catheter and funnel *Soft rubber ear syringe*

FIG. 111.—Equipment for giving oil or other fluid by bowel.

and the baby is kept quiet until the bowels move. The oil may be retained for some time, and very thorough evacuation usually follows. If the catheter (soft rubber tube, see Fig. 111) is used, it should be oiled and gently inserted with a twisting, corkscrew movement, so that the end of the tube cannot remain caught in a pocket of the loose, wrinkled mucous lining of the bowel. The tube may be inserted from 3 to 4 inches. No force whatever should be used to introduce anything into the baby's bowel. After the tube is in place, the oil is poured slowly through the funnel. The tube is slowly withdrawn and something held over the anus as directed above. Soapsuds made of warm soft water and bland soap, or warm water with a pinch of salt, may be used instead of oil.

[1] The experiment has been tried of filling the rectum with cotton. It was found that headache, nervousness, and depression followed, resembling the familiar "toxic" symptoms of constipation.

Cautions.—A baby should never be given more than one dose of laxative without a doctor's orders, as repeated doses of cathartic cause constipation instead of relieving it. Any continued irregularity demands diagnosis and correction. The mother should make an earnest study of trying to regulate the baby's bowels without giving laxative medicines. It is one of the most unfortunate things that can happen to have the regular rhythm of the baby's bowels chronically upset, thus establishing an early "cathartic habit."

The muscles of the bowel contract with wormlike peristaltic movement when the stomach begins to churn its food. This is the reason why a few moments after eating is the natural time for the bowels to move. The muscles soon become trained to act at a certain time with great regularity, although the rhythmic interval varies in different individuals and is influenced by diet and activity. Nothing should ever interfere with the regularity of the day's feeding, and the bowels should become perfectly regular also, although they may move one, two, or three times. *Glycerin suppositories or "soap sticks," "paper spills," or irritants of any kind should not be used for an infant.* Plain, unmedicated cocoa butter or gelatin suppositories may be used as emergency relief. The rectum is a highly specialized, highly sensitive organ, which should be protected as carefully as the eye or the mouth. There is no doubt that lasting injury sometimes follows the meddling use of irritants and cathartics, which have a reactionary effect and tend to establish constipation if frequently repeated.

Diapers.—It will minimize the unpleasantness of caring for the baby's diapers if a square of soft old linen or a very soft toilet tissue or paper handkerchiefs or regular "diaper filler" is placed inside the diaper to receive the bowel movement. The filler can then be burned or disposed of in the toilet, and the diaper is much more easily washed. This is especially desirable during the first week, as the first bowel movements are dark and stain the diaper.

Washing Diapers.—A jar with a tight cover should be used to receive the soiled diapers, and they should be covered with cold water after all loose bowel movement has been removed with newspaper and burned; or soiled diapers may be held firmly by one corner and rinsed by flushing the toilet several times, then placed in the jar of water. They will wash more easily if not allowed to dry. They should be sudsed, boiled, dried, and ironed in the regular way. *Wet diapers should always be scalded and dried before being used again, as the ammonia in urine is irritating.* Diapers should be dried in the sun if possible, and should be ironed unless the material is very soft. Lye, strong soap, bleaching powder, or any strong chemical should not be used on the diapers; mild soap and hot water are sufficient. They should be thoroughly rinsed.[1]

Crying.—*A healthy, happy, comfortable baby does not cry more than is necessary to state his needs. When any baby cries he has something to cry about, and it is the mother's business to try to find out the reason.* A baby may cry for the following reasons:

Because he is tired. Some people say that babies soon learn to cry to be taken up, and that they should be disciplined and left to "cry it out" until they drop to sleep with exhaustion. If mothers would remember that a baby needs to have its position changed often and its clothing straightened in order that its tender muscles and skin may not actually suffer, there would be less crying and so-called "temper" in babies. Frequently they become tired because they are tucked in too tight or pinned up so that they cannot move. It is more scientific to find out *why* a baby likes to be taken up than to assume that he is "spoiled" and is having a "temper tantrum." Since restraint of movement is about the only cause assigned for the infantile "rage," it is wise to see if he does not have a normal urge to move some part of his body and cannot do so. When he is taken up, his discomfort is relieved. This is all he asks! He may also be tired and hypersensitive because he has been overstimulated and handled too much. A strict reorganization of method is the only answer to this.

Because bands become tight and clothing rubs or chafes or pins prick, or because he is lying upon lumps or wrinkles. Every effort should be made to prevent the baby's clothing from annoying or fretting him; it should be loose enough to permit him to move every part of his body freely; and the surface under him should be perfectly smooth at all times. Also, the surface of the body

[1] Many city laundries now provide daily diaper service at a weekly rate, completely relieving the mother of this taxing duty.

in contact with the bed becomes hot, and he needs to be turned to cool his skin.

Because his sleep has been disturbed. A baby whose sleep has been disturbed will be fretful, tired, and justly cross.

Because of distress in stomach and bowels, which may be caused by the various conditions mentioned elsewhere.

Because he is hungry. This is a perfectly good reason, but the mother should be quite sure that it is the reason. Children often cry because of *thirst,* which should always be thought of as a possible cause of discomfort.

Because he is sick. The sick baby appears heavy-eyed and listless and whimpers, rather than cries. A low, plaintive wail marks the very sick child. A child in acute pain, such as earache, cries out suddenly and is inclined to turn the head back and forth, while an older infant will grasp at the painful region.

Indigestion or Colic.—To take a baby from the breast and put it on artificial food because it has colic or indigestion, or because it loses weight, is usually unnecessary and often a very serious mistake. All efforts should be directed to building up the mother's health, obtaining more sleep and rest for her, getting mother and baby out of doors, paying close attention to regularity and manner of nursing, and, especially, giving careful attention to the mother's diet. The mother must help herself by self-control and careful regulation of her daily life. Holt says that any great excitement on the part of the mother may lessen or completely arrest the secretion of milk, or even so alter it as to make the child acutely ill.[1] It should always be borne in mind that indigestion may be caused by many reasons other than the quality of the mother's milk. The commonest of these are the following:

Tampering with the Baby's Stomach by Feeding It before the Mother's Milk Comes.—It cannot be repeated with too much emphasis that *the baby should receive nothing but boiled water and breast milk except by order of the attending physician.*

Irregular Feeding or Too Frequent Feeding.—This is a common cause of indigestion. The stomach of the infant who is nursed irregularly never has a sufficient chance to rest. It takes about 3 hours for the average baby's stomach completely to empty

[1] HOLT, *op. cit.*, p. 135.

itself, after a usual meal, hence the common use of the 3-hour schedule.

Nursing Too Fast at a Free-running Breast.—A vigorous baby will sometimes nurse so fast, especially if the mother's milk flows rapidly, that he will promptly get a big, hard curd in his stomach and have a pain as big as his appetite. To avoid this, the mother may pull the nipple from his mouth for a few moments several times during the nursing. It will be better for him to cry from indignation over this than from real pain later.

Swallowing Air.—Breast-fed infants who have no obstruction in breathing are not so likely to swallow air as are artifically fed

Fig. 112.—Patting the back to expel air.

infants. However, some do, and the stomach may be so distended with a bolus of air that there is actually not room for a sufficient amount of milk. The mother should lay the child against her shoulder and pat his back until the air escapes. When he belches up the air, a small amount of milk may come with it. Pediatricians now advise patting at the end of nursing, and one or more times during nursing if the baby is inclined to swallow air (see Fig. 112).

Insufficient Food.—Some pediatricians assert that, contrary to popular belief, this is a frequent cause of colic, particularly evening colic. Evening colic may be one of the first signs of a dwindling milk supply. The gastric glands secrete hydrochloric acid at the usual time; if there is not milk enough to combine with it, the contents of the stomach become highly irritative, and increased peristalsis may even cause acid vomiting. Usually, however, the baby simply shrieks until the stomach empties the irritating substance into the bowel. This type of colic is likely to come on in the afternoon or evening, because that is the time when the mother is tired and her milk secretion is the lowest. The baby acts hungry, drinks water greedily, and sometimes pulls away from the empty breast with a cry of rage. Weighing the baby before and after nursing, as mentioned on page 414 will determine how many ounces of milk he has actually obtained. A supplemental feeding of modified milk after the breast is drained will often put an end to the classic "3-month colic."

Colic accompanied by underweight, constipation, diarrhea, or other signs of poor nutrition or poor condition should always be promptly referred to a baby specialist. Here, as always, lay advice is dangerous.

Fat Indigestion.—Some healthy young mothers produce milk having a higher fat content than some babies can comfortably dispose of. Fat pellets may appear in the stools and active discomfort may appear some time after nursing. Holt suggests giving a little warm water just before feeding, in order to dilute the stomach contents.[1] Such a mother should usually reduce fats and sugars in her diet, preferably all fats other than butter and cream—these are valuable for vitamin A.

Rickets.—Low-calcium rickets may cause convulsive indigestion resembling colic. This will occur in infants receiving insufficient vitamin D, calcium, or phosphorus (see page 264). The infant may have been predisposed on account of his mother's prenatal diet and care, or her diet during lactation. He will require cod-liver oil, sunshine, and the essential minerals in addition to his mother's milk (see page 251).

Acute Infections.—Infants may have acute indigestion in connection with sinus or ear infections. Because the infant cannot describe or locate his distress, the real cause in this case may be overlooked and neglected.

Weaning. *When to Wean.*—Under normal conditions weaning should be a gradual process, beginning at six to eight months and ending by ten or eleven months.

[1] *Ibid.*

Not all mothers can adequately nurse a baby this long, and it will be necessary to begin supplemental feeding at any time the breast milk becomes insufficient in quantity or quality.

All authorities agree that the baby should have all the milk his mother can give him and have it regularly, and that the breast milk should not be permitted to dry up until he is safely established upon his post-weaning dietary. The supplemental feeding should be given just after he has taken all the milk there is in the breast. Then he may have enough of the artificial food fully to satisfy his hunger. Even a little bit of breast milk seems to aid in the digestion of other food.

Some pediatricians advise one bottle feeding daily almost from the start. Their reasons are: (1) the baby is trained for weaning or any emergency in which it may be necessary to place him entirely on the bottle, and (2) it gives the mother a period of freedom during which she may get away from home for business or pleasure.

Breast-milk Stations.—So great is the value placed by pediatricians upon human milk for the human baby that milk is now purchased and dispensed by many city feeding clinics. Fortunately many women produce more milk than their own infants can consume. The surplus may save the life of another infant who is deprived of his right in this respect. Women selling their breast milk must pass rigid health examinations, and the milk is withdrawn under strictly sanitary conditions. Naturally a high price must be paid to induce women to take this trouble. During 1927 a total of 17,466 ounces of breast milk was collected and dispensed by the feeding dispensary of Boston.[1]

In former times, before the invention of rubber nipples and modified milk, or the rise of sanitary science, the only salvation for an infant who was deprived of his mother's milk was the wet nurse, *i.e.*, the mother of another babe who, because of pay or pity, shared her own infant's food with the unfortunate one and nursed two babies at once. Wet nurses are still employed where breast feeding is vitally important to an infant and human milk cannot be properly collected and supplied. Great care must

[1] TALBOT, FRITZ, "An Organization for Supplying Human Milk," *New England Journal of Medicine*, Sept. 27, 1928.

be taken as to the health and habits of a woman who nurses a delicate infant not her own.

If the mother becomes pregnant, weaning as a rule must be begun at once and pushed rather rapidly. Few women can properly nourish two successive children at once. Occasionally a vigorous woman can do this by strictly observing the most advantageous diet and care. The physician should always determine the feasibility of this. If the mother becomes ill, the doctor must decide whether weaning is advisable. Fortunately, it is seldom necessary in ordinary illnesses. The return of menstruation does not usually injure the milk supply. A nursing mother who menstruates should, however, be especially careful not to overwork or become too tired, especially during her periods. Occasionally the flavor or quality of the milk seems to be altered at the time of the periods, but this is rarely, if ever, injurious to the child.[1]

How to Wean.—When the decision is made to wean the baby, the usual procedure is to begin by giving in the place of the second or third daily nursing, cow's milk modified by the formula for 1 month younger than the actual age of the child (see Chap. XXXVIII).

If the child is sitting alone (at six to seven months), he will be reaching for cup and spoon. It is then well worth while to encourage him to drink the milk rather than take it from a bottle, and thus avoid having to sterilize nipples and bottles; it is better for the teeth, and it also does away with the very troublesome process of "breaking from the bottle" later, which is often much more difficult than weaning from the breast. If the milk agrees with the baby after a few day's use, the strength should be rapidly increased to the formula for the actual age.

When the baby is one month older, modified cow's milk, fresh or condensed, may be substituted for another feeding. In another month, a third nursing may be replaced, ordinarily now using whole milk. At the end of the fourth month, the fourth and last nursing is replaced. Most mothers prefer to keep the evening nursing until the last.

[1] STANDER, H. J., *Williams' Obstetrics*, p. 494, D. Appleton-Century Company, Inc., 1936.

If weaning is properly conducted, the milk flow will gradually lessen, the baby will gradually become accustomed to other food, and the only one to experience any grief will be the mother, who will regret that the supreme experience of nursing her baby is to be no longer hers.

If the baby should be nine months old in July or August (in a climate in which these are hot months), he should be given fruit juice, cereal gruel, vegetables, and modified cow's milk, etc., *in addition to his mother's milk*, but it will be safer to withdraw the mother's milk more slowly and keep the milk flow until cool weather, for it is very valuable to the child if illness should occur during hot weather.

When to Give Food Other than Milk before the End of the First Year.—There is a tendency among pediatricians to give foods other than milk earlier than formerly, and in greater variety. Such foods must be carefully selected and correctly prepared, and this new attitude does not justify feeding the baby "tastes" of everything or *anything* from the adult table.

The infant's diet is now selected for the purpose of securing the food factors which newer nutritional science has shown to be important. They are the same in order of their importance to the child as to the mother: (1) proper growth proteins, (2) minerals, (3) vitamins, (4) carbohydrates and fats for energy calories. These essentials have been discussed as to importance, effect, and source in Chap. XIV.

Growth Proteins.—The best source of these is human milk; the next best is cow's or goat's milk. At any time that the mother fails to supply enough protein to her growing babe, arrest in growth will occur and breast milk must be supplemented by other milk. Milk is commonly the one important source of protein for the nursing infant and the young child.

Applying our knowledge of the balanced diet, we may construct a chronological dietary schedule up to the first birthday somewhat as follows, always remembering that any schedule must be adapted to the particular child, with the use of common sense and according to good medical supervision. Milk, of course, is basic food for any child at any age. From no other food can he secure adequate growth proteins and calcium. From it he also obtains milk sugar, vitamins, and other minerals.

From the age of three to four weeks, vegetable water may be added in slowly increasing amount to the drinking water or given separately. This is usually done only when the infant's condition indicates a lack of minerals, particularly iron (see page 253).

From two to three months, sometimes at three or four weeks, give orange juice or tomato juice, gradually increasing the amount and remembering that tomato juice is less potent and must be given in larger amounts to be a perfect substitute for orange juice. This is given specifically for vitamin C (see page 262), but it also provides other vitamins, minerals, and sugar.

From one to three months of age, if the baby is born in later summer or fall, or at two to four months if he is born in spring, give cod-liver oil or haliver oil, beginning with ½ teaspoonful daily as directed by the physician, increasing to three times daily, or give in one larger dose. The oil may be added to orange or tomato juice, although most infants accept it readily from a pipette or a spoon. Viosterol is prescribed by physicians in some cases as a substitute for cod-liver oil. *Any vitamin D concentrate should be given only as prescribed by a physician* (*see page* 266). The oils are given to provide calciferol (vitamin D) and also vitamin A. Viosterol contains no vitamin A (see page 259).

At the age of four to six months whole-cereal gruel may be given once daily and gradually increased. This provides thiamin (vitamin B), also other vitamins in small amount, minerals, carbohydrate, and incomplete protein.

At five to seven months give strained vegetables one or more times daily, for most vitamins, all minerals, and a small amount of carbohydrate.

Upon the appearance of the first teeth give crust of dry bread or zwieback, or hard cracker, to encourage chewing, spacing of teeth, and development of salivary glands. By one year these may be given twice daily before regular feedings.

At six to eight months, sometimes much earlier, give a small amount of egg yolk daily, increasing it until by one year the child may have a whole egg several times a week. From the yolk the infants get vitamins A and D, iron, sulphur, complete protein, and some fat. Since some infants are allergic to egg white, the mother should watch for colic or rash following the first taking of whole egg.

For variety, scraped ripe apple, baked apple, prune juice and pulp (if not too laxative), ripe pear, ripe banana, or almost any choice, ripe, seived fruit may be given in small amounts quite regularly from nine months on. Also milk soups, junket, custard, strained rice, macaroni, mashed baked potato, scraped beef lightly broiled, seived steamed liver, crisp bacon mixed with other food after the baby begins to chew, all may be given in small amounts. Meat broths may be used as a base for cereals or vegetables, but they have little food value beyond stimulating appetite and adding flavor.

Eating Habits. *Regularity.*—Every child, no matter what his age, should eat regularly. In order to be ready at the regular time, the baby must sleep at a regular time. Nothing should interfere with the baby's regular schedule.[1] No matter how busy a mother may be, it takes more time to care for a cross, fussy baby than to be punctual and systematic and have a healthy, happy child. Schedules need changing as conditions change and as the child grows. One should not make a fetish of regularity.[2] If for some reason the baby does not take the full amount of food at a particular feeding, it is sheer cruelty to let him cry with hunger until the exact minute of his next scheduled meal arrives. It is sometimes the part of wisdom and common sense to vary any program to suit temporary circumstances.[3]

Eating Alone.—From the very beginning of his taking solid food, the baby should sit on his own chair before a little table. He will learn to eat properly and will see only his own food, and so will not even be curious about what the rest eat (see Fig. 113). The mother can then eat her own meal in peace and quiet while the baby plays happily in his play pen or sleeps. The rest of the family will not be tempted to spoil his liking for simple, wholesome food by giving him "tastes" of things he should not have. This plan eliminates the dangerous high chair, which need never be used.

[1] WHITLEY, MARY T., "Bases of Habits," *Child Study*, January, 1937.

[2] WOLF, ANNA W. M., "The Fetish of Habit Training," *Child Study*, February, 1939.

[3] ALDRICH, CHARLES A., and M. M. ALDRICH, "Habits Belong to Children," *Child Study*, February, 1939; also, BLATZ, WILLIAM E., "Some Reflections on Habits," *Child Study*, February, 1939.

Chewing.—The baby should be encouraged to chew and should be given plenty of time to sip his milk and chew every bite of food, but he should be kept continuously busy until he has finished his meal. *It is all-important that the habit of deliberate, careful chewing be encouraged from the start.* When the baby's teeth come through the gums he wants to chew. This is the psychological moment. Let him never forget for one day how to chew. If this instinct once fades and bolting the food becomes a habit, it is very hard ever to train a child to chew his food properly. It is a great mistake for a busy mother to feed a child entirely on soft food from a spoon because it can be done more quickly and easily than to bother with letting him feed himself. This is training him in bad habits and is injurious to his manners, digestion, teeth, and health.

FIG. 113.—The child should learn to feed himself at his own little table.

Eating between Meals.—In no one thing will the mother have harder work than she will in preventing well-meaning but mistaken relatives from giving the baby cookies, candy, pop, ice cream, etc., between meals or when visiting. No growing child should ever eat sweets of any kind between meals. *Especially should no child during its "second summer" ever have a taste of anything not included in its regular feeding schedule.* If the child seems hungry between his regular meal periods, his food requirements may be increasing with growth and he may need more or heartier food. He may not be eating enough breakfast. If he seems to require an extra meal or lunch, this should be established as a regular function. Otherwise the rhythm of his metabolism and elimination will be disturbed.

The establishment of regular physiological rhythms through the establishment of regular health habits is fundamental not only to health but to mental training and development, a subject which is discussed in the following chapters.

Rickets.—A few years ago rickets was said to be the most prevalent disorder of infancy existing in the Northern Hemisphere. The very general use of vitamin D concentrates and sun baths has greatly reduced the incidence of rickets.

Rickets is a constitutional disease affecting all tissues of the body. It is due to defective calcium-phosphorus-magnesium metabolism. The bone changes are so obvious and spectacular that rickets is commonly supposed to be a bone disease. Imbalance or deficiency in the metabolism of these minerals produces many other symptoms, including anemia, poor digestion and assimilation of food, nervousness, head sweating, etc. The bones fail properly to calcify and so enlarge at the epiphyses (growth centers—see page 118), and become distorted because of their softness.

Rickets may be caused by lack of calcium in the diet of the mother during pregnancy and nursing, thereby depriving the infant of the material with which to make proper bone growth; this also impairs the calcium-phosphorus quotient in his blood. *The commonest cause of rickets, however, is deficiency in vitamin D,* without which the body cannot utilize the minerals under consideration. Vitamin D is synthesized in the animal body from a *sterol provitamin* which is found in connection with the fat (oil) in skin, hair, feathers, leaves, etc. (see page 264), and which must be irradiated by ultraviolet light from direct sunlight or from ultraviolet lamps. *Vitamin D,* then, can be (1) manufactured within the infant's body through stimulating the provitamin in the sterols in his skin by exposure to sunlight or to ultraviolet lamps; (2) administered in concentrated form, as cod-liver oil, halivor oil, or viosterol; and (3) administered in irradiated foods. Some dairies now provide irradiated milk. Egg yolk and very green leaves provide some vitamin D, although no food is known to contain enough to be fully protective against rickets in an animal that is not directly exposed to ultraviolet light.

In the North Temperate Zone there are so many cloudy days and in cities there is so much smoke, it is the part of wisdom to protect the infant by administering vitamin D concentrates and by sun baths, particularly during winter months and rainy months.

Sun baths should be directed by the physician. There is considerable danger of burning the skin of a young infant. It should be exposed very briefly at first. Some physicians begin by exposing one hand the first day for 1 or 2 minutes, both hands the second day, etc., until by the end of a week or 10 days the entire body may be briefly exposed.[1] The eyes should always be protected against direct light.

FIG. 114.—I like my cod-liver oil.

Sun lamps should be used *only under the direction of a physician.* If potent, their rays are very much more powerful than direct sunlight and can easily do great harm. On the other hand, many commercial lamps are quite useless.

The danger of overdosage of vitamin D concentrates is very real. No mother should take the responsibility of determining the kind and the dosage of the concentrate she uses. The preparations vary so greatly in strength that she cannot know how many "units" the "half-teaspoonful" recommended in some text represents. Reported cases of overdosage or "hypermineraliza-

[1] "Sunlight for Babies," a leaflet of The Federal Children's Bureau, Washington, D. C.

tion" (too much calcium deposit in the tissues) are multiplying. Vitamin D seems to be the one vitamin the use of which may be overdone.

Cod-liver oil, the oldest of the concentrates, is still considered to be one of the most effective. Small children do not object to the taste and commonly take it willingly from a spoon (see Fig. 114). If the older child does not take it during his second summer, he may object to it in the fall. In such a case, most physicians will substitute the tasteless but highly concentrated viosterol.

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CHAPTER XXIV

THE BABY'S FIRST YEAR: BEHAVIOR AND TRAINING

Sympathy for Babies

I am so sorry for babies
The poor little gabies!
They always are being caressed
And dressed and undressed
And diapered, stockinged, and sandaled
And handled and dandled
And lifted or put into bed
And forcibly fed
And having their character soured
By being bescoured
And poked into, polished, and scrubbed
And endlessly tubbed.

And then they are barked at and booed at
And mewed at and cooed at
And asked where and which are their toes,
How some animal "goes"
And suchlike ridiculous questions
That spoil their digestions
And ruin whatever remains
Of their infantile brains.

They're worried to smile "just for Fanny"
Or Auntie or Granny
And pinched and wrong-ended and squeezed
And fiendishly teased.
Their privacy isn't protected
Nor ever respected,
For folks are invited to peep
And see them asleep!

No ifs, buts, perhapses, or maybes—
I'm sorry for babies.

ARTHUR GUITERMAN.[1]

In spite of its inexhaustible complexity and variability, the developmental stream of early human behavior is so ordered by biological laws that it may be systematically studied. There is indeed no such thing

[1] Reprinted by special permission of the author and *Ladies' Home Journal*, copyright 1929, Curtis Publishing Company.

as utter randomness even in the behavior of the sprawling infant. The more closely his very sprawling is studied, the more pattern it assumes. . . . The random activity of the four-weeks-old infant is distinctive from that of an eight-weeks-old infant.—ARNOLD GESELL.[1]

Patterns of Behavior.—The large group of genetic scientists who are observing young children are investing infancy with new and tremendous interest. It becomes a fascinating thing to be the parents of a child and watch the orderly unfolding of a genetic pattern that has been in the process of creation ever since there was life upon the earth.

Gesell has designated the first 40 weeks of life as the *perception-prehension* period, or the period during which maturation of the coordinating mechanism proceeds to a degree of efficiency such that precise coordination is possible between cortex, eye, and hand. He regards this as a significant landmark in development. On pages 639, 640 will be found the normative summaries for the first 10 months.

On reading the various biographies of individual babies, one is impressed with the similarity in the sequence and age of their behavior responses as compared with the normative summaries here listed, also with the equally obvious fact that no two are exactly alike.

Millicent Shinn, in 1900, kept a day-by-day record of the development of her niece, which is still classic. Her description might apply to any normal child of today, so clearly does it depict the developmental sequences of infant growth.

Miss Shinn[2] records that her niece, up to six weeks, had made no sounds other than the dismal, monotonous cry of the first day, an inarticulate fretting, and a sharp cry when startled. At six weeks, cooing murmurs, gurgles, and tiny shouts and various vocal experiments began. At eight weeks, she stared for some 15 minutes at Miss Shinn, turning her head, as her mother handled her, so she would not lose sight of her aunt's face. She then gave her attention in the same determined manner to her mother's face, then turned from one to the other as if comparing

[1] GESELL, ARNOLD, *The Foundations of Experimental Psychology*, Chap. XVI, The Individual in Infancy, Clark University Press, 1929.

[2] SHINN, MILLICENT, *The Biography of a Baby*, Houghton Mifflin Company, 1900.

them. About this time she would turn her head to look for something out of sight, suggesting the dawn of associative memory.

When near her third month, the baby "was possessed by the most insatiate impulse to be up where she could see," fretting and wailing when forced to lie down. During her third month she seemed to discover the difference between grasping her own hand with the mouth and grasping the breast or other substance "not her." She became able to bring hand to mouth, although she then grasped it with her mouth rather than put it into her mouth. She grasped objects accidentally encountered and conveyed them to her mouth, but did not look at them until near the end of the third month. She moved hands, arms, and legs a great deal.

At twelve weeks she first recognized her grandfather's face with a joyous cry. At three months her language included panting, murmuring, babbling, chuckling, shouting, and crowing. She turned her head in refusal or dislike. On the day she was three months old she tried 25 times, with scarcely a pause, to raise herself into a sitting position, striving and straining until red in the face; she now loved to sit propped with pillows, and vigorously resented lying down.

During the fourth month she spent a great deal of time simply looking, and fretted to be carried around so that she might see new objects. "Always with a look of surprise and eagerness, eyes wide and brows raised."[1] She was not so active or so noisy as during the previous month. She was enjoying a new-found world of visual images.

Miss Shinn thinks she "had not at all learned the bounds of her own body"; she knew it only by chance touches, and had little control below her arms. If her body was touched she did not look to see what had touched it. She did not reach purposefully for objects. It was during her fourteenth week that she seemed to discover a connection between the sight and the feeling of an object in her hands. She then soon began to grasp at things upon which her eyes rested.

Miss Shinn relates at length the active interest of her niece in her surroundings. She seemed to insist on making the acquaint-

[1] *Ibid.*, p. 117.

ance of her environment and became quiescent only when fully satisfied with her exploration of a familiar room. During her fifth month she seemed to be stimulated by a strange room, looking about with evident eagerness and curiosity, a seeming desire to penetrate the unknown. As her range of vision increased she followed the movements of persons.

She became charmingly responsive, smiling and crowing, and several times laughed out loud when played with boisterously. She was free from fear or nervous excitement and loved a frolic in which she would be "tossed, rolled over, or slid down one's knee."

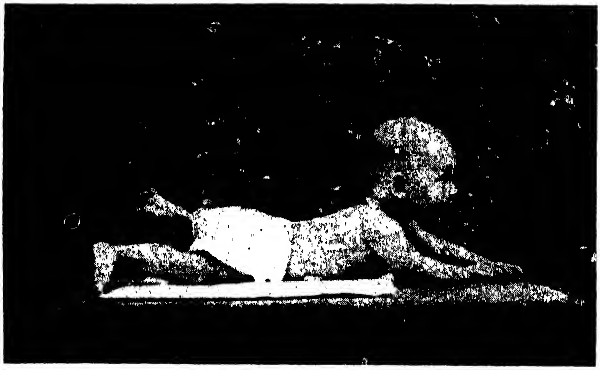


FIG. 115.—Four-and-a-half months: struggling up.

She was busy during this period making experimental sounds. "She would lie looking earnestly at me, draw her breath, gather her lips into shape, and finally explode the sound with a great expenditure of breath." Also a "note of real desire, unheard before, appeared in her voice."[1]

During the fifth month she entered suddenly "the era of handling things." Miss Shinn describes the "swift four days in which the baby came into realization of her powers of using hands and eyes together." One is reminded of Coghill's Amblystoma when it abruptly became able to swim and later to walk (see page 209). "In a few days she had become a different baby, with a new world of interests, and a wonderfully more varied and vivid life."[2]

[1] *Ibid.*, pp. 137, 139.
[2] *Ibid.*, pp. 141, 146, 153.

She rapidly learned to distinguish between flat surfaces, such as pictures, and objects that she could grasp (at nine months she had an amusing experience in trying to grasp the *shadow* of a moving rope).

Miss Shinn wisely advocates a wide variety of experience at all times as indicated by development. "Certainly the wider

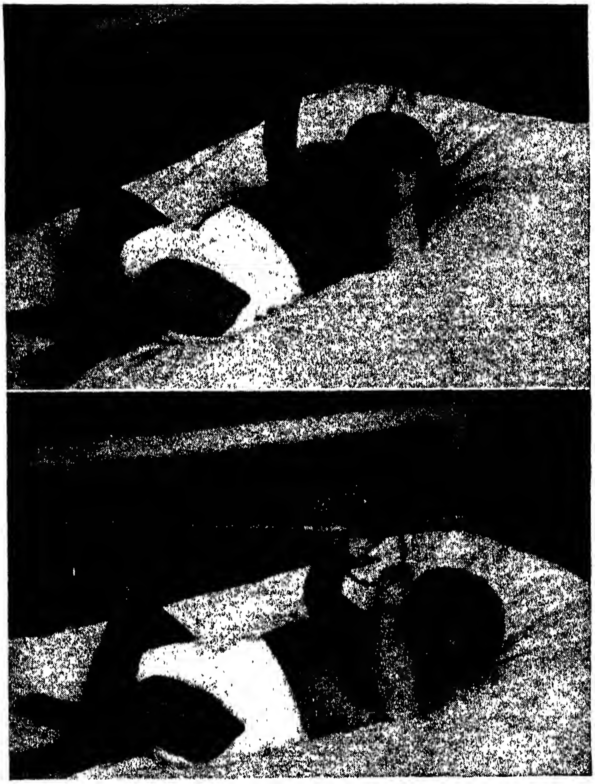


FIG. 116.—Five months. Grasps a dangling ring.

liberty of holding and handling he [the child] can by any device be allowed, the better; the instinct is very strong, and wholly healthy, and the thwarting of normal instincts is not good for any one's nerves or mind."[1]

During her sixth month she began to notice that objects fall, and then to watch them falling. She began to imitate clapping

[1] *Ibid.*, p. 155.

or spatting movements; to try to creep when placed upon her face; she investigated the parts of her body; showed recognition of vocalization addressed to her. Her sense of localization developed rapidly, and she watched with great concentration the movements of others, such as the entire process of setting a table, resenting any interruption of her prolonged inspection.

FIG. 117.—Six months old and already finding this a rather jolly world.

FIG. 118.—Six months old and sitting without support.

At seven months she began to romp rowdyishly, clutching at hair and faces and laughing loudly. She learned to associate names with persons, her favorite "grandpa" first. During this month she learned to wave "by-by."

During the eighth month she acquired "pat-a-cake" and other accomplishments and learned to inhibit a few movements at "no-no."

During her ninth month she crept freely and rapidly and taught herself to stand alone, "by diligent self-training." There was great increase in the little one's mental alertness, her eager curiosity in following movements, her look of effort to understand, her growing clearness in grouping associations and interpreting what she saw.

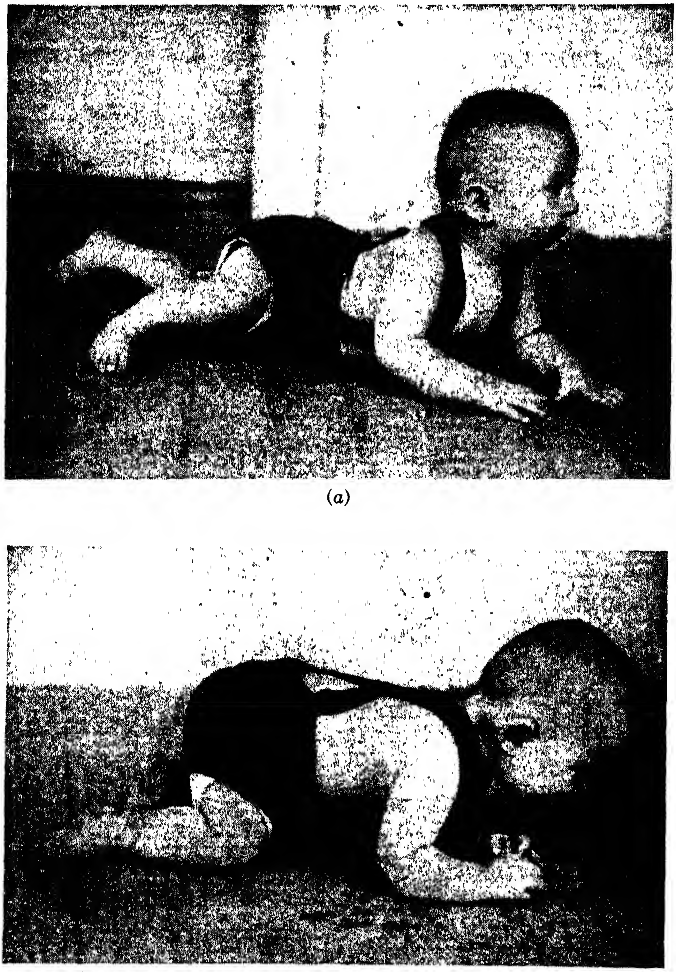
Her handling of things had long developed into elaborate investigation, turning an object over and examining every side, poking her fingers into crevices, opening and shutting lids, turning over the leaves of books; and now she was no longer satisfied with investigating such objects as she came across by chance—she began to have a passion (which increased for weeks and months, and long made up a great part of her life) to go and find what there was to see. She crept to the window and stood at the low sill, to look out, beating the pane with her soft little hands and laughing in an ecstasy of delight if the dog wandered by. She crept into the hall and explored it, sitting down in each corner to take a survey, and to look up the walls above her. Her toys were neglected; she was impatient of being held in arms, and eager only to get to the floor and use her new powers. She crept happily about for hours from chair to chair, from person to person, getting to her feet

FIG. 119.—Seven months old. Sitting quite securely and grasping with whole hand.

at each, and setting herself cleverly down again; smiling and crowing at each success, and coming to us for applause and caresses. . . .

Outdoors her happiness was even greater than in the month before, and her cries of rapture as she looked up, down, and around, and realized her own activity in the midst of all the waving and shining and blooming things, were remarkable—uttered, as it were, from the very deeps of her little soul, with that impassioned straining of the central muscles by which a baby throws such abandon of longing or ecstasy into his voice. . . .

. . . The power of communication was considerably increased in this month by the acquisition of one exceedingly useful sign. The way in which it was developed is an interesting example of the evolution of such signs. First the baby began to use her forefinger tip for specially close investigations; at the same time she had a habit of stretching out her hand towards any object that interested her—by association, no doubt, with touching and seizing movements. Combining these two habits,



(a)

(b)

FIG. 120.—Seven and one-half months. (a) I see the cat. (b) I'll go after it.

she began to hold her forefinger separate from the others when she thus threw out her hand towards an interesting object; then, in the second week of the month, she directed this finger alone towards what interested her; and by the third week, the gesture of pointing was fairly in use. She pointed to the woodshed door, with her mewing cry, when she wished to see the kittens; to the garden door, with pleading sounds, when she wished to be taken thither; to the special bush from which she wished a rose. She pointed in answer, instead of merely looking, when we asked, "Where is grandpa?" "Where is Muzhik?" [the dog]. . . .

The first attempts at climbing, too, appeared before she was quite ten months old. In the third week of the tenth month the baby had let herself down by her hands quite cleverly from a large chair in which

Fig. 121.—Seven and one-half months old and ready for anything.

Fig. 122.—Nine months old. The greed to explore.

she had been scrambling about—a feat that must have been quite instinctive, since she did it well and easily at the first try. The last day of the month, as she hovered at the foot of the stairs (a region about which she had much unsatisfied curiosity), some one helped her to put her knee on the lower step. Thereupon she laid hold on the next one, and pulled herself up, and with the same help, mounted two steps more. . . . A candle was set on a higher step as a lure, and, sure enough, the little thing, unaided, set her knee on the higher level, laid hold with her hands, and drew herself up.[1]

[1] *Ibid.*

At the close of the ninth month this little girl was "pouring out strings of meaningless syllables, with marvelous inflections and changes," with the faint suggestion of purposeful repetition of certain syllables—dă, dă, etc.

The feature that stands out in this charming description is the development of awareness of a world outside oneself. It is not commonly realized that the infant so young as this has a need for great variety of experience.

Dr. Charlotte Bühler presents an interesting analysis of her observations of a number of children during their first year. She says that between the second and third months a turning point occurs, marked by playful experimenting; the first active response to position; the first coordination of two senses acting simultaneously; the first social reactions and expressional movements, all indicating that the "passivity" of the newborn has been replaced by "receptive interest." The child pays attention to his own movements and sounds.

Between five and six months another turning point occurs in the development of behavior in the child, marked by continuity and concentration of effort and attention; the first sure grasping; an active seeking for stimuli, instead of merely reacting to experiences that happen to come to him.

Dr. Bühler, like Gesell, thinks the tenth month a turning point, but the behavior phenomenon which seems to her significant is the purposeful use of tones and syllables, *the dawn of communication.*[1]

Dr. Karl Bühler designates the last quarter of the first year as the "chimpanzee age,"[2] a period during which the child exhibits about the level of behavior of certain of Köhler's apes, as described in *The Mentality of Apes.*[3] Other observers have noted similarities between the behavior of young children and primates.[4] The outstanding difference is that the young primate

[1] Bühler, Dr. Charlotte, *The First Year of Life*, Chap. XII, The Stages of Development, The John Day Company, 1930.

[2] Bühler, Karl, *Mental Development of the Child*, Chap. II, Harcourt, Brace & Company, Inc., 1931.

[3] Köhler, Wolfgang, *The Mentality of Apes*, Harcourt, Brace & Company, Inc., 1926.

[4] Morgan, John J. B., *Child Psychology*, p. 31, Richard R. Smith, 1931; Kohts, N., *Infant Ape and Human Child*, published in Russian with English

becomes arrested in development at an early age, reaching his full maturity while the human child is still in infancy.

Emotional and Intellectual Development.—Lovisa Wagoner says, "The goal of emotional training is the development of a rich and deep emotional life which finds expression in ways that are acceptable both to the individual and to the group."[1] As discussed in the chapters on brain and behavior, the principal function of training and education is that of bringing the emotions under the dominion of the organ of reasoning, the cortex—making all behavior "acceptable." The infant at birth shows passivity, aggressiveness, and withdrawal. If the head is forcibly held, the arms move more vigorously than the legs. If the legs are held, the effort at withdrawal is more vigorous in the legs than in the arms. In both instances the movement spreads to the entire body.

The most primitive emotions are the phylogenetic, protective emotions of fear and rage. Some investigators, notably Watson and his group, think they have seen evidence of these very soon after birth. Others are equally positive that there is no evidence of any inborn or instinctive specific emotional responses. From evidence presented in Chap. XII, it would seem that the newborn infant is a reflex organism, with little centralized control above the brain stem; therefore specific emotional behavior is not to be expected. The Ohio group states that, in the tests performed by them, infants rolled tightly in cloth, or with nostrils held shut, may calmly go to sleep and that only 1 to 2 per cent show any defensive reactions.[2]

We should think of the child as a maturing organism which must, as a matter of survival, integrate with his environment.

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summary, 1935; KELLOGG, W. N., and L. A. KELLOGG, *The Ape and the Child*, McGraw-Hill Book Company, Inc., 1933; JACOBSEN and YOSHICKA, "Development of an Infant Chimpanzee during Her First Year," *Comparative Psychology Monograph*, September, 1932; HARLOW, H. F., "Comparative Behavior of Primates," *Journal of Comparative Psychology*, October, 1932.

[1] WAGONER, LOVISA C., *The Development of Learning in Young Children*, Chap. IX, Mastery of the Emotions, p. 148, McGraw-Hill Book Company, Inc., 1933.

[2] PRATT, NELSON, and SUN, *The Behavior of the New-born Infant*, pp. 176, 179, Ohio University Press, 1930.

We have had glimpses of Miss Shinn's niece struggling into her environment with joyful eagerness. That integration implies the formation of associations, wholes, units of relatedness, conditionings, involving few or many of the aspects of living, and linking the mechanisms of emotion and sensation with the thinking, reasoning brain.

All maturation creates an urge for use, expression, action, which becomes a goal.[1] Restraint or prevention of normal organic activity is unnatural and arouses protective and defensive responses, such as withdrawal and active resistance, accompanied by crying, as seen even soon after birth. With the progress of maturation the simple primitive reaction of resistance passes through the unconsidered, emotional resistance and attack of the child and immature adult, and eventually becomes correlated with glandular, cerebellar, and cortical mechanisms, and may become finely coordinated into purposeful action patterns, such as trained wrestling, fencing, games and contests of skill, shooting with firearms, etc. Carried into organic group action we have the incredibly refined, detailed, and barbarous social phenomenon of war.

The more frequently the child encounters situations making a goal of resistance to restraint and thwarting (which may be physical or purely psychic), the more resentment and resistance reactions will become habitual—temporary gradients of cortical response will become permanent gradients. The "fields" (the "engrams" of Papez—see page 213) take definite possession of the association pathways; aggressive attitudes are formed.

The instinct of survival is the strongest and most basic of the instincts; threat to safety (survival) arouses the emotion of fear. Fear sets off the impulse to run or fight; whether the child runs or explodes in a fury of rage and resistance will depend upon his maturity, upon the character of the stimulus, and also upon his innate personality as conditioned by his previous experience.

[1] Seashore says: "Man has an instinct to do everything that he can do. The possession of capacity carries with it the tendency to use that capacity; with the possession of wings goes the capacity to fly, with the possession of the capacity for reflection goes the tendency to reason," C. E. SEASHORE, *Psychology in Daily Life*, Chap. X, Play, D, Appleton-Century Company, Inc., 1913.

The great lesson of life is learning that one must accept certain restraints. This is the whole of what we term *discipline.* It is suggested many times in these pages that the infant should begin at once to learn to accept certain restraints upon his freedom, such as feeding at regular intervals. Some would add his acceptance of long periods of inactivity in his bed at the convenience of his mother. Consideration of his normal activity needs, such as those described by Miss Shinn, makes us less certain of this.

Disciplines such as accommodation to regular health habits can usually be managed without arousing the anger reaction. *But discipline must not conflict with growth;* this is a critically important point. As the child develops, however, the need for activity and expression increases, together with the infant's inability to express his need otherwise than by energetic attempts to do the sort of thing he is ready to do, and opportunity for conflict becomes frequent. When the child has an inner urge to bang and throw he becomes enraged if spoon and ball are taken away from him. If none are given to him, he may become simply fretful and difficult because of a thwarted urge for activity. When he becomes interested in his surroundings and wants to view his environment from a sitting position, or, better still, from being carried about in some one's arms, has he not a right to rage when he finds himself thrown upon his back, tucked in, and strapped in, with nothing but a canopy or a ceiling upon which to practice his new coordinations of vision and touch?

When he discovers the stairs, and is found (so unexpectedly!) when nine or ten months old to have climbed up several steps, gleeful and crowing over his accomplishments, he has a right to kick and scream if snatched up rudely, insulted by "no, no" if not a spat from some elder who does not understand. While the urge to perform this particular stunt is in the ascendency he will make himself a safe climber if he is permitted to do so, especially if a goal in the form of a toy is put at the foot of the steps, and the baby acquires a "complete experience" the first time, by being encouraged to come down. He learns that going up and coming down belong together. While he probably will be unable completely to negotiate the coming down, he should at least make the attempt and "complete the idea."

Few occasions arise in which it is desirable or necessary to thwart the natural activity of any child. *It is the mother's business to give him safe and convenient opportunity to do the kind of thing that he wants to do.* As we have seen, even before ten months of age, the child has many and varied needs for activity. *Continually to thwart these is to retard mental and physical development and elicit frequent anger reactions. An unhappy, distorted personality may be established even at this tender age. Both fear and anger result from situations with which the organism is unable to cope.*

It seems probable that particular fears are determined by the experience of the child. A burned child dreads the fire. The infant who has had a painful or jarring fall fears withdrawal of support. An infant whose ears have been hurt by sharp sounds fears loud noises.

While fear of dark is not instinctive, and many children entirely escape this experience, yet many children do show fear of dark when it is difficult to account for it by the child's experience. One wonders what may be the sensations of an infant who is just come into the conscious enjoyment of vision on fully awakening in the dark and being unable to see. May it not be a sensation of thwarting equivalent to having the eyes held shut?

Agreeable emotions (the "tender emotion" or "love") in the young child are called forth by sensuous physical comfort, softness, patting, stroking, caressing, kissing. Much has been written by the Freudians and behaviorists about the undesirability of conditioning the habits and behavior of the child around these emotions. Much of this discussion appears to the configurationist to be distorted and extravagant in emphasis. The worst indictment against excessive caressing and handling of the infant is that it tends to center the child's interest and attention upon his bodily sensations rather than upon doing and accomplishing (introvertive rather than extrovertive behavior). As the child grows older, he is confronted with the necessity of accommodating to the affection of his elders rather than to the general conditions of a normal environment. He comes to evaluate his conduct in the light of approval or disapproval on their part instead of judging his acts according to their origin and effect and his joy in "doing."

Most parents would think that the behaviorist goes too far who says, "Never hug and kiss them, never let them sit in your lap. If you must, kiss them once on the forehead when they say good night. Shake hands with them in the morning."

This severely formal attitude, however, is less harmful than the other extreme of sentimentality one often sees in the parent or nurse who smothers the soft, adorable infant with insanitary, bacteriologically horrifying kisses, and who cannot resist constantly handling the helpless victim. Such an adult is himself emotionally unstable and will distort the personality of any child. If we can keep the fact in mind that we do not wish to have the child think about his bodily sensations in one way or another, rather we wish him to be interested in the world around him, and in establishing a normal relatedness to the people and things with which he must have increasing dealing, it will be quite clear that he has little need for emotions other than the pure joy of being healthily alive and active; and that we should try to help him have as little acquaintance as possible with fear, rage, or love (of the sort described). We would not, however, deprive any child of the sense of security and joy to be found only within the encircling arms of parental love. Tenderness, a feeling of unique closeness, a sureness of understanding, a sense of belonging, are every child's right; these inhere in the parental relationship. These are not to be confused with the erotic, possessive sentimentality discussed above.

Buford Johnson says:

> The warning to parents concerning the evils of display of affection to children have resulted primarily from studies of unadjusted adults. There is serious danger in withholding from children those reactions which mean for the child a genuine regard for him. . . . The affection displayed by his parents for him is a major factor in his adjustments. . . . Display of affection should be given with the primary purpose of manifesting the affection and not as rewards or as motivations of an act.[1]

Certainly the child should not be subjected to experiences with which he is not developmentally mature enough to cope. A child

[1] JOHNSON, BUFORD J., *Child Psychology*, Chap. IX, Emotion, p. 363, Charles C. Thomas, Publisher, 1932.

at eight months may retain a lasting fear of stairs if he accidentally creeps off a landing and receives a painful bump. A month or two later, when actively interested in exploiting the stairs, he will take many bumps when hands and knees slip, but will not be frightened and will pay surprisingly little attention to the hurt.

The supreme emotion of life is seldom mentioned in discussion of the emotional life of the young child, and that is the *joy of action* so delightfully pictured by Miss Shinn. The infant's cup of happiness runneth over when he achieves the use of a new set of coordinations—learns a new trick. *This is the joy of achievement, the supreme motivation of life. This emotion we should foster in the child at every step in his growth;* through it he will conquer fear and rage by acquiring a feeling of being able to cope with the conditions producing them; through it he will protect himself from devastating excess of the "tender emotion."

The urge to do, to achieve, calls into function, as cortical development proceeds, the tools of accomplishment which we designate as *imitation, curiosity, imagination* (see page 228). We have seen the impulse already appear in our ten-months-old child to imitate simple patterns of motor behavior, such as waving by-by and playing peekaboo. Miss Shinn describes the very early "satiable curiosity" in her niece for exploring her environment.

In fact our child has during his first year of life developed at a faster rate and learned more than he will in any remaining similar interval of his life. He has a personality, and has acquired habit patterns which may change little during the rest of his life.

Training in Early Infancy.—We have seen that definite adaptation to environment occurs during even the neonatal month of life. By one year very pronounced shaping of habits and personality has come to pass. The child has acquired habits of eating, sleeping, and elimination which determine in large measure his physical growth, his health, his nervous poise, and his comfort. All of these affect his emotional reaction and behavior. He has achieved a degree of motor coordination commensurate with the maturing of his nervous system, and this has been affected to a marked degree by his opportunities to exercise and experiment with his abilities.

The first problem of the parent becomes that of recognizing the appearance of developmental levels and providing opportunity for exercise and experience without overstimulation or premature stimulation of the immature mechanism. This involves wise conditioning of behavior units as they come into function; *i.e.*, conditioning bowel and bladder action, food responses, fear response, etc., at the appropriate times. It must never be forgotten that the behavior mechanism matures by units or systems and not by uniform, generalized development (see page 207).

The second problem of training becomes that of *providing situations such that the child can secure complete experiences*, or rather, fostering the completion of his casual, daily experiences. It is probable that in child rearing the chief deterrent to normal mental development and to optimal emotional satisfaction and balance is the fragmentary character of the child's experience occasioned by the parent's failure to recognize the "goals" created by the infant's developmental progression (see page 451). For example, the infant of between six and eight months becomes interested in throwing and banging. This marks the linking and coordination of the reflex mechanism involved in making these movements with cortical centers which are just coming into use. The child *needs* to throw and bang in order to develop the big throwing muscles; he *needs* to throw and bang in order to acquire precision of control of these fundamentally important coordinations. When the child wants to throw and bang, he should be given an abundance of safe and appropriate opportunity to perform these acts until he is completely satiated, or has achieved his goal, completed his experience, or whatever term we may wish to apply to this phenomenon. This completion will be indicated usually by the fading of interest, and the rise of other goals, or inner developmental urges, such as standing, creeping, walking, manipulation of objects, etc.

The child who is not given opportunity to throw and bang during the period of ascendancy of this urge, or who is baffled and thwarted in his efforts in this direction will lack an important unit of training and experience and surely will not be quite normally symmetrical and rounded in his mental and physical growth.[1] An account is given in *Child Development Abstracts*[2] of a child whose hands were tied to prevent self-injury after circumcision, and later during illness to prevent scratching, and finally, habitually tied at night until he was six years old. The child failed to develop normally in mind until given freedom of motor activity, whereupon he developed mentally with rapidity. The child's mind can only express itself through physical activity.

Even during these first short months of life many opportunities arise for the application of these very fundamental principles. When the infant becomes able to distinguish form and light and movement in objects, he needs a wider and more varied environment than during the neonatal period when he is merely digesting, sleeping, and maturing his machinery of behavior. When he becomes able to lift his head he should be given frequent opportunity to exercise his head, neck, shoulder, and arm muscles. He should be placed in a variety of positions and attitudes during his wide-awake hours; all done quietly and without jerking or excitement.[3] The infant needs only to be quietly exposed to his normal environment and given an opportunity to adjust to it, and the activities of the home need not be adjusted in any radical manner to the child. *Adjustment to a normal home is the foundation of his training.*

[1] One young father tried to "train" his nine-months-old son not to throw a spoon given to him while sitting in his high chair, by picking up and returning the spoon each time and at the same time slapping the baby's hands. The natural result was to "condition" the child in fear of his father, since the obvious association was between the slapping and the father rather than between the slapping and the throwing; and the bewildered father finally retreated and put the spoon out of the reach of the justly enraged and baffled baby.

[2] Vol. 5, No. 5, October, 1931, 1002, from Hill and Robinson, *British Journal of Medical Psychology*, Vol. 10, 1930.

[3] It may be appropriate here to say a word of disapproval of the way many persons approach an infant. They raise the voice, laugh in a loud and excited manner, and poke, jab, and grimace at the helpless infant and, all too frequently, tickle, jiggle, and otherwise try to stimulate laughter and emotional response from him. This is artificial, overstimulating, and altogether pernicious.

When imitative behavior appears, the parent is given an enormously important tool for training. When the child reaches for the spoon and wants to try to feed himself, he should be assisted and encouraged in the effort. This will normally come at about the time the throwing, reaching, banging coordinations have brought his big muscles under cerebellar control, (see page 193), which is immediately followed or overlapped by the appearance and coordination of the grasping and picking movements, and all correlated with sitting up between five and seven months. When the infant can both reach and grasp with some degree of accuracy and mental control, he is equipped both to imitate and to initiate a limitless variety of activities. For this reason Dr. Gesell considers this complex achievement to be a landmark in development.

It is important to recognize the appearance of the imitative urge and expose the child to opportunities to imitate appropriate acts, and conversely to protect him from acquiring undesirable action patterns or configurations because of exposure to undesirable stimulation. An example of the latter is afforded by the frequent practice of young fathers of boxing with the infant, often beginning during the banging period. The baby soon learns to strike back with great glee, and father and baby enjoy romps of this character, innocent at the time, but likely to set a pattern of behavior that may be difficult to recondition later. Indeed, one serious objection to the common practice of slapping the hands of an infant as a technique of inhibitory training is that naturally and instinctively the child slaps back. It is difficult to think of any logical reason why he should not do so.

The classic by-by, pat-a-cake, little-pig-went-to-market, and peekaboo imitation plays are good but should be used judiciously. *No infant should be stimulated to "show off," and no infant should be surrendered to the mercies of visitors, relatives, or strangers, to be subjected to inappropriate, exciting, and fatiguing manipulation and play.*

It is important to stress these points with reference to this period of development because it is the infant from six to twelve months old who is most likely to be used as a plaything during the period in which he is becoming so delightfully aware of his human associates and so fascinatingly responsive to social approach. It is easy to forget that he needs time and quietness in which to make adjustments to the new world of awareness. A very good rule in making the acquaintance of infants and young children is to permit them to make the advances. Attention should never be forced or urged upon a child of any age. Children who are used as playthings and thoughtlessly exploited to minister to adult amusement and parental pride often begin to acquire definite protective reactions, even before the age of one year, and behave with shyness toward strangers, cry easily, and show other signs of unfortunately conditioned behavior.

In order to give the child an adequate amount of freedom, he should have a play pen from the time he can sit alone. He should be placed in it, for short intervals at first, during his most active periods of wakefulness (see Fig. 169). The play pen should never become a prison in which the baby is incarcerated for the mother's convenience.

Play Equipment for Early Infancy.—A study should be made of the playthings most liked and used by the baby, and the mother must expect to provide new employment constantly if the child is to be given opportunity to develop his machinery of behavior. In general, articles of the normal environment should be used as occupational material, as far as is easily possible or appropriate. The child enjoys these quite as much as he does special commercial playthings, and he is at the same time learning to know and use his environment. First playthings (and later ones as well) should be durable and easily cleaned. During this period, when everything goes into the mouth, sterilizing the playthings should be a daily rite.

Playthings should be appropriate to the level of maturity; first, things to chew, such as ivory or rubber rings or disks; next, things to throw and bang, rattles, tablespoons, balls, etc., when he sits alone—anything of such size and weight that he can handle and manipulate it. Especially should he be permitted to satisfy his curiosity about anything and everything he sees and wants to explore. The only way in which he can learn weight, distance, color, texture, fragility is through experience. "No, no" may condition an unusually plastic child not to interfere with the mother's convenience, but "no, no" is not educational. More often "no, no," used as a principal tool of training, creates an attitude of rebellion and resistance.

The child who is permitted to handle breakable objects under careful supervision can be taught to handle them with care, and *carefulness becomes a goal of achievement of interest to him.*

"Stop" or some such command should be set apart and used only when prompt obedience is actually necessary for the safety of the child, as when he is going into immediate danger. It should be used so seldom and with such emphasis that obedience is assured. He should never be made to feel that exploring and learning is a crime. If he pulls over a plant, breaks the pot, spills the dirt, and wrecks the flower, it is not necessary to slap his hands and scold in order to prevent recurrence. Discussion of the event in conversational tones and simple words, holding the attention of the creeping infant to the process of cleaning up, the regretful tone "too bad, no flower, dirty floor," etc., will be more likely to prevent recurrence than will angry tones, slapped hands, and a conditioned child who has learned, chiefly, to explore when no one is looking, *since explore he must.*

One advantage in using spoons, cups, bottles, etc., as playthings is that the child learns correct names and acquires familiarity with usable objects.

During the period of actively picking up things and putting them in the mouth, great care must be taken that the baby does not get hold of objects of swallowable size. He may have strings of buttons, safety pins, and beads if they are very securely fastened.

Summary of the First Year.—By the table on page 637 we see that boys and girls at one year differ very little in size: girls at one year range from 26 to 32 inches in height and from 17 to 23 pounds in weight. Boys range from 26 to 33 inches in height and from 17 to 23 pounds in weight.

At the age of six months the infant begins to sit up, and thereby he discovers a new world. He has a new range of vision and new freedom of movement for his arms. He can reach and grasp and bang and throw. He has his attention called to his mouth by the pushing of his teeth. He bites and chews on everything and puts everything in his mouth. Food becomes a matter of keen interest to him. He begins to reach for spoon and cup.

His liver becomes depleted of its prenatal store of iron at about this time. Nature obviously intends that he shall begin to chew and to eat a new variety of iron-containing foods.

At twelve months of age the average child can stand and climb; some even begin to walk. He can say several words but understands many more. He has trebled his birth weight, which was doubled at five to six months. His legs are lengthening in proportion to his arms. His head, chest, and abdomen are still approximately equal in circumference, although the chest is in the lead. His circle of experience is enlarging greatly, his activity and occupational needs expand daily. His habits of eating, sleep, and elimination should be fully regularized. He shows distinct personality traits. He will reach out into his environment in geometrically expanding fields as he sees farther, runs farther, and wonders more about the universe.

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CHAPTER XXV

FEEDING THE RUNABOUT CHILD

Food

Wholesomest of meats is bread;
Of sauces milk is wholesomest;
A flowing brook, in gravel bed,
Is of all beverages best;
The heartiest toil gives earth its fruit;
The sweetest music is the lute.

Old Welsh Song.

Feeding after Weaning. *The Daily Schedule from Twelve to Twenty-four Months.*—The child may sit at his own little table with his own dishes, pretty colored oilcloth doilies, etc. He should be encouraged to feed himself whenever he wants to do so. A cloth should be given him with which to wipe up his "spills." He will do this happily and will acquire the "complete idea" that spilled things must be cleaned up and that the one who spills is the proper one to clean them up.

Every mother should make a daily schedule for the baby, changing it as indicated as the baby grows older, and should follow it with "elastic rigidity." The daily schedule for the child from twelve to eighteen months of age may read somewhat as follows, changing the hours to correspond with the rising hour, which will vary in different families.

1. When the baby first wakes up give him a drink of water; place him on the toilet to urinate; then give him orange juice or tomato juice with cod-liver oil. Let him kick and play or go into play pen until dressed for breakfast.
2. 7:00 A.M. Breakfast: piece of dry toast, zwieback, or very hard cracker (he may have this to chew while the mother is preparing the rest of the breakfast); cereal mush, glassful whole milk.
3. 7:30 or soon after eating. Bowels move (placed on toilet).
4. 8:00. Bath (unless he has been bathed when undressed in evening, or before dressing in the morning).
5. 8:15–10:00. In play pen, out of doors if possible.

6. 10:00. Drink of water; urinate; walk with mother's help, varied play, back in play pen; or he may have nap, if he is having two naps daily.

7. 11:00. Dinner: dry toast, zwieback, or hard cracker; large tablespoonful or more of vegetable mash. One of the following: jellied egg; or cereal mush; or tablespoonful of mealy baked potato with cream or butter and a little salt; or junket; or unsweetened custard; or meat broth with rice; or milk soup and crackers. Glass of milk. He should usually have one egg yolk each day.

8. 11:30. Urinate.

9. 11:30–3:00. Nap, if taking one long midday nap. A short nap, if taking two naps.

10. 3:00. Drink of water, urinate. Lunch: a slice of bread and butter or its equivalent, glassful of whole milk or buttermilk. Cod-liver oil in fruit juice may come at this time rather than in the morning.

11. 3:30–5:30. Play pen, sand pile, ride in baby buggy, or walk.

12. 5:30. Drink of water; urinate; visit with mother.

13. 5:45–6:00. Supper: bread and butter with applesauce, or baked apple, or prune pulp, or cooked ripe pear, or pulp of a sweet orange; glass of whole milk or buttermilk. Or boiled rice with milk with fruit sauce. Or dry toast with cereal mush and glass of milk or buttermilk, and fruit sauce; or milk toast with fruit sauce.

14. 6:30. Put to bed.

Some children from twelve to fifteen months old will wake up for a drink of milk at 9 or 10 o'clock. The necessity for this will depend upon the weight and general condition of the child and the amount eaten at his regular meals.

Frequency of Feeding.—As has been said, the time at which a child begins to eat with the family will vary according to the convenience of the mother, the regularity and spacing of the family meal schedule, the appetite and training of the child, his sleep schedule, and other variable factors. There is a certain advantage in keeping the child on a separate schedule, with his meals by himself, until he can eat neatly and until he is fully adjusted to a three-meal schedule. Most healthy children of fifteen to twenty-four months who habitually start the day with a nourishing breakfast will eat enough food at three regular meals to supply their nutritive requirements and will not need to eat between meals. Indeed many infants under modern feeding put themselves on three meals before they are a year old. Any time a healthy child begins to dally with one of his four meals, a respacing of feeding intervals will probably show that he is fully satisfied with three well-balanced meals. Until a child can do this it is better to keep him on a four-meal schedule, as it is difficult properly to space mid-meal feeding so that it does not impair the appetite for the next meal.

If it seems advisable to have the child eat with the family and he does seem to require food between meals, this should be given at a carefully selected time. In many families there is a longer interval between lunch and dinner than between breakfast and lunch. Where lunch occurs at 12:30 and the evening meal at 6:30, most children should be given a light lunch on waking from the afternoon nap.

The important thing is to have a regular schedule. The normal child's body will adapt its functional activity to any program that fully meets the physiological requirements of the body. The times at which shifts of schedule must be made are more or less critical times. Usually changes in the habitual schedule should not be made abruptly, for the reason that the cells and organs of the body cannot quickly change in chemical function or nervous response. *They must be given time in which to do this.* The digestive tract will furnish more of one kind of fluid and less of another and have these ready at one time or another time when the new experience has become invariable. Usually, however, physiological changes make some shift in schedule necessary. It is a wise mother who can recognize this and avoid useless conflict with growth.

The Family Dietary.—When the child comes to the family table it is very difficult to prevent him from eating the same foods that the rest of the family are having. The only way to make the child safe and to avoid conflict is to provide a family dietary on which the child can thrive. Fortunately, this can be done, as the ideal family dietary follows in general the same lines as that advocated for the child.[1]

A dietary that will meet the nutritional requirements of members of the family from the age of two years to fourscore will

[1] Rose, Mary Swartz, *Feeding the Family*, Chap. XIV, Food for the Family Group, The Macmillan Company, 1940; Lanman, McKay, and Zuill, *The Family's Food*, Chap. V, Food for the Family Group, J. B. Lippincott Company, 1931.

The Parent's Magazine has a regular department, "Feeding the Family," which gives, each month, recipes and suggestions for a whole family dietary.

follow somewhat the following general form. The varying needs of the manual worker, the young, and the aged can be met by varying quantity and emphasis and by providing personal "extras" or substitute dishes when necessary.

Milk.—A quart of milk for each child should be furnished. Crumbine and Tobey say: "A quart of pure milk in some form is desirable and necessary to promote the growth, health, and physical efficiency of every child, at least to the age of twelve."[1] A liberal amount of this may be used in cooking, but the serving of a glass of milk to each growing child at each meal should be as much a matter of course as the serving of bread and butter. It is the duty of the mother to see that her children (except in cases coming under legitimate exceptions) actually consume this much milk, and it should be her pride and pleasure to study the matter of variety and palatability *and make them like it.*[2] McCollum says that milk is the one food for which there is no effective substitute. This applies to the average child. There are exceptions to this, as to every rule. Some children would eat little else if required to drink a full glass of milk at every meal. And there are cases of milk allergy. The child who does not fall in with the "herd" should be studied by a nutrition specialist and have a diet outlined for his special case, to make sure that he does get the essentials, particularly the minerals, vitamins, and complete protein contained in the quart of milk.

Eggs.—Even at their highest cost, eggs furnish more calories and protein than can be obtained for the same money in any kind of meat that it is safe to give to a child. Egg yolk contains extremely valuable vitamins and minerals that are not found in meat with the exception of the edible organs. It should be the family custom to use eggs at one meal every day in addition to those used in cooking. It is now considered desirable that the growing child have one egg yolk daily, on account of the availability of its iron, copper, and sulphur, and the presence of vitamins A and D.

Meat.—There is a wide difference in opinion as to the age at which children may properly be given meat. As a matter of fact,

[1] CRUMBINE, SAMUEL JAY, and JAMES A. TOBEY, *The Most Nearly Perfect Food*, p. 108, The Williams & Wilkins Company, 1929.

[2] *Ibid.*, Chap. IX, Milk and Good Cookery.

the child need never have meat if he has a full milk and egg quotient, but bits of choice cuts of chicken, fish, scraped beef, and mutton chops may be given with safety even to a very young child, provided that the meat is finely chopped, seived, or scraped, and given in small amounts. Liver, which is rich in vitamins, protein, iron and other minerals, is now included in most diet lists for even very young children. Certainly a very little finely scraped steamed beef liver may be given the child occasionally. Liver is often prescribed for anemic children. When it is used on the family table, a portion should be especially prepared for the child, who, of course, must not have fried liver.

Cured meats such as smoked or preserved meat (with the exception of crisp bacon), tough-fibered meats such as hamburger, highly spiced meats such as sausage, and greasy or indigestible meats should never be given to young children. When or if the family elects to indulge in such meats, a special portion of some appetizing substitute must be served to the child. The judicious use of meat to give flavor to soups and other foods and to furnish the essential amino acids, which are lacking in vegetable proteins such as beans, macaroni, etc., is to be commended. Most families now seem to find that these various needs are met by the use of meat once every day.

Grains, Cereals.—It has been explained that the important vitamins and minerals are found in the germ and next to the hull of grains and seed vegetables. White flour and hulled cereals contain very little except starch and a variable amount of protein in the form of gluten. These substances, while they are perfectly digestible and valuable for energy, are seriously lacking in the materials of growth, particularly vitamin B. The growth factors can be added in milk, meat, fruit, and vegetables, but very few dietaries do include enough protective foods to replace entirely the important factors removed in milled grains. Every family should use whole-grain breads and cereals, or enriched flour,[1] in order to safeguard the teeth, bones, and blood of all members, old and young, but especially the appetite, digestion, and development of the growing child.

[1] "Enriched flour" in which thiamin, calcium, and other vitamins and minerals are added to white flour, is being produced by flour mills.

The family that consumes an adequate milk ration and whole-grain breads and cereals has established a very sound basis for the nutrition of all its members. These two items are of especial importance to the family that uses a low-cost dietary. No mother should say that she cannot afford to buy milk for her family.[1] Milk is one thing she cannot afford to curtail or omit. And it must be remembered that "Bread is the staff of life" was written in the days when no other kind was known but coarse, whole-grain breads, which actually did contain most of the essential vitamins and minerals.

Vegetables.—We eat the roots, tubers, seeds, and leaves of plants. Of these, only seeds contain any important amount of protein. Beans, ripe peas, lentils, peanuts, and cereal grain all contain protein. Certain essential amino acids are lacking in these proteins and they must be added by combining milk, meat, or eggs with these (see page 239). When combined with a small amount of animal protein, seed vegetables may be used as meat substitutes in the family dietary. Some of these are rather difficult to digest, however, and must be given to small children with caution.

Root and tuber vegetables, when properly cooked, furnish many of the essential minerals and growth vitamins, and also provide carbohydrates, or energy foods, and cellulose, or roughage. This class of vegetables should be used liberally on the family table (strained for small children), especially the yellow roots and tubers (see page 259).

Leafy vegetables are now considered to be indispensable in the human dietary on account of their vitamin and mineral content. Since some vitamins are destroyed by open heat, and minerals are dissolved and drained away in water, these vegetables should be used in a raw or lightly cooked state, or waterless, vacuum methods of cooking should be employed. The thrifty custom of saving the water in which vegetables are cooked and using it as a base for broths and soups is to be commended.

Raw leafy vegetables and salad vegetables, such as carrots, celery, etc., may be chopped fine, lightly salted, and spread in bread-and-butter sandwiches. This may be served to the

[1] CRUMBINE and TOBEY, *op. cit.*, p. 169.

toddler as a substitute for the richer salad served to the family. Mixing several vegetables used in this way adds variety and obscures the flavor of strong vegetables. In many nursery schools, the vegetable sandwich is a regular item of the menu. Finely chopped raw vegetables may be incorporated in gelatin, a combination always popular with children.

Cabbage is more generally available in the winter, when other fresh leafy vegetables—especially in the country—are scarce and high in cost. Every mother who does not have fresh vegetables easily available should make a study of serving this important vegetable in wholesome and varied ways. All the members of the family should be trained to eat fresh, raw vegetables freely. It will be found that they will then have much less liking or craving for pickles, condiments, and highly spiced relishes.[1]

Fruits.—Fruits are important because they contain vitamins and minerals, also carbohydrates in the form of sugar and cellulose. They are especially important to young children because of their high sugar content. The toddler, on account of his great activity, needs energy food in abundance. The best way for him to get it is in fruits, root vegetables, and cereals, together with some fats. The child who eats fruit freely every day should not crave candy and pastry. The same thing is true for the entire family. The mother of Our Child should serve fruit desserts in abundance and should always serve citrus fruit juices for breakfast. Keeping a bowl of fruit on the table for all meals is one way of encouraging free consumption of fruits. She will find that when her family is fed in this way, it will willingly excuse her from pastry making, there will be no conflict with the toddler on this point, the meals will cost no more, and the health of all will be conserved.

Potatoes.—In the American dietary, the potato occupies a unique place. It is the universal "filler" which, together with bread, contributes much of the bulk of the ordinary moderate-cost meal. The potato is chiefly starch, but it does contain vitamins, and near the skin is a rather important amount of minerals; it is alkali-producing and thus affords an important balance or "buffer" to the acid-producing cereals, meat, and

[1] BOOKOVEN and PITTMAN, "The Economy of Cabbage, Carrots, and Spinach," *Journal of Home Economics*, September, 1931.

bread of the usual dietary. On account of the high starch content of this vegetable the meals of the average family will be better balanced if potatoes are served not more than once daily. Of course a method of cooking that conserves the mineral content, such as baking or boiling in the skin, is to be preferred. Fried potatoes should not be served to the toddler for reasons explained on page 245. Rice is acceptable as an occasional substitute for potatoes, although polished rice contains little else than starch; rice and potatoes should never be served at the same meal. On account of its high vitamin content, brown rice, or unpolished rice, is much more valuable than white, polished rice.

If the homemaker is resourceful in preparing the foods here indicated in varied, palatable, and attractive ways she will find that her family, from toddler to grandmother, can safely eat at the same table and all will enjoy their food and thrive upon it.

Special Points in Feeding Young Children. *Water.*—The child should be given plenty of water to drink between meals, always from his own cup. Unless one can be perfectly sure of the water supply, the water should be boiled and cooled. Children sometimes fret for food when they are really thirsty rather than hungry but do not know how to state their discomfort.

Eating with Clean Hands.—From the very first the baby's hands should be washed before he handles his bread and other food. This is important because babies handle everything and may contaminate their food. It is also important from the standpoint of training in future health habits. Well begun is always more than half done in the matter of child training. The child who has never known anything other than eating with washed hands will be so thoroughly conditioned that in later childhood it will at least be less often necessary to send him away from the table to perform this rite! The baby should never be permitted to pick up food or anything else that has dropped on the floor and put it in his mouth again. While he is struggling with his first crusts he may be placed in the middle of a clean surface on a bed or on a clean sheet spread upon the floor or in his play pen; then someone should watch that he does not get his food dirty and that he does not choke.

Proper Seating at Table.—When the child begins to eat at the table he may then have a "youth's chair" or may sit on a small box placed on an ordinary chair (see Fig. 123). He should always have some place to rest his feet. Children are often restless and hard to control at the table simply because they are weary and uncomfortable. A little step may easily be added to any ordinary chair. If a youngster has eaten at his own small table until he is two or three he will never need to use the dangerous high chair, which is so easily overturned.

Variety and Palatability.—If the child is fed a variety of well-cooked, appetizing food suitable for his age, he will not be likely to object to particular foods unless the matter is suggested to him or discussed before him. Children frequently turn against wholesome and desirable articles of food because they are so badly prepared that an adult could not enjoy them, and presented so continuously that the child becomes bored. It is better to stop for a time offering foods that have become distasteful, and then to present them in a new form, rather than to attempt to compel the child to eat.

FIG. 123.—An improvised high chair.

Sweets.—Honey and molasses may be used with moderation. These are natural sweets; and they also contain some minerals and vitamins and have some laxative effect. If the child has these occasionally, with plenty of fruit and simple desserts, he will need little other sugar. Sugar should be used sparingly, if at all, on cereals or fruits except for a little on tart fruits. It is much better to teach the child to like the fine natural flavor of the different cereals, fruits, and vegetables than it is to have to "bait" everything with sugar to get him to eat it. Sweets between meals impair the appetite and favor tooth decay because of the acid-promoting effect, which tends to soften the dental enamel. Sweets are habit-forming and tend to create a craving for sweets in excess.[1] The longer the child can be prevented from

[1] ROSE, *op. cit.*, p. 183; SHERMAN, H. C., "The Problem of Sweets for Children," *Bulletin of the American Child Health Association*, May, 1929;

having his first bite of candy, the better. It would be better if he never made its acquaintance.

Things a Growing Child Should Never Eat. *Any Food in Which Starch Is Coated with Grease.*—As is stated on page 245, all starch is partly digested by ptyalin in the saliva while it is being chewed and on first entering the stomach. No other digestive fluids act upon sugar or starch until it reaches the bowel. If starch is coated with grease, the saliva does nothing to it in either mouth or stomach and the bowel must do it all. This taxes anyone's digestion, but especially that of a small child. For this reason, pie crust, doughnuts, fried potatoes, or other fried food should never be given to a child.

Anything It Cannot, Will Not, or Does Not Chew.—Corn, cucumbers, radishes, popcorn, nuts, tough meat, etc., are examples of food unsuitable in this respect.

Highly Flavored, Seasoned, or Spiced Foods.—It is a serious mistake to give young children food flavored with pepper, spices, or vinegar, or highly sweetened food. This includes sausage, wienies, pickles, relishes, preserves, mustard, etc., which soon destroy the child's liking for simple, wholesome food and start endless trouble and capricious refusal to eat what he should eat. Such things use an enormous amount of digestive energy to no purpose, since they have little or no food value.

Pancakes, Biscuit, or Soft, Fresh Flour Bread.—These form a doughlike bolus, which cannot be properly mixed with digestive secretions. The test of proper bread is that it crumbs when mashed between the fingers. Bread that forms a soft, sticky mass when rubbed between the fingers is unsuitable for small children.

"Treats" between Meals.—Popcorn, peanuts, candy, pop, ice-cream soda, etc., not only do a child no good whatever, but actually do him much harm by spoiling his appetite, overworking his digestive organs, and making him difficult to manage. Above all, a child should never be "bribed" with these things. Ice cream is a wholesome food when used as part of a meal. It should not be given between meals.

The Importance of Breakfast.—Breakfast is the key meal of the day. If the child does not eat enough breakfast, he is cross

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Sweeney, Mary E., and Dorothy Curtis Buck, *How to Feed Young Children in the Home*, p. 17, Do Children Need Sweets? The Merrill-Palmer School, Detroit, Michigan, 1938.

and hungry in an hour or two and fusses until he is given a "piece." Then he is not hungry for his noon meal, and must have another "piece" in the afternoon. This soon becomes a daily occurrence and will make any child irritable, spoiled, and subject to indigestion.

Reasons Why Children Do Not Want Breakfast.—1. Indigestible food the evening before. If the digestive organs have had to work all night, they are not yet ready to care for another meal.

2. Eating too soon after rising. A child who is brought from his bed to the table in his night clothes, or when scarcely awake, cannot be expected to eat. Every child should have a drink of water on waking, and then be quickly bathed and dressed and given a few moments to play, out of doors if possible, before being served with breakfast.

3. Unappetizing food. Too often the child who sleeps late is expected to eat cold, unappetizing food. No matter how busy the mother is, nothing can possibly be so important as the matter of serving a fresh, well-balanced morning meal to her growing children. In the long run she will save time by doing this, as the well-fed child will be happy and will not disturb her later by teasing for a lunch.

Preparation and Care of Food. *Milk.*—Unless certified grade-A raw milk can be obtained, it is better to measure out enough fresh milk in the morning to last all day, put it on the stove, and bring it quickly to a boil (it should not bubble for longer than 2 minutes), cool it quickly, and keep it on ice. *It must be kept cold from the moment of milking except for the period of heating.* Just what is needed is poured out at each meal, and the child's cup should stand in hot water to take off the chill before it is given to him. Ordinarily the child should be given plain whole milk. The cream should be thoroughly stirred in before each feeding is taken out. Part of the cream should be removed from Jersey milk, or any milk with high fat content.

Zwieback, or "Twice-baked" Bread.—This is made by baking sliced bread in a quick oven until it is of a delicate brown.

Cereals.—Whole-grain cereals should be used very freely in the feeding of growing children. The refined and prepared cereals have had valuable minerals and vitamins removed. Children should be given a variety of cereals. Oatmeal may be the stand-by, but some other cereal should be used two or three times per week in order that the child may not become tired of the sameness of his diet.

Cereal Gruel.—Sprinkle oatmeal, corn meal, barley, cream of wheat, farina, rice flakes, or other uncooked cereal in enough boiling water to make gruel about as thick as ordinary flour gravy when done (the amount of water varies with different grains). Boil hard for 3 minutes, then put into a double boiler and cook 20 minutes to 1 hour or longer, according to the degree of processing the cereal has had in the factory; add ⅛ teaspoonful of salt to each cup of gruel. All cereals with hulls should be rubbed through a sieve before they are given to infants under one year old.

Cereal Mush.—Cereal mush should be about as thick as mashed potatoes. Cereal mush may be wet with a small amount of cream or whole milk, but to older children it should be fed thick enough to encourage some chewing. If properly salted in the making, the mush will have a good flavor and will not need the addition of either salt or sugar to make the child like it.

Vegetable Water.—Take one cupful each of two or more of the following vegetables (finely chopped): spinach, carrots, celery, tomatoes, string beans, green peas, dandelion greens, young turnips, young turnip tops, cabbage, or other tender root or leafy vegetables; add water enough to cover them; then put on the cover tight and cook the vegetables slowly until they are barely tender. Overcooking destroys vitamin C. Boiling water should be added as fast as the liquid boils away. The water should be drained through a fine sieve and a little salt should be added.

This kind of vegetable extract is often prescribed for delicate and anemic infants and may be added to the diet of any child. Modern pediatricians often advise adding vegetable water to the infant's drinking water once or twice daily. It is especially rich in iron, potassium, and other minerals. Blending the flavors of several vegetables tends to prevent the child from acquiring dislikes of certain vegetables of strong flavor.

Vegetable Mash.—Proceed as for vegetable water, but allow the water to evaporate, then strain the pulp through a coarse sieve. All fiber and coarse parts should be strained out for small children.

Fruits.—All fruit given to young children should be perfectly ripe and fresh. Only ripe, sweet oranges should be selected for the juice given to infants. Only perfect fruit should be given to any young child. Canned tomato juice may be used if good brands are selected in which only choice ripe fruit was originally used.

Prunes and other dried fruit should be carefully selected; only fruits that were choice and ripe before drying should be cooked for small children. Bananas are nutritious and easily digested if fully ripe. The skin should be dark, but the pulp firm and fresh. The high caloric content of bananas should be considered; otherwise the child may be overfed.

To Cook Prunes or Other Dried Fruits.—Wash thoroughly, cover with water; soak overnight or for one or more hours in an aluminum or porcelain-lined pan; place on stove *in the same water;* simmer very slowly until the water is syrupy and the fruit soft.

For a baby under six months old, strain off the juice only. For one older than six months rub the pulp also through the sieve. Ripe dried fruit requires no sweetening. Apples, pears, or ripe bananas when baked form wholesome articles of diet for even very young children. Prunes may cause loosening of the bowels and should therefore be used with caution. Prunes are often given because of the laxative effect where there is a tendency to constipation.

Eggs.—Coddled or soft-poached eggs are prepared by dropping the egg (with or without the shell) into boiling water, covering the pan closely, and removing it from the fire. Remove the egg from the water when of a jellylike consistency. The yolk of hard-boiled eggs is easily digestible and may be fed to any child who is permitted to have egg. Hard-boiled white of egg should not be given to a child.

Feeding Problems. *The Child Who Will Not Drink Milk.*—Children may refuse milk for any of the following reasons.

1. Bottle-fed babies who have been fed on sweetened condensed milk or milk modified with too much cane sugar are likely to refuse plain unsweetened cow's milk.

2. Children who nurse the bottle or breast too long sometimes refuse to drink milk from a cup.

3. The mother may at some time have given the child milk that tasted or smelled of onions, cheese, fish, or some strong food that had stood near it; or the milk may have been tainted by the cows' having eaten wild onions or some strong herb in the spring pasture; or the milk may have at some time begun to turn sour.

4. The child may have been spoiled by being given sweetened drinks, cocoa, and highly flavored food, which he naturally prefers to the mild-flavored milk.

5. The child's diet is permitted to become monotonous and unattractive. He craves a change, and the only way he has of expressing this is to refuse the things he has had continuously. *The child will drink milk continuously, just as he eats bread at every meal, if he is given a variety of other things.*

6. The child is permitted to become capricious and undisciplined. This kind of child never feels well and is capricious about his food as well as everything else. *The answer to this is a course in child study for the mother—never punishment for the child.*

7. The commonest reason is the failure of the mother to realize the importance of a full milk ration for every growing child. After the child has once been permitted to stop drinking milk it may be difficult to retrain him.

The Child Who Craves Meat.—Any person who does not eat a sufficient amount of milk or milk products or eggs will crave meat. Everyone should have some animal food every day. The child who does not have a full milk ration every day craves other animal food to take its place.

It would be very dangerous to give the child enough meat, cheese, eggs, or beans to furnish him the same protein value as the quart of milk that the average child should have every day.

It is practically impossible for any child to make a normal, healthy growth without a reasonable amount of milk. If the child actually drinks a cupful of milk at every meal and receives some besides in the cooked food, with an egg or some cottage cheese occasionally, he will not be likely to crave meat. On the other hand, *no child should be permitted to live on milk to the exclusion or limitation of solid food.*

The Child Who Refuses to Eat New Food.—This situation is another that is more easily prevented than corrected. Unless a child has had an unpleasant experience connected with the tasting of new substances, he will naturally be responsive to the suggestion, "Here is something new and good to eat." It will be an adventure. Then be sure that the new substance is delicately prepared and appetizing, and *offer it in small amounts when the baby is actually hungry.*

When offering new vegetables, especially those having decided flavors, give small bites with crumbs of bread or toast, or mix them with potato or put them in a sandwich, in order to allow the child to become gradually accustomed to the new taste.

Every care should be taken to prevent the child from hearing others discuss any wholesome article of food unfavorably. The mother should try to bring up her children without prejudice against anything not harmful. It should be a basic item in family training to avoid discussing any food unfavorably at the table.

The Child with a Poor Appetite.—The child who is constipated, who has large adenoids, diseased tonsils, and bad teeth, who gets too little sleep, or who does not have enough outdoor life and fresh air, or one who eats irregularly or capriciously, is likely to be finicky and delicate about his eating. The child who eats too often or who is stuffed with dainties or who is harried and nagged by a nervous mother will not eat well. The child who does not get enough vitamin B or, in other words, enough fresh, protective food will be undernourished and lack appetite (see page 260). Lack of appetite may be due to such poor general tone that the muscles of the stomach even are sluggish and the stomach does not promptly empty itself.

A child who does not become hungry when limited to three good, wholesome meals per day should have his sleep schedule lengthened, also his time for fresh-air play. If he still fails to eat, he should be examined by a physician and have his defects, if any, corrected.

The Psychology of Feeding.—The attitude of the child toward food and feeding is all-important. We now know that *the child acquires these attitudes very early* and that they are very persistent. We need to recall the fact that his environment is constantly establishing new gradients in his flexible protoplasmic and nervous structures and that these tend to become permanent and difficult to eradicate. It is not only important that the child shall eat the foods required for his optimum growth, but *it is of even more importance that he shall like them and prefer them, as only in this way will he be sure of continuing to eat them after he becomes old enough to choose his own food.*

We now know also that aversion to food interferes with digestion, and that forced feeding may not only bring about injurious inner nervous conflict but may cause actual illness and prolonged malnutrition. Instead of establishing gradients for permanent use and enjoyment of desirable foods, gradients are established for permanent dislike. This defeats the very purpose of the parent.

A child should never be forced to eat when he is not hungry. It is more sensible and humane to find and correct the cause. Besides, conflict only intensifies the situation and piles up trouble.

With these facts in mind we can appreciate the importance of helping the child to establish the right feeling and attitude toward foods when they are first presented to him. We can also appreciate the importance of avoiding the establishment of likes and dislikes and attitudes that must be corrected later if the child's welfare is to be conserved.

Establishing Good Food Habits.—Most of the practical points involved in the psychological management of feeding have already been mentioned in this chapter. Briefly, these points are

1. Regularity such that physiological adjustments or rhythms can be established.

2. Variety such that the child does not become tired of a few staples like bread and milk.

3. Balance such that the child does not develop obscure physical cravings and caprice because his tissues are actually hungry for food factors that he is not receiving.

4. Matter-of-factness about meals and foods. The taking for granted that everyone is going to eat what he should eat does much to prevent conflict.

5. Family harmony as to likes and dislikes. If any adult has food aversions, it should be a matter of family policy to avoid calling the attention of the child to these in any way.

6. Good cheer at table. Mealtime should be a happy time. Unpleasant matters must never be discussed at the table, and, above all, matters of discipline should never be discussed or administered during the meal hour; scolding and nagging and teasing should be taboo. A funny-story contest at mealtime is a splendid custom. Experiments with animals show that the secretion of digestive juices is arrested and that digestion actually ceases when an animal is frightened or teased or becomes angry and emotionally disturbed.

7. An intelligent understanding of food values and nutrition and a practical knowledge of good cooking are essential, of course, in making the balanced ration appeal to the family. The mother of young children should constantly read new literature upon these subjects and participate in extension courses or group activities relating thereto, and avoid falling into a rut of monotonous repetition in food selection and preparation.

Breaking Bad Food Habits.—The best way is to let go, stop all conflict, and begin all over again. This is not easy, as the food situation is only one feature of the total parent-child relationship, and the mother (and the rest of the family) must, as abruptly as possible, acquire a new philosophy toward childhood. Respect for the personality of the child must replace coercion.

1. Change the atmosphere. The change must be utter and entire—not an irritable or insistent or coaxing or nagging word! Nothing disarms resistance like this and nothing short of this will disarm resistance.

2. Take desirable responses for granted. Serve the child as matter-of-factly as other members of the family. If, as has been indicated, the other members do eat what he is supposed to eat and do it as a matter of course, he will tend to fall in line. He must be treated with the same courtesy and consideration as prevails among the adults.

3. Give him time in which to make readjustments. He cannot abruptly change either his mental or his physical responses. He must have time to forget the old situation. In order to do this he must not be reminded of it. He must be served with a balanced ration but one which differs somewhat in appearance and flavor from the articles of most frequent former conflict. This should be done smilingly, without discussion or argument. If he

does not eat it there is still no fuss or argument, and it is usually, though not always, unwise to make substitutions at the time of refusal.

4. Do not humiliate the child. The mother should treat a request from the child with courtesy; if he wants another kind of bread or cereal, or will compromise on something that is easily available and of equivalent food value, it may be sheer good policy, as well as common courtesy, to go part way in making it easy for the child to "save his face."

The child will quite naturally prefer to make a selection if he discovers that he can secure it by negativistic behavior. It will not hurt any child to miss a meal or to eat lightly for a few meals. Hunger is the best sauce. Many children become persistently capricious and difficult because the mother yields to demands for irregular feeding, especially of sweets, and the child never knows the sensation of healthy hunger. If the child shows need of food before the next meal, he may be given milk or bread and milk or other simple, bland food, quietly and in a cheerful, matter-of-course way. If possible, leave the child alone with the controversial food so that he will not have the humiliation of having a witness to his capitulation. The parent must be willing to forego the personal satisfaction of having the child "surrender." The sense of independence and self-respect is to be fostered, not crushed. If essential food is refused, take the refusal casually but, in most instances, offer nothing else. Prejudice can sometimes be overcome by serving very small portions of the offending food. Later the servings can be increased so gradually that the fact is not noticed by the child.

If the child, by any chance, can witness and assist in gathering and preparing vegetables and fruits, and particularly in the planting and care of a garden, the transfer of interest to eating the finished product comes naturally and happily. A child who refused tomato juice was permitted to help raise some tomato plants, gather the first fruit, and squeeze the juice. He was then eager to drink it. Merely squeezing his own juice may provide the necessary incentive.

5. Ignore all emotional explosions. Divert the attention of the child to other interests if possible, but remain serenely deaf to teasing, screaming, stamping, and tantrums. Give the child

time to learn that there is a new and inflexible order of things and that such methods will not bring him the desired results. *This involves time and especially patience.* The mother must continually remind herself that the situation was of her own making and that she cannot undo it in a twinkling, and she should constantly try to put herself in the child's place.

Such, in general, is the way in which nursery-school children are trained and retrained. Children are highly sensitive to atmosphere. An atmosphere of dictatorial, irritable insistence and, equally, an atmosphere of sentimental coaxing, and especially a combination or alternation of the two will make any normal child negativistic and stubborn. An atmosphere of inflexible but cheerful taking of cooperation for granted tends to make almost any child cheerful and cooperative, in time.

Above all, the mother must not let the child know that she is solicitous or worried about his nutrition. She should protect the child from the concept or suggestion of illness just as long as she can. The idea of health, however, may be presented to him in very simple terms as he becomes able to understand. It is a very wrong method to try to scare a child into eating spinach or into drinking milk by telling him that he will become ill or thin or ugly if he does not. It is also bad psychology to tell him oatmeal will make straight hair curly! This only deepens aversion and keeps undesirable thought images before his mind and imagination.

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CHAPTER XXVI

THE CHILD FROM ONE TO TWO: DEVELOPMENT, LOCOMOTION, LANGUAGE, TRAINING

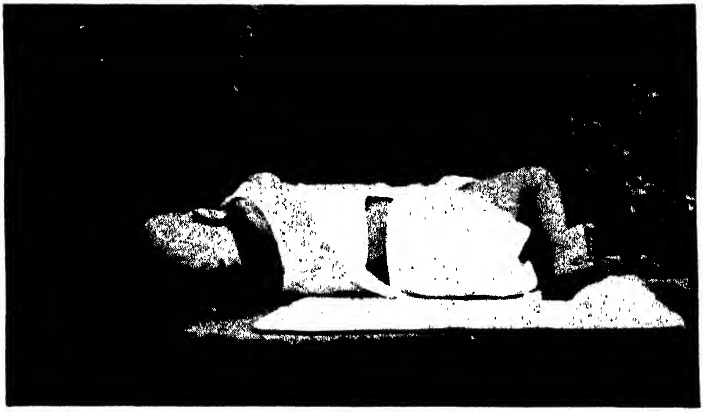
Hold childhood in reverence, and do not be in any hurry to judge it for good or ill. . . . Give nature time to work before you take over her task, lest you interfere with her method. . . . A child ill taught is further from virtue than a child who has learned nothing at all.

—J. J. ROUSSEAU, *Emile*, 1762.

We have now seen Our Child arrive at a stage of development which has made him keenly alive to a world outside himself. He has become aware of sound, light, color, form, density, and space. He has discovered his mechanism of locomotion; he can cause things to move; he can explore, discover—*learn.* He can by consciously modifying his vocalization obtain response from others. He is full of the urge to experiment and to explore. He especially wants to touch, feel, lift, handle, manipulate. Usually the preference for right or left hand is apparent by the end of the first year. He coordinates tactile sensations with taste and smell and sound. His centers of association and coordination are connecting with each other and with the subcortical centers of sensation and emotion (see Chaps. XII and XIII). His consciousness is becoming integrated into functional unity. He has become aware of others and delightfully responsive. Out of his original helplessness and passivity an aggressive and assertive personality emerges. It becomes our pleasant duty to watch the further transition of our infant into childhood as he perfects the tools of *locomotion* and of *speech.*

Locomotion.—According to Gesell's normative summary for twelve months, the average normal infant not only pulls himself up from a sitting to a standing position, but walks with help. At fifteen months he stands and walks alone; at eighteen months he climbs a chair; at twenty-one months, he walks backward and walks, attended, on the street; and at twenty-four months he runs (see normative summaries, page 642). Maturation, notably of the cerebellum, determines rate and sequence of locomotive activities.[1]

Miss Shirley reports that the 25 babies included in her study[2] exhibited individual characteristics in walking, subtle differences in the stepping habit and characteristic ways of placing the feet, pointing the toes or curling them under, or patting one foot on the other. The feet of the infants were oiled and the prints they made upon strips of white paper were dusted with lamp-



(*a*)

FIG. 124.—The story of locomotion. (*a*) Four and one-half months: rolling over.

black. The observers became able to identify many records by reason of individual characteristics.

She reports a wide variation in the ages at which these children walked. The most precocious child could walk when led at twenty-three weeks; the most retarded at seventy-two weeks. The median age of walking when led was forty-two weeks. The

[1] "The cerebellum grows very slowly in the first five months, then suddenly it begins to develop faster, until finally it attains its greatest rate of growth in the last half of the first and the first half of the second year, reaching its full size toward the end of the fourth year. The time at which its greatest increase is indicated, at the end of the first year, is also the time when the child is learning to sit and to walk—activities requiring the effective regulation of bodily equilibrium which the cerebellum supplies." KURT, KOFFKA, *The Growth of the Mind*, p. 59, Harcourt, Brace & Company, Inc., 1927.

[2] SHIRLEY, MARY M., *The First Two Years*, Vol. 1, Postural and Locomotor Development, p. 82, The University of Minnesota Press, 1931.

age of walking alone varied from fifty to seventy-six weeks, with a median of sixty-four weeks.

(b)

(c) (d)

FIG. 125.—The story of locomotion continued. (b) Seven months: hands and knees. (c) Nine months: stands with support. (d) Twelve months: an anxious moment. Balances with arms.

Perfection of skill in walking alone was attained at sixty-four to ninety weeks. From this time on, improvement was a matter of speed and accuracy. Miss Shirley says that the infants settled down between eighteen and twenty-four months to a rather uniform rate of about 170 steps per minute covering a distance limit of about 30 meters. Three women, as controls, walking briskly, covered, respectively, 42, 48, and 49 meters and took

(e) (f)

(g) (h)

FIG. 126.—The story of locomotion continued. (e) Twelve months: less anxious but still needs arms. (f) Thirteen months: arms coming down. (g) Fifteen months: exploring the universe. (h) Eighteen months: quite the man!

145, 142, and 143 steps per minute. This indicates that the child moves more rapidly but covers only three-fourths the distance covered by his mother. In proportion to his leg length the child probably takes longer steps than the adult.

These findings indicate that the adult in walking with a child should always permit the child to walk at his own natural speed and never (as one frequently sees) pull him along by an arm and force him to assume an unnatural gait.

The stepping angle assumed by these children varied at first. Most of the infants "toed out" when they first began to stand and walk. Only two infants were consistently pigeontoed throughout the period. Most of the infants tended to reduce the stepping angle to zero and toe straight ahead by the age of two years.

FIG. 127.—A precocious one-year-old. Walking well upon her first birthday.

Miss Shirley reports that the small, wiry children tended to walk earlier and better than those who were shorter and heavier. Martin, a child of the wiry type, "jumped on his toes" at twenty-seven weeks of age, completely skipped the stage of standing with help, and at twenty-nine weeks walked across the room, with help, in 30 seconds. By thirty-five weeks of age he was not only walking well but was stopping on his way to investigate toys. He was walking alone at fifty weeks of age and walking rapidly at fifty-four weeks.

On the other hand, Torey, who was heavy, with short legs and small feet, showed no interest in standing or walking and occasioned much anxiety by his refusal. At seventy-two weeks of age, however, he suddenly walked without help for the first time and almost ran. At the age of seventy-four weeks he was walking well.

Miss Shirley states that a fair prediction of the walking age may be made by doubling the age at which the infant sits alone. She sees some evidence, not yet conclusive, that the proportionate length of leg enters into the matter of walking, since the first four babies to achieve a leg-trunk ratio of 0.60 or more were also among the first to walk, while the last four babies to achieve this ratio walked very late.

Since the children appearing in this experiment were all presumably healthy and were all permitted perfect freedom, the differences shown would seem to represent differences in rate and completeness of organic development. Miss Shirley interprets her findings on the basis of the maturation hypothesis. She says:

> The sudden appearance of integrated locomotor skills that the babies apparently had never practiced is in accordance with the development of locomotion in Amblystoma [Coghill]. The law of integration first and individuation into reflexes later probably applies to babies as well as to lower vertebrates. . . . Coghill's interpretation is in perfect agreement with these observations.[1]
>
> There is orderliness in the development of a particular motor skill; creeping, sitting, and standing all have their patterns. Because it follows a pattern, motor development meets the requirements of the maturation hypothesis. . . . Training and conditioning unquestionably play a rôle in motor development, but their rôle is subservient to maturation and inborn trends.[2]

Miss Shirley was able to discover no coordination between the use of the arms and hands in prehension, as described during the period of early infancy, and the ability of the child to walk. She says that the use of the hands and arms in reaching is a different matter from maintenance of postural control and locomotion.

Burnside made a photographic study of the early locomotion of a series of children and found a wide variety of hitching, pulling, crawling, and creeping movements. She concludes that the infant goes through a period of experimental movements and that early environmental conditions may determine in part the specific locomotion action pattern.[3]

Dr. Myrtle McGraw in her study of Johnny and Jimmy found that up to the age of nine months specific locomotive actions

[1] *Ibid.*, p. 191.

[2] *Ibid.*, pp. 172, 180.

[3] Burnside, L. H., "Coordination in the Locomotion of Infants," *Genetic Psychology Monographs*, Vol. 2, 1927.

appeared in the same sequence and at about the same ages in both boys. By fifteen months, however, the trained twin, Johnny, surpassed the control twin, Jimmy, by a month and a half.[1] Remembering that the coordinating motor center, the cerebellum, is beginning to function actively at about this time, it would seem logical that experience (environment) should begin to determine and modify development and function in this field of activity. Eventually, however, after the conditions of the experiment were terminated, Jimmy seemed to overcome, in considerable measure, the effects of his early, enforced inactivity.

Some psychologists ascribe importance to motor development and locomotion as an index to mental capacity. Terman found that the average age for walking in average normal children is about 0.8 month older than for gifted children, while feeble-minded children are almost 12 months later than normal children in walking. Miss Shirley, however, was unable to find any coordination between motor development and mentality in her group of healthy well-cared-for babies.[2] She thinks locomotor precocity offers a far from satisfactory clue to intellectual precocity, although a "small but positive relationship" was shown to exist between motor and intellectual skills when these children were subjected to the Minnesota intelligence tests for eighteen months.[3]

Motor Play.—Miss Shirley observed and classified the motor play of her test children by periods corresponding closely to Gesell's normative periods. At the close of early infancy the child is struggling to his feet and learning to use his arms and hands. Miss Shirley says, "play was still activity per se." As soon, however, "as the baby could move about under his own steam his activity became directed toward a goal and was not indulged in exclusively for its own sake."[4] When the child in the learning-to-walk period really wants to get somewhere he

[1] McGraw, Myrtle B., *Growth, A Study of Johnny and Jimmy*, D. Appleton-Century Company, Inc., 1935; Curti, Margaret Wooster, *Child Psychology*, Chap. IV, Growth Motor Development, Longmans, Green & Company, 1938.

[2] Shirley, *op. cit.*, p. 172.

[3] *Ibid.*, p. 134.

[4] *Ibid.*, p. 140.

usually drops down and creeps. He is a persistent climber at this age. He climbs up into chairs and goes up the stairs on hands and knees. He climbs the leg of an adult who holds him by the hands, a gleeful game all babies seem to enjoy. Kiddy-cars and walkers are used and abused at this period. The tendency of apparatus of this sort is to lead the child to excessive use and activity of legs and feet while entirely inhibiting corresponding developmental exercise of the arm and shoulder girdle. The child should climb and pull and push to his heart's content. Thus only can he develop a symmetrical body, equally strong and useful in all its parts.

FIG. 128.—Fourteen months and already going up in the world.

Babies at this age love to shove chairs and movable articles of furniture. Before a child can walk alone it can propel its buggy along the street, holding onto the handle. At from fifteen to eighteen months of age the child learns to come down the full flight of stairs. He now uses the stairs purposefully, to get somewhere, rather than for the pure joy of exercise. He climbs down from furniture; he soon begins to run; he loves a chase; he learns to use chairs as tools on which to climb for something out of reach.

Imitative motor play develops steadily during the entire period of later infancy. We saw that the child at ten months has begun to play pat-a-cake and by-by. He adds to his repertory as opportunity affords until by two years he is entering with spirit into many make-believe games and tries to dress himself, sweep the floor, and do many things that he sees others do.

That new levels of behavior are made possible by the completion or closure of new circuits within the nervous system is illustrated by "spurts" of activity. "For weeks at a time a child remained at a standstill, and suddenly within a day's time he had climbed the next step and was functioning on an entirely different motor level."[1]

Training.—The various experiments in training in motor activities seem to agree in showing that basic (phylogenetic) structures mature and will function in sitting, standing, creeping, walking, grasping, etc., as soon as sufficient maturation occurs, regardless of stimulation or training; and that delay in performance because of enforced temporary inactivity will not cause permanent retardation. Such skills, however, as proficiency in skating, swimming, climbing, etc., must be developed (ontogenetically—"individuated") within the basic mechanism (see Chaps. XII and XIII). Training, therefore, consists in affording opportunity to the child for developing motor skills, and particularly, as stated, in capitalizing the maturation urges as they appear. See Chap. XXXV for practical suggestions.[2]

Language Development.—Gesell gives the normative summaries for language during the later infancy period as follows: At twelve months says two words; adjusts to simple verbal commissions; places cube in or over cup on command. At fifteen months says five or more words; uses jargon conversationally; points to nose, eyes, or hair. At twenty-one months joins two words in speech; names one picture; repeats things said. At twenty-four months names three of five objects; points to five objects on a card; uses words in combination.[3]

Miss Shinn records of her niece that in the middle of her fifth month she seemed to imitate the movement of her mother's lips when she said "papa." Miss Shinn thinks this was the beginning

[1] *Ibid.*, p. 173.

[2] Sherbon, Florence Brown, *The Family*, Chap. V, The Skeletal and Muscular Systems, McGraw-Hill Book Company, Inc., 1937.

[3] Gesell, Arnold, *Infancy and Human Growth*, pp. 132–134, The Macmillan Company, 1928.

of discrimination in articulate sounds. The child began at about that time to hold out her arms and make expressive whimpering, coaxing sounds addressed obviously directly to the person whom she wished to take her up. Miss Shinn thinks this was not so much the beginning of human language as it was of the language that "the baby shares with all beasts and birds."[1]

A month later the baby began to "pour out long, varied successions of babbling sounds, which expressed content, interest, or complaint very clearly." In the latter part of the sixth month the baby "would coax for a frolic by leaning forward with an urgent 'Oo! oo!' and expressive movements of her body." If she wished something else, to be taken up or given an object, "there were small but quite definite differences in tone, expression, and movement, so that we usually knew at once which she meant."[2] At about this time she began to show signs of recognition when her name was spoken. During her seventh month she seemed to begin to connect the name with the person in the case of members of her family and seemed to have some idea of the meaning of "No, no!"

It was during her eleventh month, however, that consistent repetition of certain sounds occurred. She chattered more than ever in expressive jargon, but out of the random matrix of sound syllables appeared. "Da!" was suspiciously often ejaculated when she threw out her hand in pointing. "Na-na-na!" separated itself out as a wail of protest, and "Ma-ma-ma!" seemed a whimper of discontent and loneliness. During the month Miss Shinn is sure that the baby associated the word "gone" or "all gone" with disappearance. She would make various sounds, such as "Gng," "Ng-gng," and finally achieved "Gong." This word meant all manner of disappearance. She used it when she dropped something; when her food went down her throat; when she felt the bald spot on her father's head; when she slipped off a step. Twice before her first birthday the baby turned and looked into Miss Shinn's face when some one left the room and said "Gong!" At other times she seemed to say it as if stating a fact to herself rather than as if imparting information.

[1] SHINN, MILLICENT, *The Biography of a Baby*, p. 159, Houghton Mifflin Company, 1900.

[2] *Ibid.*, pp. 169, 175–176, 229.

During the last days of her first year she began to exclaim "By" and "My." The only other word she acquired during her first year was "Kha!" This sound, expressive of disgust, was addressed to her when she put her fingers into food and in other such situations. She soon used it in its correct connection, although her disgust was imitative rather than real, as she still continued her digital explorations.

Although her definite vocabulary was limited to the above exclamatory sounds, for her real talking "she used a wonderfully vivid and delicate language of grunts, and cries, and movements. It was remarkable what shades of approval and disapproval, assent, denial, and requests she could make perfectly clear."[1]

The baby's understanding of speech far exceeded her use of words. Miss Shinn says she knew at one year, by accurate test, 51 names of people and things; 28 action words which she proved she understood by obeying commands and requests, and a few adverbial expressions like "where" and "all gone"—84 words in all, securely associated with ideas.[2]

During the twelfth month she learned to nod in assent, and to say "E" in approval, possibly an attempt at "Yes." She had also a definite negative grunt.

Margaret Curti describes the origin of speech thus:

> Simple movements, then, including cries or vocalizations, early become significant in making possible communication with and "control of" adults. As gestures, they may be said to represent the first stage in the development of language, although to the infant himself they have no symbolic meaning.[3]

Dr. Curti says that the process by which sounds and gestures acquire symbolic meaning is deeply significant in the development of the child.

> During the first half-year we may observe in infants the spontaneous making of simple sounds, first almost purely vowel sounds, such as ă and ä sometimes aspirated (hä or ah) or nasalized (an); later, especially after the third month, various vowel-consonant combinations, as mă,

[1] *Ibid.*, p. 237.
[2] *Ibid.*, p. 236.
[3] Curti, *op. cit.*, p. 253.

gă, ăng; and finally vowels with labials and fricatives, making such sounds as păp, ŭv, and the like. These sounds apparently occur in an order determined roughly by growth of the finer laryngeal and other muscles. . . . A part of the general random reflex activity of the infant, they are called out by intraorganic stimuli, and are connected with a general state of bodily well-being and organic tonicity. These speech sounds are to be contrasted with the sharper cries or noises which are definitely emotional in character.[1]

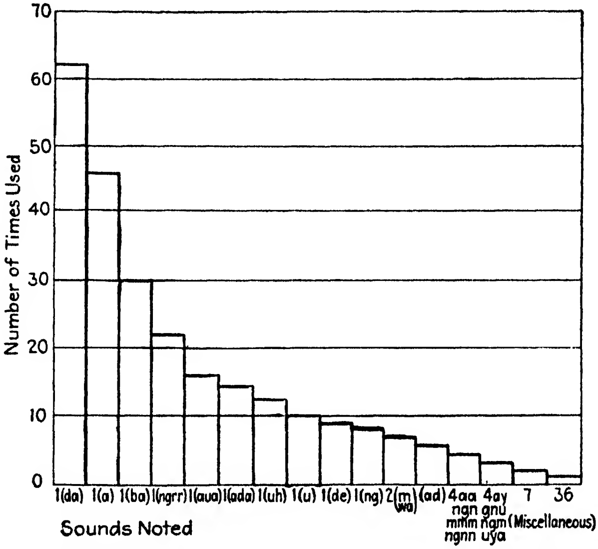


FIG. 129.—Vocalization chart of I. M., age six months. Sixty-four different sounds were distinguished, and their frequency is shown in the diagram. (*From Gesell, The Mental Growth of the Pre-school Child, The Macmillan Company.*)

L. M. Malmbery of Gesell's staff recorded as completely as possible all the sounds uttered by one child during 24 hours. Figure 129 shows the result.[2]

Dr. Curti explains speech as in part a conditioned response.

When a baby articulates a given syllable, for example "da," he is being stimulated by two main groups of stimuli, one the auditory group represented by "da," the other a kinaesthetic-tactual group arising from the responses of the laryngeal, throat, and tongue movements

[1] *Ibid.*, p. 259.

[2] GESELL, ARNOLD, *Mental Growth of the Preschool Child*, p. 216, Fig. 150. The Macmillan Company, 1925.

which occur as the word is said. Now with a few chance repetitions of the sound, we have the essentials for the formation of a conditioned response, namely two stimuli affecting the organism at the same time and followed by a common response, the speaking of another "da."[1]

Hearing the sound "da" spoken by others becomes an adequate stimulus to utter "da." He thus practices the sound and develops facility in articulation. Eventually the sound, or some modification of it, comes to include further items in its "condition" or "configuration," da-da may come to denote a certain individual, the father of the child.

Random vocal sounds uttered repeatedly by the child may come to have chance conditioning which escapes the notice of the parent, as when the child persists in saying "na, na" when he wants a drink because his mother chanced to give him a drink when he was practicing this vocal exercise.

Adults may assist the child by repeating to him clearly the sounds he is trying to make. Doctor Curti says that the child will not repeat from merely hearing a sound which he has not already used—in other words, for which his vocal mechanism is not ready. It is, therefore, a waste of time to try to "teach" an infant to utter entirely new sounds or words.

It is interesting to reflect that human young of all races are provided with vocal mechanisms capable of producing similar ranges of sounds. Environment in the form of racial experience has shaped these sounds into equivalent languages which may be translated one into another. Thus a child's language becomes one item of his racial and social inheritance[2] (see page 88).

Buford Johnson asserts: "All vowel and consonant sounds necessary for speech are made within the first year and sometimes within the first six months."[3]

From attaching sounds to objects as names, the child comes to associate sounds with situations—as "gone" with disappear-

[1] Curti, *op. cit.*, p. 259.

[2] Wagoner, Lovisa C., *The Development of Learning in Young Children*, Chap. XII, Learning to Talk, pp. 182–183, McGraw-Hill Book Company, Inc., 1933.

[3] Johnson, Buford J., *Child Psychology*, Chap. VI, Speech, p. 193, Charles C. Thomas, Publisher, 1932.

ance, in the instance of Miss Shinn's niece; or meowing with a cat. Thus action words are added to name words.

Before the child can formulate a sentence one word commonly stands for an entire sentence. "Wa wa" may mean "Give me a drink of water." "Miew" may mean "I want to play with the cat."[1]

Jessie Chase Fenton says:

Endless repetition is characteristic of childhood; the performance of any act suggests itself again, and the child finds inherent satisfaction in repeating a sound or a gesture or action of some kind in a monotonous sequence that would drive a grown person to madness. This tendency is first strikingly evidenced in the baby's babbling. But though any given sound may be reiterated indefinitely before it is relinquished, there is nevertheless great richness and variety in the babble as a whole. Usually it contains a far wider range of separate sounds than the child will have use for in later life. Among my baby's first sounds were a number of gutturals not used in English at all, among them the German *ch*, and a harsh throaty *gh*: the German sound of ö and French *eu* occurred frequently, and a considerable number of slurred vowel sounds which I could not set down at all in our alphabet. Together with these occurred in many different combinations nearly all of the sounds used in English, though put together often in combinations which we never use, such as *dzhi*, *dth*, *ngya*. The sounds of *f* and *v* I did not catch at all during the first year, nor *qu*, though the *k* and *w* sounds of which it is composed were common.[2]

Rand, Sweeny, and Vincent say that vocal skill is developed from random vocalization just as skill in walking develops from random movements.

At first these sounds seem largely reflex in character, varying over a range of about 12 or 14 vowel and consonant sounds. Within the first eight months, however, the variety of these sounds has been extended so that there are included all the sounds necessary for any language; English, Spanish, French, . . . German, and African sounds being recognized by Mrs. Blanton in her study of infants.[3]

[1] Arlitt, Ada, *Psychology of Infancy and Early Childhood*, Chap. XIII, Language, pp. 277–278, McGraw-Hill Book Company, Inc., 1930.

[2] Fenton, Jessie Chase, *A Practical Psychology of Babyhood*, pp. 122–123, Houghton Mifflin Company, 1925.

[3] Rand, Sweeney, and Vincent, *Growth and Development of the Young Child*, p. 201, W. B. Saunders Company, 1940.

"Tak-kn" (thank you) was achieved by Mrs. Fenton's child in the following manner. The child chanced to hand his mother's purse to a lady saying "Did'n" as he did so. The lady said "thank you" and handed it back. He proceeded to hand the purse to each person in the room in turn, who handed it back, saying "thank you." Before he had completed his rounds his "did'n" has been modified to "tak-kn" which then became a firmly established word in his vocabulary but seemed to mean *giving* rather than *receiving*, since it was the act of giving the purse that stood out most vividly in this particular experience.

A small friend of the author who was addressed with punctilious politeness by the members of her family acquired a corruption of "*please*" as one of her first words. It sounded somewhat like "p-hŭ" spoken explosively. This symbolized desire to her. She would approach her mother, take her by the hand, lead her to the sink, point to the faucet and utter her pleading "p-hŭ," repeating it until her want was satisfied. When she was thirteen months old her mother was on one occasion clapping her hands and humming a rhythmic tune for Mary Catherine to dance. Her mother stopped abruptly to say something to a friend. Mary Catherine walked up to a third person, performed her little caper, and said earnestly "P-hŭ! p-hŭ!" meaning "Please go on with the music, I'm not through."

Mrs. Fenton says:

> A natural spontaneous sound becomes most easily attached to meanings; hence teaching which concerns itself with such sounds will have most effect in stimulating mental development in the matter of associating sounds with meanings.[1]

This seems to confirm the theory of maturation as basic to learning and also the principle that educational effort must follow maturation as evidenced in the spontaneous activity of the child, rather than force or anticipate this.

Mrs. Fenton records that her child first seemed to hear entire sentences as rhythmic configurations of sound before he could distinguish the component words. He would obviously try to repeat these, although at first able only to indicate the rhythm

[1] Fenton, *op. cit.*, pp. 130–131.

and tone. His "Diz-iz-zee-ee" at bedtime was an unmistakable echo of "This little piggy." He would imitate the accent and inflection of nursery rhymes in jargon without uttering a single word in detail. When he became able to distinguish words and attach meanings to them he stopped trying to say whole sentences.

For months this baby continued to master words, attaching definite meanings to them; then during his twentieth and twenty-first months he had a period of sheer and accelerated imitation, during which he repeated *everything* he heard, apparently for the sheer joy of imitation and exercise of his vocal mechanism. He was much intrigued by telephone conversations, standing behind his mother and repeating the numbers and fragments of conversation accurately.

Mrs. Fenton asserts that words whose meaning is suggested by their sound are favorites with small children. She says her son, even when knowing the correct name for an animal, preferred the descriptive word and persisted in calling chickens "chee chee," the cow "moo," the sheep "baa," etc. During his twentieth month he voluntarily began to use the correct names and produced the sound made by the respective animals only on request. Like all children, Mrs. Fenton's baby first used one-word sentences such as "Buggy" meaning "I want to ride," or "Down" for "I want to walk." He used few verbs up to the end of eighteen months, when he produced his first real sentence: "Daddy! Kool! Man! Atto!" uttered when he had seen his father get into an automobile with another man and drive away. He paused with each word as if putting the idea together bit by bit. By the end of his second year he put words together more fluently with less pause and less effort for each word.

Speech Training.—The young child at first *thinks aloud.* He cannot help trying to say the name when he sees the object or the action, or uttering descriptive jargon if he has not yet achieved the word. The transfer from spoken to silent speech is accomplished imperceptibly. *At first the mind seems to require expression in speech just as the body requires expression in action. In fact, the developmental urge merely finds outlet through the muscles of the organs of speech instead of through regular skeletal muscles. Eventually the child learns to sit still and to keep still.*

In both instances complete development through action must precede repression and control or there will be retardation of structural development and of function in body and in mind.

Children should not be urged to repeat difficult or meaningless words. This only encourages the use of words without knowledge of their meaning, and fosters mental inertia and boredom. The role of the adult is constantly to define and interpret at the desire of the child, and by careful enunciation and repetitions to assist the child in acquiring correct understanding and formation of language. To insist on a child's saying "Thank you" whenever he is handed an object is to attach an irksome and annoying and meaningless connotation to a purely artificial adult convention. Mary Catherine, without ever having been requested or urged to say "please," spontaneously associated the word with the idea of securing what one wants. With her this was a one-word sentence of great satisfactoriness and effectiveness, and she is on the way to becoming an unconsciously courteous child.

No child should be urged to speak. He should be given the widest possible variety of suitable experience; he should be spoken to clearly, always on his level and when the speaker has his attention. He should be conversed with in words that he can understand, great pains being taken to have each word or sentence convey in some degree its correct meaning to him. His adults should be alert to the importance of conversing with the child whenever he wishes attention, and he should be permitted to talk as and when he likes. Word drill, such as "Say 'dog,' not 'da,'" or withholding a drink to try to force the thirsty baby to say "wa-*ter*" instead of "wah-wah," is sheer folly, and only serves to confuse the poor baby, who is using his vocal apparatus in the only way its immaturity will admit. Protective negativisms may thus be aroused which soon become interpreted as disobedience and stubbornness.

The Origin of Language.—There are several theories as to the origin of language. One is that sounds expressive of emotions, such as cries, roars, grunts, groans, come to be consciously used as warnings, mating calls, for terrifying, etc. This is the *emotional theory* of the origin of language.

Another is the *onomatopoeic theory,* which sees language originate in sounds descriptive of the buzz, hiss, whistle, bleat, etc., of various animals or other sounds of nature. In either case, the sound became the symbol of the situation.[1]

Doctor Wheeler thinks both gesture and picture preceded (phylogenetically) definite sound language. The pictured language certainly preceded written language—the picture becoming gradually simplified and symbolized until we have the various alphabets of the world.

The transition from vocal to silent speech or silent thinking compels speculation as to the process involved. Dr. Wheeler believes

> Much of thinking consists of vocal-motor imagery [symbolization] and this imagery involves incipient movement of the speech muscles. The movements can be recorded, and their amplitude varies directly as the definiteness with which the words are imaged. . . . If every performance is executed by the organism-as-a-whole, muscles obviously function to some extent in all kinds of responses.[2]

Since language appears to be a matter of social inheritance (see Chap. VII), it is important that the language situation that the child inherits, as he inherits his family or his country, shall be correct. The child comes into possession of a good, bad, or indifferent speech situation just as he comes into the social status and religious and political convictions of his family. If the members of his family use clearly enunciated and varied words, rich in number and content, spoken in modulated tones, the child will promptly acquire elaborate tools of spoken and silent thinking. He will acquire correct pronunciation by unconscious imitation and will learn to enrich his use of words by associating with them fine shades of meaning.

Improper Language.—The child who is able to satisfy his inherent craving for free exercise of his organs of speech and thought and who has a satisfying variety of experience, will not as a rule be attracted (permanently at least) by the language of the ignorant and uncultivated. He will not need expletives and slang to pad out and complete his limited and inadequate assortment of symbols of expression.

[1] Wheeler, Raymond H., *The Science of Psychology*, pp. 133–134, The Thomas Y. Crowell Company, 1929.

[2] *Ibid.*, p. 433.

It seems reasonable to suppose that with adults expletives are relics of the one-word sentence of the child. The individual under the stress of necessity for being effective in speech, without having an adequate assortment of words, "packs a punch," so to speak, into unusual or tabooed words. At certain stages of development children feel this need ontogenetically just as persons of arrested social and mental development exhibit a corresponding phylogenetic tendency.

A three-year-old who was being carefully reared in a cultured family and was not supposed ever to have heard an improper word crawled under a bed in an attic after his ball. His astonished mother heard him say expressively several times, "Gosh! Gosh!" When he crawled out his mother said "What did you say, Frankie?" "Gosh!" answered the unafraid child. "Why did you say that?" "Gosh, Mamma, it's dusty under there!" Being taken by surprise, and not knowing what to do, she wisely did nothing. While the rather bewildered young parents were anxiously consulting, Frankie, not having the word impressed upon his mind by dramatization, promptly forgot it after a short period of experimentation, and was never given to the use of crude or vulgar language.

The author was acquainted with two other children who were reared to the age of four and a half probably without ever having heard emphatic expletives used. Their emotions were more primitive than their vocabulary, however, and on one occasion when their nurse had required them to sit on chairs on opposite sides of a room for punishment, she was horrified to have them hurl at her with the virulence of the most concentrated profanity: 'You old chair!" "You table!" "You clock you!" . This same pair later acquired for their private, personal adjustments between themselves a prize epithet, which seemed to carry measureless capacity for catharsis. This was "You-old-maker-faces, you!"

The family adopted the policy of ignoring this phase, which soon faded out. When these children started to go to the public school they brought home during the very first days an assortment of "By George's," "Oh Heaven's," and worse. After they had experimented with these acquisitions for a few days or weeks, without creating any excitement and without deriving any special satisfaction, these too were dropped. The young persons in question never afterward showed any tendency to adorn their speech superfluously.

Even very young children are highly sensitive to atmosphere and the customs of the country in which they find themselves. One mother anxiously inquired whether her boy and girl of twenty-five and forty months had been heard to use "bad language" at the nursery school. She was assured that the children were never out of hearing of an adult and that they had never been heard to say anything improper. She said that the father was very profane, that the children when at home were beginning to talk like him, and that her efforts to correct them only made them worse. Never before or afterward, however, did they use any such language at the school.

The child must be permitted to discover words and their uses just as he discovers and trains his body for use, and that is through exercise, experimentation, experience, correct pattern through family custom, and intercourse with friendly, cultured people. Under such circumstances the child experiences the same kind of creative joy in forming sentences that he does in drawing a picture or building a block house.

Thus at the end of infancy, at two years or thereabouts, Our Child is entering fully upon the world of speech, which is to open to him the limitless vistas of science, art, and creation itself.

Developmental Behavior.—During later infancy the child integrates responsively with a wider environment. Speech and locomotion open doors of experience more rapidly than he can explore. No wonder he must be busy every waking moment; there is so much to do, to know, to learn! The year-old child is bent on manipulation. He creeps and climbs to explore, but primarially for the sheer joy of movement. In his greed for manipulatory movement, he may pull the cloth from the table, dishes and all, pull over furniture, break objects. He loves to put a lid on a box or a cork into a bottle endlessly. Dr. Goodenough mentions an instance of a young child who opened and closed the hinged cover of a box 79 times in immediate succession.[1] The very useful forefinger, now separated from the thumb,

[1] GOODENOUGH, FLORENCE L., *Developmental Psychology*, p. 259, D. Appleton-Century Company, Inc., 1934.

is poked into everything. New tactile sensations delight the child. He turns the pages of magazines and books, he manipulates paper, he runs or creeps after balls, and loves to throw everything of convenient size or weight.

At fifteen months the child shows increasing complexity of imitative and manipulative ability. He finds new relationships and begins to make combinations. At eighteen months he runs about freely. He can stoop over and pick up objects, squat down and rise unaided. He can turn the pages of a book deftly. He pulls rolling toys. He is constantly combining and exploring relationships. At two years the child is enthusiastically bent on learning about the wonderful world he sees about him. He does not have to think so intently about *how* to talk and walk—he can explore and he begins to ask questions. He cannot readily and fully express himself and may have emotional explosions because adults do not get his meaning, particularly when he is not given time fully to explain himself.

Fig. 130.—The child begins to turn the leaves of books (thirteen months).

At twenty-four months the child is taking a determined interest in dressing and undressing and can do more or less of it by himself. He feeds himself expertly. His toilet habits are quite thoroughly established, although under excitement and absorption in play, accidents may occur. He exercises caution in avoiding danger. He tells experiences vociferously and quite intelligibly; recognizes and explains pictures. He recognizes and names several colors; he knows his own name; he knows two numbers and has some concept of one or many. He tries to repeat familiar stories. He builds imaginatively with blocks and wants someone "to see"; and he tries by word, gesture, and jargon to tell about what he has done. He is increasingly imitative. He is active, affectionate, busy; and he shows very definite individuality.

With all these statements of norms and likeness, however, no two children (except identical twins in the same environment) will ever be alike. At two years Our Child is through with babyhood; with great determination he is assuming responsibility for his own care, safety, and conduct. He is recognizing himself as an individual. He is declaring his independence. It is a thrilling and critical phase of growth. His adults should salute him and respect him!

Training in Later Infancy.—The basic principles of training during this period are similar to those of early infancy—to foster increasing adaptation to a stable and regularized environment, together with essential freedom and release of creative energy. The child must continue to learn to accommodate himself to necessary conditions; food and sleep must be wisely regulated to meet his changing needs. Changes in schedule may need to be made gradually or abruptly, according to the child's development. He may suddenly become unable to go to sleep at his regular nap time. This may, of course, mean temporary excitement or a too-long morning sleep. It may mean a lessened need for sleep. In the nursery schools this particular emergency is met by having all children lie down at some midday interval, which is made a pleasant occasion by soft music, very quiet storytelling in a low monotonous voice, etc. All the children rest, and most of them drop asleep sooner or later for part or all of the period.

The tactful mother will not make an issue of the nap and arouse resistance. Her chief object is not the satisfaction of enforcing obedience—it is to rest her child, although she must be alive to the educational importance of leading the child into an attitude of willing acceptance of the desirable disciplines of orderly existence. A sulky, negativistic child is not likely to relax or to derive benefit from enforced inactivity. It is the mother's job to make the nap time a happy, matter-of-course time and to recognize when the day comes for changing from a two-nap to a one-nap schedule, and finally to recognize when a quiet, happy rest period must replace sleep. Most two-year-olds require one fairly long nap in the middle of the day. This means four meals per day, as the child must have dinner early, and will require midafternoon food to carry him to his evening mealtime.

Feeding discipline is discussed in Chap. XXV and also in connection with early infancy. The best assurance of food conformity is a healthy appetite and a balanced and varied diet, with regular feeding intervals.

Quiet, unemotional inflexibility should prevail in regard to meals and sleep in essential details, permitting the child the satisfaction of choice wherever the details involved are nonessential.

Fig. 131.—Teresa on her first birthday. *A*, going up; *B*, coming down.

Emotional Training.—As was stated in Chap. XIII, the supreme emotion of childhood is the joy of accomplishment. Every waking moment, the child is trying with desperate intensity to accomplish something. He is happy as long as he is free to carry on his quest for experience. When he meets situations that he cannot master and is baffled and thwarted, he becomes afraid (withdrawal) or angry (aggressiveness). He rejoices in conquering difficulties. The child at every age works intensively to accomplish whatever may be his purpose or goal at the moment, disregarding hurts and fatigue to a surprising degree.

Miss Shinn describes the effort of her niece at three months of age to raise herself to a sitting position (see page 441). A runabout child intent upon a goal will forget hunger, thirst, and the need to defecate and urinate; he will be insensible to cold and wet, until he succeeds in completing his building of a tower of blocks or making a train of cars out of a pile of bricks he has chanced to find in the yard. He craves "complete experience."

It is to be hoped that the parents of Our Child will encourage him to achieve; that, by the time he is two, they will have permitted him to overcome difficulties to the extreme limit of his capacity; but that they will have protected him as far as possible from experiences beyond his developmental level of comprehension, which necessarily create the undesirable and destructive emotions of discouragement, fear, or anger.

Safety. *Safety from Falling.*—Training for safety is important during the period when the child's greed to explore outstrips his experience, his facility with language, and his physical skill in coordination.[1] Special attention should be given to eliminating hazards in the home, such as sharp corners and articles of furniture that may be pulled over.

Unnecessary hazards should be eliminated in every home. Stair steps should not end flush with a door, for instance, either going to the basement or coming down from the second story. Even an adult is likely to open a door and step inside without looking at his feet. There should always be space to take a step or two before starting down the stairs. All stairs should be provided with at least one handrail.

The railings about second-story verandas and porches should be high and secure. If such a space is desirable as a play place, the railing may be reinforced with poultry netting while the child is small.

Window screens should be securely fastened, especially those of the upper story, and the netting should be strong enough and fastened securely enough to bear the weight of a child if he accidentally falls against it.

[1] Losh, Rosamond, "The Child's Greatest Hazard," *The Trained Nurse and Hospital Review*, April, 1935; Sherbon, Florence Brown, *The Family*, Chap. XXXVIII, Safety, McGraw-Hill Book Company, Inc., 1937.

In every family there should be one expression that will arrest motion instantly, and *this should be used only in emergency.* "*Stop*" is a forceful and arresting word, but any word loses its force with too frequent repetition.

From the time that the child can sit alone until he is able to climb out of his pen, the play pen is an important item of equipment. The child is safe and has more freedom in his pen than when he is confined to walker, crib, or bed. He should be placed in his pen whenever the mother is too busy to give him her personal attention. It is a good plan to have a small indoor pen with the floor raised a few inches, to lift the child above dust and

FIG. 132.—Daddy made the steps.

drafts, and a larger fencelike enclosure of slats or poultry netting which may be moved about the yard according to shade, wind, etc. (see Fig. 169).

Whenever the child is at large, so to speak, during his creeping months, he does require constant watching. This is a most important period in training for safety and caution. Children should not be conditioned by fear so much as helped to learn how to take care of themselves. Instead of trying to make a child afraid to climb the stairs, the mother should take time to help him learn how to come down as well as go up (see Figs. 131, 149). If a gate can be put on the stairs three or four steps from the bottom, during this period of exploration on the part of the child, he will thoroughly enjoy going up and down the lower steps and will learn for himself how to negotiate steps safely and independently. In nursery schools a set of three or four steps forms an item of equipment of value in achieving motor skill.

Small platforms and packing boxes of various sizes as play materials help children to learn where the edges of things are, and they soon learn not to walk off the edges of steps, sidewalks, and platforms.

The child may be helped, by making every experience a complete experience, to recognize hazards and overcome them. The first time the toddler stumbles over the doorsill, instead of picking

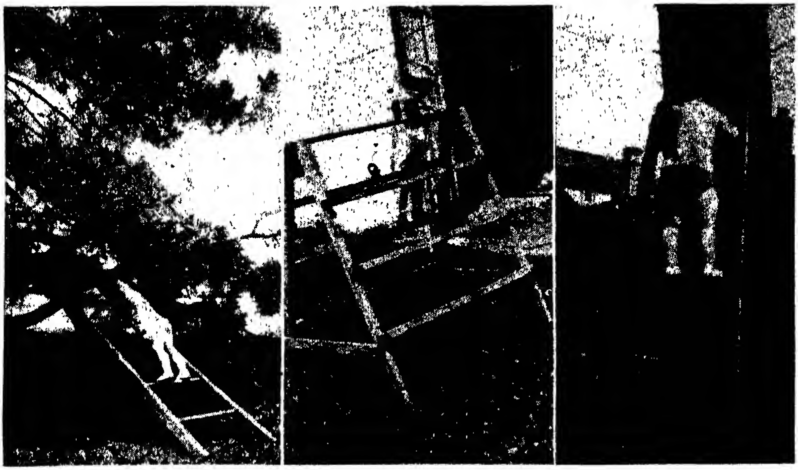


Fig. 133.—Children climbing.

him up with pity and caresses and saying "Nasty old floor to hurt my baby," let the mother quietly help him up, show him the sill and how his toe caught on it, then lead him over it again, showing him how to lift his foot a little higher at the sill.

Fire Hazards.—Fireplaces should be protected by heavy fire screens. Bonfires should be carefully watched. Matches may be fascinating objects to the two-year-old. One mother taught her runabout child to bring every match to her and let her pinch off the head. That belonged to her—it was "Mamma's"—the stick "belonged to baby." Eternal vigilance in keeping matches systematically out of sight and reach, or, better still, the use of safety matches only, is the one safe method for this period of active exploration and experimentation.

Toddlers are frequently "possessed" to turn gas jets. Merely saying "No-no" and slapping hands may only lead the child to explore when mother is not looking. The only safe method is effectively and completely to allay the child's curiosity. One mother, discovering her child turning the gas jets on the kitchen range, said, "Those are mother's. Baby must not touch mother's handles. Baby must touch here"—pointing to the broiler-door handle. "Now what is mother's place to touch?" The child pointed to the jets. "Now what is baby's place to touch?" The baby pointed to her handle. "Baby will never touch mother's place?" The baby shook her head. The child never again molested the jets. Each mother must try in her own way to condition her own child to particular situations without undesirably repressing the desire of the child to learn.[1]

One of the most frequent and terrible accidents is from scalding with hot liquids. The reaching, inquisitive toddler so easily upsets a coffee pot, a basin of hot liquid or cooking food, or falls into larger receptacles. Every adult should have a sixth sense, eternally on the alert, if a runabout child is in the house. One needs literally to keep an eye on him every minute. During periods of necessary haste and confusion the child should be in a play pen.

Water Hazards.—Lily pools, fishponds, stock tanks, etc., should be well guarded. Poultry netting may be used about pools. Watering troughs and tanks on farms should be securely fenced if there are toddling children about, although children promptly learn where danger lies and it is the visiting child, unaccustomed to seeing bodies of water, that usually falls into them. However, any small child may accidentally fall or be pushed into deep water. On the earliest favorable occasion, every child should be taught to float and to swim. Very young children, if properly taught, may learn to take care of themselves in water and may learn to avoid unnecessary danger.

Electricity Hazards.—The chief hazard in the case of electricity is that of touching exposed contacts in sockets or attachments with wet fingers. Open floor and wall sockets should have plugs screwed into them at all times. All electric attachments in bathrooms should be particularly well guarded, as even adults

[1] FENTON, *op. cit.*

may electrocute themselves by merely turning a switch while standing in water or using wet hands.

Hazards from Sharp Instruments.—The period of greatest hazard from sharp or pointed objects is the period of uncertain

Fig. 134.—Two years old and not afraid.

movement, greed to explore and manipulate, together with complete lack of experience. Eternal vigilance is the price of safety. Dangerous things must be kept completely out of sight and reach; yet, at the same time, the child must make the acquaintance of knives, forks, and scissors. The rounded kindergarten scissors, the blunt little knife and fork usually given to a child afford a good introduction. Curiosity should be satisfied as completely as possible when the child wants to peel vegetables or cut cloth, always remembering that suppressed desire is likely to lead to surreptitious attempts to "complete experience."

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CHAPTER XXVII

THE TWO-YEAR-OLD

Think not because the chrysalis struggles that it is in need of you.
Oh I pray you, stay your eager hand lest you despoil its silver wings.
MURIEL STRODE.[1]

General Development.—At two years the child usually has trebled his birth length and increased his birth weight about five times. His legs are relatively longer than they were at one year. His chest measures more than his head or his abdomen. His feet still make quite flat prints because of the pads of fat within the arches.[2] His spine is beginning to assume its final curvatures. The bones are slowly ossifying (ossification is not complete until the age of twenty to twenty-four years). The plates of the skull are firmly united (see page 120). The cerebrum has increased in size 2½ times since birth and is now approximately half the adult size.[3]

The liver, at two years, has trebled its birth weight, and has taken on its permanent histological structure and physiological functions. The pancreas has enormously increased in size. The child's stomach has an approximate capacity of 500 cubic centimeters, as compared with 30 cubic centimeters at birth and 100 cubic centimeters at the age of one month.[4] The intestines are longer; the sphincter muscles of rectum and urethra should be completely under voluntary control. The tonsils and the lymph and salivary glands grow rapidly during this period. The

[1] *My Little Book of Prayer*, The Open Court Publishing Company.

[2] Dr. Vernette S. Vickers, of the Department of Child Hygiene, of Harvard University, writes: "It is generally believed that the young child always has a fat pad where the longitudinal arch will be later. . . . We have found that many children do not have a definite fat pad while others do not lose it for several years. It is very possible that there should be more than one type of shoe for infants."

[3] HESDORFFER, M. B., and R. E. SCAMMON, *Studies on the Growth of the Nervous System, Anatomical Record*, 64: 1936.

[4] ABT, ISAAC A., *Pediatrics*, Chap. III, W. B. Saunders Company, 1923.

heart has increased greatly in size (four or five times the birth size by six years). The pulse rate is 100 to 120 beats per minute. In general, the structure and tissues of the child are considerably more like adult organs than they were at one year of age, but it should be remembered that all tissues are soft and green; while he is active and is apparently "on the go" every minute, close observation will show that he does not do one thing for long at a time—and, to a considerable extent, he really rests each part of his body as he goes along. He tires very quickly if required to continue one activity, such as walking on the street or pursuing overstimulating activities—prolonged play with older children, for example. On account of the keen mental stimulation afforded by his new-found world, the two-to-three-year-old should be carefully safeguarded against fatigue.

Command of Body.—The second birthday sees Our Child firmly balanced upon his feet, able to get about freely and swiftly and to explore his environment in its height, breadth, and depth with a fair degree of safety and efficiency. If he has had proper freedom and encouragement he is now in reasonable command of his body; he feeds himself with very little assistance; goes to the toilet when necessary, requiring help only with difficult fastenings, and washes his own hands; if his clothing is sufficiently simple, he can remove it and assist in putting it on. He is intensely interested in doing for himself. He resents unneeded assistance; he would far rather get a drink for himself than have it handed to him. He actually enjoys wiping up his own spills. The wise parent will further this independence to the fullest extent, recognizing that his maturational urge is indicating that now is the natural time for setting up an individual and independent personality, and that now is the time for him to begin really to take care of himself. Time spent at this point in helping him set permanent patterns of good habits is an investment in time saving in the future, and in permanent efficiency for the child.

His horizon is expanding day by day as he sees farther into the world about him. He is also discovering a wealth of detail in familiar objects. To the one-year-old the cat was a soft, moving object which could be mauled about agreeably and which said "meow." Now the cat is discovered to have fur, eyes, tail, ears, and claws, each of specific interest. Spinach is not only something more or less satisfying to put into the mouth; it is something that grows in the garden (we hope he has a garden), that is cut, washed in an alluring way through many waters, and cooked, that changes its color and has salt and butter added—all prior to, and interestingly related to, the eating of spinach. He is interested in the entire procedure and wants to help with it all, from garden (or better still, from garden seed) to table.

If his physical regimen in food, sunshine, activity, and sleep has been correct up to this time, his body will, in a sense, run itself for the next three years (or, indeed, for the rest of his life). He should now rapidly become stabilized in his health habits and in physiological growth.


Fig. 135.—We hope he has a garden (twenty-seven months).

Mental Food.—*His dominating need from this time on is intellectual companionship.* He now needs a balanced mental diet in exactly the same sense that he needs balanced food at the table. This mental diet should be adapted to the maturation of his brain precisely as his food must be adapted to the maturation of his digestive system and the metabolic needs of his body.

As his physical habits become established, so now his mental habits, good or bad, will be established.[1] His personality is taking on final configuration, or field formation, as determined by the integration of his hereditary structure with his environment. It is indeed a critical period of enlarging field structure and emergence of complex field properties for the entire family group as the child makes his personality increasingly felt. The cortex is ready to assume more rapid ascendency over the thalamus (see page 221) if the experience of the child is regulated toward that end. Parents should realize this and try to prepare themselves to meet the mental situation, just as modern parents

[1] Wagoner, Lovisa C., *The Development of Learning in Young Children*, Chap. V, Maturation, McGraw-Hill Book Company, Inc., 1933.

are training themselves in adequate management of the factors of physical health. What is the two-year-old developmentally ready to do?

Orientation in Space.—First of all, we may say he is equipped to explore in wider arcs the *space* surrounding him. According to the freedom with which he is permitted (*he should be assisted*) to negotiate distances, he becomes able to estimate distance and accommodate to the apparent size of remote objects and to form judgments that will determine and train muscular coordination. The child must learn through experience not to reach for the moon, and to realize that the child a block away is not a doll. He must learn through experience that he cannot go across the street as simply as he goes into the next room. The child who is confined within narrow spaces and who is not permitted to gratify his natural exploratory urge will be retarded in acquiring complete and competent space configurations. That the child is now structurally and mentally ready for this experience is shown by his ability to walk, climb, and run, and by his insatiable urge to use this ability.

The child will usually pass through a peak of exploratory zeal during which he is "on the go" incessantly. He does not sit down to detailed projects; he is interested in what is just farther on. He is blocking out or surveying the configuration of his world. *He is orienting himself in a tremendously expanded field of sheer distances.* Presently he will return to the items that he discovers and examine them in detail, but first he wants to experience the whole of it. The limit of the "whole" constantly expands. At first his bed and his play pen limit his spatial configurations. Then he discovers the spaces of his room, the adjacent room, the house, the yard, the block, the town.

Parents sometimes fear that the child who is passing through this period is showing "lack of concentration," that he may remain "flighty." The wise parent will recognize the futility and undesirability of trying, during this period, to force such a child to "stick to one thing."

Running away at this age is prompted more by the urge to explore space than because of the desire for companionship, which later becomes the dominant motive for breaking bounds.

community life: alleys, cats, dogs, traffic, and active groups of other children. The child can learn only through his sensory experiences. Telling him things, at this age, is futile unless he can see, taste, touch, handle, or "experience" the thing mentioned. Hence, environment in large measure determines trends of interest and extent of learning.

The writer had an experience illustrating the instinct for orientation when a mother with a two-year-old child came to live in her home. At once the child started to explore the house. Her mother was much embarrassed and tried to restrain her. The writer insisted on accompanying Lucy on a tour of inspection, permitting her to investigate every room and every closet and to handle everything about which she was curious, and explaining to her where she was to live with her mother and father and where the other family were to live, and that they would be glad to have her come to see them *any time they were there.* The result was that during an entire year of joint occupancy of the house the child never invaded the privacy of the second family or committed any depredation whatever (with the exception of one glorious "make-up" at a toilet table!).

The instinct for orientation is primitive and doubtless protective. On another occasion the family dog, a terrier, was taken to spend a summer in the boarding school attended by the young daughters of the family. When released in his new surroundings, the terrier promptly disappeared. After a time he returned breathless and satisfied and was reported to have explored on the run every nook and cranny of the large building. After seeing for himself what sort of place he was in, he promptly settled down to reasonable acceptance of the spatial restrictions imposed upon him.

The Nature of Things.—As Our Child goes about his little world he becomes interested not only in the extent of it but in the characteristics of it as conveyed to him by his senses. His senses are the servants of his mind. His feet carry him to the rosebush, but his eyes convey to him an image of size and form and color. He eventually becomes aware of, and able to express in words, the fact that the leaves are green and the flowers red. If permitted to handle the parts to his satisfaction, he will discover that the stem is hard, the thorns are sharp, the leaves stiff, and the blossom soft and fragile. He may discover that a branch may be broken from the bush and that he can wave this about or strike the ground with it. During this activity he may notice the fragrant odor. If he puts some of the leaves or flowers in his mouth, he will get a distinct impression of taste. As he waves the branch he receives tactile sensations of mass and size and weight. If an understanding companion is near who says "roses," "leaves," "stem," "thorn" to him, he associates an auditory symbol with his experience and at that or a later time will experiment in reproducing the sounds that are now conditioned or integrated with the other items of the configuration.

If intelligently managed, the child has had a "lesson," a "complete experience." This will be effective—in other words, the child will *learn*—only if maturation, experience, and interest integrate to form an organic "whole," a field with complete field properties (see page 32). If the child were intent on an orientation excursion to the garage at the back of the lot, the time would not be propitious to pause at the rosebush for a "lesson."

At a later time the child may enlarge his configuration of the rosebush as his experience takes in a wider radius, by noticing that it is attached to the ground and does not move about as do the dog and the cat. He may observe that the rosebush sways in the wind, while the house and the electric-light pole do not. He will notice the relative size of the bush, the elm tree, and the nasturtiums. These are concepts that will probably come later, after he has felt, smelled, and visualized the physical qualities of the rosebush, the pole, and the house. The process of comparison or reasoning will be evoked. Expressed in terms of the philosophy of the whole, the child becomes aware of a larger environment, or field of experience. Out of this "matrix," qualities or field properties appear of which he had formerly been completely unaware; concepts unfold much as a bud expands into a flower. We must ever bear in mind that it is the maturation of the reacting organism that makes enlarged experience possible. The initial configurations must be accurate and complete or they will not contribute correct field properties to the enlarged pattern or configuration and the field will be distorted and incorrect; the petals will be dwarfed within the bud. The child who has experienced only branches of rosebushes brought from the florist will have an inadequate concept of a growing bush, even with the aid of pictures and verbal description. The child who is not permitted to handle the vase upon the piano under guidance, but who pats the picture of a vase in the book and turns the pages without disaster, must not be blamed if he later breaks a family treasure.

Therefore, as Our Child moves about, eagerly orienting himself in a large new world, recording patterns of imagery and relationship within the plastic cortex of his brain, he applies all his senses to the objects which he meets. He is becoming cautious about tasting strange substances, and he is learning caution in handling and lifting. He drops and breaks fewer things; but he handles, lifts, feels everything, and if he possibly can he moves and carries and manipulates all new objects. He wants to know *everything* that his senses in their present stage of development and training will tell him. He listens with interest to all statements or explanations that are couched in language he can understand.

The importance, during this period, of understanding companionship and of conversation that follows the interest of the child cannot be overestimated. The point must not be lost, however, that the elder must follow and not dictate or even suggest or stimulate effort beyond the spontaneous interest of the moment that reflects his maturation. The child should be told all he wants to know, and he should have all his present curiosity satisfied as to physical properties, uses, etc. *To go beyond this is to force his mind beyond its maturity.* When he has mentally organized and assimilated this experience, he will want to place it in a larger pattern. He still needs the elder right at hand to give him just the help he requires (and no more) when the larger relationship bursts upon him—when he wants to know *why* the rosebush stands still, or *why* the petals fall and the leaves do not, or, still later, *why* trees and flowers stand still while dogs run and birds fly.

The child must be given full opportunity to organize his own experiences. The adult cannot do this for him. This has been the fault (and still is in many cases) of educational method. We tell a child that a ball is round or that two and two make four, and when he repeats this, parrotlike, we are prone to think that he has learned a fact. Until he has knowingly experienced roundness or twoness and fourness we have not only wasted our own time but we may have actually retarded and bewildered the child.

Expression.—The increasing contact of the child with environment creates an inner urge for expression, an innate necessity "to do something about it." His incredible brain wants to do something tangible and material with the tangible and material part of his environment. He wants to know more about everything, so he asks questions. As he blocks out his field of experience in space, it blossoms with field properties, and he wants to juggle these "properties," make them do things—"create."

The Language and Thought of Early Childhood.—Jean Piaget classifies the language of childhood as first *egocentric* and later *socialized.* Egocentric language he further classifies as (1) repetition, (2) monologue, and (3) collective monologue. Socialized speech, which does not occur, according to his observation, until later childhood, is classified as (1) adapted information, (2) criticism, (3) commands, requests, and threats, (4) questions, and (5) answers.[1]

The child during his early years is intensely egocentric. The infant is at first only dimly aware even of his own body. In later infancy he becomes vividly aware of himself, takes charge of himself in a measure; during early childhood, as we shall see, he becomes increasingly aware of others.

Piaget made his observations on the language of children in the Maison des Petits (Geneva), a school for young children somewhat resembling our nursery school; and his conclusions are based on an analysis of the utterances of the children in this school. He says that with the exception of questions and answers, which he puts in a separate category, "The child's language . . . constitutes . . . a complete whole in which [his] intelligence is represented at every stage of its development."[2]

Accordingly, most of the child's conversation, with the exception of questions, during his egocentric period is not addressed to anyone in particular. We have seen that endless repetition of syllables and sounds characterizes the child's first vocal efforts.

[1] Piaget, Jean, *The Language and Thought of the Child,* Chap. I, The Function of Language, Harcourt, Brace & Company, Inc., 1926.

[2] *Ibid.*, p. 35.

He continues this in learning names as his twelve months' vocabulary of two to ten words increases to an indefinite number of hundreds of words (see page 531) at twenty-four months, at which time he is beginning to combine two or more words into very simple statements. As he learns a new word he may repeat it over and over in much the same way that he repeats a new motor activity.[1]

The child is incapable of keeping his thoughts to himself; he utters, or tries to utter, everything that comes into his mind. He prattles as he works. "He has no verbal continence." He keeps up a string of running statements as to what he is doing, couched according to his vocabulary, first in jargon, then in words, now in sentences of two or more words. "Speech, before it can be used to socialize thought, serves to accompany and reinforce individual activity."[2]

He is not unaware of his companions, but he is unable to express himself from their point of view. He shows this in what Piaget calls "collective monologue," in which he speaks for the purpose of being heard, but does not speak directly to another child.

In a word, the child hardly ever even asks himself whether he has been understood. For him, that goes without saying, for he does not think about others when he talks. He utters a "collective monologue." His language only begins to resemble that of adults when he is directly interested in making himself understood; when he gives orders or asks questions. To put it quite simply, we may say that the adult thinks socially, even when he is alone, and that the child under seven thinks egocentrically, even in the society of others.[3]

The transitional character of the child's thought at this period as expressed in speech is further described by Piaget.

The child is neither individualized, since he cannot keep a single thought secret, and since everything done by one member of the group is repeated through a sort of imitative repercussion by almost every

[1] SMITH, MADORAH ELIZABETH, "An Investigation of the Development of the Sentence and the Extent of Vocabulary in Young Children," *Iowa Studies in Child Welfare*, Vol. 3, No. 5, University of Iowa Press, 1926.

[2] PIAGET, *op. cit.*, pp. 38–39.

[3] *Ibid.*, p. 40.

other member, nor is he socialized, since this imitation is not accompanied by what may properly be called an interchange of thought.[1]

Questions.—The child's first question is "What is that?" This is his vehicle for accumulating names of things. This comes very early, between one and two years in most children. When the child has acquired a sufficient store of name words and action words, together with a few prepositions, descriptive words, and pronouns, he begins to use words as a tool for the acquisition of knowledge to supplement the evidence of his senses. Up to this time he could not ask "Is the stove hot?" or "How does the stove feel?" He could only touch it to find out. He evidently does not think much beyond the evidence of his senses. With the acquisition of the new tool of adequate language he becomes able to establish endless configurations of relationship, a process which is to continue unceasingly as long as the individual continues to think and reason.

When he begins to ask questions, as in the case of the monologue, the child cannot keep still. His queries must be voiced even though he knows or can easily ascertain the answer. He is still thinking out loud. Later he becomes able to suppress much of his questioning aloud and thinks things out, or finds out, or looks up the answer for himself, or asks only certain appropriate persons to tell him what he wants to know. This is in line with his increasing ability to keep his thoughts about his activities to himself. He becomes able to think silently.

The "why" age begins between two and three, usually well toward the third birthday, depending somewhat upon language development and upon the richness of experience and the degree of freedom and spontaneity accorded to the child. The peak of the vocal questioning period may appear between four and five, and it tends to diminish by seven, as the child matures in his thinking to himself. Piaget classifies "why's" as: the "whys" of *causal explanation*—"Why haven't they (little goats) got any milk?"—and the "why's" of *motivation*—"Why are you going away?"—and the "why's" of *logical justification*—"Why do people say 'strayed'; does it mean lost?" These obviously represent somewhat ascending degrees of complexity in thinking.

[1] *Ibid.*, p. 41.

The vocabulary growth of children from two to five has been sketched in the previous chapter. The child of three with a vocabulary of 1,000 words can ask a great many questions. Indeed, his ability to ask questions doubtless has much to do with his rapid increase in vocabulary between two and three.

During the egocentric period the child cannot conceive of facts as existing apart from his relation to them. He would cheerfully eat the last bite while his mother starved, because he has no concept of hunger apart from his own experience. Adults sometimes strive with premature and misguided zeal to make young children "sorry for poor kitty," or move them by "Mamma will cry if you hurt her." With the rise of query a child begins to be able to grasp relationships, and with incredible rapidity he acquires concepts (configurations) of very complex situations. He extends his field of experience into the fields of experience of others, and becomes able to conceive of hunger and thirst in terms of the experience of other persons and of other things. However, it pains the child as much if someone spanks his doll or pinches his Teddy bear as if the punishment were administered to a playmate, or even to himself.

The Role of the Adult.—As has been said, the need of the child during early childhood is intellectual companionship. To be sure, he will discover much for himself, and he should be permitted to go as far as he can, since this is the basis of independence and is the only way to develop his abilities. At every turn, however, the toddler meets experiences he cannot understand without aid. He needs an understanding elder, child or adult, to answer *all* his questions—an elder who can, in as large a degree as possible, put himself in the child's place, conceive of the meagerness of the child's mental concepts, and explain to him in words that carry definite meanings to him *just the thing he wants to know.* This elder must not only answer the child's every question; he should try patiently to understand the ideas that are taking shape in the child's mind and protect him from making false associations and drawing wrong conclusions from fragmentary evidence, or rather, *put him in the way of drawing correct conclusions for himself.* This does not mean that the adult will overwhelm the child with facts. Rather, he will hand to the child *just the brick he is reaching for* with which to build his wall of knowledge. If the child has quiet and freedom and resources he will build firmly and symmetrically, guided by his unfolding organic urges. The adult must not meddle or confuse; he must protect and assist when that is necessary and then only.

To change the figure of speech, the tentacles of the child's mind reach out for space and sustenance as the rootlets of a growing plant explore the soil. The quality of the soil must be correct (the balanced mental diet, correct environment) and the sensitive rootlets must not encounter too many stones or obstructions (repression, interference). Wise guidance is the gentle rain that renders the experiences soluble, while the sunlight of sympathetic, affectionate understanding, vitalizes the whole process. To carry this figure to its logical conclusion it is necessary to mention the fact that the sturdiest plants learn to accommodate to wind and storm and chill and snow. This means that the child must be permitted to struggle for some of his experience, and only helped when his difficulties are clearly beyond his capacity to overcome. This is expressed in a very practical, terse precept in training: *One should never do anything for a child which he may reasonably do for himself, and one should never tell a child anything which he may, without too much difficulty or discouragement, discover for himself.* Guidance may often take the direction of leading the child to make discoveries and of thus giving him the satisfaction of accomplishment and aiding him to build up independence and self-confidence.

Complete Expression.—In line with this precept is another to the effect that *the child should be encouraged in full and complete vocal expression.* If language is the tool of thought, fragmentary vocal expression may be taken as an index of slipshod, immature, fragmentary thinking. It strengthens the child's thinking to state his meaning as fully as he is able. A very common error in child management is the custom of accepting detached words, grunts, and gestures in lieu of statements. The child will naturally spare himself unnecessary effort. If pointing to the sink and uttering a fretful sound will produce a drink of water he will not exert himself to say "I want a drink," or "Please give me a drink."

While the matter of requiring complete expression from the child must not be overdone or allowed to become irksome or distasteful, the child should be encouraged to talk, and especially, *he must be given time* to put new words together and "say it all," even though the mother is in a hurry and knows what the child is trying to say, and even though it were much easier for her to interrupt by answering him or giving him what he wants than to wait until he has said completely what he is trying to say.

It seems reasonable to suppose that disjointed fragmentary language experience during the period of active language formation may affect in lasting manner the language habits of the child. Conversely, the acquisition of careful and precise habits of expression during this plastic, labile period cannot help affecting favorably the permanent language equipment and promoting habits of clear, precise thinking.

The role of the adult is to think with the child, in terms of the limitations of the immature child mind; to protect him from thwarting and baffling experiences which hamper and limit the satisfaction of his organic hunger for complete knowledge. To succeed in this the adult should know as well as science is able to tell him what to expect in the way of maturation plateaus or levels. At least he must be wise enough to follow nature's lead, and especially not to enter into conflict with normal growth.

Discipline and Training. *Negativism.*—A behavior crisis is likely to occur between eighteen and thirty months in children who reach the peak of orientation urge before their language facility is sufficiently developed to keep pace with rapidly accumulating experiences. *The child is filled with urges which he cannot talk about.* He is met at every turn by thwarting and interference, and his one tool of resistance is a sit-down strike accompanied by shrieking and a fiercely reiterated one-word sentence, "No!" or the classic two-word sentence, "I won't."[1] Too often the parent thinks this a disciplinary crisis in which the matter must be settled "here and now" and "once for all" as to "who is boss." Force is used, often to the point of sheer brutality, when the relative size and experience and sensitiveness of child and parent are considered. The child is torn between an inner force impelling him irresistibly not to eat the spinach, or irresistibly to finish building the train before he goes to bed,

[1] One lively youngster, torn between his aversion to saying "yes" and his desire to say "no," coined the effective compromise word "yo."

and an outer irresistible force which pulls and spanks and humiliates and hurts him. The parent may browbeat him into a semblance of obedience and imagine he is developing character and respect for authority. Actually, irreparable injury often is done to the parent-child relationship and the bewildered child is left with a smarting sense of injustice and humiliation for which he has no words. He may be more able in the future to avoid displeasing the parent by overt behavior, but he will not be helped in making decisions on the merits of situations.

Dr. Martha Mae Reynolds, in an intensive study of the negativisms of children, discovered significant correlations between language facility, fatigue, ill-health, and negativistic behavior.[1] The answer lies not in permitting lawless behavior, but in understanding the laws of development and behavior as set forth previously in this and in many other texts. The only real discipline is self-discipline, and the parent should feel triumphant only when he has led the child to make a correct decision for himself. He should feel only humiliation and failure when, through the exercise of his superior strength, he has made a puppet and a slave of his child. That parent should hang his head in shame who has made his child afraid of him. Control through infliction of pain is degrading to both the child and the adult; it is completely unnecessary. The best disciplined children in the world today are the nursery-school children, and no nursery-school child ever was spanked, slapped, scolded, or humiliated. The famous quintuplets have never been hurt or punished. Dr. Blatz, in writing of their training, says:

> The problem thus raised is: by what method can the social activity of the young child be so arranged that his learning becomes efficient? For centuries punishment has been accepted as the basis for the arrangement of consequences. Modern psychology looks toward a more efficient arrangement . . . because the philosophy of punishment is outworn and a new concept must be introduced. . . . The only consequence of unacceptable social behavior, under this concept of discipline is isolation . . . it is one of the most difficult aspects of the disciplinary scheme. . . . The inflicting of pain or punishment is much easier, and, taking into account its sadistic implications, it gives more immediate

[1] Reynolds, Martha Mae, *The Negativisms of Preschool Children,* Columbia University Press, 1928.

satisfaction to the perpetrator. It is much easier for the parent to spank his child . . . than for him to deprive the child of his company . . . the only arbitrary consequence which was not inherent in the learning situation, was isolation.[1]

The phase of development under consideration in this chapter is peculiarly critical and important. It is the period during

FIG. 136.—Marie in isolation. Is Marie a bad girl? No, not bad, but that mischievous twinkle in her eye indicates that she's not above playing pranks on her sisters—for which she is now being disciplined. (*Blatz, The Five Sisters, William Morrow & Co., Inc., World Copyright*, 1936, *NEA Service, Inc.*)

which the personalities of parent and child integrate through understanding, happy relationships, or it is the period during which conflict arises—a conflict that tends to grow rather than to lessen. Respect for authority will come through quiet, impersonal, friendly firmness and fairness, rather than through forcing the child to acknowledge his parent as boss and compelling him unquestioningly to "mind when he is spoken to."

[1] BLATZ, WILLIAM E., p. 130–131, *The Five Sisters*, William Morrow & Co., Inc., 1939.

CHAPTER XXVIII

THE THREE-YEAR-OLD

Wouldst thou know how to teach the child? Observe him and he will show thee what to do. —FROEBEL.

The increasing maturity of the behaving mechanism of the child at three as compared with the child at two is shown in all his responses.

Motor Development.—He is more certain in his movements, is less liable to fall, to stumble, or to drop and spill. He is more venturesome as to the difficulty of feats undertaken; he can climb higher and explore further. He can assist in setting the table with fair accuracy. He can hang up his own wraps (if the equipment permits) and put his clothing and toys in their accustomed places. He can place a set of blocks neatly in a box.

He dresses himself more completely and in less time than at two and now can manage fastenings that he could not manage at two. He is still interested in taking care of his own bodily needs, but these have ceased to have the absorbing interest of new activities. If successfully managed, correct personal habits should now show some signs of becoming automatic. Not that the three-year-old can be depended upon to perform his own toilet and go to the bathroom with no supervision or assistance, but he should require much less attention now if his mother has carried out a consistent policy of encouraging full independence. Where the two-year-old usually holds the adult's hand when walking on the street, a year later he often enjoys walking alone like a grown-up. Since he gives less attention to the act of walking he can give more to where he is going. He can cross the street alone and watch for vehicles. He enjoys this new sense of efficiency and resents being led, helped up steps, etc.

The three-year-old should be reasonably skillful with tools. He loves to drive nails, saw boards, and dig holes. He can build rather complicated block structures. He attempts new and difficult projects, and will work with desperate intensity upon them.

Language.—As to his language, according to the Iowa study[1] of sentence formation, the three-year-old averages 3.3 words per

Fig. 137.—He loves to drive nails and saw boards and can build rather complicated block structures.

sentence as contrasted with 1.7 words per sentence at two years. In an average 1-hour conversation he uses 223 words, as compared with 78 words at two years (see page 531). This means

[1] Smith, Madorah Elizabeth, "An Investigation of the Development of the Sentence and the Extent of Vocabulary in Young Children," *Iowa Studies in Child Welfare*, Vol. 3, No. 5, University of Iowa Press, 1926.

that he can exchange ideas more fluently and ask many more, and more complex, questions. He begins to wonder about relationships as well as names and qualities of objects. He still thinks out loud, and he is still essentially egocentric. He carries on a running commentary about whatever he is doing.

He uses 68 per cent of complete sentences, as compared with 37 per cent a year previously. He uses more verbs, pronouns, and qualifying words and relatively fewer nouns. He uses plurals and past tense. The average three-year-old (according to the Iowa study) has a total vocabulary of 896 words, as compared with 272 at two years.

He can repeat familiar stories and describe a recent experience. His memory span is lengthening.

Adaptive Behavior.—He begins to discriminate colors; he has a vague sense of number, and distinguishes two, sometimes three or more, but often repeats long series of numbers learned by rote.

AVERAGE ACCOMPLISHMENT IN WORDS OF 124 CHILDREN IN 1-HOUR CONVERSATIONS[1]

Number of children	Age group		I. Q. (average)	Words	
				Total number	Number to the sentence
	Years	Months			
11	2	0	109	78	1.7
18	2	6	106	118	2.4
17	3	0	109	223	3.3
23	3	6	107	334	4.0
17	4	0	109	400	4.3
22	4	6	105	415	4.7
16	5	0		400	4.6

[1] SMITH, MADORAH ELIZABETH, "An Investigation of the Development of the Sentence and the Extent of Vocabulary in Young Children," *Iowa Studies in Child Welfare*, Vol. 3, University of Iowa Press, 1926.

The three-year-old can draw a circle from copy, open doors, put on an apron before playing with paints, drag chairs to the table when the meal is ready, notice the habitual order of things in the home, and when his attention and interest happen to be fixed upon a situation will occasionally voluntarily cooperate in maintaining this order. Whereas the two-year-old will wrap a doll in a bit of cloth and be satisfied, the three-year-old may bring the doll and ask the adult to dress it or attempt to do it herself.

The three-year-old should know his own full name, the name of his street, and the name of his town. These names should be impressed upon every child early as a factor of safety if he is lost or kidnaped.

Social Behavior.—The three-year-old is increasingly fond of animals and small children. He notices their behavior and may want to feed and care for them. An infant should not be left within reach of a toddler, as he may try to lift and carry it, with disastrous results. He shows occasional interest in the comfort of others. He is vaguely and briefly distressed by the suggestion that the doll or the cat or his mother may be "hungry."

The three-year-old wants to help and participate in all familiar activities. He is pleased when his elders express approval of his efforts. One mother remarked, as she was making a pudding, "I believe I'll put in another egg." She left the room momentarily and when she returned the "other egg" reposed in the pudding, shell and all, while her three-year-old son beamed with gratification at having "helped mother."

In describing the two-year-old we said that he was orienting himself in space and learning what his senses would tell him about things, and that he was busy discovering that he is a person and can operate himself. We might say that the three-year-old is orienting himself in social activity. He is interested in *what is done with* these hard, soft, round, light, heavy articles that he has discovered in his environment.

At two he was absorbed in discovering that the cat had fur, claws, teeth, and tail. He now discovers that the cat eats, drinks, and chases a ball when he throws it. He now wants to feed the cat and put her to sleep in his bed.

At two he was interested in feeding himself; at three he wants to help prepare the food and wash his own dishes. At two he discovered that peas were interesting round, green objects which he could pour from cup to bowl endlessly; at three he wants to help shell and cook the peas and carry the dish to the table. He is in the midst of everything, always in the way. His "what?" has changed to "why?" and presently it will be the "why of the why?" and "how?"

This urge to orient in the life of the family or any living activity about him is as significant and critical as the drives to orient in space, and exercise his senses.

While the nursery school is making invaluable contributions to child development, one of the criticisms offered against it would appear to be valid. The nursery school presents an artificial situation, and the child who goes through this phase of social orientation in the school rather than in the home may never feel so completely a part of the home life and be so familiar and efficient in home activities as does the child who participates in the actual daily activities, who is given a piece of dough on the other side of the bread board, who helps set the table and shell the peas, and follows his mother about in all her duties.[1]

This intimate life in the home also affords an important opportunity for development of the intellectual companionship between parent and child, which we have said is the outstanding need of this entire developmental period. The mother who is prepared to recognize and enjoy the dramatic unfolding of her child's mind, who is willing to give him her thought and her time, has here an ideal setting in which to establish a rapport and a mutual confidence and understanding which anticipate and safeguard the relationships of the sometimes difficult after-years. There is a temptation to shut the toddler away from the intrinsic activities of the home because he does interfere with the mother's accomplishment of her tasks. To do this, however, is to rob him of a rich, natural educational experience. In homes where domestic help is employed the family is fortunate that can command the services of patient, child-loving women who do not object to and even enjoy having a toddler follow them about and share their activities. Gardening, incidental repair work, or carpentering should be capitalized. On one occasion some painting was being done about a home. The small three-year-old was seized with an insatiable urge to "paint." Her nurse mixed some flour and water, gave her a brush, and engaged her to paint the basement wall. When she was completely satisfied, the garden hose quickly removed the work of art. There had been no conflict and the child had learned something.

[1] STRANG, RUTH, *An Introduction to Child Study*, pp. 161–162, Helpful Activities, The Macmillan Company, 1938.

Management.—The line of training has been indicated in the discussion of personal-social development. It consists in meeting developmental phenomena in an intelligent, understanding, and helpful manner. The mental and physical development of the child and his increasing activity, however, bring problems of adjustment that are sometimes serious and difficult to meet. Among these are (1) securing space and material for free activity; (2) helping the child to acquire independence of character without arousing negativisms and tantrums; (3) prevention of running away; (4) the establishment of good emotional reactions, especially the prevention of fears.

FIG. 138.—Paul at three and a half. "I think I'll stop trying to train him, and *observe* him for a while," writes his bewildered mother.

Space and Material for Activity. With each year the child needs more space and greater variety of things to do. It taxes the resourcefulness of any household to keep a lively youngster busy. Helping mother (or the maid) as she goes about her work will consume irregular units of time. There remain long hours to be filled—and, if the child's developmental needs are to be met, wisely filled—with interesting things to do.

Several modern young parents of the writer's acquaintance made a study of equipping their homes to supply these activity needs and still to preserve order and system in the home. These homes are all five- to seven-room houses with small yards. The houses all happen to have cement-floored basements. The scheme that these parents developed is as follows.

1. A playground space is set apart in the back yard, and there equipment for climbing, sliding, digging, and throwing is installed, at first very simply for the young child, who finds a sandbox, a slide, a pile of boxes, a supply of balls and wagons, several kinds of steps and ladders and swings sufficient to keep him interested

FIG. 139.—An attractive back-yard playground. Note the rabbit hutch and dog kennel. All equipment was made by the father.

and busy (see Figs. 139 to 141). In each of these instances the father added a piece of equipment from time to time to maintain interest and meet larger activity needs.

FIG. 140.—A small space will hold equipment for the essential big-muscle activities.

2. A corner in each basement was set apart for "dirty activities" (see Fig. 142). Here are found clay and easels and paints, tubs of water, also indoor gymnasium equipment for rainy days,

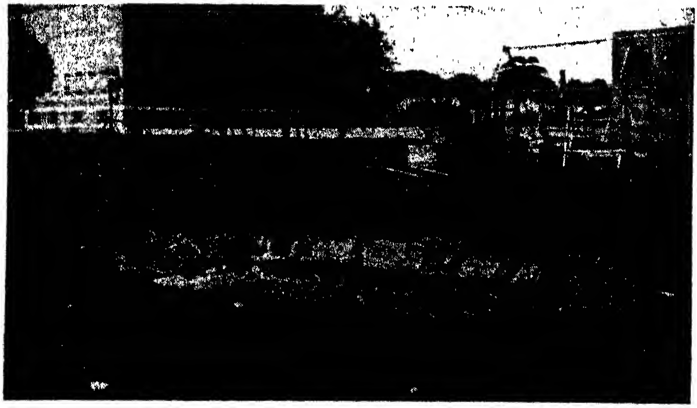


FIG. 141.—A spacious back-yard playground. The shallow wading pool is greatly enjoyed.

such as swings and rings suspended from rafters, ladders along the wall, balancing boards, walking boards, etc. Particularly noisy things, like whistles, bells, gongs, and drums, are also kept here, as well as carpenter tools, boards, boxes, hammers, nails, and saws, and an indoor sandbox.

3. In the family quarters some place—in several houses a small room—has been set aside; in one a wide passageway has been utilized, in another the child's own sleeping room. Here the quieter occupational material is arranged. Here are low shelves for books, games, and small objects, small wheeled apparatus, dolls, blocks, domestic equipment, etc.

Fig. 142.—Any corner in a basement, which can be made clean and light, can be utilized for the more disorderly play activities and for rainy days.

This arrangement really furnishes four varieties of employment: (1) following the mother around and using the family equipment and participating in the family life; (2) free, big-muscle activity out of doors; (3) a generous and delightful variety of constructive activities, in the basement, that are not appropriate for well-kept living quarters; (4) clean, quiet occupational material which is not unsightly and not too difficult to keep in reasonable order, and especially, so placed that the staging of creative play need not be disturbed while a project is under way (see Fig. 152). It sometimes takes days for the complete dramatization of a project in building or homemaking. It is disconcerting to the child to have everything put away in the midst of his creative effort because an adult must use the space.

This arrangement seems to be ideal as far as providing for the many needs of the child is concerned. Where the family

Fig. 143.—There should, if possible, be a corner for domestic play.

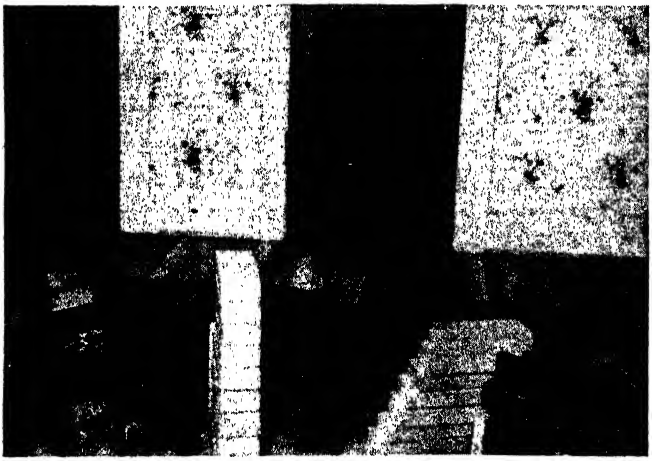


Fig. 144.—Blocks should be large enough to build with. These were sawed from 2-by-4 planks and dipped in dress dyes to make them decorative.

must live in an apartment and the three several spaces are not available, the mother must be very resourceful and see how far she can go in meeting these different needs by screening and equipping a back porch and one corner of a living or sleeping room. *The child must have outlet. He will seek for it through the grown-up possessions if he is not given possessions of his own that provide adequate outlet and exercise for his maturation urges.* It is far simpler and more educational to provide a child with adequate occupation than to enter into constant conflict with him because he is driven to find his own.

The arrangement described makes it possible for the child "painlessly" to acquire correct concepts of order and ownership. In a household where there are no clearly established boundaries of ownership, and where there are not sufficient "places for things," including playthings, and hence things are not in their places, the child has no opportunity to develop orderly habits, or socialized and correct ideas as to sharing and ownership.

A confused environment prevents a child from forming clear configurations of thought and reasoning. He can be nothing but confused and unpredictable in emotion and behavior and thinking.

Running Away.—Until the child has acquired reliable cooperative attitudes he must be safeguarded by supervision or by the enclosure of outdoor spaces. Poultry netting provides cheap and convenient means of enclosing either large or small play spaces. Such restrictions must not take the place of training in reliability. Every opportunity should be utilized for training and testing the child's cooperativeness and dependability. Sending him on small errands, gradually enlarging the distance and the size of the assignments, with approving discussion of the excursion as a reward when he carries it out successfully, is one very educational way to go about this. Usually children can be conditioned in observing necessary space restrictions. In one of the homes mentioned (see Fig. 140), the small lot was on a street corner and next to an alley, and no fencing was used. The one difficulty was the ease with which neighbor children poured in. The children of the family never took advantage of the situation.

When the three-year-old does run away (as he usually will sooner or later), he may do so either because, being bored and seeing nothing interesting to do at home, he starts out to find something to do, or because he remembers that Johnny has a set of fascinating tools; or he may now run away because he is lonely and feels the need of the companionship of the child down the street; or he may merely still have the spirit of adventure and exploration that activated him when he first discovered a world of explorable space.

The effective management of the situation, in this as in every other situation, depends upon determining the reason for the escapade. The first thing to do is to talk quietly with the child, without creating a scene or dramatizing the event; *the mother should get his point of view before giving him her own!* Remedies should always fit diagnoses. If he has merely been bored, the mother should consider herself the one to be punished and she should make a mental resolution to attend more strictly to her child's vocational needs. If the child craved companionship, this will be the mother's cue to arrange more opportunities for play with other children. If he wanted to see the world, she should make it possible for him to do so under suitable escort.

In the immediate situation the child should not derive satisfaction from it. He should be promptly returned to his home, and a clear, simple, impressive but dispassionate explanation should be given to him. This should not be too elaborate. "Mother *must always* know where you are, you *must always* ask mother when you want to go away. You may not stay at Johnny's when you go without asking mother. You may play with Johnny only when you *ask mother first.* The same method should be followed, no matter what the cause of the excursion. Prevention of repetition depends upon accuracy of diagnosis and skill on the part of the parents in preventing similar situations in the future. If repeated, the experience may be made definitely unsatisfactory by requiring the child to stay with mother until it becomes irksome, explaining, without resentment or anger, that "Mother must know where Billy is all the time." "Do you want to stay with mother all the time or can mother leave you in the play yard and know that you will stay there?"

Emotion and the Three-year-old.—The variety and intensity of emotional reactions keep exact pace with the progress of the maturation (organization) of body and brain. Comfort and discomfort (see page 399) expand to include all satisfactions and all thwarting of inner drives to expression, as well as active physical discomfort and pain. At two years, the child's emotions are bound up with his drive to become independent of his previous caretakers and his drive to become cognizant of a rapidly enlarging world—in short, a general impulse to become an independent personality. His chief resentments are called out by circumstances that thwart these fundamental drives. His chief pleasures are called out by achievements in running himself and in finding out about things.

Fear, as has been said (see page 450) is produced by the sense of inadequacy in meeting situations that threaten the safety of the organism. Fear produces two protective reactions, withdrawal and attack. The two-to-three-year-old first runs from a recognized source of pain, such as impending punishment, but when overtaken and held he may strike out at his captor. These two methods of fear reaction may become definitely incorporated in the personality configuration of the child who is repeatedly subjected to the emotion of fear. One child will become belligerent, a fighter, an *extrovert*, another may establish the habit of withdrawal and become timid and cowardly, an *introvert*. The tendency to emphasis of resistance or withdrawal is doubtless to some degree inherent in the constitutional organization of the child. It is also doubtless true that the inherent tendency may be influenced in either direction by experience. A naturally timid child may have his full capacity for courageous reaction encouraged and developed, and thus achieve a well-balanced personality; on the other hand, a naturally courageous child may be subjected to painful experience so much beyond his maturation level and capacity for adequate reaction that his spirit may be permanently cowed and broken.[1]

The three-year-old child will have established both more varieties of emotions and more intense emotional reactions than he showed at two. His satisfactions are now extended to include not only physical comfort and free physical activity and pleasure

[1] Marston, Leslie R., The Emotions of Young Children, *Iowa Studies in Child Welfare*, Iowa University Press, 1925; Fisher and Gruenberg, editors, *Our Children*, Chap. XIII, Anger and Fear as Assets, by William E. Blatz, Viking Press, Inc., 1932.

in association with familiar persons, which were his chief satisfactions at two, but also association with children of near his own age, and creative, constructive, planned activities, such as doing things he sees others do—building, drawing, modeling—and to this should be added the intellectual satisfactions of accumulating information—facts, "what" and "why"—and of ownership.

His "dissatisfactions," which now cover an increasing range, comprise not only fears and restraint of movement and freedom, but a widely increasing range of personality reactions. The child at two is thrown into rage by restraint of physical liberty, and may contract a more or less permanent resentment configuration known as *negativism.* He is more or less resentful of violation of property rights; he is quite jealous of his rights and selfish with his possessions. With his increasing socialization at three, involving intimate sharing of the experiences of his associates in the home, some approach to vicariousness or sympathy begins to appear. The experiences of the child, as affected by the mother's policies and attitudes, may veer in the direction of hypersensitiveness to displeasure, or "tenderheartedness," or he may develop a protective reaction of defiance or an extreme disregard of suffering, or "cruelty."

At this age the emotional "sets" or attitudes of the child are forming rapidly. It is important that the mother, as one aspect of her intellectual companionship and understanding fellowship with the child, should protect him from injury to his personality through establishment of distorted or unbalanced emotional trends. It were better that the young child be spared extreme emotional experience of every sort, since paroxysms of rage or fear are devastating to personality, nerves, glandular action, and bodily health.

It is important to avoid establishing extreme likes and dislikes for persons. The parent should encourage interest in doing things and interest in discovering the meanings of the phenomena of human relations insofar as the child's development permits him to grasp such meanings. All the child's experiences and learning should be as impersonal as possible. He is not a "bad boy" because he pulled the cat's tail. It was too bad to pull the kitty's tail and *make her cry; his attention should be focused upon the act and not upon himself.* Johnny, down the street, is not a "bad boy" because he uses questionable language. "Certain words that Johnny uses are not nice words and for this reason we never use them in our home. Sonny will not say words which we never use." The child, at this undiscriminating age, should not be permitted to begin to separate moral sheep from goats, and classify his acquaintances as "good" and "bad." The perfectly natural next step in that case is the protective impulse to keep

FIG. 145.—A homemade climbing tower which has many uses.

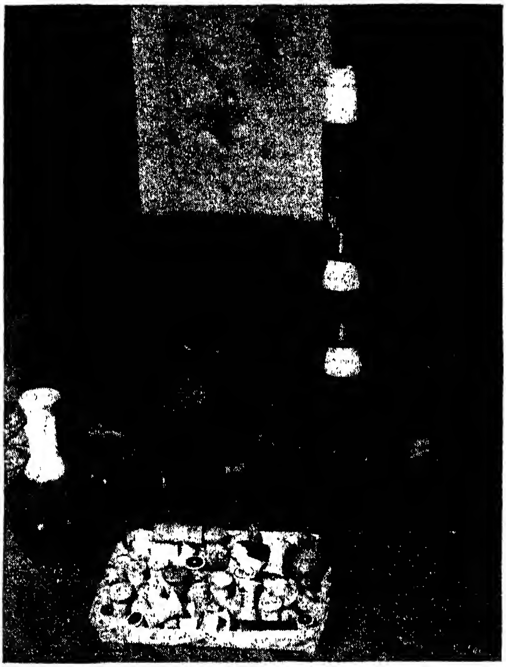
himself, by fair means or foul, in the favored class! At this unmoral stage of his development he cannot be expected to discriminate as to methods. It is much better pedagogy to stimulate impersonal interest in learning about human actions and their effects, whether the actions be his own or those of another. The child should be assisted in acquiring experience that will enable him to see all around an act and its consequences and *formulate his own judgments.* Especially, he should be helped to view his own behavior as if it were the behavior of another. Who has not wished that he might "stand off and see himself"? "Oh wad some Power the giftie gie us, to see oursels as ithers see us!" This power may be established in large measure by beginning with the very young child. The judgments of children whose minds and emotions have not been distorted by fear or warped by the biases of their adults are astonishingly true and trustworthy. To be sure, the desire may be stronger than the judgment—a situation which arises even with mature individuals—and parental firmness may have to be used. However, extreme resentment is not likely to be aroused, or if it is, will be

FIG. 146.—Two homemade easels in use.

brief, provided the parent, himself, is not emotional over the matter.

While this impersonal policy should extend through all the years of parental association and influence, it has its active inception during this period of early socialization. Nothing is more difficult to retrain than wrongly "conditioned" emotions.

Activities.—Imitation and imagination are coming into ascendancy during this delightful year and, like every other new-found faculty, must have outlet and expression. The child's mechanism of coordination is maturing rapidly. He needs materials for constructive effort; building materials, such as blocks (see Fig. 144) and boards; hammer, saw, and nails; spade, shovel, and hoe, and a place to dig a cellar, cave, or pool, or make a garden;



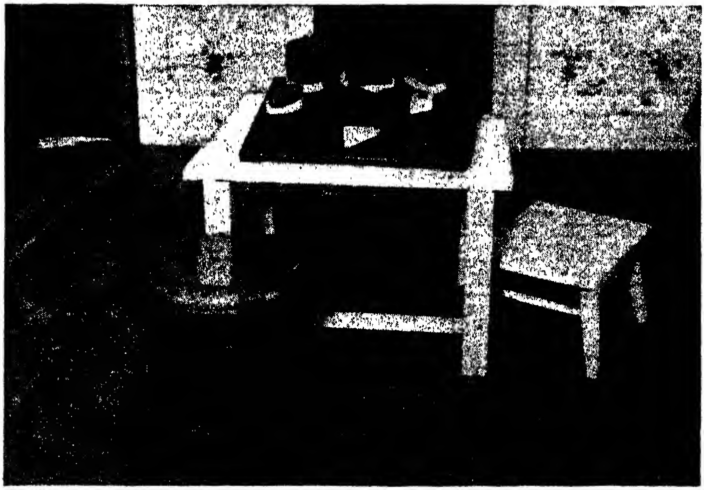


FIG. 147.—Spools of all sizes and various types of pegboards are always popular.

modeling material—wet sand, mud, clay or plasticine[1]; an easel, large sheets of paper (wrapping paper or newspaper stock), a blackboard, paints, brushes, crayons (see Fig. 146), and always and especially, at every age, "creative junk." Large pegboards lend themselves to endless creative and dramatic purposes, especially when combined with bottle dolls, *i.e.*, bottles of all

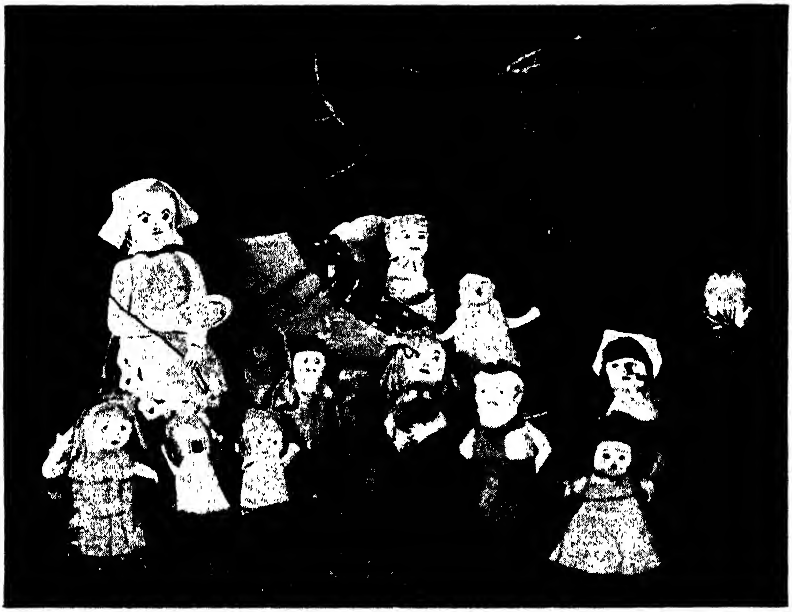


FIG. 148.—The old woman who lived in a shoe (pegboard and bottle dolls).

shapes and sizes with stuffed cotton heads, and dressed in crepe paper (see Fig. 148). Always wagons, wheelbarrows, etc., are needed for transportation of materials and essentials. For such

[1] The need for a plastic medium of expression arises early. The country child makes "mud pies." The poor city child must be given clay or plasticine and *a place must be provided in which he may learn creatively "to feel the shape of things."*

The writer, when visiting the Indian pueblo at Taos, New Mexico, came upon a group of small children about three years old playing at the edge of a shallow stream. One had a heap of wet earth which she was shaping with her tiny hands, while the others were washing bits of cloth in the stream—just as all the three-year-olds of the world were doing (if they had the opportunity) at the same moment. The developmental drives are universal and intrinsic.

a purpose a platform with swivel casters set in the corners and a rope to pull it by is highly satisfactory.

This may sound like a formidable list, but the articles may be gradually assembled at very small cost. Simple constructive materials have great educational value. Many commercial toys have very little. A load of mill ends and grocery boxes with hammer, nails, and saw, and a box of household junk—such as bottles, bottle caps, cans, small boxes, broken utensils, etc.—will provide perpetual outlet and activity for any child during any stage of the period in which he actively imitates, imagines, and creates.

Summary.—By the age of two years, Our Child had become a personality and declared his independence—possibly by way of negativism and temper explosions. By three, with good management, he should have become a well-integrated member of his family. He has a greatly expanded field of activity. His personality has deepened and widened. He is a delightful companion; he is ready to extend his social integration among a wide range of friends and acquaintances.

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CHAPTER XXIX

THE FOUR-YEAR-OLD

This then is the torrential force that comes unbidden out of the mysterious recesses of personality and fashions things out of wood, color, fabric, clay, and words; the thing that dances, sings, leads a dozen dramatic incarnations; the thing that drives a small child into profound research or sets him digging into a difficulty with the energy of a dog in a woodchuck hole; whose ways are sure and whose outcome is beauty.

—HUGHES MEARNS.[1]

Expanding Personality.—According to the process of physiological development, association fibers between the thalami and the cortex and between the various areas of the cortex are developing and maturing rapidly during the period from three to five years of age. By six years the brain and skull will reach nearly adult size (see Fig. 68). The conscious life of the child now expands almost explosively. The four-year-old child runs to associations (see page 203). It is as if the cortical cells, having been abruptly connected with each other by the closing of many circuits of dendritic connections (as described by Coghill (see page 209), were busy setting up configurations, seeking "insights" all over at once. The world suddenly becomes full of goals. This takes the form not only of integrating new experiences to form meanings, but the recombination in memory and mental imagery of former experiences in more or less temporary, so-called "imaginary" wholes, configurations, or situations. "Feeling out kinships among the elements of experience is always a fanciful act and is the secret of insight and outlook."[2] The child may require considerable time—some may need even several years—to become able to distinguish clearly and always between the real and the imaginary. This should be recognized by the adult as a normal developmental phase through

[1] *Creative Power*, Doubleday, Doran & Company, Inc., 1927.

[2] STARBUCK, E. D., and others, *A Guide to Books for Character*, Vol. II, p. 14, The Macmillan Company, 1930.

which the child will come by the simple process of maturation. There is no more danger that the child will continue to confuse mental imagery and reality than there is that he will continue to climb stairs on hands and knees.

At the age of five years the child will step into the expanded environment of the public school. The last year he is strictly in the home is critically important. The parents should have several clear-cut objectives in their management: (1) the firm establishment of physical health and of essential health habits; (2) the establishment of sturdy independence in thinking and in character; (3) care that, while the child is necessarily being weaned from dependence upon the members of his family, the bonds of understanding and companionship shall be strengthened in every possible way. It is after he steps away from the home, so to speak, and begins to function in larger social relationships, that he will need a strong sense of belonging to his home and a feeling that there is *one* place where he will receive affection and understanding and where he can always have a hearing, where he need not be on the defensive, where he feels relaxed and at ease. While a certain amount of informal training in habits of order must still go on, the important thing during this momentous year is that the parents shall try to understand what is going on in the rapidly flowering mind of the child. Too often the parent becomes increasingly a drillmaster instead of a companion; order and manners seem the all-important achievements, and a dead wall of conflict arises between the child and his parents.

As the child enters this critical year, the parents should take a long look ahead—look at the child with clarified vision. The father and mother should talk together and plan together as to how they may work cooperatively toward a common purpose: the cultivation in their child of a strong mind in a strong body and a richly developed and, especially, a joyous personality.

Physical Health.—The child should be physically perfect before starting to school. The modern parent who keeps the child under medical supervision will not let defects become established. Enlarged adenoid, infected tonsils or teeth, faulty posture, malnutrition, etc. will be checked in their incipiency if possible, or receive early correction. The parents should be especially alert as the time approaches for school entrance. School health statistics generally show that children tend to come into the public school with the defects already established, which the school must laboriously and expensively have corrected. Until that is accomplished the child is definitely handicapped. The school spends precious time making the child "free to learn"; he should be free to learn when he enters school. Particularly careful medical and physical examination should be made during this year. The parents should be assured as to the following points:

1. The nutritional showing should be above reproach, as evidenced by clear skin, bright eyes, lustrous hair, firm subcutaneous fat, keen relish for wholesome food, regular elimination without artificial help.

2. The nervous system should be normal, as shown by regular habits of sound sleep, cheerful acceptance of the general conditions of life (provided they are such as *should* be accepted!). There should be absence of extreme nervous excitability and undue tendency to weep or rage. On the whole the child should be joyously, exuberantly happy and active.

3. The parents should be certain of the condition of vital organs, vision, hearing, tonsils, and teeth.

4. The posture and feet should be critically scrutinized and any corrective work indicated should be carried out and completed, if possible, before the child starts to school.

5. If the child has not been immunized before one year (see page 712) against smallpox and diphtheria, it is imperative that this be done before he starts to school. Further immunization for whooping cough and scarlet fever will depend upon the judgment of the child's physician. There is, however, no difference of opinion as to smallpox and diphtheria. Immunity to colds and respiratory infections should have been carefully built up by diet and hygiene (see page 257).

While the mortality and morbidity rates for all children's contagions are the highest in the preschool years, the four-year-old should have quite strong immunity; he should be tough, resistant, active, joyous, in short—a sturdy, aggressive little animal, but a human animal endowed with a rich, overflowing, creative personality.

Health Habits.—By the time the child is four years old, certain essential health habits should have become so set in the daily routine of his living that they are practically automatic. This includes the essential routines of bodily cleanliness: baths, daily cleaning of teeth, eating with clean hands, etc. It includes regular eating and sleeping, the acceptance of a balanced diet, and regular elimination.

By the time he is four years old, the child should be fairly well able to take care of his own body in regard to baths, teeth, washing hands, eating, dressing, and toileting; during the fourth year the child should be completely trained in these respects. He should now be especially trained in street safety, crossing streets, traffic rules, etc. He should be completely trained not to touch anything that could have been touched by the mouth of another person. The mother must ask herself what her child would do if another child offered him a bite of his apple or the loan of his "sucker," whether he will put his pencil in his mouth, etc. He must be trained to avoid putting in his mouth things that have fallen on the floor or the ground. This must be done through quiet daily example and practice, and care must be taken not to establish "phobias" and "obsessions" of neatness.

Before he starts going to school, the child should be able to use correctly and properly to care for a handkerchief (or paper tissue). He should remember to put on wraps before going out of doors, when such a course is indicated by the weather. He should be trained in the proper usage of sharp and pointed objects and in proper caution about machinery. He should be able to run and climb with good coördination and control.

Habits of Independence.—In addition to the habits essential for health and safety, the child between four and five should make definite advance in achieving a certain sense of responsibility in observing and accepting the factors entering into total practical situations. He should learn that when he takes off his night clothes they are, as a matter of course, to be hung in the proper place by someone, and that the person wearing a garment is the proper one to care for it. (The hook must be within his reach). If this item is made a factor in the dressing situation from the very beginning of his interest in dressing himself, it is much more likely to become automatic than it will if the mother picks up the pajamas until the child becomes large enough to reach the adult hooks. It is likely to take continuous and often distasteful insistance to establish any habit after the first interest in the performance of the act has faded—after not doing it has become a habit.

The child should be helped to see the total bathroom situation from the time of his first attempts to wash himself: where soap, towels, and washcloths belong; how the lavatory bowl and his tooth mug are cleaned; how his own things should be put away—anything that he, himself, uses. Again the secret of success lies not in offensively continuous "insistance," but in a quiet, invariable taking order for granted.

This procedure applies to the care of wraps, and includes putting cap and mittens and overshoes in certain places. When the child starts to go to school, he should have been trained to know where his belongings are and to take reasonable care of them, simply because he has been helped to see in his daily living that everything has a place, that everything requires some care, and that the owner and user is the one to be responsible for this care. This may sound like an irksome, insistent policy; actually, it is the easiest way to live, and the only way to reduce the routines of living to such a minimum that there remains a residue of time for friendly intercourse and the enjoyments of life.

General independence ("weaning from the apron string") should be furthered during this year by giving the child every possible opportunity to think for himself, to make his own decisions, to see for himself the factors in every situation. If he wishes to take a dining-room chair into the yard to furnish the basis for a tent house, it is more educational to talk it out than to utter a flat negation. "What do you want it for? What would we do about the scratches that are certain to occur? Do you know how much the chair cost? Do you know how long Daddy would have to work in order to buy a new one, or to refinish this one? Can't you think of something less expensive that can be used?" The hunt for something more suitable may in itself be made interesting and instructive. Especially, however, the child has been spared the feeling of frustration and resentment that flat refusal would have aroused in him in his effort to carry out a perfectly legitimate and, to him, an urgent creative project. He has been led to see a total situation, and to assume responsibility.

The parents must have open-minded and sympathetic interest toward the child all the time and must try to manage every situation so that it may contribute to the development of independent thinking and cooperative, socialized attitude. If he comes in crying because an older child has broken his wagon, the mother may sit down quietly and help him think it through. Did Johnny mean to break it or did he step on it accidentally? If he did it purposely, was he angry? If so, what made him angry?

FIG. 149.—A complete experience.
Going up. Farther up. Coming down.

What was said and done after the accident? Was the owner of the wagon in any way to blame? What does he think Johnny should do about it? How would it do for him and Johnny to talk it over tomorrow? Wouldn't he rather manage it himself than have the two mothers take a hand? If the child can be helped to develop a capacity for seeing both sides, for taking blame when he should, and a liking for managing his own affairs, his character is strengthened.

Development from Four to Five.—The normative summaries for four-year-olds are given on page 643 and may be somewhat more extensively stated as follows:

Motor Development.—The four-year-old manipulates with greater deftness and sureness than before and can negotiate more difficult situations. He can climb high in a tree and turn around and come down unaided, whereas he probably would have required some assistance at three (see Fig. 149). He can hippety hop, leap on one foot, and, if he has been encouraged, turn somersaults. He glories in motor adventures, such as climbing the underside of a ladder and walking the ridgepole of the garage. He has better command of his clothing, brushes his teeth more efficiently, can lace his shoes, but is probably still uncertain about tying the knot.

The four-year-old puts toys or other articles in place much more speedily than he could at three and is somewhat more likely to restore things to proper places without suggestion. Many things that were new and experimental at three are becoming automatic at four. He requires fewer reminders and fewer trials in hanging up wraps, washing hands, and wiping up spills. The four-year-old negotiates the walking board more successfully than he did at three, placing the feet one before the other alternately, whereas the three-year-old tends to shuffle along.

Baldwin reports that the average child at two years of age placed the blocks in a form board successfully in 257 seconds; at three years he required 76 seconds, and only 38.1 seconds at four. At five years he had reduced this time to 30.4 seconds.[1]

Language and Thought—Vocabulary.—Four-year-old children increase the vocabulary rapidly with the rise of associative thinking. The Brandenburgs found that the child who was studied increased her vocabulary 52 per cent during her fourth year, starting with 2,282 words at four and ending with 3,915 at five. They found that this child at forty months used an average of 950 words per hour and asked an average of 376 questions per day. At no time was she silent for longer than four minutes. At fifty-two months she uttered 14,953 words during the day, or an average of 1,244 per hour; she asked 397 questions per day or an average of 33 per hour.[2]

Descoeudres, in a comparative test of French children of upper- and lower-class parents, reports that four-year-old children of the

[1] BALDWIN and STECHER, *Psychology of the Preschool Child,* p. 86, D. Appleton-Century Company, Inc., 1924.

[2] BRADENBURG, G. C. J., Language Development during the Fourth Year, *Pedagogical Seminary,* Vol. 23, 1916.

wealthy class averaged 2,216 words in their vocabulary, while those of the common class averaged 1,896 words.[1]

Nice reports the all-day conversation of one four-year-old child. During the day she used 1,135 different words, but uttered a total of 5,519 words during the 6 morning hours and 4,999 during 7 afternoon hours. She used 2,686 sentences averaging 3.9 words each and asked 300 questions, or an average of 23 per hour.[2] Strang states that the average child uses about 900 words at three years, about 1,500 at four, and about 2,000 at five years.[3]

Time.—The four-year-old is becoming oriented in time as well as in space and in social relationships. He may know (of course, only if he has had opportunity to learn) the difference between forenoon and afternoon: he knows that breakfast, lunch, and dinner succeed each other; he knows yesterday, today, and tomorrow, and he is learning the significance of the days of the week. Obviously he cannot go beyond his memory span, and accurate memory for seven consecutive days is a considerable feat. Holidays will stand out longer in the memory images until the child builds up concepts of Christmas, birthdays, etc. He begins to be interested in the progress of the hands around the face of the clock and to recognize its meaning, although he cannot, of course, read the figures. He readily learns that when the hands are at certain marks he is expected to go to bed. Occasionally it works as a game for the child to see if he may not slip away when the hands of the clock reach "bedtime" and put himself to bed without mother's knowledge.

Distance begins to assume definiteness as the four-year-old understands the meaning of near and far, and of block as meaning from street to street. He is able to indicate which of two objects is nearer to him. He is able to discriminate small units of difference in size, length, and weight.

[1] DESCOEUDRES, A., Development of the Infant from Two to Seven Years, reported in the *Twenty-eighth Yearbook of the Society for the Study of Education,* Studies in Language Development, p. 506. Quoted by permission of the society.

[2] NICE, M. M., "Concerning All-day Conversations," *Pedagogical Seminary,* Vol. 27, 1920.

[3] STRANG, RUTH, *An Introduction to Child Study,* p. 166, The Macmillan Company, 1938.

Number also has meaning at this age. One of the Stanford-Binet tests for four-year-olds is the ability to count four pennies. Kuhlmann, however, places this test at five years. Although not actively conscious of number configurations, the child may arrange blocks or marbles in groups of two or three. He may count verbally in sequence as far as six to ten or more. He may count with marbles as far as nine.

Colors.—At four the average child can name eight colors. The studies of color preference seem to show an early preference for yellow changing to red, and later to blue.[1] This discrimination and preference may be structurally related to the development of the color organs of the retina.

Adaptive Behavior.—The four-year-old can now make his behavior conform to more complex patterns. At two he scribbled aimlessly according to the direction of greatest ease of movement. At three his scribbles become somewhat formed and he may decide that he *has* drawn a man or a house. He may actually have drawn only a head, a hand, or a chimney, which he instinctively symbolizes as a "whole"[2] (see page 609). At four he may announce that he *is going* to draw a man or a house and produce recognizable likenesses of those objects, with most of the essential features present.

At four he will complete a picture in which the head or an arm is missing. Gesell says he will add three missing features. He will try to wrap up objects in paper. If the plates are placed upon the table, he can lay the silver very accurately. After the table was set, one four-year-old heard his mother invite a

[1] *Ibid.*, p. 178.

[2] "A study of the data shows that those parts of whole objects familiar to the children which were used as stimuli, were frequently responded to, not as familiar elements, but as other wholes. The child is familiar, for example, with the features of the face, having been taught to point and name the eyes, ears, mouth, or nose of his mother or other familiar persons. Yet, when these parts of a whole are separated from their usual background, they are often responded to in terms of the larger whole, as when he calls an eye 'a face,' or an ear 'a shell.' . . . Lashley, in his experiments with vision in rats, finds a similar tendency to respond to the whole situation rather than to its elements." ELIZABETH GORDON ANDREWS, "Development of the Pre-school Child," *University of Iowa Studies in Character*, Vol. III, No. 19.

playmate to stay for lunch. She soon afterward discovered him adding a plate and service to the family table for his guest and doing it entirely correctly and without suggestion.

The child at four can be trusted to carry out small errands, although, since his sense of the lapse of time is not yet well developed, interesting diversions may delay his return. The important thing is that he is mentally responsive to the idea of sharing responsibility.

Personal-social Behavior and Training.—It is in the personal-social aspects that the behavior of the four-year-old is most significant. As has been said, he has achieved personality orientation in that he has *discovered himself;* he has achieved *spatial orientation* and has been making the acquaintance in detail of his environment and its management. He has achieved a considerable degree of *social orientation.* He is now achieving definite *mental and emotional orientation,* and is brushing wits with his elders. He can argue the matter of postponing the time for going to bed, and present many reasons for wanting to go to his chum's house to play. The temptation is to cut him off emphatically, if not rudely. The parent should realize that this is a critical phase of growth, during which the child establishes his techniques for communicating effectively with others.

Adults should take particular pains to restrain impatience and talk with the child only in such language as they desire the child to acquire. No matter how firm the parent must be, he must guard his tongue and let no word or intonation or expression slip which he would dislike to hear echoed back to him from the mouth of his child. The child must be treated as an equal; he inwardly and subconsciously resents being treated as an inferior. If the parent "snaps" impatiently at the child, he can expect nothing but rudeness and defiance in return. It becomes enormously important that the child shall acquire correct attitudes and motivation as well as correct techniques of communication. "It is more important that he shall *feel* right than *do* right," since it is his emotional pattern that will determine his future attitudes and conduct and shape his personality.

The adults in charge of the four-year-old will meet a constant challenge to make correct values appeal to his mind, to help him become able to meet the issues of life fairly and impersonally and independently. Masterly restraint is necessary to keep the adult from thinking for him. The adult may hold the palette of mental colors from which the child selects according to his conscious need. Never should the adult put brush to the canvas of the child. It is better that the picture should be "a poor thing but his own" than a hodgepodge in which the personality of the child is submerged and lost and dominated by the adult, who is

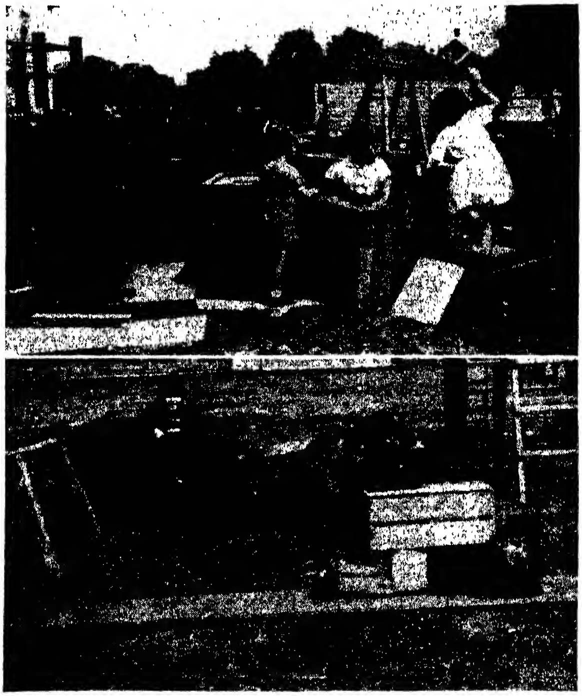

Fig. 150.—The four-year-old wants to play with other children.

so anxious to display his child with pride that he does not see what is going on inside the child's mind.

During his fourth year he has great need for companionship with other children. This is shown by his gregarious drive which impels him so strongly that he will brave extreme parental punishment and disfavor to be with other children. Hunger for companionship of other children is the usual cause of running away at this age.

While as a young child he has enjoyed having other children about, he has not *required* them in the sense that he now requires them. Now he wants to play *with* them in organized, social play (see Fig. 150). *This he must do* in order to learn to function in the social group. He should have full and satisfying contact with other children, not only of his own age but of varying ages. One of the valid criticisms of the conventional nursery school, as it is organized at present, is that the age stratifications are rigid and tend to become more rigid as larger groups are involved. While the child should learn through experience to hold his own with his own age, he should also learn through experience to adapt to younger and older ages. His mother, for this reason, should seek opportunities for him to be with mixed groups and thus discover how to adapt to the child who is weaker and to the child who is stronger than himself.

Reasoning and Imagination.—Between the ages of four and five the configurations or fields of the child's experiences expand in every direction. He is not only actively interested in shelling peas and preparing them for the table, carrying them to the table and serving them, as he was at three, but he wants to know why we do not eat the pods; why peas must be planted in the ground to produce more peas; why we gather more than we plant; what "grow" means; why salt and butter are added; and so on endlessly. He becomes interested in bringing others into his experiences. He is still vague in his discrimination between the animate and inanimate objects of his acquaintance. It may easily be that he has a closer sense of companionship with his Teddy bear, his dog, or his doll than with even some of the members of his own family, who may actually have spent fewer hours with him and figured less actively in his thoughts. He may play with imaginary playmates who seem very real to him. He is highly dramatic and "stages" everything. So vivid is the imaginative life of the child, it is often difficult to determine whether he actually confuses real and imaginary occurrences or whether to him both merely seem equally valid and are equally enjoyable.[1] He often becomes insensibly aware that Santa

[1] "One of the most striking results in this study and one which confirms the findings of previous observers is the prevalence of the fantastic type of imagination in the third and fourth years. So general is this characteristic

Claus is someone he knows, dressed up, but he enjoys the make-believe quite as much as the myth, and often the mother cannot tell when the child first becomes aware of the deception.

Jack's beanstalk which grew skyward at such an impossible rate is such good fun that whether it is true or not makes no difference to the child. Two children were comparing notes about two little pitchers that had been given them. "Mine is the biggest." "No, mine." "Mine is so big Mamma and Papa and everybody can drink from it." "Jesus can drink from mine," retorted the other. Not to be outdone, the first one terminated the argument by saying. "Mine reaches clear up through a hole in the sky and God drinks from it." All this, with the two small pitchers before them!

With the rise of imagination and associative organization, the child's ability to transfer and project his own feelings to others becomes possible. At times, when his attention happens to focus in this direction, he may become deeply solicitous about the well-being of others—but this solicitude is as likely to be directed toward a doll, a dog, or a favorite toy as toward his mother or his baby sister. Two children about four years old were vaccinated in their home; while the rest of the family were receiving attention, they went off, returning with their favorite dolls and insisting on complete duplication of the procedure, even to the scratches and the celluloid shields, for the dolls. If they themselves were to be "kept from getting sick," they desired the same protection for their beloved companions.

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that from whatever point of view we have considered it, the height of this type appears at these years.

"A careful study of the responses given by the child, as well as an observational study of his attitudes and behavior, would indicate that the child is responding in all seriousness and with full assurance that he is giving the correct answer. The image aroused by the stimulus would seem to be so vivid as to be taken for the object itself. It is at this age that parents and teachers should pause before condemning fanciful stories as purposeful untruths, or by stern repression sealing up those avenues of expression through which creative imagination seeks an outlet. The ability of the child to see resemblances hidden to the unimaginative mind of the adult . . . is a gift, which if rightly directed, may produce an artist or a scientist." Elizabeth Gordon Andrews, "Development of the Preschool Child," *University of Iowa Studies in Character*, Vol. III, No. 19.

When there is illness in the home, children in the period of imaginative ascendancy are often found dramatizing the occurrences of the sickroom with their dolls and pets; food, medicines, and baths are given; temperature is taken, a stethescope used, enemas administered, etc. This is in part sheer dramatization but also, in part, the beginning of social concern.

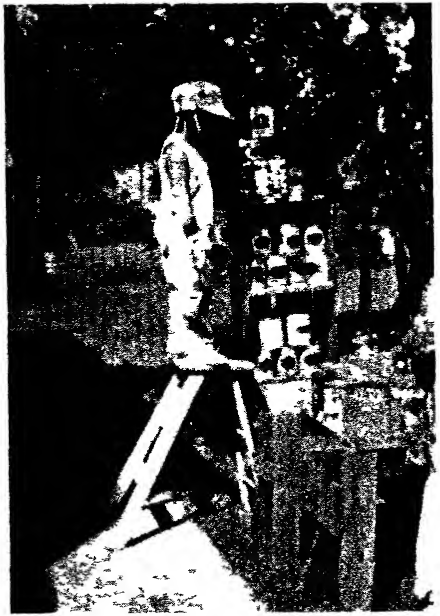
Two children who had been taken to visit a new mother and baby were later discovered, one in bed with a doll on her arm, the other bustling round. The one in bed calmly remarked, "I've just had a baby and Sis is my nurse." The nurse in question was taking her duties very seriously.

Whereas the child between two and three will set a tea table and put a doll in a chair and pour and drink endless cups of make-believe tea, the child nearing four is more likely to bring another child or an adult or her dolls into the plot and to pour tea for her companions and apportion the imaginary cake and carry on conversation.

The child from two to three may happen to see the six-year-old brother stealing sugar. It will not occur to him that the event is of interest or importance, except as it may suggest to him that he may do the same thing—otherwise, he will probably go along about his business. A year later he will more than likely exclaim about the naughtiness of the act and "run to tell." He has discovered that acts mean something, that things are not only done (and a year before it was the doing that was interesting) but that there is a reason for doing them.

This is the time when the child begins to ask, "Where did Mrs. Brown's new baby come from?" If the unmodern adult is luckless enough to say "God gave it to her," the next question may be "Where did God get it?" "God made it." "Did God make everybody?" "Yes." "Who made God?" "Where does God live?" "Can we go to see God?" etc.

The matter of so-called "sex instruction" has always been a parental bugaboo. The problem has vanished into thin air in families in which the policy prevails of following the child's developmental levels and of answering every question in the child's own vocabulary. See pages 579 and 584 for discussion of particular phases of the question.



A

B

C

FIG 151 —The four-year-old enters into group play *A* the four-year-old merchant sets up business with packing boxes, empty cans, and other "junk", *B* the neighbors do business *C*, money (bottle caps and paper tokens) rolls in!

Occupation for the Four-year-old.—Construction and creation characterize everything that the child does during this period. He can carry on longer and more complex projects (see Fig. 151). He may even spend several days in building a house or laying out a town or a farm. Housekeeping projects may be prolonged indefinitely. The playhouse should, if possible, be large enough for the child actually to live in it. A large packing box in some

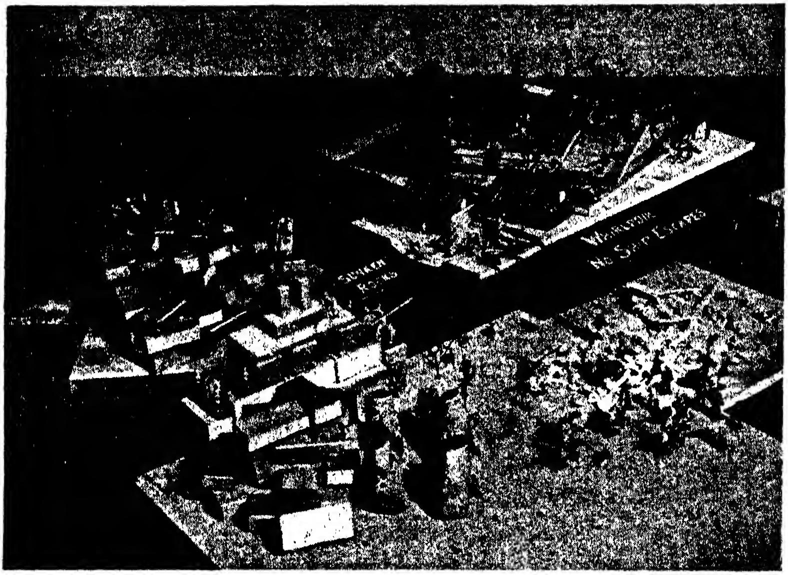


FIG. 152.—A general view of the wonderful island showing Captain F. R. W.'s ship at anchor. Pegboards used in dramatic floor games. (*From H. G. Wells, Floor Games, Small, Maynard Company.*)

sheltered spot is a perpetual pleasure. The child's play space (see page 537) should be so situated that any construction project can be left alone until the child has entirely finished with it. H. G. Wells describes a delightful pegboard project that he and his sons carried on for a period of weeks (see Fig. 152).[1]

The climbing tower, slide, and ladders which the child earlier so much enjoyed when he simply used them for exercise now become items in creative enterprises (see Fig. 145). One four-year-old in a nursery school used the jungle-gym as a stable for a menagerie and tied up the younger children, who suddenly

[1] WELLS, H. G., *Floor Games*, Small, Maynard and Company, 1912.

became lions and elephants, with imaginary rope. There was wild excitement when one of the "animals" escaped. A fence was made of ladders, etc.

Boards, boxes, nails, saw, hammer, a shovel stout enough for real use, a place out of doors in which the child may dig and build, a great number of building blocks, mill ends, etc., and *always* the box of household junk. These are essentials for both boys and girls. Real tools of small size should come into use, with instruction in their proper care and orderly arrangements for keeping them.

Girls begin to take elaborate care of their dolls and dishes. Laundry equipment is used in much detail, also the small housekeeper must have broom and dustpan. As associative memory develops, the child constructs a replica in miniature of his world of experience; he will be endlessly busy about this if he can command the constructive material which it is the parents duty to provide.[1] Also, the parent should expose the child to a wide variety of wholesome experiences: visits to parks and to the zoos and to the country; raising a garden; encouragement in using paints, clay, and crayons; cutting and pasting; picture books; using suitable victrola records; making musical instruments, etc. All these open doors to rich inner life.

Life is so exciting, during this period, that there may be difficulty in securing rest and quiet and regular sleep. The child cannot bear to stop the interesting things he is doing. It should be made easy for him to break off; he must be assured that his project will be undisturbed. While he should not be bribed, a pleasant change of occupation may be suggested, such as music, a story, or putting the dolls to sleep.

The all-important factor, ever and always, is a relationship of quiet friendliness between parent and child.

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[1] Bridges, K. M. B., "Occupational Interests of Four-year-old Children," *Journal of Genetic Psychology*, Vol. 36, pp. 551–569, 1929.

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CHAPTER XXX

THE FIVE-YEAR-OLD

Every child should have mud pies, grasshoppers, water bugs, tadpoles, frogs, mud turtles, elderberries, wild strawberries, acorns, chestnuts, trees to climb, brooks to wade in, waterlilies, woodchucks, bats, bees, butterflies, various animals to pet, hayfields, pine cones, rocks to roll, sand, snakes, huckleberries, and hornets, and any child who has been deprived of these has been deprived of the best part of his education.

—LUTHER BURBANK.[1]

At the age of five years or thereabout we lead Our Child to the schoolroom door, and he enters upon a new regimen, which is to dominate his activity and his thinking for at least 10 years, and possibly 20. As was set forth in the previous chapter, he should have been made ready for the change.

Physical Care of Self.—He should be able to go alone for a reasonable distance on familiar streets and to run and climb and avoid dangerous situations. He should be able to take care of himself completely, get a drink, go to the toilet, wash his hands afterward without reminder, take care of his own wraps, clean up his own play debris, willingly put things in their places, and assist the teacher in the care of room and equipment. He should be responsible in the care of his health—about putting on wraps before going out to play, not drinking or eating after others, not putting pencils or fingers in the mouth, etc.

Language.—At five years of age the child should enunciate clearly, use complete sentences, and state his full meaning. He should be able to narrate a complete occurrence and repeat a familiar story. The habit of narrating experiences within the family circle should have been encouraged and developed, so that the child will feel easy and free in describing the experiences of the schoolyard and street. He has a well-developed sense of humor. His imagination is in the ascendancy. He is able to differentiate between imaginary and real, although still strongly

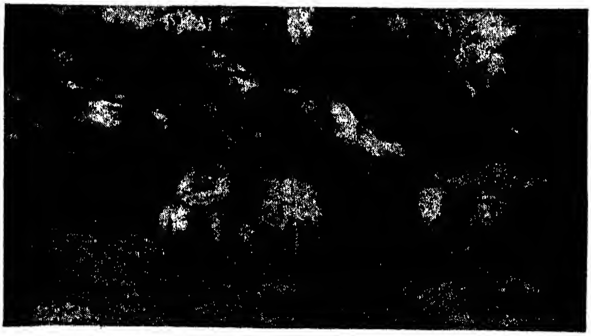
[1] *Training the Human Plant*, D. Appleton-Century Company, Inc.

under the spell of "make-believe," and with proper training is fairly reliable and truthful. He asks many questions, which gradually become more penetrating in his search for causality. His knowledge of time, space, number, form, and color has increased. He usually has well-defined appreciation of tune and rhythm.

In adaptive behavior the five-year-old who has had the type of educational experience previously presented in this text will cooperate, without very much reminding, in watering the plants, caring for pets, and in putting things away. He can remember and carry out three or more verbal commissions at a time.

He draws and builds purposefully with a plan or design in his mind (see Fig. 156). His mental visualization is more accurate and extensive than previously. His associative memory has developed much during the year. He picks up new words like a chicken picking up corn. He loves to repeat them, and his attempts to give them meaning are sometimes so ludicrous that it is difficult not to laugh at him. The child should not be subjected to embarrassment, however. If a definition conveying any sort of meaning to him can be given when he uses a new word, this should be done. His experimentation with grown-up language should be treated in a matter-of-fact, casual, and helpful way, without too much attention or seriousness. The child is reaching out for larger thoughts, and, as always, he must have time for the unfolding of configurations or wholes of meanings. The parent should not comment on a child's behavior in his hearing. Whether the comment is favorable or otherwise, the result is an intensification of self-consciousness, which is undesirable. One child hung around the parlor in a mysterious manner during a social call and finally said, "Mother, aren't you going to tell Mrs. Blank what I said yesterday?"

The World about Him.—As Burbank expressed it, the young child should be exposed to or turned loose in the world of nature. The city child should be taken to parks, woods, zoos, to the country, for long days, and for vacations on farms if possible, and should be given every available opportunity to make the acquaintance of the marvels of creation at first hand. He should have had such experiences all his life. Whether he has had them or not, it is now the psychological moment for emphasis, as he has come to the place where he is consciously building his concept of a world. In keeping with his expanding interests, he is awakening to meaning in all living phenomena. The growth of plants, the blossoming of flowers, the birth of kittens, the new baby, mating birds,



(*a*)

(*b*) (*c*)

FIG. 153*a-c*.—Every child should have *brooks to wade in.*

insects, worms, fish, running water—all are entrancing. All living phenomena are of equal beauty and equal interest. He has acquired (we hope) no prejudices, shames, or artificialities of judgment. A dirty alley kitten is as priceless to him as a pampered Persian; a toad or a green tomato worm as desirable and interesting as a goldfish. He is not afraid of snakes. He

(d) (e)

(f) (g)

(h) (i)

FIG. 154*d-i*.—Animals to pet.

should be so well informed and well satisfied about natural phenomena, including sex facts, that surreptitious experiences will not have special appeal, and his home relationships should be such that he will have no embarrassment or reluctance in telling his parents anything that occurs at school.

Fig. 155.—Wild strawberries—grasshoppers—hay fields—frogs.

In social behavior the five-year-old should be able to settle many, if not most, of the difficulties that arise between himself and other children. He should be cooperative and present no disciplinary problem to his teacher.

The child of five is beginning to glimpse the larger relationships of life. He sees that people live together as neighbors and that a number of people live near each other to form a town or a city, that these people obey some head as do members of a family.

There are the father and mother in the family, the superintendent in the school, the pastor in the church, and the mayor in the town. Some children at this age even grasp vaguely the idea of state and nation, but only if their experiences have given them some concept of larger spaces through journeys, pictures, or stories.

If properly developed along the line of actual experiences, the child of five will have a real sense of respect for authority and will

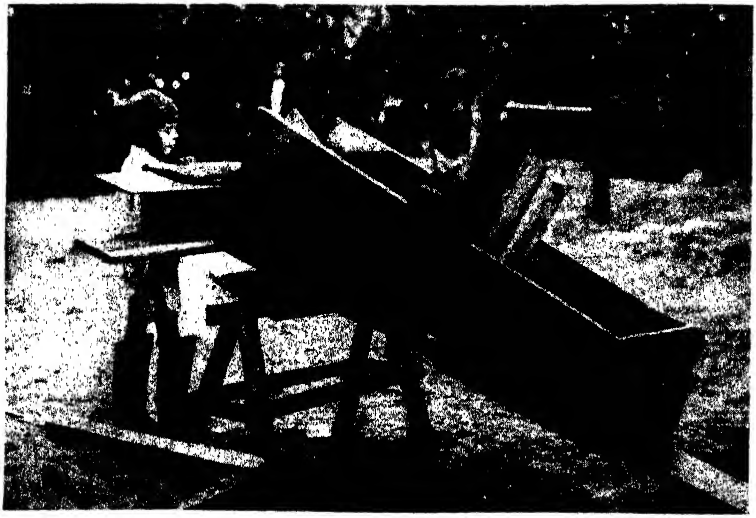


Fig. 156.—The five-year-old loves projects. This boy drew his own plan and built this airplane without assistance. He had recently had a trip in an airplane and had used tools since he was two years old.

realize that everybody minds someone higher up. He should, if possible, know and have friendly relationships with policeman, mailman, and other municipal officials, and be interested and intelligent about their respective duties.

He may be embarrassingly direct and personal in asking questions, such as, "Why does your face break out?" or "Don't you have a husband?" He will have a keen sense of ownership, and will actively resent infringement of his own property rights. If not unfortunately conditioned, he will tend to have reasonable respect for the rights of others. He now acquires increased appreciation of the fact that everything belongs to somebody and that personal "rights" have constantly to be determined.

Even the young child can be led to feel the universality of the principle; this makes his small hurts and social adjustments easier for him to manage.

Socially the child is beginning to force himself into human relationships. He organizes simple group play with children of his own age and younger, and he insists on being taken into the group activities of his older brothers and sisters. This is invaluable training in social adjustment.

Money.—As the child steps out by himself to do small errands at the neighborhood store, he begins to handle money. From two years on he probably has a bank into which he drops pennies, and he learns that pennies and nickels may be exchanged for coveted objects. Even the four-year-old may have his allowance of a penny or a nickel every Saturday when the other members of the family receive their allowance or spending money. The child between four and five learns to count five pennies and may get the idea that if he puts his allowance in his bank this week he can buy more next week. The use of money should be made an interesting but very simple game, and the child's allowance should not be increased as a bribe or withheld for discipline. It should belong strictly to the field of *personal finance.*[1] The point is that his first experience with money should be educational.

Play and Occupation.—The five-year-old plays more constructively, sticks at projects longer, and is interested in smaller details than he was during the previous year. He is interested in organizing and arranging his possessions and playthings, but may find it irksome *always* to put things where they belong. The mother should be satisfied with helping the child develop a liking for and acceptance of order and system, and she should beware of defeating her purpose by unpleasant insistence or nagging or scolding about lapses when the child is tired or preoccupied.

The five-year-old really makes things that will last and can be used, and he will work at a house or a boat for days in succession (see Fig. 156). He makes elaborate scrapbooks, cutting and pasting quite accurately. He draws and models much more skillfully; he has a definite sense of rhythm. He sings accurately; he dramatizes elaborately.

[1] GRUENBERG, SIDONIE M., and BENJAMIN C. GRUENBERG, *Parents, Children and Money,* Viking Press, Inc., 1933.

Adaptation to School Life.—The daily schedule should have been changed gradually in anticipation of any adaptations needed when the child enters kindergarten. His bedtime should have been thoroughly established at such an hour that he awakens spontaneously, early enough to eat a generous breakfast in a leisurely, happy manner; have his accustomed bowel movement; and set out for the school in a tranquil state of mind. Too often the entrance of the child into school life ends tranquil, happy days for him, and initiates a long sequence of days of pressure and hurry. "You must get up and get ready for school!" "Hurry up and eat or you will be late." Then the visit to the toilet is omitted some morning when things lag, or the child is too tense to have satisfactory results, and a period of cathartics and nervous and physical upset follows.

The quiet, tranquil initiation of the child into his school life without interruption of any of his health habits is of critical importance.

The sleep program of the child should have been adapted to the hours of the impending school period long in advance of school entrance (see Chap. XXXVI). Most children of five have dropped the midday nap, but need to observe a very early and very regular bedtime. This should be *thoroughly established* in anticipation of the excitement of the new experience, which may make it difficult for him to go to sleep at first.

Every growing child of any age should have a period of regular midday rest, even if a brief one. The mother should take special pains to have her kindergarten child observe this happily and quietly. Fortunately the customary half-day session makes this easily possible.

The food needs of the child entering school should receive careful attention. *Breakfast is the key meal.* Breakfast on the first day of school is the most important item of the eventful day and determines in considerable measure the degree of fatigue experienced by the child. The mother should be prepared to see that her child does not fall into irregular and perverted food habits.

The temperamental adjustments of the new school child are also most important. The child who has had nursery-school experience, or who has had an abundance of opportunity to play with other children, will have little difficulty. The mother may, however, have more or less frequent opportunity to act as friendly mediator and interpreter to her small child in regard to new situations and difficulties that arise on school ground and street. She can do much to help her child in developing an independent, courageous, and impersonal attitude toward life and to prevent the entertainment of self-pity or the development of egocentrism. With the rather sudden expansion of social contacts and with accommodation to the personality of the teacher there may be intensification of extrovert or introvert tendencies which call for tactful management.

In short, our five-year-old is, or should be, an independent human being with the habits and attitudes quite firmly established that he will carry through life.

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CHAPTER XXXI

PROBLEMS

To a Naughty Little Boy

With unforgiving haughtiness
We chide your naughtiness,
How dared you try, abandoned little lad,
The thing we so incitingly forbade!
What was it?—stealing jam from pantry shelves?
Well, we do that ourselves.
Nor craving jam, nor having any mind to
The villainies our mentors seem inclined to,
But when they arbitrarily taboo them,
Of course we do them!

ANONYMOUS

I believe All children's good,
'Ef they're only understood, . . .
Even Bad ones 'pears to me
'S jes' as good as they kin be!

JAMES WHITCOMB RILEY.[1]

Physical Problems.—Undesirable patterns of physical behavior may arise in the early years and become conditioned as habits. The physical habits most often listed as bad habits are thumb sucking, nail biting, bed wetting, and masturbation. The watchful parent will try to prevent the repetition of unwanted actions to the point at which they become conditioned into habits. Having become established, they must be caused to fade through disuse. To accomplish this requires quietness, tact, and patience. *A habit cannot be pulled out of the field pattern of the individual's personality*—it must be quietly crowded out and replaced with more desirable patterns. New paths of association must be established between reflexes, thalamus, and cortex. To use force is to fix attention upon the very thing one desires the child to forget. In fact, conflict seldom, if ever, accomplishes the desired end at any age or in any relation of life.

[1] *Home Folks,* Used by special permission of the publishers, Bobbs-Merrill Company.

Thumb Sucking.—All infants at sometime grasp and suck the soft little hand or fist. The whole effort of the mother should be to prevent the occurrence of the act as often as she is able. In the infant, quietly withdraw the hand, and if the child is old enough, put something in its hand; putting a soft cotton stall over the entire hand at bedtime may help. Diverting the attention of the older child with an interesting plaything or a suggestion for some play activity, an interesting errand, bringing out a book to look at, anything that will cause him to forget to complete the act. If he sucks his thumb, fingers, or fist at bedtime, the use of a snuggle-rug arrangement of his coverings (see Fig. 108) will be effective with the small child, if he is completely comfortable and does not associate the covering with the habit. Even in summer, a thin sheet may be so arranged. The child must be able to move and turn freely, and must accept the situation happily or it will do much more harm than good. Parents should not become panicky and intense, as the physical results of thumb sucking are not so disastrous as was formerly supposed and most children voluntarily stop before lasting injury is done to palate or to teeth. Persistent thumb sucking after the child reaches the age of socialized play sets him apart from his group and weakens his personality development. *Persistence of any antisocial habit has its basis in a total situation in which there are many more wrong factors than one particular practice. The entire setup of the child's living should be studied and adjusted.*

Nail biting may occur in nervous, thwarted children even of preschool age. It may occur in any child whose nails are not properly cared for. It is highly irritating to have rough, snaggy nails that catch on fabrics. Some persons have such sensitive nail beds that they cannot tolerate the friction and instinctively try to smooth the edges of the nails with the teeth. A visit to a manicurist and provision of a suitable personal manicure outfit, with careful watching that the nail edges are kept smooth and closely filed, will practically always lead to the habit's fading. If the habit has a neurotic basis and becomes intractable, the nervous child's real trouble is much more serious than the overt act of biting the nails, which is only a minor symptom of deeper difficulty—usually only one of numerous symptoms. The parents of such a child may need to place him temporarily in a complete change of environment and take themselves firmly in hand, learn the basic principles of nutrition, development, and training, and begin all over again. A happy, healthy child seldom bites his nails or attends persistently to any one part of his body. He does not have time! If the child is not happy and healthy, something is wrong in the situation and it is the responsibility of the parents to find out what the trouble is. Usually it has its basis in parental ignorance.

Masturbation.—The mouth, the finger tips, the glans penis, and the glans clitoris are the most sensitive organs of contact in the body. We have seen that stimulation of the lips and of the fingers and nails may easily establish habit configurations. Likewise, pleasurable stimulation of the organs of sexual sensation may occur quite accidentally, just as the infant discovers that he can suck his thumb or the child discovers that he can smooth his rough nails with his teeth. Handling the genitals may be caused by local discomfort from adherent clitoris or foreskin or from lack of cleanliness or friction from clothing. The management of all situations is first, securing complete physical comfort, then fading through disuse, accomplished with watchful, quiet diversion, managing that the child has as few opportunities as possible for surreptitious practice of the habit. This child should go to sleep with his arms *outside* the covers and so filled with playthings that he cannot easily reach his sex organs. Bedtime stories and sitting with the child until he goes to sleep may be necessary.

If the child is old enough to comprehend, he may be told quietly that boys and girls do not touch themselves in these places except for purposes of cleansing. He should not be shamed or made to feel that there is something "nasty" and "bad" about these parts of the body. In fact, all references to the organs of elimination (he naturally cannot grasp the significance of sex organs) should be as frank and casual as that of any other part of the body. The usual attitude of adults inevitably arouses curiosity, and both their reticences and lurid emphases keep the child wondering and excited with his "mind on the subject," a condition contributing to the easy establishment of the practice of manipulating the organs. To command the child to cease the practice or to threaten punishment or to punish only makes the situation worse and creates distorted and undesirable concepts.

Here, again, the nursery school is pointing the way to correct method in training. In the modern nursery school the whole matter of toileting is carried on as matter-of-factly as is eating or hand washing. Boys and girls use the same toilets and any questions pertaining to the subject are answered frankly and directly. Nursery-school children conform to the usages of good society in their conduct and are modest and well behaved.

The child who becomes a confirmed masturbater, like the confirmed nail biter, thumb sucker, and bed wetter, is a child who has many things wrong with him other than the habit. Attention should be directed to bringing his physical condition up to par and so adjusting his environmental relationships that he leads a quiet, but busy, happy life and that he has a sense of security and affection in his relations with his parents. A happy, vigorous, busy child does not have time to waste in silly repetitious actions. His attention is not focused on his body except through hunger, thirst, and the urge of sphincters for elimination. The concentration of effort in breaking any habit should be upon bringing the child into normal physical condition and into normal balance with his environment. It is practically always found that the habits mentioned then disappear, along with the emotional problems.

Bed wetting (*enuresis*) can be in some measure controlled through regular habits and through conditioning to dryness, even before the sphincters of the urethra come under cortical or voluntary control. It is impossible to tell in an individual child just when it becomes possible for him to control the emptying of the bladder, and it is ruinous to nerves and morale to try to force conduct prematurely. The child who is tranquil and happy, and who accepts a regular schedule of living, will, in this as in many other behaviors, respond to maturation and insensibly begin to take care of himself.[1] He should be made to feel it an achievement to be proud of when he asks to go to the toilet or goes by himself. Most children are able to do this by the age of eighteen to twenty-four months; some, before. Both day and night control is complete in most children by three years. Night control, naturally, is harder to establish. Of course, under excitement or deep absorption in activities, "accidents"

[1] MELLON, EVELYN EMIG, "Some Babies Train Themselves," *Parents' Magazine*, May, 1939.

will occur. No child should be punished or humiliated for such slips.

The child who fails to show voluntary control at the normal time, as in the instance of the other undesirable habits mentioned, should be studied in the total situation.[1] A few rare cases are strictly physical, but practically all are due to faulty early training or have a neurotic basis. A medical examination should reveal any physical abnormality. The enuretic child should not be deprived of fluids—a procedure that produces concentrated, irritating urine—or be badgered, harried, or humiliated (which causes nervous tension), and, above all, *should not be drugged.* A few years ago physicians were more given than they are now to writing prescriptions for kidney sedatives at bedtime, designed to lessen the amount of urine excreted. No one but a specialist and then, in the case of a clear-cut pathological condition, should prescribe genito-urinary medication. Only outstanding child specialists should be consulted. In diagnostic study of a case, the times of urination should be recorded for each 24 hours for several days or a week, thus determining the individual pattern.

Some children, like some adults, have bladders that do not comfortably hold a usual amount of urine, and they must empty the bladder oftener than the average. Children who are tense may go to the toilet at bedtime and still, with the first deep sleep, have a sudden relaxing of the sphincters. When the individual time pattern has been ascertained, the micturition program for the child must be regulated accordingly. Most children become conditioned quite early to going all night without voiding. Others must void one or more times. Getting the child up a few minutes before the time of habitual voiding, seeing that he is fully awake and completely empties the bladder will tend eventually to condition the child to spontaneous awakening and going to the toilet. Some success has been reported from waking the child a little later each night until he finally goes all night without voiding. Most older enuretic children should go to a psychiatrist rather than to a medical man, unless he is a pediatric specialist. The great majority of such children are cases for management rather than medicine.

[1] THOM, DOUGLAS A., *Child Management*, Federal Children's Bureau, 1928.

Emotional Behavior Problems.—Most so-called "behavior problems" may be said to have their basis in the experimental adjustments precipitated by new levels of maturation, with consequent spurts of increased new activity and sudden expansion of environment, coupled with lack of experience.

Guidance consists in quietly steering the child in the direction of correct and advantageous integrations or configurations of conduct and habit. The wise parent will not be alarmed at the sudden appearance of undesirable conduct; rather, he will quietly study the situation and help the child in a companionable and impersonal way to make correct adjustments. Nothing so surely sets the habit mold in the undesired pattern as does overemphasis or punishment or the creation of a violent emotional situation. Most so-called "undesirable" or "problem" behaviors which become persistent have an emotional basis or drive; this should be kept clearly in mind.

Wheeler says, "In general, the source of all emotive behavior is, as in all behavior, an undifferentiated total pattern."[1] This may become differentiated through internal or through external stimulus. Certain behavior situations that may become set in undesirable habits have been discussed in connection with the maturation levels at which they tend to appear A further discussion of some of the commonest behavior problems having an emotional basis follows.

Fears.—Assuming that fear occurs when safety is threatened and the subject feels inadequate to cope with the danger in question (see page 450), it is the part of constructive educational method to help the child insofar as possible to recognize and to meet or to avoid danger without permitting him to experience the injurious emotion of actual fear. The most devastating fears, however, are not incited by actual objective dangers so much as by situations that appear casual to the adult, but which engender in the child shrinking, repugnance, and withdrawal.

In training emotions we are concerned not so much with the child's acute fears as with his subtle vaguely felt fears. Frights, terrors, and acute fears are relatively infrequent. Subtle fears, including timidity,

[1] Wheeler, R. H., and Francis Perkins, *Principles of Mental Development*, p. 206, The Thomas Y. Crowell Company, 1932.

bashfulness, lack of confidence, undesirable inhibitions, are important and frequent.[1]

All behavior is chemical in the sense that chemical changes that alter electrical potential occur in brain and body cells with every thought and every movement. It has been demonstrated by Cannon,[2] Crile,[3] and others that the cortical cells of the brain undergo crination (shrinking) with fading of the Nissl bodies (see page 173) under fear, just as definitely as they do under exhaustion, disease, or surgical shock. The terrified child is a sick child; the parent who subjects a young child to a paroxysm of fear and pain from corporal punishment, together with acute humiliation to his personality, has thrown the entire kinetic mechanism of his child's body out of balance. Digestion, elimination, and sleep are disturbed to a less or greater extent. *Violence has been done to the total organism.*

Courage is the attitude produced by a feeling of competence, a belief that one can successfully surmount the impending danger. Or, in the well-disciplined character, it is a sturdy facing and acceptance of inevitable facts, even though these involve pain or sorrow, such as having a splinter extracted, or accepting the death of a relative. The child who has functioned as an independent person all along the way is trained thereby to meet difficulties courageously. *Normally he has a consuming urge to solve his own difficulties.* Control through fear is devastating to personality, in that it tends either to create timidity and cowardice, with secretiveness, sulking, and lying, or to produce in the aggressive type of child defiance, belligerence, and anarchy, which may also be coupled, in extreme cases of violent disciplinary control, with a concealed sense of inferiority, lying, and secretiveness, often masked by blustering assertiveness.

Fears are easily conditioned in young children during the labile period in which organization of mental processes is actively taking place through exposure to situations beyond their develop-

[1] "Training the Emotions: Controlling Fear," *Boston Public School Document* 2, p. 9, 1928.

[2] Cannon, W. B., *Bodily Changes in Pain, Hunger, Fear, and Rage,* D. Appleton-Century Company, Inc., 1929; and *The Wisdom of the Body,* W. W. Norton & Company, Inc., 1932.

[3] Crile, George E., *Man an Adaptative Mechanism,* The Macmillan Company, 1916.

mental maturity. The work of Mary Cover Jones in this field is well known.[1] Among other experiments, Dr. Jones conditioned young children to fear of rabbits by striking a loud, sharp bell simultaneously with the appearance of the rabbit. Later the children were reconditioned by gradually and quietly introducing the rabbit at mealtime, thus bringing it into a pleasant rather than an unpleasant configuration. Dr. Jones finds "direct" conditioning the most effective method of eliminating fears; in other words, associating the "fear object" with a desired or "craving object."

Every mother should be alert to the fear experiences of her child, and she should make every effort to have all fear experiences eradicated or converted into configurations of competency and courage. Where it is at all possible or suitable, the child should be encouraged and prepared to meet and solve difficulties himself instead of being assured that "mother won't let the bad dog hurt her baby." Tell him he may pet dogs when the persons they belong to are with them, but that he had better not touch strange, lone dogs, since they may be sick and we do not know what they might do.

The child should be prepared to meet certain possible frightening or dangerous situations. The children in every home should be instructed in fire precaution and proper behavior during accidents by fire: to roll instead of run if clothing catches, how to call the fire department, and how quickly to smother different types of fire. Every accident productive of fear which comes into the experience or observation of the child should be made educational and kept as free from panic as possible. Help even the youngest child to think "What can I do? What can be done?" in emergencies, rather than to yield to helpless terror. Especially, the child must not become conditioned to being passively rescued from danger (see page 593).

Jealousy is the reaction that occurs naturally when the child's egoistic integrity—the self-configuration, the "field" which his life experiences have established—is threatened on the side of his

[1] Jones, Mary Cover, "The Elimination of Children's Fears," *Journal of Experimental Psychology*, Vol. 7, pp. 382–390, 1924; "A Laboratory Study of Fear," *Pedagogical Seminary* 1924; "A Study of the Emotions of Preschool Children," *School and Society*, 1925; and "Conditioning and Unconditioning Emotions in Infants," *Childhood Education*, 1925.

affection or love. He is led to conclude from the evidence of changes in the relationships between himself and others whom he loves or admires that he is to receive less than belongs to him in the way of affection or attention. It is the counterpart of

FIG. 157(a-d).—Responsibility for "our baby" makes a difference.

the feeling of resistance and resentment when one's tangible personal belongings are taken away from him. He has just as definite conviction of ownership in one case as in the other.

The situation oftenest arousing jealousy is the arrival of a new baby. The toddler has been led and even encouraged to regard his mother as his own personal, exclusive mother, belonging to him in a sense differing from her relationship to anyone else in the world. He cannot help being bewildered and resentful when a little crying, red-faced, uninteresting intruder seems to step into his place and rob him of his "very own truly mother." This is an illustration of the wisdom of guiding the interest of the awakening mind and emotions away from the personal. The child who is interested in events and what people do, rather than in the relation of persons and events *to him*, is far less likely to experience personal resentments and jealousies. He will be so interested in what is going on that he will not take much notice of the necessary absence of small accustomed attentions.

Of course the wise parent will have forestalled any such reaction by bespeaking his cooperation and help and emphasizing the fact that it is "our baby," whom we must all care for with equal sense of proprietorship and responsibility (Fig. 157). *This does not leave the toddler out of the drama; it gives him a part.* This is his right as a member of the family; it is his right from the standpoint of profiting by an educational opportunity. This greatest of human events should be made as "complete an experience" as is possible at his stage of maturation. To let him have but a fragment, and that tinged with discomfort and a withdrawal of accustomed show of affection, is to confuse him and injure his personality.

Jealousies between children over sharing possessions and parental attention can be overcome by scrupulous fairness on the part of adults and by the persistent effort to lead children into impersonal attitudes. Obvious favoritism indicates to the child that the parent cares more for the child to whom he gives the biggest piece of cake. This is what he really resents. When the solution is checked up to the children themselves, the parent presenting the evidence and acting in a strictly impartial judicial capacity, children can settle situations for themselves much earlier and much oftener than we commonly realize.

Rage, Anger, Temper.—The primitive emotion of rage or anger has been discussed on pages 426, 449. Like fear, anger may be said to rise out of the undifferentiated emotional matrix through the stimulus of thwarting situations. The stimulating situation in the case of fear is the near approach of pain, discomfort, or danger to oneself or to a dear one, or the imminence of danger to cherished possessions, etc. The subject feels thwarted or unable adequately to meet or prevent the threatened injury.

The stimulating situation in the case of anger or resentment is one that prevents or thwarts the realization of an immediate goal. Fear may pass over into anger when escape becomes impossible, escape being the immediate goal sought.

The child who has been burned is terrified and runs away if threatened with a hot poker; while a child who wants very much to play with matches and set fire to a pile of leaves is angry and resistant if the matches are taken away from him. The child who is chased by another child with a hot poker may be both afraid and angry. He is afraid of the threatened pain and furious because his goal of safety and comfort is threatened.

Rage, anger, and temper tend to be aggressive emotions and are more common to the extroverted than to the introverted type of child. The extrovert expression takes the form of attack and resistance, while in the introverted child anger may take the form of smothered resentment, sulkiness, or brooding.

Thwarting that provokes anger may take the form of restraint of freedom, as when an infant's hands or feet are held, or a toddler is dragged into the house by an adult; or the thwarting of one's right of possession, as when one child takes a toy belonging to another. One's code of justice or mores may be thwarted, as when an older child brings Daddy's slippers although this rite has belonged to the toddler. The thwarting or injury may be to one's personality, as when someone jeers at Mary's red hair or Eddie's modest family car. Teasing and nagging from adults or larger children arouse justifiable resentment and may precipitate emotional explosion because of maturational inadequacy to cope with the humiliation of the situation.

The reactions, like all physical reactions, are protective or corrective. The small child struggles and screams. There are marked organic adjustments to the situation (as described in Chap. XI under Adrenal Medulla). Under the stimulus of "emergency energy," the child is literally forced into activity. This energy must have release. The more drastic the child's sense of thwarting or injustice, the more intense is the energy charge in the nervous system. To struggle with a child who is stimulated by a surplus of adrenin in his blood stream is to add fuel to the fire; it is literally to sit on the safety valve. *He is physically (chemically) unable to relax or come out of his anger tension until his energy charge has spent itself.* When both parent and child are suffering from "adrenin intoxication," conflict may continue until the child is exhausted, and often the parent has committed excesses in punishment that appall him when he "comes to himself" and views his conduct in retrospect.

The more helpless the child, the fewer avenues he has for expenditure of his emergency energy and the more likely he is merely to have a tantrum of screaming accompanied by slashing, pounding movements of the whole body. Such children in a paroxysm of helplessness and fury will beat their own heads against the wall or the floor, tear clothing, and break and throw manipulatable objects. (Adults are known to behave in a similar manner at times!) Children who are continually subjected to thwarting that provokes anger reactions may become subject to tantrums and habitual negativism and establish habits that may distort the personality permanently.

Dr. Florence Goodenough in a published study, *Anger in Young Children*, reports that overt manifestations of anger appear to reach a maximum during the second year and that as age advances the anger reaction changes from explosions of violent, undirected energy to relatively purposeful behavior. It will be noticed that the peak of anger coincides with the peak in negativism (see page 526) and that this is the period during which language development lags behind activity and new experience. After-reactions such as sulkiness and resentment increase with age. Dr. Goodenough discovered that overt reactions were of short duration. Among 1,878 outbursts, fewer than one-third lasted as long as 5 minutes. Another significant observation was that children suffering from colds, constipation, or other deviations from health showed increased anger reactions. There was also positive correlation between the incidence of previous illness and frequency of anger reactions. Children were most prone to anger shortly before meals. Also, the greater the number of adults in the family, the more easily the child showed anger.

Dr. Goodenough concludes with the following suggestive remarks.

A subjective judgment of the total home situation secured by a consecutive reading of all records for each child leads to the conclusion that the control of anger in children is best achieved when the child's behavior is viewed with serenity and tolerance, when the standards set are within the child's ability to achieve, and when these standards are adhered to with sufficient consistency to permit the child to learn through uniformity of experience, without such mechanical adherence to routine that the child's emotional or physical well-being is sacrificed to the demands of an inflexible schedule. However, when departures from the established schedule are made, they should be determined by a recognition of the needs of the child and not simply by the convenience or mood of the adult in charge. Self-control in the parents is, after all, likely to be the best guarantee of self-control in the child.[1]

Revenge.—Extreme anger reaction takes the form of revenge, or retaliation, which may be immediate and overt or repressed and delayed. The introverted, repressed child, in particular, may quietly plan retaliation for injury, which he easily rationalizes as justice. If Johnny breaks his wagon, it appears to him only fair for him to watch his chance and, without danger to himself, "get even" by breaking Johnny's train of cars.

Many criminal acts of adults doubtless arise from early conditioning of this type. The personality may become so distorted by the habitual emotion of resentment that one may feel that all society is against him. Such a person is permanently negativistic and forever on the defensive. The child who is teased, "picked on," and tormented because he is sensitive or peculiar is at an insuperable disadvantage in his family or in society, and he may "take it out on society" during all his later life.

Cruelty.—Young children, because of imperfect coordination and lack of experience, handle animal pets just as they handle animal toys and dolls. Sometimes a sturdy child inflicts pain and actually tortures a defenseless kitten. Dogs and cats, moreover, will endure surprising maltreatment from young children. With the rise of awareness of others, the child should learn to avoid inflicting pain, and he will if his environment is normal. He requires time, however, in which to become aware

[1] Goodenough, Florence L., *Anger in Young Children*, pp. 248–249, University of Minnesota Press, 1931.

of the difference between pulling the petals from a flower and pulling the wings from a butterfly or pulling the tail or ears of a cat. He must, especially, live among people who are kind to each other and to animals, and who do not permit the child to inflict pain upon living things. An instance of misguided judgment of a common type was that of the mother of twins, one of whom bit the other frequently as they shared the same carriage. When they reached the age of about eleven months, the mother had the brilliant idea of making the put-upon twin able to defend herself and teach the rowdy "how it felt." She, accordingly, held the fist of the biter to the mouth of the bitee. The one net result was that the pair chewed each other alive until they were five or six years old. The child cannot comprehend the meaning of suffering in other living things until he reaches the dawn of socialization (see page 561). Animal pets must be protected from him and he must first learn humane treatment through imitation of the conduct of others.

Destructiveness, like other persistent antisocial behavior, is much more easily prevented than cured. Two reasons predominate in creating definite destructiveness in the normal child. The first is the character and care of his play material. Flimsy, commercial toys literally "fall to pieces." They are made to last only until the sale is consummated. In the household in which this type of play material is permitted to predominate there is usually no thought given to the orderly care of the child's possessions, and he cannot acquire configurations and action patterns for respect and care of play materials. The other reason, especially for older toddlers, is the lack of interesting occupation. As the child's curiosity and activity increase, it becomes much more interesting to take things to pieces than merely to look at them and handle them quietly. Playthings should be made to be taken apart. The greed to "see the wheels go round" is a hunger as gripping and as essential and natural as that for food or air.

As in the case of any other undesirable behavior, nothing is gained by scolding and punishment. New and proper configurations must be created by providing motivation and outlet, and, as always, the child must be given *time* in which to make adjustments.

Lying.—Parents constantly consult specialists in the hope of obtaining formulas that will answer two insistent questions: (1) "How can I make my child *mind?*" (see page 227); and (2) "How can I cure my child of *lying?*" To the average parental mind a "lie" is any statement that deviates in any particular from the truth, the whole truth, and nothing but the truth. It does not occur to the parent to examine his own conduct by this rigid criterion; yet the average parent, by the same criterion, lies many times to his child.

Imaginative lying has been discussed on pages 229, 454. The child should be permitted to pass quietly through the period during which he is becoming able to discriminate between the real and the imaginary. He may happen to overhear someone relating an experience with a strange dog on the street. A big black dog is impressively described who tore a hole in a woman's coat. This may be dramatically repeated by the child when he goes to visit his grandmother the following day, except that the child in all seriousness says, "A big, big, dog, *black* dog, bit hole in Johnny's coat." He may insist upon the truth of the story and may repeat it to several others. He instinctively visualized himself in the situation and for him this relationship leaped into reality.

Nothing is gained by confusing the child with emphatic correction which implies that he should not have said what he was impelled to say. Experience seems to show that the adult may possibly help the child to some extent by quietly remarking "Was it *your* coat really, or was it Mrs. Brown's coat?" or "You're just *playing* that it was your coat, aren't you?" There should be no rebuke in the tone; and if the child insists that it *was* his coat, it is better to accept the tale without further comment.

Deliberate misstatements by the very young are usually born of fear of punishment and may become so set in the configuration of the child's personality that he will continue to shirk consequences throughout life. The somewhat older child learns to lie to obtain what he wants, particularly if the parent lies to him, and especially if the child is unnecessarially thwarted. A two-year-old was given two bananas and told to take one to his brother upstairs. He was heard to stop, just out of sight on the stair landing, where he industriously crammed one banana down his own throat and when the mother found him with the other one in his fist, he virtuously declared he had given the first one to Fritz. The mother dispensed justice by requiring him to take the remaining banana, under escort, to Fritz, and was wise enough not to deliver a moral lecture to the little, completely unmoral primitive, who was really a normal, delightful child.

Lying, like every other behavior, must be analyzed in the "total situation," and should be managed according to the basic motivations of the act. If a child is dealt with truthfully and fairly, there is little danger that lying will become a habit. He can safely be permitted to pass through the experimental phase when he *is finding out what truth is* without preaching, nagging, or punishment. Some children go to the age of four or five years without discovering that it is possible to give any other than a truthful answer, then suddenly discover that an "expedient" answer may be very useful. Other children learn very early to give the answer that seems likely to produce the pleasantest results. One needs to remember that the child at this age is completely unmoral and that he cannot think in terms of "the common good," *e.g.*, why social security depends upon common trust! He must learn truthfulness from his social atmosphere, from imitation of family example, and from the unconscious acceptance of clearly worded precept, which is so administered that it appeals to his sense of fairness.

Disobedience.—Under the theory of development and behavior adopted in this text there is no place for the term *obedience* in any sense other than its accepted use in the world of adult relationships. The child should, from the hour of his birth, learn to conform to certain situations and to accept authority. The child who has not developed protective reactions through unwise management tends usually to be cooperative. He will incline to respond to the requests and desires of others when these do not run too violently counter to his active interests and desires. When he must conform against his will, quiet, impersonal inflexibility will eventually bring acceptance of mealtime, bedtime, and all necessary conditions. The commonest mistake that parents make is in permitting an attitude of resentment and even anger to develop within themselves. The parent who knows and remembers that the child is reacting in the only way in which he can react at his particular maturation level and to the particular situation, and who can preserve an impersonal attitude and not treat the child as if he had committed a personal offense toward the parent, is the parent who will have the best control of the child and who will most effectively help him eventually to gain control of himself.

It cannot be too frequently reiterated that all relationships with the child should be friendly, impersonal, and free from violent emotional content. The adult who can remain friendly with a child who is doing violence to the adult code and making trouble for that adult, and who can at the same time keep the child in control, is the person who will have a constructive influence upon the character development of the child and will really affect his conduct favorably. This is the one who will command that much-vaunted "respect" which is a fetish with many adults. The natural and inevitable reaction of a child to anger and blame in an adult *is withdrawal from the faultfinder.* It is true that the child may acquire a protective avoidance of the act that provoked the displeasure and punishment; *but the reason is bound up with the disciplining person,* and it will be more difficult for the child to acquire a correct perspective and understanding of the situation because the adult has introduced the distorting element of personal disapproval, pain, and fear.

Discipline and Punishment.—Punishment, in the sense of inflicting painful consequences unrelated to the act, has no place in an organismic philosophy of development and training. There is no use in beating a vine for growing across a window which *we* desire to have clear. There is no use in bruising the flesh of a child because his growth urges have impelled him to do something contrary to adult convenience. One may train a bush or a child to grow in artificial form, but it is better artistry only to assist both to achieve their respective patterns in full and complete measure.

It is not necessary to inflict pain upon a child in order to lead him to adapt to his environment. *His maturation drives take care of this.* For example, his urge to share in household activities is the expression of his active adaptation to environment. This urge presents to the mother a golden opportunity to help him establish attitudes and habits of adaptation. If she does not understand this and punishes him for getting in her way and possibly dropping a dish he is placing upon a table, conflict and misunderstanding and resentment are needlessly engendered.

Punishment is a word that should be dropped from civilized human language, certainly from the vocabulary of child development. Discipline, or "direction," has a somewhat better sound if used in a proper sense. The child meets discipline in the sense of adaptation to reality, from the hour of his birth, when he must conform to an inflexible feeding schedule. Adaptation to reality means "complete experience" and constant assistance in forming accurate logical "configurations" of cause and effect (see page 455). It is a question whether disciplinary measures that are not causally related to the act produce any constructive effect.[1]

It is a question whether the mother who slaps hands while she says "no, no," to the inquiring child has made her bric-a-brac safer than has the mother who holds the object and lets the child examine it, then says "Mother hold it; baby, no, no." The former mother is likely to think that she has succeeded because the child *eventually* stops meddling. The child of the second mother stops meddling just as soon or sooner, and her child knows something about the qualities and handling of bric-a-brac which the first child does not. The first mother does not know that her child simply grew or matured beyond the meddling phase. Still less does she realize that the outstanding effect of her discipline has probably been to cause her child to seek satisfaction of his interests *when she is not looking*.

The policy of complete experience (configuration psychology) involves helping the child to see and even experience in some measure all the consequences of every act. If he goes upstairs, he must come down. If he climbs a ladder that has been left against the garage, the mother, no matter how much fortitude it takes, should quietly stand by and encourage and, if need be, insist that the child come down entirely by himself. The child should not be made nervous or frightened, and the mother should stand where she might catch him if he were to fall, but she

[1] MILLER, MARION M., *Our Children*, Chap. IX, Discipline—Old and New, Viking Press, Inc., 1932; and "Parents and Discipline," Institute of Child Study, *Publication* 17, University of Toronto Press, 1940.

should not say "Don't be afraid, I'll catch you" (unless to a very small child). He should realize fully the difficulty and something of the danger involved in the act. This is more effective in preventing repetition than spanking or scolding (see Fig. 158).

A two-year-old, finding the icebox door open and a number of round red tomatoes lying on a shelf, had a joyful moment throwing these right and left. The mother felt like scolding, possibly like spanking. Fortunately she was fair-minded enough to consider that the child had simply done what he had learned to do with red balls—throw them—that she had betrayed him to tempta-

A *B*

Fig. 158.—*A*, David (32 months) was found on the ridgepole of the garage; he came all the way down safely by himself; *B*, Virginia (18 months) was discovered at the top of a 16-foot ladder; she came down safely. The safe descent was the most thrilling part of these adventures.

tion by leaving the door open, and also that, after all, there was little likelihood of repetition. In order to make the experience educational, however, she did ask him to help her put them back, explaining the difference between balls and tomatoes, that the ball was "his," while the tomatoes were "mother's," and that mother kept her red balls in the icebox. The experience was completed by reminding him that *when things were thrown, somebody always had to pick them up*—"Baby throw; baby pick up."

There is little danger of this child's repeating this particular act, although the memory span of the two-year-old is short and he may completely forget the "lesson." Through organic "transfer of training"[1] he may possibly think in similar situa-

[1] Whipple, Guy, in the *Twenty-seventh Yearbook of the Society for the Study of Education*, Public School Publishing Company, 1927.

tions, "Does this belong to mother or to me?" Another thing that may occur, however, is that when the grocer delivers some tomatoes a few days later the mother may find the toddler industriously storing them away in the icebox, even if he must climb on a chair to open the door.

The habit of generally cooperative response, which is the highest type of obedience, is established by observing several principles in management.

1. Be certain that the child understands what is expected of him, and remember that his memory span is short and that requests must be repeated.

2. Request rather than order; encourage the idea that he is doing the thing because he wants to do it, or at least of his own free will, rather than because he must.

3. Show quiet approval of cooperation, but of the act, rather than of the child. Say, "That was a great help to mother," or "You did that well," rather than "You were a good boy." It should never be forgotten that the less the child thinks of himself as "good" or "bad" and the more he thinks of the meaning of the situations, the better rounded will be his character development. He should learn to do things *because they should be done and because it is interesting to do them,* rather than because doing them brings praise to him. The insistence should be upon the thing rather than upon the child. Emphasize *going to bed,* all boys *go to bed,* boys must *go to bed,* rather than *you must* (give up and) go to bed.

4. Do not be a tyrant bent on forcing the child to acknowledge that the parent is "boss."

5. Insist only on essentials. Do not place yourself in the embarrassing situation of commanding a child to do something that is actually not important and discover that you must weaken discipline by permitting disobedience or enter upon a devastating conflict with the child, leaving him with a smarting sense of humiliation and injustice.

6. Take cooperation for granted. A firm expectation disarms resistance. The mother says, "Johnny, I've told you six times to put away your overshoes. *Are you going to do it?*" Just then father comes in and says "John, put away your shoes!" and Johnny has started for his shoes before his father has ceased speaking. It is very likely that Johnny has been spanked by

his mother oftener than by his father. He simply knows which one expects obedience.

In general, clearness, fairness, firmness, and friendliness will produce a cooperative, independent, responsive, and helpful child.

Other Problems. *Change of Environment.*—When young children are taken on journeys or visits, or are moved to a new home, considerable attention should be given to the mental-hygiene aspect of the situation in the case of the toddler. First of all, the regularity of his life should be conserved at all hazards. His food and sleep routine cannot safely be disturbed. Secondly, he must be protected against confusion and bewilderment and fatigue. Pains should be taken to provide him with favorite playthings, and adults must restrain themselves from impatience with the child because of their own fatigue. His questions should be answered and the transition should be made as quietly and as naturally as possible. The entire experience should be made a pleasurable adventure to him.

Unavoidable Shock.—When a young child is exposed to the sight or experience of violence in the form of accident or catastrophe, such as a fire, an automobile accident, or personal injury, the mental shock may be serious and lasting. Every effort should be made to obliterate the memory. He should not hear the matter discussed. The excitement of adults communicates itself very directly to the child. His questions should be answered but in the least terrifying terms possible and with a calm, nonchalant manner. As soon as possible, transfer the child's interest to some absorbing activity. Especially see that the child goes to bed and to sleep with pleasant images in his mind, and that he is fed regularly and that his mind is pleasantly diverted while he eats.

If the experience has conditioned fear in relation to trains, automobiles, or other commonplace objects, reconditioning will need to be skillfully done. The original impression should have faded as much as possible before the child is brought into contact with the source of fright. The first contact afterward should be strongly associated with something pleasant. The child must not be forced into a situation that terrifies him—such as getting on an elevator if he is afraid of falling, or into a car after an accident. The child's cooperation must be secured, and it is easy to perpetuate an antagonism by too much coaxing and insistence.

Death.—When a familiar associate dies, or a pet dies, the necessity arises of trying to explain death to the child without creating shock and grief. In the case of death in the family, great control should be exercised and the young child should be spared contact with the evidences of violent grief on the part of elders. *Sleep* is about the only word possible to use with a child in explaining death, but this must be done guardedly. One child was made afraid to go to sleep himself after such an explanation.

Fortunately, the customary drama and pageantry of the funeral ceremony soften the impression and color memory for the child. Also, normally, children—owing to their primitive physical and social maturation and short memory span—bear separation from familiars very well. Few normal children grieve over the absence even of the mother, provided that they are made comfortable and their established regimen is not disturbed.

In the case of children who do not yet talk, quiet disappearance of the dead kitty or bird, with a casual attitude and substitution of new interests, is the best method. From the questioning age on, frank explanation with dramatic burial ceremonies will meet the situation when a pet dies; and such a child may be taken to a family funeral if it can be managed casually and if the music, flowers, and beauty of the occasion are emphasized. Whatever is told to the child should be in his own vocabulary and within his comprehension, and without emotional coloring.

Left-handedness.—So much uncertainty exists at the present time as to the cause and results of left-handedness in children that it would seem to be the part of wisdom to let the left-handed child alone, at least until there is evidence of more complete agreement among psychologists as to proper method of training, and as to whether it is necessary or desirable to try to change the natural inclination. The child who is harassed and constantly disturbed in his thinking and activity by being urged to "use the other hand" is subjected to nervous strain and irritation. There is evidence that this may even cause nervous tics (jerking of certain muscles of face or body) and stammering and stuttering. It is true that occasionally naturally left-handed persons do establish the use of the right hand without obvious injury. The proper method of doing this and the means of preventing undesirable effects are uncertain at the present time.

Adoption.—Every suitable "childless" home should absorb, not one, but several "homeless children."[1] Foster children should be obtained from a first-class child-placing agency that is scrupulous and discriminating in the matters of investigating the heredity and health of the adopted child and in the selection of a home for the individual child. The matter of explaining the situation to the foster child is a perplexing one. No child should grow up in ignorance of the fact that he is an adopted child.

One family of the author's acquaintance told their first adopted child a here-and-now story of how they "wanted David," how they "hunted for David," and went to look at this baby and that baby who "was not David," and finally, how they "got clothes ready, and toys ready, and a tub ready, and a basket ready—and took the basket and went to a big town and—found David, and brought him home in the basket to be their little boy." The child never tired of the repetition of the story, and asked a question now and then, as he grew older, until he quite understood the situation. A poignant moment occurred when David was getting the matter of childbirth straight in his mind. "Then, mother, you didn't borned me?" "No, David." After a pensive moment he said, "I wish you had." Questions, especially questions the full answer of which would go beyond the child's understanding and experience, should be answered very simply and the explanation should *not* go beyond the child's maturation level.

In the instance given, the adoption of a second baby was a glorious event to David, equal in glamour and thrill to the arrival of any "really, truly" sister.

In general, any normal or necessary experience can be made satisfying to the judgment and reason of the child. His person-

[1] Gallagher, Eleanor Garrigue, *The Adopted Child*, The John Day Company, 1937; Gesell, Arnold, *Guidance of Mental Growth in Infant and Child*, Chap. XIII, Reducing Psychological Risk in Adoption, The Macmillan Company, 1930; Gagliardo, Ruth Jane, "We Wanted Children," *Parents' Magazine*, May, 1937; Sargent, Helen D., "Is it Safe to Adopt a Child?" *Parents' Magazine*, October, 1935; Norris, Kathleen, "Adopt That Baby," *Ladies' Home Journal*, April, 1930; Jenkins, R. L., "On Adopting a Baby," *Hygiea*, December, 1935.

ality should be protected from grief, bewilderment, and shock without giving him untrue or distorted concepts.

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CHAPTER XXXII

CULTURE AND ART IN THE YOUNG CHILD'S LIFE

We prevision our growing boy or girl as a cultured man or woman who perhaps above everything else finds himself at home and at ease in all the varieties of situations with which life presents him and with all people with whom day by day he rubs elbows in lesser or greater intimacy. . . . All the little common daily communications between parents and children become potent cultural impacts.

—MALCOLM MACLEAN.[1]

There is great practical importance in the question whether it is simpler and easier to bring about changes in the personality by direct attack or by modifying the cultural pattern surrounding the personality. —JAMES S. PLANT.[2]

The security of our civilization rests safely only to the extent to which we help to fashion new human-power to carry on with a wisdom which is born from a sensitivity to balance. —ALBERT CHRIST-JANER.[3]

Man is an image of God only when he continues the creative work of God. —FRANZ CIZEK.[4]

The development of expressive power increases sensitivity, sharpens the perceptive faculties, makes the creature more alive to the world. An ability to express oneself is in itself important to happiness. . . . It becomes apparent, then, how desirable it is to cultivate the natural sensitivity and freedom of expression the child possesses—to cultivate them not as training for a special field but as an enriching of personality extending into all fields. —GRANT WOOD.[5]

Richer than I you can never be,
I had a mother who read to me..
UNKNOWN.

Children speak naturally in a form that we adults are accustomed to call poetry; and without any searching for appropriate use of the medium. That is because their minds are wholly intent upon

[1] "The Parent as Cultural Impact," *Child Welfare Pamphlet* 70, University of Iowa Press, 1939.

[2] *Personality and the Cultural Pattern*, p. 24, The Commonwealth Fund, 1937.

[3] "Art in Child Life," *Child Welfare Pamphlet* 71, University of Iowa Press, 1939.

[4] *Child Art and Franz Cizek*, p. 36, The John Day Company, 1937.

[5] "Art in the Daily Life of the Child," *Child Welfare Pamphlet* 73, Iowa University Press, 1939.

> *something real within them, the language is instinctive and really of secondary consideration; they fashion it to the significant form exactly as other artists handle their mediums, swiftly and without disturbing thoughts of standards outside themselves. The child poet—without ever knowing that he is a poet—"weaves to his song the music of the world and of the clouds."* —HUGHES MEARNS.[1]

Culture and the Home.—"Culture" means the state of having been "cultivated," made to grow. When we speak of the culture of a plant, a person, or a group, we mean the degree of development attained by the plant, the person, or the race in question. In accepted social usage a person or a group is said to be "cultured" when a high degree of educational, scientific, social, and artistic development has been attained—an attainment reflected in the daily pattern of living of the individual or of the group. The outstanding characteristic of the highest human culture is gracious, creative living. Worldly success and mechanical and artistic skills do not in themselves constitute culture, although this is a commonly accepted belief. The child becomes "cultured" primarily in the home and only secondarily in galleries and schools of art.

Every parent would say he desires his child to become a cultured adult. Too often he thinks the way to culture lies only in formal instruction in art and literature and in lip familiarity with the contents of galleries and the programs of the opera. Parents and prospective parents would do well to realize to the fullest extent that culture lies in gracious nuances of living within the family group, which can be made free to all without money and without price, and that essential beauty lies all about us if we have eyes to see.

> Culture has two aspects: the acquisition of skill so that one can create, and the development of taste so that one can discriminate. Rather they are two closely bound-up strands of the same process. . . . In the average family, the home still remains the determinant in setting the standards of aesthetic appreciation.[2]

Many of us parents have a struggle to exert any cultural impact upon our youngsters in the art field because we ourselves were brought up

[1] *Creative Power*, p. 75, Doubleday, Doran & Company, Inc., 1927.

[2] BLATZ, WILLIAM E., *The Five Sisters*, Chap. III, The Habit of Culture, pp. 79–80, William Morrow & Co., Inc., 1938.

generally with a whole set of wrong attitudes about art. We were conditioned, for the most part, to think that it hung on the walls of galleries or sat forever still on the shelves of glass museum cases. . . . Now the best that we can do is learn for our own and our children's sakes that art is all about us all the time. That it lies in the ties and clothes and hats we wear. That it is in rich color and the fine design of our dinner plates and kitchen ware and coffee pots. That Greek vases and jars and Ming bowls were the butter jars and the wine jugs of an older people.[1]

"'Personality' covers a developing, changing phenomenon which is 'all' of the mental life of the individual at any given moment."[2] The mental life of the child unfolds within his environment and forms a unity, a field, a configuration with it. The cultural pattern of the home determines and sets the attitudes and trends that will mark the cultural pattern of the individual. "As the twig is bent" applies in this connection quite as truly as in any other. Parents must be, inasfar as they can, what they want their children to be.

After all, personal culture is naturalness—growth that is free from strain, artificiality, or distortion. To the true artist beauty is intrinsic in the structure of the universe. Appreciation of beauty is the most natural thing in the world. Angelo Patri says "Teach children to be easy. Show them how. Move with ease. Talk with ease. . . . Be easy." What a pleasure it is to go into a home in which there is an atmosphere of ease; where no one is unpleasantly on the defensive; where each one can be himself; where there is mutual respect, resilience, and good humor; where there is simplicity and order. Such a home is a cultured home, no matter what may be the economic or educational status, or technical accomplishment in any of the arts.

The secret of fostering the poise that characterizes true culture (perfect naturalness) lies in the day-by-day promotion of impersonal attitude and capacity for perspective, which has been discussed in earlier chapters, and in the feeling of complete security and "belongingness" that inheres in the unique bonds of

[1] MacLean, Malcolm, "The Parent as Cultural Impact," *Child Welfare Pamphlet* 70, p. 13, University of Iowa Press, 1939.

[2] Plant, James S., *Personality and the Cultural Pattern*, p. 71, The Commonwealth Fund, 1937.

family affection. MacLean thus describes the poise of the truly cultured individual:

> He may fit thus easily with a graduate dean or a plumber, an artist or a vacuum cleaner salesman, a small child or a grey haired grandmother. He approaches his problems with courage and sense instead of with fear and superstition, whether these problems be in the area of his own personal life and its integrity, in his intimate human relations with other members of his family, in the handling of his biologic needs and drives, in his activities among all the powers and gadgets of modern industrialized and mechanized civilization, in art or music, literature or religion, or in his widest sensitivity and activity in community and broader civic, economic, and political relationships. We want him balanced in these things, not extreme.[1]

Setting the domestic stage for cultured living is only the first step in the organic integration of personalities to form a family. It is easy to say that parents should be what they wish their children to become; actually, this sets up an impossible ideal. For one thing, the parent who should find himself ready to say "I *am* what I wish my child to be" would be an intolerable prig and an imposter. The closest possible approximation is for all members of the family to strive together with tolerance to achieve a cultural way of life which they all seek with a common desire; to live together with complete frankness and complete respect, and with affection deep enough to withstand the scratch and sting of the inescapable irritations of daily life. Families in which complete honesty and naturalness prevail withstand great stress and strain without dissolution; in fact, like the mountain pine, the winds of adversity cause them to shove their roots the deeper into the soil of their common life.

Art and the Child.—The child incorporates in the field of his personality some response to every experience he encounters. The expression of any vivid experience, real or imagined, is art. Every child is an artist. He has the same natural impulse to dance, to sing, to draw, to drum and whistle and twang that he has to build or dig, or run and climb. He makes all available mediums his own as outlet for his rich, vivid creative impulses. The role of the adult is to refrain from inhibiting this spontaneous outpouring of creative urge. It is significant that artists such as Franz Cizek in Vienna, for whom all children draw, and Hughes

[1] MacLean, *op. cit.*

Mearns of New York, for whom all children write poetry, have first to "release" the creative urge, create an atmosphere of ease and naturalness. It is a rare child who does not become artificial and inhibited in expression at a very early age.

Art expression is a form of social language. It is a communication of inner thoughts and feelings conveyed through forms, colors, textures, lines, and juxtapositions to fellow creatures. It becomes the person's expression of an attitude. It is a young child's naïve expression of his attitude toward the world he lives in.[1]

To force our own concepts upon children of this age is to suppress them, to kill their imagination, their spontaneity, to take away their creative ability.[2]

The average child . . . lives a great deal more vividly than the average adult. He is more sensitive, more alive to his environment. Worry and distractions do not keep him from getting the sap out of life as he goes along. The simplest incident in his world is a vivid adventure. He extracts infinitely more, in proportion to his equipment, out of the ever-changing drama of immediate experience than does the average adult.[3]

Young children should have the imagination fed by exposure to the beauties of nature, exposure to beautiful sounds, colors, forms, and rhythms. They should, at the same time, have access to art media, and then they should be let alone and given techniques only as they ask for them. Franz Cizek, Grant Wood, Hughes Mearns, and all artists agree that the child can reproduce only his own primitive, inner life at the level of the moment and that he should not be coerced into trying to produce what an adult sees in the situation or what the adult thinks the child should see. Madeline Dixon, out of a rich experience with preschool children, says:

We soon find that opportunities to make some of the child's less expressed ecstasies, curiosities, and fears articulate to himself seem to

[1] Kerr, R. N., "Art and the Young Child," *School Arts Magazine*, September, 1936.

[2] Cane, Florence, *Creative Expression: The Development of Children in Art, Music, Literature, and Dramatics*, Hartman and Shumacker, editors, The John Day Company, 1932.

[3] Wood, Grant, "Art in the Daily Life of the Child," *Child Welfare Pamphlet* 73, University of Iowa Press, 1939.

develop best through the media of music and painting and dance and dramatics. But, as we provide these opportunities through the arts for such young children, it must be with no goal of accomplishment ever in mind; with no premium on measurable results; with as little superimposing of our own ideas as possible, with no overt stimulation. We can help him with simple rudimentary skills, so that he has some use of efficient tools here as in mechanical pursuits. Beyond this, expression in the arts should be scarcely a step beyond play. The arts should be vehicles for his fancy, for his imagination, permitting continually greater and greater capacity for release, sharing and understanding among the children themselves. The arts must never exploit, any more than play must exploit. They should express for the child inherent needs and urges; they should be languages communicating his vague wonderment, and should permit, to some degree, formulation of those things not of simple definition.

I doubt whether the child exists who has not, somehow, a deep-lying need for this sort of exchange in his own level. Adults fail him here because they are too far away from the age of three, four, and five.[1]

Drawing and Painting.—The graphic arts preceded written language phylogenetically (see page 499); therefore, we expect the child (ontogenetically) to draw before he writes. We find the manner of using the pencil at the various age levels featured throughout the normative summaries (pages 639 to 643). Opportunity should be provided in the home for the child to use pencil and crayon, and to paint with the large, free movements that are natural to him. A wall blackboard provides a cheap and satisfying means of free-arm scribbling (see Fig. 142) and drawing with white or colored crayons.[2]

The homemade easel is an important item of play equipment (see Fig. 146). One roll of inexpensive newspaper stock will provide drawing paper for all the preschool years. A mother who dates each used piece and lays it away in sequence will have an interesting "graph" of the mental development of her child.[3]

[1] DIXON, MADELEINE C., *High, Wide and Deep*, pp. 4–5, The John Day Company, 1938.

[2] BOETTIGER, ELIZABETH F., *Children's Play Indoors and Out*, pp. 45–57, Picture Making, E. P. Dutton & Company, Inc., 1938.

[3] MCCARTY, STELLA AGNES, *Children's Drawings*, The Williams & Wilkins Company, 1924.

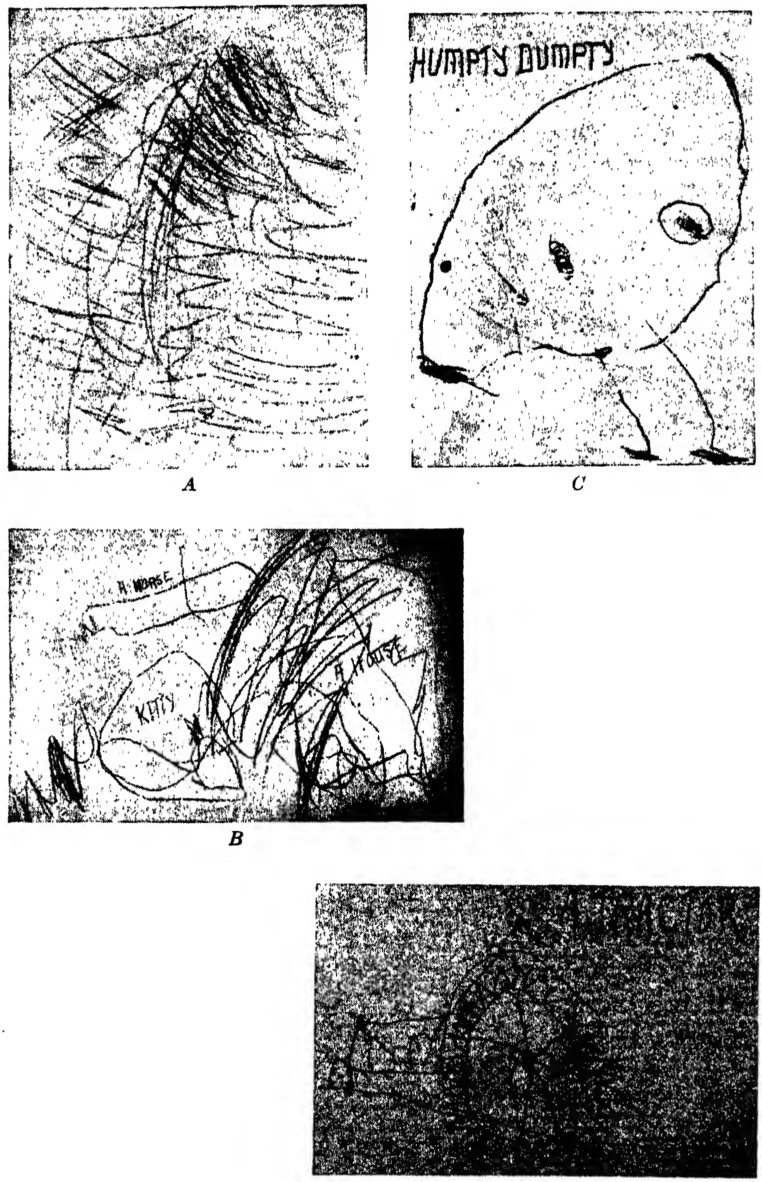

FIG. 159.—Childrens' drawings. *A*, formless scribble; *B*, decides he has made certain objects; *C* and *D*, draws purposefully.

At first the child scribbles for the sheer joy of movement (see Fig. 159 A). Later he decides that his scribbling is a house or a dog, through the chance resemblance of certain strokes to a chimney, a window, or the leg of a dog (Fig. 159 B). This is the symbolism stage, which precedes the stage of deliberately setting out to draw a house or a dog[1] (Fig. 159, C, D).

A *B*

FIG 160.—Johnnie (five years) and Betty (three years) undertake, from memory, to draw their house at the same time. Both draw three sides of the house. Betty puts door on wrong end and adds chimney in wrong place as an afterthought. Johnnie draws curtains at all the windows, adds the street number and smoke!

The primary colors in nonpoisonous water-color pigments or tempera can be purchased at small cost. These may be mixed in jars, and the row of colors with a jar for holding water and for washing the small brushes should stand in the tray of the easel. A pad of large sheets of paper thumbtacked to the easel and a small rubber apron hanging on the back of the easel complete the outfit.

[1] JOHNSON, BUFORD J., *Child Psychology*, p. 319, Charles C. Thomas, Publisher, 1932.

Finger painting, as developed by Ruth Shaw,[1] is a psychologically logical and delightful activity in which the paper is laid wet and flat upon a low table. With pastelike paints the child smears on his picture with his hands and without benefit of tools. The results are surprising. Children delight in the large, free manipulation without brush or pencil. The management is more complicated than that involved in mere drawing or painting, but it is well worth the attention of any mother having time to

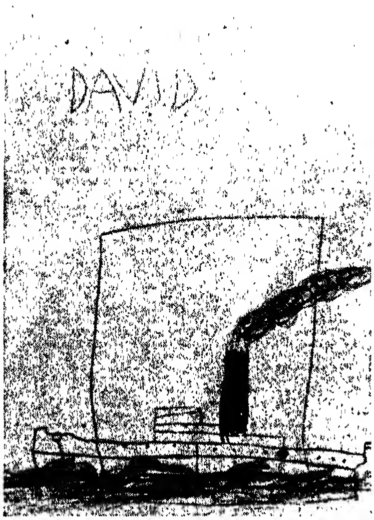

FIG. 161.—Five-year-old David had made a study of the structure of ships. Offhand he drew this picture with essential parts: sail, anchor, flag, portholes, waves—and smoke.

FIG. 162.—A delightful example of "essentials." Note the five fingers.

devote to it. The real finger paints may be too expensive or difficult to secure. Tempera pigments may be freshly mixed with starch paste to form a quite acceptable substitute.

No effort should be made to train or direct the child's use of graphic materials (aside from the orderly care of this as of all possessions). He will use media as he feels the need of coordinating eye and hand, and as an expression of his developing concepts of form, color, and movement.

[1] SHAW, RUTH FAISON, *Finger Painting*, Little, Brown & Company, 1934.

Plastic Modeling.—The natural craving to model creatively may be met in the home by providing a jar of modeling clay or a brick of plasticine, with an occasional orgy of creative activity in wet sand or a puddle of good, old-fashioned mud. The stage should be so set that the child may be allowed to make all the muss he wants to make while the "action" lasts. Then he should help, according to his age, in restoring things to order.

Fig. 163.—A finger painting by a three-year-old WPA nursery-school child.

Children follow much the same order in modeling that they do in drawing. First, the child enjoys handling the plastic medium as sheer movement. He pats and pounds, pinches off pieces and pounds them flat. Later, he rolls the pieces into balls; then, as in drawing, he decides he has made a plate, a cup, or a doll. Still later, he decides that he will make a cat or a horse, and he will achieve most of the essential parts (Fig. 164).

Music and Rhythm.—Dr. C. E. Seashore says the taproot of all music is the first understanding smile between mother and child, which develops eventually into audible, musical laughter. The infantile sounds develop inflections, modulations, pitch, volume, rhythm, and tone quality; sound for pleasure is the beginning of musical experiment and musical appreciation.

FIG 164A —Symbolism. Sharon, aged three, announced she had made a drum major with buttons on his coat.

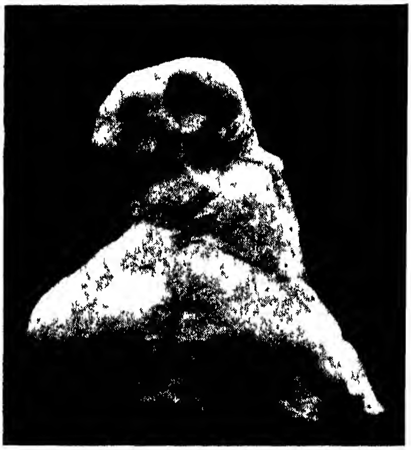

FIG. 164B —Symbolism "This is my mother, here are her eyes, here is her bosom, here is her lap."

FIG. 165.—Sharon and Eddie (four years old) dressed up in long skirt and in cowboy chaps. Each then modeled him and herself—not each other.

Thus the recognition and feeling of pleasure in sounds, and the power to make agreeable sounds reveals to the child an unfolding musical world. His whole organism responds to it. This is an element of musical feeling. . . .

Speech has the same art as music; namely pitch, loudness, time, and tone quality which result in such musical forms as inflection, rhythm, articulation, and vowel quality. The child is, of course, not conscious of any of these as such and yet under favorable circumstances will quickly develop beautiful speech which means that it is well inflected, well modulated in loudness, beautifully rhythmic, and rich and clear in vowel qualities. If the child has a good ear, instinctive liking for these aspects of speech will develop surprisingly early.[1]

It is an important feature in the cultural life of the family that all conversation and communication shall be carried on in correct and beautiful speech. Controlling the speaking voice, especially under anger or excitement, may be one of the first things to be considered by the parents who wish to establish a cultural and artistic atmosphere for the child.

Still, the child is a primate, who first loves noise as noise, just as he first loves formless scribble and pounds his plastic clay. He needs to shout just as he needs to throw and bang. He loves drums and horns and whistles (and who does not?). The parent should be able to make occasions and so situate the child, in cellar or attic, or out of doors (see page 536) that he may make all the noise he wants to—get it out of his system. The parent should calmly plan for this; otherwise, jangled nerves may betray her into competition with the noise and she may revert to the primitive by yelling at the child. If she is wise, she will resolutely try to give him the rich remembrance of having heard nothing from her but controlled and beautiful speech; at least, he should not have to hear habitually strident, high-pitched voices.

Along with, or alternating with, the need for sheer noise and primitive rhythm, the child will enjoy and should hear singing, piano, victrola, radio, etc. Always there should be music *for him*, keyed to his level of appreciation, simple songs which he may sing, rhythms to which he may skip or dance or march, and dramatic finger play and musical story which he may enact. Around and back and above him, as a vaguely appreciated background or atmosphere, there should also be good adult family

[1] SEASHORE, C. E., "Music before Five," *Child Welfare Pamphlet* 72, Iowa University Press, 1939.

music: personal performance, radio symphonies, victrola records, etc.

All the child's musical efforts, as well as other creative effort, should be spontaneous; he should have perfect freedom in interest and in response. It will be found that he requires color, line, movement, and sound, all and more, to give expression to the vigorous inner life that wells from the depths of his unfolding spirit.

The craving for pleasure in sound radiates through the sense of rhythm into graceful movements, the beginning of dancing and dramatic action, even from the crudest kicking and tapping movements of the infant. His speech becomes rhythmic, melodic, dynamic, beautiful. His whole body becomes reverberant in response to the sounds of nature. Laughter progressively acquires new and beautiful forms. Even crying may give satisfaction of an artistic sort. The swinging of the pendulum of the old clock on the wall is music. The patter of rain, the splashing of water have musical elements.[1]

Dr. Seashore thinks there should be no formal musical training before the age of five years. During these first years the child should develop pleasure in musical sounds, in singing, and in free manipulation of musical instruments. He must be expected to respond only at his natural level of motivation and achievement.

Dr. Harold Williams says that the child should be allowed perfect freedom in listening or in manipulation of material. Joyous participation should be encouraged, rather than precision of control.[2] In the pamphlet indicated, Dr. Williams describes various exercises in rhythm and primitive music appropriate for the very young child. In the chapter on Music Making in *Children's Play, Indoors and Out,* will be found excellent suggestions for the management of the musical experience of the young child.[3]

Storytelling and Literature.—The child begins to turn the leaves of books and to recognize pictures of familiar objects before he is a year of age. The natural thing is for the parent to talk to him about the pictures. Thus storytelling begins, and it

[1] *Ibid.*

[2] Williams, Harold M., "Musical Guidance of Young Children," *Child Welfare Pamphlet* 29, Iowa University Press, 1933.

[3] Boettiger, *op. cit.*

passes by almost insensible degrees from one-sentence stories, such as, "The boy has a red ball" or "The girl's name is Jane," to the colorful dramatizations demanded at four and five years of age.

Pictures and stories are the preschool child's textbooks and should be carefully selected as to character and comprehensive as to scope. The mother should give a great deal of attention to the art of storytelling. Stories and pictures do more than merely entertain the child, even at one year. Stories and pictures do much in atoning for any restrictions of his environment, and in shaping his attitudes and emotional sets or configurations. Therefore, pictures and stories should first relate to the familiar experiences of the child and afterward make him familiar with the more remote and casually experienced parts of his environment.

Thus, from pictures of cups, spoons, milk bottles, clocks, chairs, etc., as illustrated in the *First Picture Book*,[1] the child passes naturally to pictures (especially for the city child) of the cow who gives the milk, of the barn where she sleeps, the pasture where she eats grass, and so on endlessly, expanding the child's horizon as his thinking and imagination develop.

The "here-and-now" type of story, so delightfully developed by Mrs. Mitchell,[2] probably should always predominate, and should be so employed as to round out the child's experience and information in a symmetrical, educational manner, always following and capitalizing any immediate curiosity or interest on the part of the child.

Catherine Hood Sears relates delightfully her experience in telling stories to her four young children.[3] Her method with the youngest seems to be to talk along in simple "here-and-now" statements concerning whatever is going on. Episodes develop later into longer stories. "Mary Catherine gave Granny a flower; Granny said 'Thank you' "—later expanded into a narra-

[1] MARTIN, MARY STEICHEN, *The First Picture Book*, and *The Second Picture Book*, Harcourt, Brace & Company, Inc., 1930.

[2] MITCHELL, LUCY SPRAGUE, *Here and Now Stories*, E. P. Dutton & Company, Inc., 1923; and *More Here and Now Stories*, E. P. Dutton & Company, Inc., 1933.

[3] SEARS, CATHERINE HOOD, "How to Tell a Story," *Baby Talk*, December, 1939.

tion of the trip to the garden, the kind of flower, the visit of Grandma, etc. The graphic, clear repetition of simple experiences helps the child in speaking and in thinking. Mrs. Sears also says a story is better than an argument in negativistic situations, such as refusal to remove or put on wraps.

There is at present a rather active controversy relative to fairy stories and other traditional tales of the kind, with "Mother Goose" as the storm focus.[1] Most observers seem to agree that during the period of the active rise and ascendancy of imagination, the child needs make-believe stories, as he needs and employs make-believe play. This need and the observed appeal of fairy tale and myth are, doubtless, features of the recapitulatory experience of the child, who must repeat in his thinking, merely by virtue his primitive thinking mechanism, some of the phases of primitive culture.

The parent who is trying to follow the lead of the child's maturation will recognize the time to enter joyously, with the child, the land of make-believe. Fairy stories should not replace here-and-now stories. Probably nothing but "true" or "here-and-now" stories should be told to the child until he becomes able to make believe, and able to enjoy the improbability of the unreal and the fantastic.

The child who grieves over lost faith in Santa Claus does so in part because he is bewildered at having been taught two contradictory things as being true. No child should ever be told an untruth, certainly not deliberate, unnecessary untruth to the effect that there are giants, orges, and witches who eat up bad little boys (or a devil who will burn them alive). "The fanciful tale, when properly told, is one of the greatest integrators of life. Stories, of course, are for fun and fun is wholesome."[2]

At the proper stage, however, children gleefully enjoy the most weird, improbable, and fantastic tales of hair-raising escapes and experiences. It requires nice judgment and sympathetic contact

[1] Roylace, Elizabeth, "The Case for and against Mother Goose," *Children, A Magazine for Parents*, August, 1927; and Gruenberg, Benjamin C., *Readings in Child Study*, pp. 148–150, The Macmillan Comapny, 1926.

[2] Starbuck and Shuttleworth, *Fairy Tale, Myth, and Legend*, p. 9, The Macmillan Company, 1928.

with the particular child to know when (or if) and how often exciting stories should be told, even when the child fully realizes that they are frank unreality. Fairy tales, myths, and legends should be carefully selected for artistic validity and should be free from crude, vulgar, or cruel characters or action. By this criterion the Mother Goose tales would have to be used *selectively*. Many of them are good, even by modern standards, and have the virtue of having been "aged in the wood" of centuries of child judgment. A few of the tales in certain collections do not ring true artistically and are rather crude from the standpoint of cultural standards, as when Jack Spratt and his wife "lick the platter clean," or when my son John goes to bed with "one shoe off and one shoe on."

In addition to here-and-now and make-believe stories, we may add what might be called "diction" or "rhythm" or "nonsense" stories. Children of all ages enjoy jingling, alliterative, singsong, rhythmic sequences of words, which may not make sense at all. These probably have some value in training voice and ear, at least they "tickle the ear," and they appeal to the child's primitive sense of humor. This type belongs particularly to the time when the child is enjoying reiteration in speech and endless repetition in muscular movement, as in pouring sand from one cup into another. This is the period during which a story must be recounted word for word, with the greatest precision, and repeated over and over again.

Aside from the character of the story, the manner of telling is important. Starbuck and Shuttleworth say:

> Story telling is an art, and the art of it lies in its very artlessness and naturalness. . . . Keep the plot simple, the action swift-moving. . . . Paint pictures of what you see with bold, sweeping strokes and clear, bright colors. . . . Appeal to the senses, make the listeners hear the wind in the willows, the growling of forest animals, the heavy thud of Thor's hammer. Make them see the little white fluff of Peter Rabbit's tail as he scuttles to safety.[1]

In short, pictures and stories, even for the littlest child, should first be good art and good literature, even if only a picture of a red apple and one sentence. The storyteller should use clear,

[1] *Ibid.*, pp. 22–23.

correct, and forceful language, carefully adapted to the maturation level of the child.

In the second place, pictures and stories must hold the interest of the child. Stories may do this through purely sensuous auditory satisfaction in meaningless jingling rhythm, or by coordinating with his awakening delight in a world of reality, or by fanciful flight into a suddenly expanding world of joyous unreality.

In the third place, both pictures and stories should produce happiness and satisfaction in the child. Nothing should be presented to him that creates in him an actual sense of fear or revulsion, or that unduly excites him. The effect should be thoroughly wholesome to nerves and imagination.

Fourthly, it is inartistic and ineffective to "draw morals." If the child does not see the point, it is useless to call his attention to it and "rub it in." On the other hand, the behavior situations dramatized in storytelling should not focus upon or unduly emphasize undesirable social conduct, both for the reason that the child may be unable, from his limited social experience, to draw correct conclusions or see the situation in its true perspective, and also because it is education of the wrong sort to present to him definite action patterns for trickiness, violence, and crime. This does not mean that only sugar-coated, goody-goody mental pabulum should be given to the child. He must eventually come into contact with reality; and story, myth, and legend prepare him "painlessly" for some of life's realities. He should have vigorous, live, dramatic action, primitive and raw at times, in keeping with his primitive stage of development, but through all it should remain true to the life values we wish to have him accept.

Movement and Dance.—What the young child feels flows through him as a total experience with expression through all the muscular reflexes of arms, legs, torso, face, and throat. He moves with vigor, symmetry, and grace. He relaxes with complete abandon. He responds to rhythms as freely and as naturally as he breathes. It is a commentary on the artificialities of our social and educational conventions that older children and adults must be laboriously *taught* to sit, stand, and walk with ease, and must be *released* and *reconditioned* to use body movement as an art medium in dance or drama.

Show an infant something that gives him enjoyment and he crows, he flings his body around in his crib, his arms and legs beat up and down, his eyes glisten, his mouth waters, he becomes a little dynamo. Between four and forty enjoyment may have some of these reactions, but on the other hand it may have only a faint movement of the epiglottis as a reaction. This somehow seems impoverishing ourselves beyond all reason.[1]

Young children are primitives. They respond to drums, cymbals, bells, horns, and whistles by swinging the arms, skipping, jumping, leaping, and marching, all of which are phases of the dance. The child yields his body to the cadence of rhythmic sounds just as he draws, paints, sings, and models in the spontaneous language of each medium.

No attempt should be made to teach the child skills in movement until he feels the need for steps and meter, just as no one should teach a child skills in other arts until his interest indicates an appropriate developmental maturity.

The free grace and symmetry of movement of normal childhood should be preserved. Especially the child should be safeguarded against distortions and repressions of free natural movement. With the child reared in an apartment or in restricted space, or with too much restraint of behavior, there is little or no opportunity to run as far as he wants to run, to swing his arms, to whirl and leap. Free grace of movement cannot be acquired within any four walls. Space and freedom in which to move the body about that central pivot where back, legs, and pelvis meet is basic to the symmetry of movement which we call "graceful carriage." The child moves his body about this focus of normal action unconsciously. Modern dance teachers find that unspoiled children perform easily and spontaneously the techniques that older students must acquire with great effort.

The parent of the preschool aged child should expose him to space and freedom and to rhythm in percussion and music in order that he may enjoy movement to the full—find an outlet for the "ecstatic urges" of young energy and develop poise and grace. Because children sometimes exhibit fascinating spontaneous dancelike performance, parents may think the child has "talent"

[1] DIXON, C. MADELEINE, *The Power of Dance*, p. 135, The John Day Company, 1939.

and put him under the tutelage of a dance teacher. This is to curb spontaniety and "put the colt to the plough." Movement is now recognized as one of the most important of the mediums of art experience and expression. But art is life. All children are artists in that they live and breathe in and integrate with a world of color, harmony, form, and movement. Formalization of artistic experience into techniques and skills is to be undertaken with discrimination and with caution and seldom, if ever, imposed upon the preschool child.

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CHAPTER XXXIII

THE RELIGIOUS, MORAL, AND AESTHETIC TRAINING OF THE YOUNG CHILD

This Universe
Exists, and by that one impossible fact
Declares itself a miracle; postulates
An infinite Power within itself, a whole
Greater than any part, a Unity
Sustaining all, binding all worlds in one.

Paraphrased from Newton's *Principia* by Alfred Noyes.[1]

When you say that if I allow not in God the operations of seeing, hearing, observing, willing, and the like . . . you know not what sort of God mine is, I thence conjecture that you believe there is no greater perfection than such as can be explained by the attributes aforesaid. I do not wonder at it; for I believe that a triangle, if it could speak, would in like manner say that God is eminently triangular, and a circle that the divine nature is eminently circular; and thus would everyone ascribe his own attributes to God.

—Spinoza.

The Little Child's Religion.—Man has always created God in the image of his loftiest concepts of the universe, nature, and human relationships—at first, a God of magic powers who could create a world and people it in 7 days; a God of arbitrary human qualities, a "jealous God, shewing mercy unto those that fear and obey him" and "vengeance" unto those who disobey his "commands"; the God of a "chosen people."

Every race and every people has conceived a God, a Creator, a Force behind the universe. This seems to be an organic evolutionary compulsion. The dispensation of Jesus introduced a very humanlike and very personal God of Love whom human creatures accept and admire in theory, although they blunderingly go about showing intolerance, cruelty, and selfishness, each after his own pattern.

Modern science has enlarged the human concept of the universe and has entirely removed man from his former assumed position as center of creation and made him appear to be a very trivial,

[1] Noyes, Alfred, *Watchers of the Sky*, Frederick A. Stokes Company.

insignificant entity in a creation so immense that the highest thought of man cannot even faintly conceive of its bounds, but an entity partaking of the very essence of Creative Power itself.

Humanity is under the necessity at the present moment of "getting itself a bigger God," one who conceived and projected not only our humanity but possibly numberless humanities on countless worlds.[1] The modern scientist is not an "atheist"; he is of all people the most reverent, the least dogmatic, the most humble[2] (see pp. 51, 55). The modern scientist is entirely willing that each human being shall believe in his own concept of God and bring his children up in his own belief.

The child who develops naturally becomes filled with questioning, with wonder, and with awe as to the nature and origin of things. The watchful parent will not anticipate this by giving the child statements that he cannot understand—in an unknown tongue, as it were—but will meet the felt need of the moment with tactful and sympathetic information.

Religion, with children, cannot entirely meet this need for questioning the unknown and sounding depths; nor can any course of science suffice. Each child must plumb vastness and infinity. Let him call it what he will—fire, water, death, God, worlds, stars. And somehow he must share his curiosity and his awe before he has too many static answers. More than factual answers he needs communication of his inherent wonder, fear, curiosity. Perhaps if he learns to use these undercurrents through expression, say in dance and music and drama, he will not need to use them so negatively, in terrors and obsessions and delusions, as he sometimes must when he buries them. . . . The important thing is to keep alive in children this wonder, to keep fresh within them not what they wonder about but the capacity to wonder.[3]

We have a great desire to foster this inquiring mind in Our Child, to lead him into a life of faith and high service. There are certain aspects of our accepted developmental theory of training

[1] COMPTON, ARTHUR H., *The Human Meaning of Science*, Chap. III, The Need for a God in Our Age of Scince, University of North Carolina Press, 1940.

[2] COTTON, EDWARD H., *Has Science Discovered God?* The Thomas Y. Crowell Company, 1931.

[3] DIXON, MADELEINE C., *High, Wide and Deep*, pp. 128–132, The John Day Company, 1938.

and education that may be applied to moral, aesthetic, and religious training in the form of fundamental precepts.

1. *At each level of development the child should look out upon his expanding world with tranquillity and joy.* This means that he is not afraid, that he is comfortable and well nourished, and that he finds continual interest and stimulation from his enlarging experience.

2. *The child should find his world of sensory impressions beautiful.* Simple exposure to beautiful sounds, odors, colors, and movements develops an innate appreciation of beauty, and creates desire and love for higher things. There probably is no greater safeguard to character than genuine love of beauty woven into the warp and woof of early experience. One cannot easily think narrow, selfish, bitter, or cruel thoughts while responding to the spell of a beautiful sunset, a symphony, or the charm of a rose. And having often or even once responded consciously to beauty in any of life's manifestations, the field of personality becomes thereby in some measure immunized to discord and disharmony.

Frances M. Frost has expressed the lasting effect of beauty in the life of the small child in the following charming poem:

Heritage

Let a child live in these hills
Let a child run
Where the small brook twists and spills
Under the sun—
Where the grass in the wind is a surging silver sea
About his feet,
And Beauty leans above him as a tree
Leans when the dusk is sweet.

Let a child live in these hills.
When he is old
He will remember woods where a wild thrush fills
Shadows with a bold
Shower of loveliness. He will walk and dream
Of a strong and darkened crest.
He will keep forever grasses and wind and the stream
And a bird in his breast!

FRANCES M. FROST.[1]

The sharing of beauty in the form of nature, music, graphic or plastic art, or poetry is one of the subtlest and strongest bonds in

[1] *Pictorial Review*, May, 1932.

family relationship. The members of families who enjoy beauty together will feel thereby a more definite sense of companionship. This does not mean that the individuals must necessarily be performers or artists. They may only listen together to good music on victrola or radio, or to concerts, or enjoy pictures together, or, especially, seek beauty in nature as a "shared" experience. The technique of providing the small child with facilities for artistic expression is discussed, in part, in connection with occupation at the various age levels, and more fully in Chap. XXXII.

3. *The recognition and enjoyment of beauty are based upon a fundamental sense of harmony which carries over into personal relationships.* The "well-bred" person, the "thoroughbred," the "real lady or gentleman," is an individual who has this fundamental sense of harmony to such a degree that discord or disharmony is repugnant to him in any aspect of life. The child who comes up through his developmental levels in the quietness and freedom implied in the organismic theory of behavior and training, and who has had beautiful, harmonious surroundings, will be likely to have poise and friendliness and a sense of fair play in his human relationships. After all, is not this the profound basis of true morality? The child who lives in an atmosphere of affection and understanding and who thinks for himself without having to be on the defensive and having to fight for his independence is prone to feel friendly and affectionate toward associates and familiars, be they children, adults, actual officials —such as teachers, clergy, or policemen—or an all-powerful but beneficent unseen being called *God*.

4. *Reverence comes very easily to the little child.* He takes unquestioningly all things that are told him by elders whom he trusts. It is no more difficult for him to believe that God made everything than for him to believe that some men made the family automobile or piano. When it comes to answering his specific questions, such as: "Did God make bad people too?" or "Why did God let the church burn down?" the parent will have to answer in a manner consistent with his own religious faith. Organismic educators hope these answers will not create confusion or fear in the child's mind. He will create for himself a world concept of beauty and harmony if his adults merely stand

by and help only as he feels the need of help, and do not lay the heavy hand of dogmatism prematurely upon his delicate and glowing and vital concepts of a wonderful creation. Religious instruction of any and every sort should, first of all, give the child a sense of security. Above all, God should never be held up as a threatening or menacing power who will punish the child for stealing jam! It is a supreme tragedy to instill any fear in the mind of a child, but especially a tragedy to make him afraid of the very core power of the universe.

5. *The matter of church attendance for young children will have to be settled according to circumstances.* Certainly physical and mental fatigue do not conduce to spiritual development or to affection for church procedures. Sunday-school instruction may be good, bad, or very bad, especially for the preschool child. The parent should be certain that the teacher who assumes the religious teaching of a young child is skilled in understanding of the child mind, and certain, especially, that the child will not receive lurid or terrifying mental pictures from the wrong type of portrayal of Biblical events. Rote learning of texts and Scripture which can have no meaning for the child is only confusing and distorting. Religious teaching, like any other, should be true to the maturation of the child's brain. The child who asked, "Where do they keep the consecrated cross-eyed bear?" was reacting at his maturation level but was not being especially "uplifted" by the service!

Religious teaching, like every other teaching, must have the simplicity and directness and casualness of the child's own thinking, and most modern parents would agree that the child may pretty safely be left to build up his own concepts of causality and duty according to his own inclination, if his environment and experience can be kept on a normal and satisfying plane.

Moral Training of the Child.—The word *moral* derives from basic roots meaning habit, custom—*mores.* Moral conduct would be defined by the average person as "right" conduct, meaning by "right" *his* conception of a code of behavior that conduces to the welfare of the entire social group, "the good of all." Obviously the meaning of the term *moral* to any individual is conditioned by his experience in the way of early teaching, personal relationships, reading, and observations. All such individual concepts taken collectively form a composite of moral standards for a cult, a race, or a nation.

The child is without experience that can give him moral concepts. He is sometimes said to be *unmoral* or *a-moral*. "Right" and "wrong" as applied to his conduct only give him a sense of approval or disapproval on the part of the adult who applies them. The terms can have no concrete meaning for him until he has had extensive experience in seeing the logical results of behavior, and especially until he has arrived at a maturation level such that he can draw conclusions and mentally organize experience in the process of his thinking.

The moral training of the preschool child, according to the organismic theory, consists in helping him to have "complete experiences," involving insofar as he can understand, the results of behavior. In addition to this, the child should be encouraged to *think for himself* and draw his own conclusions. If his environment provides him with a *moral atmosphere* in which he experiences, in the main, fair play and a show of consideration on the part of the persons with whom he associates, the child can be trusted eventually to form correct concepts of right conduct.

For the very young child, "training" should take the form of logical consequences. If he willfully breaks another child's toy, he can understand that he would feel sorry if the other child should break a favorite toy belonging to him.

If he runs away, restriction of freedom because he cannot be trusted is a logical consequence.

Insofar as possible, as has previously been intimated, the experiences of the child should be kept free from extreme emotional context. He need not be abused and punished and humiliated in order to learn to be "moral." The parent who blames the child and throws emotional tantrums himself when the child violates the adult code is not teaching his child "to love the right."

The author once went into a farm home and, seeing a charming three-year-old child, made a complimentary remark. The mother said, with offensive emphasis directed toward the child, "But you never would believe what she did yesterday! I went out at noon after the hired men had come in, and there she was, up on the seat of a wagon, before them all—*without a stitch of clothes on!* I tell you I gave her the spanking of her life."

The visitor said, "Just what did you spank her for?" "Why," said the mother in surprise, "She just naturally ought to know better." The chances are that as the "logical result" of this experience this child will have a nervous paroxysm and struggle and scream when, a few months later, she is required to remove her clothing for a preschool health examination.

In general, the term *moral training* is giving way to the term *character development.* This is more comprehensive and is freer from the implication of the "immoral," with all its sinister connotations. What we wish to achieve is well-rounded, sturdy character development. We need not think of this as being moral, or religious, or good, or bad. It is, rather, a matter of symmetrical growth.

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CHAPTER XXXIV

THE HYGIENE OF CHILDHOOD: GROWTH

The organism is a unity, but its parts do not grow at equal rates or in simultaneous cycles; the nervous system has a continuing plasticity not found in any other organ, and adults accordingly preserve a certain capacity for psychological growth. They may not grow as rapidly and as promisingly as children but they continue to grow in accordance with similar laws. Adults, moreover, have the advantages of lengthened perspective. So far as possible parents should keep alive a sense of growth, for otherwise they will not fully appreciate the simple but profound fact that the child is preeminently a growing organism. Growth is a key concept. The psychology of the child cannot be accurately or sympathetically understood except in terms of growth.

—ARNOLD GESELL.[1]

Growth. *General Growth.*—The function of young life is to grow. No young thing stops growing unless there is some deviation from normal nutrition or health. The most obvious evidence of growth is increase in size. This involves increase in linear and circular dimensions and increase in mass. Growth in size is correlated with differentiation in structure, or "development." Development and growth in a broad sense are sometimes used synonymously. Meredith says "'physical growth' and 'physical development' may be used at least for the present as interchangeable terms."[2] There has been very active effort within recent years to arrive at correlations in rates of growth increment which should serve as indices of normality. The problem was blocked out in the rough by tabulating the height and weight of a great many presumably normal children and correlating these with chronological age. As a result, we have the standard height-weight-age tables (see page 637), which serve as crude but useful measures of development.

Since height is an irreversible characteristic (a child does not lose height as he loses weight), and since it seems to be largely determined by hereditary pattern, the height of any child came

[1] *Our Children,* Viking Press, Inc., 1932.

[2] MEREDITH, HOWARD V., "An Empirical Concept of Physical Growth," *Child Development,* Vol. 9, 1938.

to be accepted as normal. The standard tables, accordingly, give the height spread at each age with the average weight for each height at the given age; *i.e.*, the average weight for all male children who are three years old and who are 36 inches tall, is 30 pounds; for all who are 33 inches tall, it is 26 pounds.

Since an "average" implies a normal range of variation, it becomes necessary in applying these standards to fix upon a zone of normal variations. This was for a time arbitrarily fixed by various workers at from 7 to 10 per cent below to 10 to 20 per cent above the average weight for height and age.[1] The "spread" as shown on the Woodbury table gives a more definite and accurate normal range.

All observers agreed and still generally agree that the child who is markedly below the average weight for his height and age very probably has something wrong in his environment, such as wrong food and sleep habits, or some bodily defect, such as infected tonsils or teeth.

At the Merrill-Palmer Nursery School percentile tables have been compiled which are somewhat more significant than the height-weight-age tables of averages. By the percentile method the child is placed precisely in his relation to other children of his age.

> A much better way of comparing a child's height with that of other children of his age is to be able to state how many children of his age exceed him and how many he exceeds. For example, two-year-old boys at the Merrill-Palmer School have been found to vary from 31.5 inches to 37.2 inches in height, the average being 34.6 inches. A two-year-old boy who measures 33.6 inches is shorter than 80 per cent of boys of his own age and taller than 20 per cent. He is said to rank at the 20 percentile of the two-year-old boys in height. It is much more helpful to know that such a child is at the 20 percentile of his age group (or that 80 per cent of the children of his own age exceed him in height), than that he is one inch below the average height.[2]

Norman C. Wetzel of the Babies and Children's Hospital of Cleveland has elaborated a "grid" (or graph) for evaluating

[1] LUCAS, W. PALMER, *The Health of the Runabout Child*, p. 30, The Macmillan Company, 1928.

[2] RAND, SWEENY, and VINCENT, *Growth and Development of the Young Child*, p. 283, W. B. Saunders Company, 1930.

physical fitness in terms of physique (body build, height-weight), developmental level, and basal metabolism. This grid is too complicated for casual lay usage, but it seems to provide a

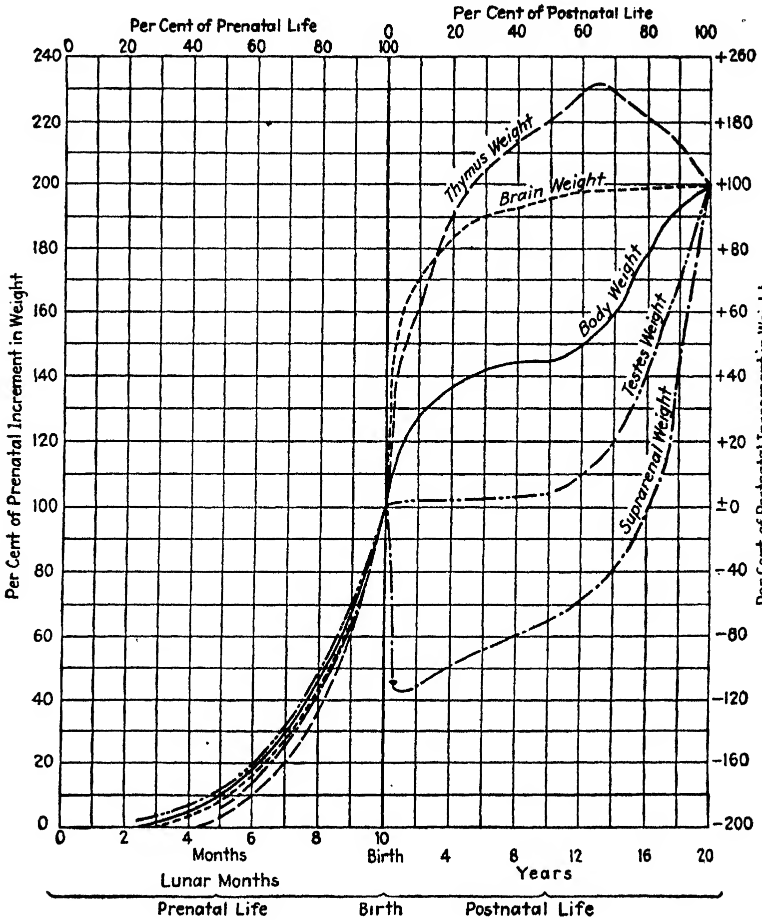

FIG. 166.—A diagram illustrating the growth in prenatal and postnatal life of a series of structures of diverse postnatal types of growth. (*Adapted from Scammon, Measurement of Man.*)

thoroughly scientific and practical method of recording the status and progress of the individual, which should prove valuable to pediatricians in their study of children, both well and sick.[1]

[1] *Journal of the American Medical Association*, Mar. 21, 1941.

As experience has accumulated, however, growth has proved to be a highly complex affair, with many variations and rhythms manifesting themselves. Davenport says, "The growth of each individual part in man is controlled by laws of its own, the end result of which is a greater fitness to environment of the organism as a whole."[1] Maturation of function also must be taken into consideration, as well as mere increase in size. Accordingly, less meaning is now attached to conformance to the height-weight-age averages and more to other signs of normal development.

Dr. Scammon discusses prenatal growth and describes six methods of postnatal growth exhibited by different parts of the body. A brief account of these will serve to illustrate the complexity of human growth. Dr. Scammon, for purposes of comparison, has reduced all measurements to 10-panel graphs, several of which we are permitted to reproduce (Figs. 167, 168). The 10 lunar prenatal months are graphed on the same scale as the 20 postnatal years of growth, in order to show comparable trends.[2]

Prenatal Growth.—It will be seen by consulting Fig. 166 that the fetal or prenatal growth of the various organs and structures, as shown by series of measurements beginning with the third month, show very similar and characteristic lines of growth. Dr. Scammon says:

> Growth in mass follows a fairly simple course, increasing very slowly in the first three lunar months, entering a period of very rapid change in the rate of growth in the middle third of fetal life, and thereafter undergoing an extremely rapid augmentation until birth. In the last month of fetal life the increase in weight takes place at a rate of over 1 per cent a day. With this rate of growth continued until the end of the first year the weight of the body would be nearly 200 pounds, and were it to continue to 20 years the volume of the body would approximate the magnitude of the earth.[3]

[1] "Interpretation of Certain Infantile Growth Curves," *Science*, Nov. 5, 1937.

[2] SCAMMON, R. E., *Proceedings of the Second Conference on Research in Child Development*, National Research Council, 1927; and *The Measurement of Man*, Chap. IV, The Measurement of the Body in Childhood, University of Minnesota Press, 1930.

[3] SCAMMON, *op. cit.*, p. 10.

Postnatal Growth.—Certain difficulties in interpretation of postnatal growth changes are encountered. As indicated, the various parts and organs of the body develop at different rates and rhythms. While the curves here reproduced from the work of Dr. Scammon are plotted on a basis of total increment over the given period of growth, and certain of them show similarity in the contour of their periods of acceleration and retardation, yet the rates may differ markedly. For example, between birth and maturity height increases 3.5-fold, surface area about 7-fold,

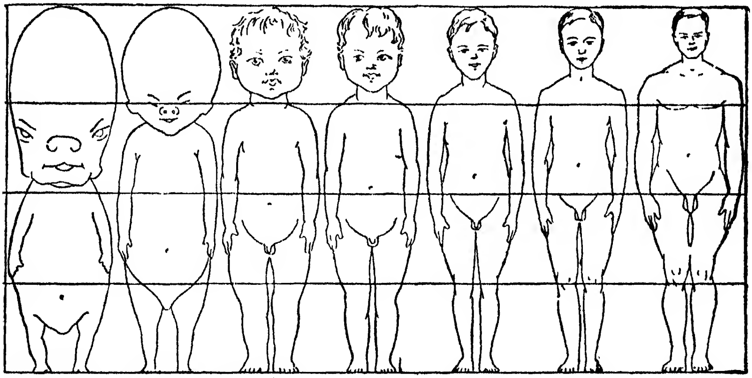

FIG. 167.—Changes in proportions during prenatal and postnatal growth. (*After Stratz.*)

while weight increases about 20-fold.[1] Another consideration is the fact that

> Equal units of increment at various stages of development often represent very different entities [units of value]. A pound's gain in weight in an infant is quite a different thing from an equal gain later in life. In the baby this increment represents a gain in brain substance and viscera, as well as an enlargement of other parts of the body; in an adolescent it is primarily an increase in bone and muscle; while in the middle-aged it is often but an accumulation of adipose tissue.[2]

We should also take into consideration the varying composition of the tissues of the body; the difference in water content, bone

[1] SCAMMON, *The Measurement of Man, op. cit.*

[2] SCAMMON, R. E., "Recent Work on the Physical Development of Children," *Proceedings of the Third Conference on Research in Child Development*, Part I, p. 1, National Research Council, 1929.

mass, fat, and muscle at various ages and in different individuals. Three general types are now recognized in most attempts at practical application of normal criteria: a normal thin type, a stocky type, and an intermediate type. All these considerations, together with consideration of the types of growth of the various parts of the body as illustrated in Scammon's curves, make it clear that the correct interpretation of growth is not a simple matter.

General Growth.—Subsequent to birth, general growth of the body follows an entirely different course from the curve shown in prenatal growth. Body weight, increase in mass of liver, pancreas, kidneys, stomach, vascular system, muscular system, and most of the external dimensions show a four-phase type of growth characterized by rapid increase during the first two years of life, a slow but steady growth until the prepubertal age, a rapid growth during puberty, and a slowing down during late adolescence and early maturity.

Neural Growth.—The brain and all its parts, the spinal cord, the eyeball and the pineal gland follow a different curve, characterized by very rapid growth during early childhood, especially from birth to eighteen months, succeeded by rapid slowing down. The relatively large size of the head and relative changes in body proportions are graphically shown in Fig. 168.

Lymphoid Growth.—The lymphoid structures that have been measured show still another type of behavior, marked by rapid growth in infancy, reaching a peak about the time of puberty, but marked by a decline or atrophy extending more slowly into maturity. The thymus, the lymph nodes, the white or lymphoid part of the spleen, and to some extent the tonsils show this general increase and decline.

Genital Growth.—A fourth method of growth is shown by the ovaries, testes, and certain other urogenital structures. These show a slight growth during infancy, followed by a latent period from the ages of one to about ten years, with rapid growth during puberty, adolescence, and into maturity.

Miscellaneous.—A few other structures of the body follow nontypical or individual methods of growth, notably the neck and endocrine glands. Figure 168 exhibits graphically these types of growth.

The Hygiene of Weight.—While not so much definite importance is now attributed to conformity to the growth tables or averages in the case of the individual child, it is considered of the greatest importance that every child gain continuously. It is rarely that any child's weight curve presents a perfectly

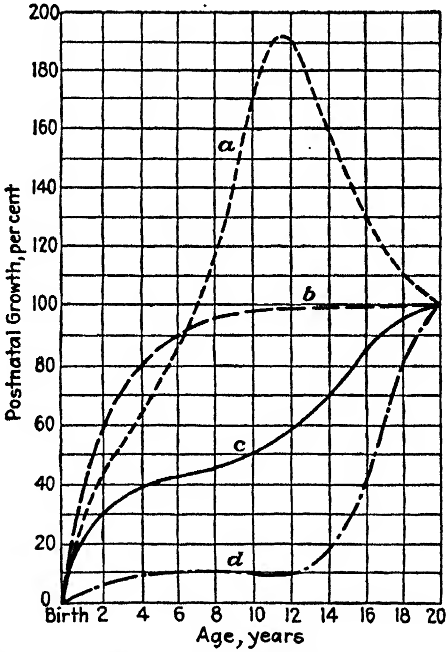

FIG. 168.—A graph showing the major types of postnatal growth of the various parts and organs of the body. The several curves are drawn to a common scale by computing their values at successive ages in terms of their total postnatal increments (to twenty years). (*a*) Lymphoid type: thymus, lymph nodes, intestinal lymphoid masses. (*b*) Neural type: brain and its parts, dura, spinal cord, optic apparatus, many head dimensions. (*c*) General type: body as a whole, external dimensions (with exceptions of head and neck), respiratory and digestive organs, kidneys, aorta, and pulmonary trunks, spleen, musculature as a whole, skeleton as a whole, blood volume. (*d*) Genital type: testis, ovary, epididymis, uterine tube, prostate, prostatic urethra, seminal vesicles. (*After Scammon.*)

straight line or a uniform course. It is probable that normal growth pursues a somewhat rhythmic course, as do nearly all forms of energies, with natural accelerations and regressions. To be certain about this is difficult, since so many experiences have the effect of retarding growth and arresting weight increase.

The mother should weigh the infant every week during the first months of life. After his condition and nutrition are stabilized he should be weighed every month during his preschool years. No child should fail to make a gain over weekly or monthly periods. Certainly no child should ever lose. A slowing or unusual retardation of increase in weight other than is indicated in the standard tables or curves should lead to scrutiny of the child's general condition. The child may be passing through a rhythmic period of increase in height which will be followed by a period of rapid increase in weight, a "stretching and filling." A period of rapid increase in height must necessarily show a period of low height-weight correlation. "The child must have time to put meat on the new bones." Normally there will usually be a period of increased appetite and food intake accompanying or following spurts of increase in height. Without making a fetish of the weight average the mother should watch and intelligently interpret the weight of her growing child, taken as one item only of the total picture of his physical and mental condition.

Peatman and Higgons, in an extensive study of preschool children, find that children reared under optimal pediatric and home care tend definitely to exceed, in both weight and height, the children used to make the Woodbury table (page 643). This is a logical expectation, but it must not be taken to indicate that an individual small child may not be in perfect condition.[1]

Symmetry of Growth.—Because body height and size are to a certain extent hereditary, the body throws up its scaffold, so to speak, no matter how poor may be the building material available. If the child's nutrition is defective because of poor food, poor appetite, fatigue, or rickets, the result is likely to be a "spindling," distorted body, poor muscles, and poor posture, but he may arrive at his hereditary height pattern somewhat as a potato sprouting in the cellar produces a long, pale runner. The excuse that he comes from a thin family often leads to serious neglect. The healthy thin type of child presents quite a different

[1] Peatman, J. G., and R. A. Higgons, "Height-weight Variability from Birth to Five Years of Age for Children Reared with Optimal Pediatric and Home Care." *Journal of Genetic Psychology*, Vol. 54; 1939.

appearance. He is straight, symmetrical, firmly muscled, happy, adaptable, and vigorous.

Reasons are given in Chap. XXXV for considering good posture as a sign of health. Good nutrition and free exercise will guarantee good posture, firmness, and symmetry, and all these are essential to optimal health.

The Health Examination.—The importance of promoting normal development and preventing deviations from health is coming to be generally accepted by modern parents of young children. There should be a health-examination center available for infants and preschool children in every community. Every infant and preschool child should receive regular health examinations either at such a center or in the office of a pediatrician. Many family physicians are now trained in giving health examinations. It is better policy to pay for preventive service than to pay doctor's fees for illness. The report of the White House Conference in the section on Medical Education shows that an increasing number of medical schools now train their students to give health examinations and require their attendance at well-baby clinics. The report advocates including this training and experience as a prerequisite to graduation.[1]

The Health Record.—The weight and growth record of every child, together with his developmental history, should be kept as a matter of course by every mother for each child. Many baby books are available; some very attractive records are given gratis by commercial concerns. A thoroughly scientific record containing forms for the significant developmental data, both physical and mental, from birth to sixteen years, has been designed by the Minnesota Institute of Child Welfare and is sold by the Parents' Magazine Publishing Company 52 Vanderbilt Avenue, New York City. Such records have personal, scientific, and historical value, and are worth all the time and effort it takes to keep them. If a detailed family history (see Chap. VII) is also kept, the parents will be able to turn over an invaluable record to the child when he reaches adulthood and establishes his own home and family.

[1] *Pediatrics: Education and Practice*, Report on Child Health and Protection of the White House Conference, D. Appleton-Century Company, Inc., 1932.

Normative Summaries for First Five Years

(adapted from Gesell)

The items of the recording schedule are reproduced below as normative summaries for each of the developmental levels. These items have been given an age location; it is clear, however, that they cannot be scored on a purely plus and minus basis and arithmetically compounded into a psychometric mental age. It must be emphasized that serious use of the schedule, in its present form, presumes a large amount of clinical familiarity with infants of every age.

Age	Motor Development	Language	Adaptive Behavior	Personal-social Behavior
1 month........	(*a*) Lifts head from time to time when held to the shoulder; (*b*) makes crawling movements when laid prone on flat surface; (*c*) lifts head intermittently, though unsteadily, when in this prone position; (*d*) turns head laterally when in prone position	(*a*) Gives definite heed to sound; (*b*) has differential cries for discomfort, pain, and hunger	(*a*) Stares at a window or at massive objects; (*b*) gives visual heed to conspicuous moving objects; (*c*) gives transient visual regard to the red ring; (*d*) retains definite hold of the ring when it is placed in the hand	(*a*) Makes tactually perceptible postural adjustments when taken up by the examiner; (*b*) shows selective regard for the face
2 months.......	(*a*) Holds head erect for a short time when held to the shoulder; (*b*) lifts head when suspended dorsally (the head being momentarily unsupported to test the compensatory postural adjustment); (*c*) lifts the chest a short distance above the table surface when in the prone position; (*d*) makes vertical arm thrusts in random play when in the dorsal position	(*a*) Attends readily to the speaking voice; (*b*) makes a facial response to a social approach (in which the examiner brings face near the child to attract attention); (*c*) makes several different vocalizations	(*a*) Eyes follow moving person; (*b*) gives prolonged regard to dangling red ring	(*a*) Head turns or fixates in response to speaking voice; (*b*) makes definite motor adjustment, in shoulder region, to being lifted; (*c*) kicks feet in bath or reacts with pushing leg movements

3 months.......	(*a*) Holds head erect and steady when held to shoulder; (*b*) rotates body from dorsal to side position; (*c*) pushes or elevates self by arms in prone position	(*a*) Smiles responsively to social approach; (*b*) gives vocal expression to feelings of pleasure	(*a*) Eyes follow moving pencil; (*b*) head turns freely in inspection; (*c*) varied tactile manipulation of ring; (*d*) varied inspection of environment (when in dorsal position)	(*a*) Startles or betrays awareness when suddenly changed to a strange situation; (*b*) quieted by voice or music; (*c*) shows anticipatory excitement, or opens mouth expectantly in feeding; (*d*) fingers one hand with the other in tactile motor play
4 months.......	(*a*) Holds head steady when carried or when swayed; (*b*) lifts head and shoulders in dorsal position as an effort toward sitting; (*c*) sits with resistant body posture when supported by pillows; (*d*) hands no longer predominantly clenched, but frequently open	(*a*) Laughs aloud; (*b*) vocalizes in self-initiated sound play; (*c*) responds vocally when socially stimulated	(*a*) Closes in with both hands on dangling ring when in dorsal position; (*b*) manipulates table edge when held in lap; (*c*) regards one-inch cube on table; (*d*) turns head in pursuing slowly vanishing object	(*a*) Inspects own hand in play; (*b*) plays in simple manner with rattle; (*c*) splashes with hand in bath; (*d*) makes definite anticipatory adjustment to being lifted
5 months.......	(*a*) Rolls from back to stomach; (*b*) sits with slight prop; (*c*) picks up cube from table on contact	(*a*) Turns head to voice or to hand bell; (*b*) gives vocal expression of eagerness; (*c*) vocalizes displeasure on withdrawal of coveted object	(*a*) In dorsal position recovers rattle which has fallen within easy reach; (*b*) makes reaching approach to piece of paper favorably presented; (*c*) eyes cooperate in prehension and manipulation	(*a*) Plays actively with rattle with recurring visual regard; (*b*) exploits bath playfully
6 months.......	(*a*) Sits momentarily without support if placed in a favorable leaning position; (*b*) grasps with simultaneous flexion of fingers; (*c*) retains transient hold of two cubes, one in either hand	(*a*) Vocalizes several well-defined syllables; (*b*) expresses recognition of familiars; (*c*) actively vocalizes pleasure with crow or cooing	(*a*) Reaches for object on sight; (*b*) picks up cube from table on visual cue; (*c*) regards pellet placed on table surface	(*a*) Bangs spoon or pats table in play; (*b*) discriminates between strangers and familiars

NORMATIVE SUMMARIES FOR FIRST FIVE YEARS—(*Continued*)

Age	Motor Development	Language	Adaptive Behavior	Personal-social Behavior
7 months.......	(*a*) Tends to unilateral reaching and manipulation; (*b*) rotates wrist freely in manipulation; (*c*) secures pellet with raking or scooping palmar prehension; (*d*) picks cube deftly and directly from table	(*a*) Vocalizes satisfaction in attaining object	(*a*) Reaches persistently for remote cube; (*b*) lifts inverted cup; (*c*) manipulates ring with sustained inspection; (*d*) gives transient heed to fallen spoon	(*a*) Plays exploitively with paper; (*b*) plays exploitively with string; (*c*) reacts to mirror image by manipulation or approach
8 months.......	(*a*) Sits momentarily without support; (*b*) raises self to sitting position; (*c*) picks up pellet with partial finger prehension	(*a*) Gives vocal expression to recognition; (*b*) vocalizes in interjectional manner	(*a*) Definitely looks for fallen spoon; (*b*) utilizes handle in lifting inverted cup; (*c*) shows manipulatory interest in details of bell	(*a*) Shows definite responsiveness to frolic play; (*b*) pats or smiles at mirror image; (*c*) restores bottle to mouth; (*d*) shows interest in throwing and sound production play
9 months.......	(*a*) Sits alone; (*b*) opposes thumb in seizing cube; (*c*) makes a locomotive reaction in prone position	(*a*) Says Da-da or equivalent; (*b*) listens with selective interest to familiar words	(*a*) Brings inset block and form board into exploiting relation; (*b*) uses string and pulls ring; (*c*) gives definite attention to scribbling demonstration	(*a*) Cooperates in rhythmic nursery games; (*b*) waves bye-bye or performs similar trick; (*c*) plays combiningly with cup and cube
10 months......	(*a*) Pulls self up to standing position (*b*) plucks pellet with precise pincer prehension	(*a*) Incipient or rudimentary imitation of sounds; (*b*) makes conditioned adjustment to certain words	(*a*) Accepts third cube or retains two cubes; (*b*) makes incipient, induced imitation of scribble; (*c*) explores form-board holes manually; (*d*) lifts cup by handle and secures concealed cube	(*a*) Makes playful response to mirror image; (*b*) dangles ring by string in play
12 months......	Walks with help; lowers self from standing to sitting position; holds crayon adaptively to make stroke	Says two "words"; adjusts to simple verbal commissions; places cube in or over cup on command	Imitates scribble or rotary spoon rattle; adjusts round block to form board or rod to hole; uses string adaptively to pull ring; secures cube wrapped in paper	Holds cup to drink from; inhibits simple acts on command; repeats performance laughed at

15 months......	Stands alone; walks alone	Says four words; uses expressive jargon	Secures third cube; builds tower of two blocks; makes discriminative reversed adaptation of round block to form board	Uses spoon; cooperates in dressing; bowel and bladder control regularized
18 months......	Climbs stairs or chair; throws ball into box; scribbles spontaneously and vigorously	Says five or more words; uses jargon conversationally; points to nose, eyes, or hair	Builds tower of three or more blocks; makes an imitative stroke with crayon; places cube in cup or plate; accepts four or more cubes	Uses spoon with good control; fills cup with cubes in play; turns pages of book; looks at pictures
21 months......	Walks attended on the street; walks backward; differentiates between stroking and circular scribble	Joins two words in speech; names one picture; repeats things said	Places square in form board; differentiates between tower and bridge; folds paper once on demonstration	Bowel control established; asks for things at table (or for toilet); pulls persons in order to show something of interest; tries to turn doorknob
24 months......	Runs; piles tower of six blocks with good coordination; imitates vertical or horizontal strokes	Names three of five objects; points to five objects on card; uses words in combination	Places blocks in row to make train; adapts to reversal of form board; creases paper definitely in imitation; places cube in cup, plate, or box	Plays with mimicry; tells experiences; listens to words or phrases; explains pictures
30 months......	Goes up- and downstairs alone; piles seven or eight blocks with coordination; tries to stand on one foot; copies vertical or horizontal line	Points to seven pictures; names five pictures	Attempts to build bridge from model; adapts to form board with corrected initial error; places one completion form; marks twice for cross	Gives full name; helps mother to put away things
36 months......	Draws a circle from copy; draws a horizontal stroke imitatively; creases a piece of paper neatly; aligns a card to an edge	Uses pronouns, past tense, and plural; names three objects in a picture; can tell simple stories; distinguishes prepositions in, under, behind	Builds bridge imitatively; builds block tower of four or more; discriminates between two short lines; combines two parts of severed picture	Can open door; can carry breakable object; asks questions of elders; puts on shoes

NORMATIVE SUMMARIES FOR FIRST FIVE YEARS—(*Continued*)

Age	Motor Development	Language	Adaptive Behavior	Personal-social Behavior
48 months......	Draws cross from copy; traces diamond path; hooks fish in fish-pond game in 15 or 30 seconds with right or left hand	Distinguishes four prepositions; uses descriptive word with picture; repeats twelve syllables	Folds paper diagonally; draws three completions in incomplete man; completes patience pictures; puts two blocks in cup	Uses building material constructively; buttons clothes; goes on errands outside of house; washes self
60 months......	Draws triangle from copy; draws prism from copy; hooks fish three times in one minute	Defines words by use; knows three or more words in vocabulary list; interprets humor; speaks with noninfantile articulation	Builds keystone gate; completes four of eight forms; discriminates weights; performs three commissions	Draws recognizable man and tree; laces shoes; puts on coat and hat alone; uses play material with advanced constructiveness; replaces material in box neatly

WEIGHT-HEIGHT-AGE TABLE FOR GIRLS FROM BIRTH TO SCHOOL AGE[1]

Height, inches	1 mo.	3 mos.	6 mos.	9 mos.	12 mos.	18 mos.	24 mos.	30 mos.	36 mos.	48 mos.	60 mos.	72 mos.
20	8											
21	9	10										
22	10	11										
23	11	12	13									
24	12	13	14	14								
25	13	14	15	15								
26	..	15	16	17	17							
27	..	16	17	18	18							
28	..	..	19	19	19	20						
29	..	..	19	20	20	20						
30	..	..	21	21	21	21	21					
31	..	..	..	22	22	23	23	23				
32	..	..	..	..	23	24	24	24	25			
33	..	..	..	..	..	25	25	25	26			
34	..	..	..	..	..	26	26	26	27			
35	..	..	..	..	..	29	29	29	29	29		
36	..	..	..	..	..	..	30	30	30	30	31	
37	..	..	..	..	..	..	31	31	31	31	32	
38	..	..	..	..	..	..	..	33	33	33	33	
39	..	..	..	..	..	..	..	34	34	34	34	34
40	..	..	..	..	..	..	..	..	35	36	36	36
41	..	..	..	..	..	..	..	..	..	37	37	37
42	..	..	..	..	..	..	..	..	..	39	39	39
43	..	..	..	..	..	..	..	..	..	40	41	41
44	..	..	..	..	..	..	..	..	..	..	42	42
45	..	..	..	..	..	..	..	..	..	..	..	45
46	..	..	..	..	..	..	..	..	..	..	..	47
47	..	..	..	..	..	..	..	..	..	..	..	50
48	..	..	..	..	..	..	..	..	..	..	..	52

WEIGHT-HEIGHT-AGE TABLE FOR BOYS FROM BIRTH TO SCHOOL AGE[1]

Height, inches	1 mo.	3 mos.	6 mos.	9 mos.	12 mos.	18 mos.	24 mos.	30 mos.	36 mos.	48 mos.	60 mos.	72 mos.
20	8											
21	9	10										
22	10	11										
23	11	12	13									
24	12	13	14									
25	13	14	15	16								
26	..	15	17	17	18							
27	..	16	18	18	19							
28	..	..	19	19	20	20						
29	..	..	20	21	21	21						
30	..	..	22	22	22	22	22					
31	..	..	..	23	23	23	23	24				
32	..	..	..	24	24	24	25	25				
33	..	..	..	..	26	26	26	26	26			
34	..	..	..	..	..	27	27	27	27			
35	..	..	..	..	..	29	29	29	29	29		
36	..	..	..	..	..	..	30	31	31	31		
37	..	..	..	..	..	..	32	32	32	32	32	
38	..	..	..	..	..	..	..	33	33	33	34	
39	..	..	..	..	..	..	..	35	35	35	35	
40	..	..	..	..	..	..	..	..	36	36	36	36
41	..	..	..	..	..	..	..	..	..	38	38	38
42	..	..	..	..	..	..	..	..	..	39	39	39
43	..	..	..	..	..	..	..	..	..	41	41	41
44	..	..	..	..	..	..	..	..	..	..	43	43
45	..	..	..	..	..	..	..	..	..	..	45	45
46	..	..	..	..	..	..	..	..	..	..	..	48
47	..	..	..	..	..	..	..	..	..	..	..	50
48	..	..	..	..	..	..	..	..	..	..	..	52
49	..	..	..	..	..	..	..	..	..	..	..	55

[1] Prepared by Robert M. Woodbury, Ph. D., published by the U. S. Department of Labor, Children's Bureau.

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CHAPTER XXXV

THE HYGIENE OF CHILDHOOD: POSTURE

The young child, Christ, is straight and wise
And asks questions of the old men, questions
Found under running water for all children,
And found under shadows thrown on still waters
By tall trees looking downward, old and gnarled,
Found to the eyes of children alone, untold,
Singing a low song in the loneliness.
And the young child, Christ, goes on asking
And the old men answer nothing and only know love
For the young child, Christ, straight and wise.

CARL SANDBURG.[1]

The Meaning of Posture.—It is interesting to consider how evolution has lifted life from the surface of the earth. It almost seems as if life were reaching out into interstellar space. First, life floated in the sea, then crept upon the land, climbed into trees, made brief excursions through the air, but always gravity has pulled it back and the earth has hugged and ultimately reabsorbed its own with jealous force.

While the primates have succeeded in briefly defying gravity by maintaining an upright position, man is the first animal to acquire and habitually maintain (except during his sleep) a posture in opposition to the laws of gravitation. Not only so, but defiance of gravitation is one of the signs of health. The more vigorous one feels the taller he stands, the more he has a feeling of "spurning the earth"; conversely, when one is wearied or depressed he droops.

The healthy, joyous child skips and dances and goes on tiptoe. The dance itself doubtless had its origin in the need to express mental and physical exhilaration in defiance of the earthly pull, a rising on the toes, a reaching out of the arms, a turning of the face toward the sky. Indeed, it is possible that the feminine fashion of wearing high heels and pointed-toed shoes is an uncon-

[1] "Child," from *Chicago Poems*, Henry Holt & Company, Inc.

scious expression of this instinctive desire to spurn the earth. Posture is a definite index of well-being or the reverse, but it is more than a physical index; it is also a spiritual and emotional index.

Good Posture.—It is an incredibly complex and delicate mechanical achievement when the baby first hoists his body into a vertical position and balances himself upon his tiny feet. Every one of the complicated muscle-bone levers in his body is thrown into new tensions. There must be precise adjustment of flexors and extensors if the center of gravity is to be maintained with a minimum of effort and of energy expenditure. Floyd A. Rowe defines good posture as "A winning fight of the human mechanism and will power against the pull of gravity."[1] *Correct posture is a position of such perfect balance that every organ and part of the body has maximum freedom and that there is an even distribution of strain and a minimum tension upon the muscles.*

Good posture involves several basic factors:

1. Good bone. The rachitic, undernourished child cannot maintain good posture because the pull of the muscles bends and distorts the soft bones, which have not been able to take up the normal amount of minerals from the blood stream.

2. Good muscle. The undernourished child will have "loose joints," "winged" scapulae, a "fatigue posture," and a very characteristic general slackness of ligaments and muscles.

3. Good alignment. A child may have normal bone and muscle structure and still be prevented from acquiring good posture because of restrictions upon his free activity from clothing, cribs, and walkers, and from lack of opportunity to use all parts of his body. The change from all fours to upright posture involves radical changes in leverage which can only be accomplished by active development and stretching and adjustment of hip, back, leg, shoulder, chest, and abdominal muscles.

The Big Muscles.—The large levers of leg and arm are matured first and used first. The child and the primate use only big muscles. They run, climb, throw, and jump. It is later in life and in civilization that fine coordinations and fine reflexes appear, making drawing, writing, and craftwork possible. The

[1] Rowe, Floyd A., in *The Nation's Health*, January, 1922.

child must climb his racial tree (see page 79) in this respect as in every other if he is to have sound basic growth.

Acquiring Good Posture.—Good posture may be said to depend upon "food and freedom." The child must have proper food and care in order to secure good bone and muscle. This has been fully discussed in the previous chapters. *He must also have freedom of movement.* The normal infant or young child is ceaselessly active during every waking moment and is active even during sleep (see page 664). Exercise is the law of life. Living matter which cannot exercise its innate functions deteriorates and ultimately dies. One of the things that make an organism an organism is that there is bound up in its structure an urge to exercise every part of that structure according to the necessities of the best development and growth of the whole (see page 226). It cannot be overemphasized that *the infant should have absolute freedom for the exercise of developmental urge in every part of his body.*

An infant who works out his body constantly and continuously according to his organic muscle urge will prepare himself to sit and stand and walk, and will have instinctively trained and developed the necessary muscles. The infant who is not hampered will do a "daily dozen" which, in rhythmic beauty and completeness, will put any system of artificial exercises to blush. Systems of exercise which are sometimes advised for infants are at best clumsy and bungling and are incomplete imitations of the normal child's own natural procedures. All he wants is a chance—not for a few minutes of freedom now and then when the mother happens to think about it or finds it convenient, but a constant opportunity to exercise at his own convenience and inclination.

This freedom to exercise every part of his body freely at all times should continue throughout his growing years. As soon as the child sits alone with assurance he should spend his waking hours in a play pen. Here he can sit, or lie, or roll over and creep, or pull himself up, at his pleasure, without waiting for the accidental and occasional and entirely unenlightened assistance of his elders.[1]

[1] SHERBON, FLORENCE B., *The Family*, p. 42, McGraw-Hill Book Company, Inc., 1937.

Body Control.—When he wants to reach up and climb he should be encouraged to do so, with a clean, safe place provided where he may go up and down two or three steps *until he masters both techniques.* Infants will climb steps before they can walk, and it is a fine coordinating exercise for giving the child command of his body.

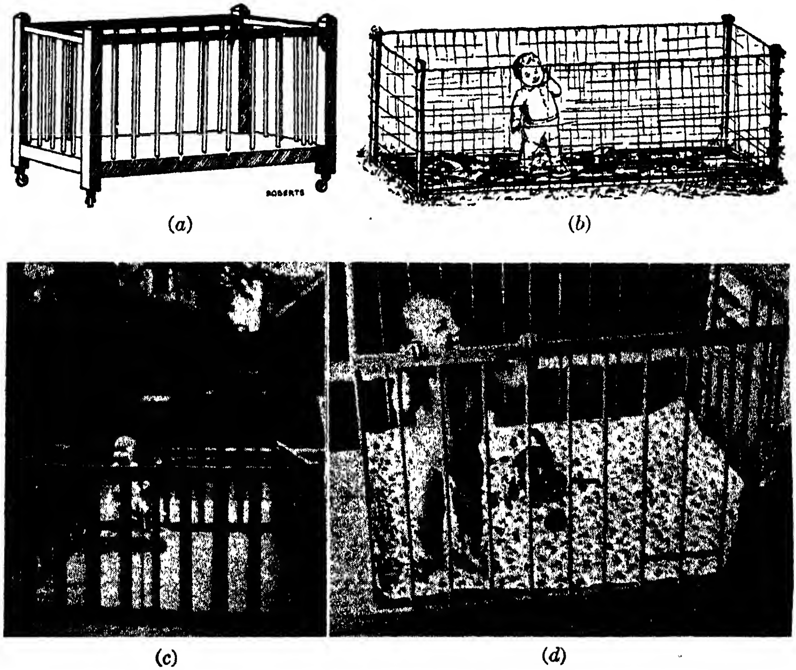

FIG. 169.—Play pens. (*a*) Indoor pen; (*b*) stationary outdoor pen (*courtesy Kansas State Board of Health*); (*c*) movable outdoor pen, hinged and collapsible; (*d*) child pulls himself up and teaches himself to walk.

Balanced Exercise.—From the time the child walks he will need a great variety of safe opportunities to use all parts of his body.[1] According to the usual household organization, there is plenty of encouragement to use the legs. Often there is over-encouragement with walkers, jumpers, kiddy-cars, tricycles, etc., but *almost no opportunity for, and more or less discouragement in the use of arm, back, and shoulder muscles.*

[1] *Ibid.*, p. 44.

The infant normally and usually creeps before he walks. In doing this he pushes back his shoulders, flattens his shoulder

Fig. 170.—He who goes up—must come down.

blades (scapulae), and exercises the entire shoulder girdle. He next pulls himself up by chairs or crib side and continues the use of the shoulder girdle. If let alone, he will climb everything climbable and will never stop using and developing chest, back, abdominal, and arm muscles. Wise parents will see to it that he has plenty of safe opportunity to do this. The nursery ladder, the nursery steps, a variety of boxes, etc., will provide such exercise with a minimum expense. As the child grows older little hand-bar swings, flying rings, doorway gyms, etc., may be added. Some of these devices are illustrated in Fig. 172.

Fig. 171.—Jumpers may distort the body. Note how the child's legs are forced apart and his back rounded.

Clothing and Posture.—When we remember how undeveloped the muscles of the child's body are, and how new leverages must be established when the child stands up, it will be clear that these difficulties should not be increased by restrictive clothing. The present way of clothing the human body presents certain serious

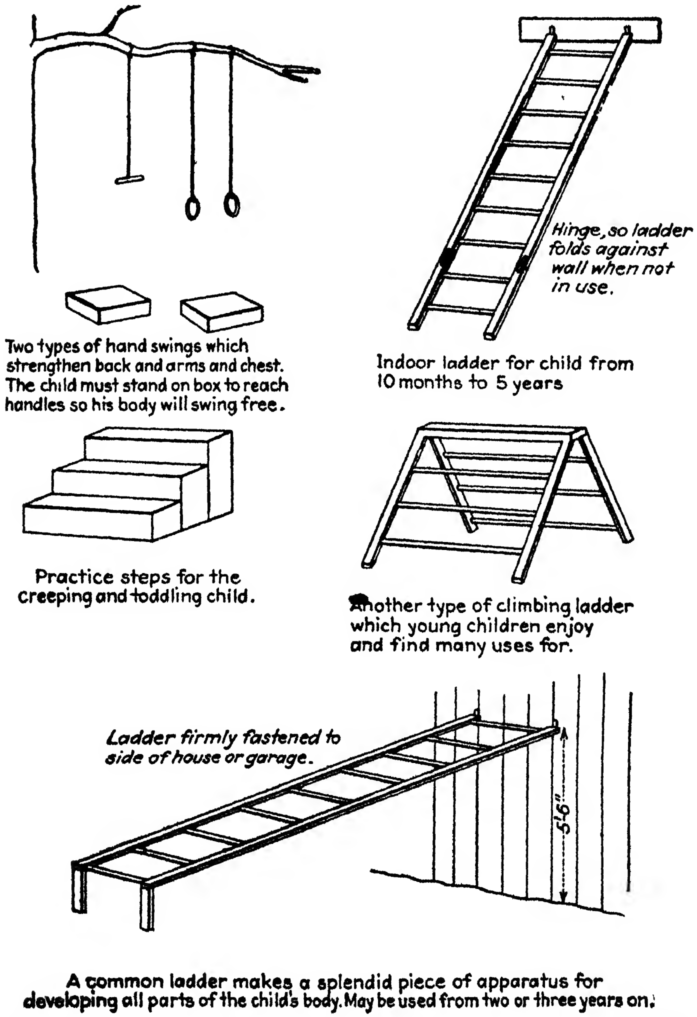

FIG. 172.—Homemade play equipment which develops the entire body.

difficulties of adjustment. Practically all types of clothing for all ages and sexes involve separate pieces of covering for the trunk, the thighs, and the feet and legs. These three segments of clothing must somehow be held together against the pull of gravity. There seem to be two possible ways of doing this: (1) to suspend the clothing from the shoulder, or (2) to use belts and garters of sufficient tightness to withstand the force of gravity. Suspending clothing from the shoulders is the preferable method, but it must be done with great care in the case of

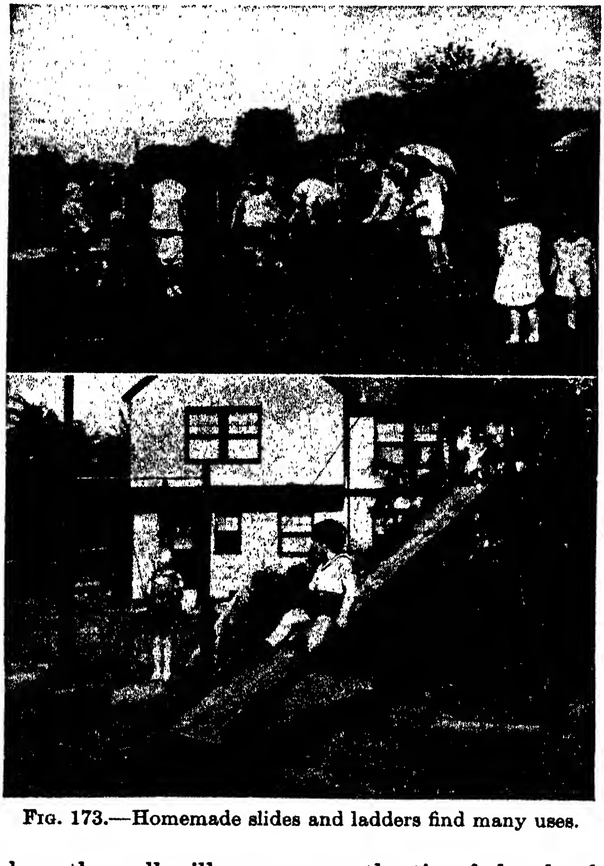

Fig. 173.—Homemade slides and ladders find many uses.

the child, or the pull will come upon the tip of the shoulder and will cause the shoulder blade to spring out, producing the very common postural defect known as "angel wings." This, by narrowing the chest, makes it impossible to fill the apices of the lungs with air. Any type of garment may have this effect if not properly fitted. The most vicious example is found in the type of commercial "waist" having an array of buttons about the waist line to which skirts, drawers, and supporters are attached. Directly under, or worse, in front of, the arm will be found the stocking supporter. In order to keep stockings from wrinkling down as the child jumps and runs, especially if the

Fig. 174.—Homemade slides and ladders.

stockings are as easy-fitting as they should be, the elastic must be snugly adjusted. This brings a constant pull upon the loosely adjusted shoulder girdle of the child (see Fig. 175). Rounding his shoulders makes it necessary for him to throw out his abdomen in order to maintain his balance on his feet. The rachitic and undernourished child, of course, shows the most marked and lasting injury.

The modern method of sidestepping the garter problem by wearing only short socks, leaving the leg bare from ankle to short pantie, is all right for the warm house or for warm weather. No child should be so exposed in cold weather. Too much strain is imposed on the heat-regulating mechanism of the small body, and children with low resistance may be seriously injured. Bloomer bands or elastics should never be tight enough to leave

FIG. 175.—Wrong type of stocking supporter. Note how the pull upon the shoulder distorts the scapula (shoulder blade).

a mark on the skin. Keeping the fashionable long trousers in place on the active, waistless boy by means of a belt is a striking example of the irrational lengths to which custom will lead. In houses that are warmly and evenly heated it is good practice to dress the preschool child exactly the same in winter as in summer when indoors. For outdoor wear one-piece coveralls with zipper fastenings provide even protection for the entire body, and do not restrict movement.

Feet, Shoes, and Posture.—The human animal needs a large foot surface to support his difficult upright posture. A relatively large surface of support should be considered to be a mark of beauty and efficiency. Fortunately, there is no tendency in

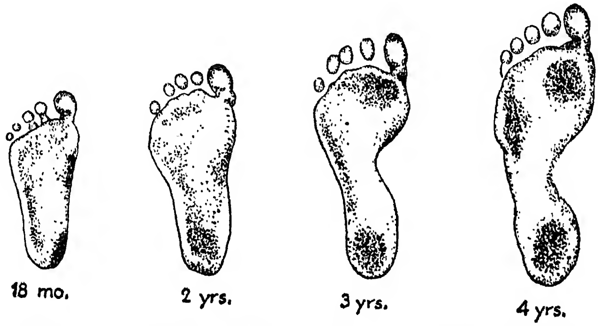

FIG. 176.—The foot at different ages. Note the gradual development of the lateral and transverse arches.

America to cramp the foot of the growing child. Children's shoes are not always well shaped, however. The delicate mechanism of the foot should be carefully safeguarded, and every parent should watch this continuously from the first steps or, rather, the first stocking, until adulthood.

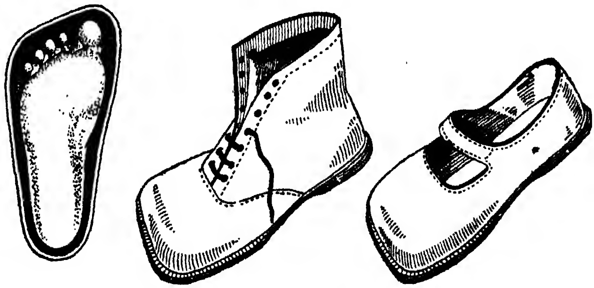

FIG. 177.—Proper shoes.

The natural foot spreads in order to furnish support in walking. In a way, the heel is the equivalent of the hind legs of the quadruped; the ball of the foot, the equivalent of the front legs. In walking, the weight rhythmically shifts from heel to ball. The long arch is the shock absorber which breaks the jar and protects the nervous system, especially the spinal cord, from a measure of the forceful impact with the ground.[1] Flat-footed people tire quickly in standing or walking.

Under the ball of the foot is a small transverse or "anterior" arch, which acts as a spring or shock absorber when the weight shifts from the heel to the toe. Only the pads under the ball of the foot just behind the great and small toes should touch the ground in the adult foot. The blood and nerve supplies of the foot are protected by the arches. When the anterior arch is flattened by bad shoes, which throw undue weight upon the center of the arch, walking becomes painful because of pressure upon these nerves. Whereas the four-footed animal has no use for shock absorbers or springs, we find these called into being by use. The infant and the toddler have a primitive foot, usually with no arches. The foot may in some children be in contact with the floor until thirty to thirty-six months of age, owing to the early cushion of fat, which may, however, disappear before one year. The child, through use in walking, jumping, etc., should develop both long and transverse arches; but shoes which give perfect freedom to the entire mechanism, especially to the ankle and the long arch, are necessary. Children should go barefooted as much as possible and should wear only shoes with perfectly flexible shanks.

The great toe is the chief remnant of the prehensile or gripping structure of the primitive foot. If permitted to function, it still serves a very useful purpose in gripping the ground and steadying the body in its walking progress. Fatigue is minimized and good posture promoted if the individual can have the service of his great toe. The two points of importance, then, in the hygiene of the young child's foot are (1) protect the great toe, and (2) protect the development and use of the arches.

The great toe is frequently bent and deformed before the child even stands upon his feet by having his soft little foot crowded into a stocking that he has outgrown or that has shrunk in washing. After he gets upon his feet the mother should watch carefully that he does not outgrow the inner line of his shoe and begin to bend the toe, and also that his stockings do not become too short. *Short stockings may do as much harm as short shoes.*

[1] Morton, Dudly J., "Evolution of the Longitudinal Arch of the Human Foot," *Journal of Bone-joint Surgery*, January, 1924.

Shoes should be flexible, with long, straight inner line and broad toe, and the soles should project far enough to protect the foot, but not far enough to be in the way. "We spend all our lives in our shoes or in our beds." Both become important, especially to the young child.[1]

In most modern houses, which are kept at a fairly uniform winter temperature of 70° or more, it would probably be highly beneficial if toddling children habitually went barefooted and wore the same one-piece garment they now wear in the summer. This would make for better structural development, better body

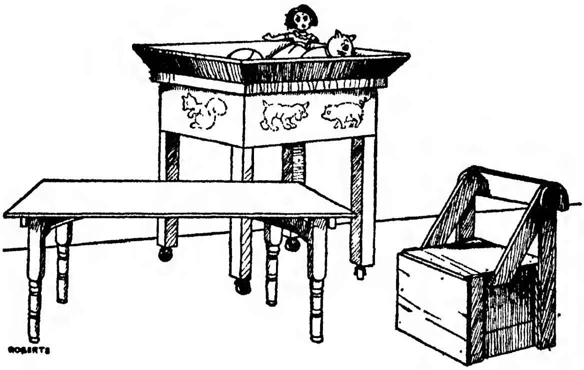

Fig. 178.—Homemade chair; shortened sewing table; homemade sandbox. (*Department of Home Economics, University of Kansas.*)

mechanics, and also for better circulation and better functioning of the skin.

Furniture and Posture.—The child is commonly ignored in planning and furnishing the home, and in many homes the child has no choice between the floor and adult chairs and tables. The result is that he crouches continually over his playthings. It is important that he should have a chair and a play table as carefully adjusted to his size as are the full-sized chair and table for the use of the adult. Since the child will need several sizes of these as he grows, both chair and table may be made from boxes, or a table may be made by sawing off the legs of a used table, and the cost thus reduced to a minimum.

[1] Sweet, Watson, and Stafford, "Physiological Changes in Posture during the First Six Years of Life," *Journal of the American Medical Association*, Nov. 17, 1928.

Children's chairs should have open backs (see Fig. 178) in order that the child may have his shoulders rest against the back of the chair, his feet touch the floor, and his hips and knees assume the angles natural for the child.

Body Mechanics.—The Subcommittee on Orthopedics and Body Mechanics of the White House Conference on Child Health and Protection, of 1930, recommends that, wherever possible,

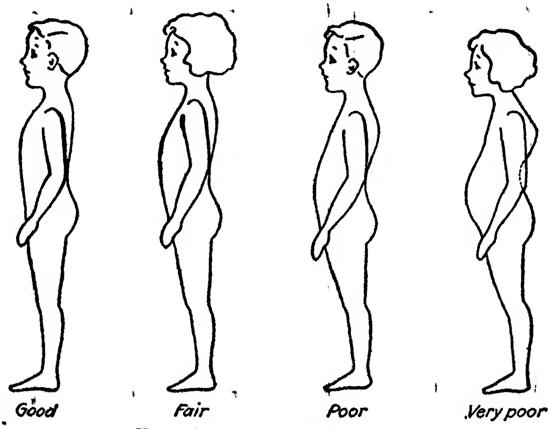

FIG. 179.—Types of posture.

instead of the term *posture*, the term *body mechanics* be employed as being more inclusive and descriptive.

Body mechanics may be defined as the mechanical correlation of the various systems of the body with special reference to the skeletal, muscular, and visceral systems and their neurological associations. Normal body mechanics may be said to obtain when this mechanical correlation is most favorable to the function of these systems.[1]

An exhaustive analysis is given of the factors of posture and associated defects. A report is given of all available studies of the incidence of poor posture among groups of various ages, and the conclusion is drawn that "perhaps 75 per cent of the male and female youth of the United States exhibit grades of body mechanics which, according to the standards of this Subcommittee, are imperfect."

[1] *Body Mechanics: Education and Practice,* Report of the Subcommittee on Orthopedics and Body Mechanics of the White House Conference, D. Appleton-Century Company, Inc., 1932.

The association of good body mechanics with good health and of poor body mechanics with poor health is a difficult matter to determine, since good health depends upon so many factors. There is considerable experimental evidence, however, that good body mechanics and good health have a definite correlation.

The Subcommittee believes that there is evidence to show that good body mechanics and good functional health in children go hand in hand and that poor body mechanics and poor functional health are commonly associated. It believes that there is evidence to suggest strongly that good body mechanics may bear a causal relation to good functional health and poor body mechanics may bear a causal relation to poor functional health.[1]

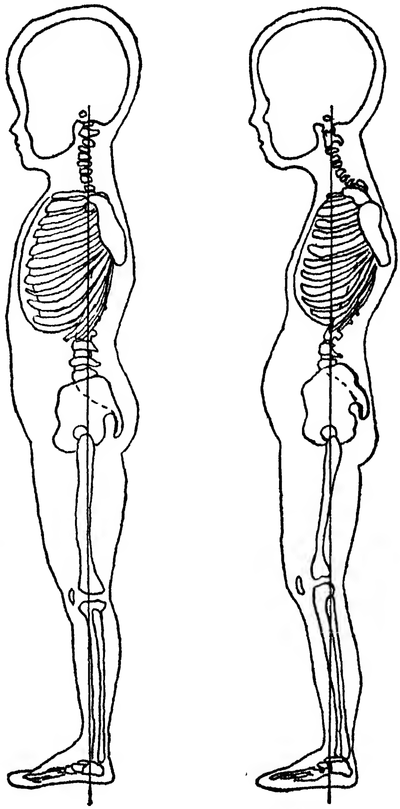

FIG. 180.—The mechanics of good and poor posture. (*From The Child from One to Six, Federal Children's Bureau.*)

Correction of Postural (Mechanical) Defects.—The first thing to do in correcting defects of bodily adjustment is to remove causes. If poor nutrition is a factor, the child's general condition must be brought up to par. The child's clothing must be scrutinized, also his environment: his bed, chairs, etc.

The second step is the provision of interesting incentives to stretch the body, to swing by the arms, to climb, to turn, to throw —in short, to use the "big muscles." Most children will correct their own defects when the factors causing them are removed.

[1] *Ibid.*

If in the course of weeks or months continuous improvement is not noted, more intensive measures may be necessary.

The third step is the employment of corrective measures. The advice of an orthopedic specialist should *always* be obtained in the case of pathological changes from infantile paralysis, injuries, etc. Where the mechanical defects are merely the result of faulty habits or faulty environment, corrective exercises may be used advantageously. It must be remembered, however, that *first and always the child should be happy*, and efforts at correction must not become irksome or coercive. It is of no use to say to the toddler "Straighten up! You want a nice, straight back, don't you?" He is not developmentally ready (see Chap. XIII) to understand this; a crooked back may even be more interesting to him than a straight one! He will enter joyfully, however, into playing "duck," "giraffe," and other corrective games. He should not know the purpose of these, and should be protected from the idea that he is different from or inferior to other children.

In *The Preschool Child and His Posture*, delightful posture games are pictured and described.[1] The important items are, however, nutrition and freedom; and the resultant happy, vigorous activity will do wonders in straightening and aligning even marked distortions and deviations from symmetry.

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CHAPTER XXXVI

THE HYGIENE OF CHILDHOOD: SLEEP

Baby, baby bright,
Sleep can steal from sight
Little of your light:

Soft as fire in dew,
Still the life in you
Lights your slumber through.

Four white eyelids keep
Fast the seal of sleep
Deep as love is deep:

Yet, though closed it lies,
Love behind them spies
Heaven in two blue eyes.

ALGERNON CHARLES SWINBURNE.[1]

The Physiology of Sleep.—Science is still unable to explain the phenomenon of sleep. The fact that in all nature the period of sleep ordinarily coincides with the period of diurnal darkness seems to indicate that sleep is an evolutionary adaptation. This does not, however, explain the essential and indispensable relation of sleep to life, nor the existence of extensive "night life." There are several theories as to the cause of sleep, no one of which is supported by conclusive proof. It is more than likely that the process is exceedingly complex and that all the causes assigned are involved, and doubtless others.

It has been suggested that sleep is purely a chemical matter due perhaps to cumulative acidosis, to depletion of intramolecular oxygen, to accumulation of fatigue toxins, etc. Another theory is that the synapses (see page 176) between the cortical brain cells and the fibers in the nerve paths communicating with the rest of the body become temporarily discontinuous—switched off, as it were. A third theory is that the blood supply to the cerebral cortex is periodically diverted, producing a temporary anemia. A theory in favor at the present time—one which is supported by recent research—is that there is a sleep center in the brain, in the hypothalamus (see page 197).

Among the body functions, tissue metabolism, food digestion, and body temperature do not markedly vary in sleep from the

[1] "Cradle Songs," *The Poems of Algernon Charles Swinburne*, Gabriel Wells, 1925.

waking state; muscle tone, pulse rate, and higher reflexes are diminished.

Growth and Sleep.—The animal grows while it sleeps. The infant sleeps most of the time and accomplishes the prodigious feat of doubling his weight during the first five or six months of his life. It will be noted that the sleep curve in Dr. Bühler's investigation of sleep resembles closely the curve of general growth for the first year as shown in Figs. 166, 168. No child who sleeps less than his system demands will achieve his full potential growth. A period of sleep reduction because of excitement or fatigue may register in the weight curve as definitely as does digestive disturbance. Experimental animals bear loss of sleep less well than they do loss of food.[1] The energy expenditure is greatly reduced during sleep. The body is not made to withstand constant activity. It must rest.[2]

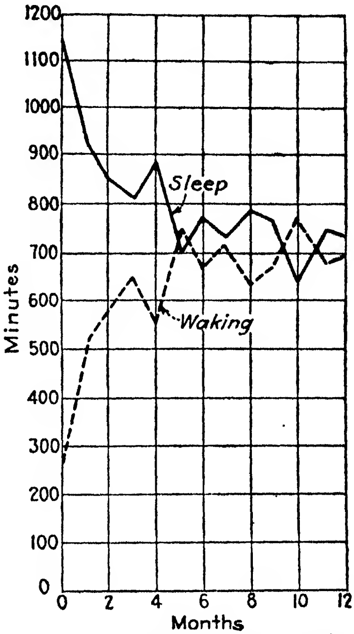

FIG. 181.—The day value for sleep and waking in minutes. (*From Charlotte Bühler, The First Year of Life, John Day Company.*)

Bodily Activity during Sleep. The Simmons Study of sleep was made by the Mellon Institute of Industrial Research of the University of Pittsburgh. One of the interesting discoveries is the fact that no one "sleeps like a log." Even a more than ordinarily quiet sleeper changed his position radically 33 times in 8 hours and 25 minutes.

These investigators say that muscle tire, visceral pressure, the increased heat on surfaces of contact with the mattress

[1] MANACEINE, MARIS DE, *Sleep; Its Physiology, Pathology, Hygiene, and Psychology*, p. 65, Walter Scott, London, 1897.

[2] ROSE, MARY SWARTZ, *The Foundations of Nutrition*, The Macmillan Company, 1938.

(reaching 96° in 20 minutes), the tendency of muscle colloids to gel under complete inactivity, the fact that rhythmic muscular contraction plays a role in the return of the venous blood to the heart—all make frequent movement imperative to bodily comfort and well-being.

Not only is the frequency of movement significant but also the range of movement. On a level bed an individual sleeping alone tends to assume symmetrical attitudes in turn such that he relieves each side and each part of his body in succession and equally.[1] The individual who sleeps with another person is more or less restricted in the range of his movements, and he is unable to relieve fatigue and tension of all parts of his body to the natural and complete extent.

These observations support the commonly stated rules of sleep hygiene to the effect that the young child should sleep alone and that he should have the same complete freedom of movement during sleep that he requires when awake.

The following tables give the result of the observation on more than 100 subjects.[2]

Average Rest Periods of Healthy People (during Sleep), in Minutes

Age	Most active individual	Least active individual	Most typical individual
Children two and one-half to four years	5	10	7
Unselected college men	7	22	13
College athletes (varsity) during playing season:			
Basketball players	8	15	11
Football players	7	12	10
Middle-aged men	6	13	9
Wives of middle-aged men	8	15	11

There is a prevailing belief that the healthy infant or small child sleeps profoundly and with little movement. Actual observation seems to show that even the newborn child has relatively short intervals of profound slumber and makes many

[1] Johnson and Sevan, "Sleep," *Psychological Bulletin*, January, 1930.

[2] Johnson, H. M., "How Should Healthy People Sleep?" *Good Health*, September, 1930.

movements during sleep, even though sleeping occupies most of his total time. Dr. Charlotte Bühler of Vienna, in a very detailed report on the behavior of children during the first year of life, comments on the relatively short sleep intervals, and while she does not present a tabulated report of this matter, her individual schedules present a picture in accord with the American observations as to activity during sleep. For example, the observation of a newborn boy contains the following comments in succession as to sleep activity during the first two days of life:

> Trembles as the cover is momentarily removed, makes several restless movements. . . . Moves in his sleep without outside reason. . . . Opens his mouth while asleep. . . . Aimlessly he moves his arms up and down his face. . . . Impulsive movements of the arms interrupt the immovability of the child. . . . Moves arms, makes sounds of discomfort, moves lips in sucking fashion without opening his eyes for a moment. Quietly he continues sleeping. . . . Moves his head restlessly, begins to cry lightly, sleeps on. Rubs his face with his fist, lifts covers with his hands restlessly, continues to sleep. . . . Makes a slight sound, the hands move restlessly, sleeps on. . . . Breathes deeply, turns his head, sleeps on. Makes a few restless movements in his sleep. . . . [1]

Dr. Bühler comments on the fact that the sleeping periods of the newborn were unexpectedly brief and gradually increased in length during the first year. She says that the average number of sleeping periods per 24 hours in the first quarter of the year amounts to 12, in the second to 11, in the third to 7, and in the last quarter of the first year of life to 6. She found in all children a surprising number of very short sleeping periods of only a few minutes each.

Giddings found that children have characteristic individual sleep patterns which vary little in health.[2]

How Much Sleep.—It is only recently that actual research has been initiated as to the definite sleep needs of children. There is as much individual variation in this as in food, exercise, and all other physiological functions. However, certain basic

[1] Bühler, Charlotte, *The First Year of Life*, pp. 114–115, The John Day Company, 1930.

[2] Giddings, Glenville, "Normal Sleep Pattern for Children," *Journal of the American Medical Association*, Feb. 17, 1934.

similarities enable us to make general rules that fit the majority of cases, just as rules have been made concerning the use of milk and eggs, although these have to be modified for particular children. In general, the investigations which have been made of the actual sleep habits of young children in the nursery schools of Chicago University, Toronto University, Minnesota University, and elsewhere[1] show that these children actually sleep less than has been declared to be theoretically desirable. It remains to be determined by carefully controlled observation what is the *optimum* amount of sleep under varying ages and circumstances.

Dr. Bühler found that the newborn spend 80 per cent of the average 24 hours in sleep and that this decreases to 49 per cent at one year. The following table gives the result by bimonthly intervals in percentage,[2] while the chart expresses the same in a time-age graph (see Fig 181).

THE DURATION OF THE WAKING AND SLEEPING STATES WITHIN 24 HOURS, IN PER CENT[1]

Age in years and months	0;0	0;1–0;3	0;4–0;6	0;7–0;9	0;10–1;0
Sleep................	80	60	55	53	49
State of waking......	20	40	45	47	51

[1] Charlotte Bühler.

The Children's Bureau of the U. S. Department of Labor, in the bulletin on infant care, says that

A very young baby should sleep from 20 to 22 hours out of 24; during the second and third months about 18 to 20 hours. When the baby is six months old he should sleep about 16 to 18 hours—12 hours at night with only one interruption for a feeding and 2 or 3 hours in the morning and 1 or 2 hours in the afternoon. . . . At six months of age the after-

[1] BOYNTON and GOODENOUGH, "The Posture of Nursery-school Children in Sleep," *American Journal of Psychology*, Vol. 42, 1930; also CHANT and BLATZ, "A Study of Sleep Habits of Children," *Genetic Psychology Monographs*, July, 1929; "The Simmons Sleep Investigation," *Journal of Home Economics*, May, 1930.

[2] BÜHLER, *op. cit.*, p. 130.

noon nap should not last later than 3 or 3:30, lest it keep the baby from sleeping at night.[1]

A study of the sleep of young children has been made by the Institute of Child Welfare of the University of Minnesota in order to determine the amount of time spent in sleep by children between six months and eight years of age. Data obtained from the records of 1,186 children over a period of 7 days in October, 1927, show the mean total sleep during 24 hours for children from six months to one year to be 14 hours, 1.4 minutes; from one to one and one-half years, 13 hours, 22.4 minutes; one and one-half to two years, 13 hours, 21.1 minutes; two to two and one-half years, 12 hours, 48 minutes; two and one-half to three years, 12 hours, 29.5 minutes; three to three and one-half years, 12 hours, 16.8 minutes; three and one-half to four years, 11 hours, 57.5 minutes; four to four and one-half years, 11 hours, 48.8 minutes; four and one-half to five years, 11 hours, 36.7 minutes; five to five and one-half years, 11 hours, 22 minutes. The mean amount of sleep is thus seen to decrease with advancing chronological age and is definitely lower than that recommended by most writers. No sex differences are shown.[2]

At the Washington Child Research Center observations were made of the sleep of nursery-school children. A unit of 34 children who were checked for 30 days showed that the average night's sleep for two-, three-, and four-year-old groups was nearly the same. The two- and three-year-olds averaged 11 hours and 6 minutes, the four-year-olds, 11 hours and 2 minutes.

In the Washington study just quoted it was found that the older children went to sleep more quickly than the two-year-olds, the latter requiring an average of 27 minutes, while the three- and four-year-olds required an average of 20 minutes.

The correlations indicate that the later the children were put to bed the longer it took them to go to sleep, and their total length of sleep was shorter than that of children who went to sleep earlier.[3]

[1] *Infant Care, Children's Bureau Publication* 8, U. S. Department of Labor, Washington, D. C., 1938.

[2] *Public Health News*, Alameda County, California, December, 1928.

[3] WHITE, MARGARET RICHIE, "Some Factors Affecting the Night Sleep of Children," *Child Development*, September, 1930.

Lydia Roberts gives the following table of sleep requirement based on her observations of nursery-school children and older children, which is also somewhat less than that stipulated by most authors.[1]

THE MINIMUM SLEEP REQUIREMENTS OF NORMAL CHILDREN

Age	Hours of sleep not less than	Bedtime not later than
2 and 3	12½	6:30
4 and 5	12	7:00
6 and 7	11½	7:00
8 and 9	11	8:00
10 and 11	10½	8:00
12 and 13	10	8:30
All through the growing period	9	9:00

It is generally conceded that "sleeping round the clock" is a valuable habit which should be continued as nearly as possible throughout the growing years. To this should be added naps to make up the gradually diminishing sleep quotient of the child. The two naps will become short in duration and finally, between two and three years of age or earlier, should be merged into one. When the child goes on a definite four-meal schedule the logical time for the nap will be right after the second meal, which will probably be about 11 A. M. He "sleeps his sleep out," and will be ready to go to bed again at 6 or 7 P.M. If the day is not broken evenly by the nap, the child will become too tired during the long morning and may be too nervous and irritable to go readily to sleep; then he will sleep late in the afternoon and will object to going to bed at the usual time and be unable to sleep if he is forced to go.

Too often mothers interpret inability to go to sleep as an indication that the child needs less sleep, when it may be really an indication of overfatigue and nervous excitement. Certainly every child should sleep all he can sleep, and conditions should be made favorable for regular and maximum hours of sleep.

[1] ROBERTS, LYDIA J., *Nutrition Work with Children*, p. 181, University of Chicago Press, 1935.

Time Required to Go to Sleep.—Some of the present confusion as to total hours of sleep is doubtless due to failure to deduct the time spent in going to sleep from the time spent in bed. It is a matter of surprise to discover that it takes even young children, or perhaps we should say, especially young children, a long time to go to sleep. The report of one investigation using 100 subjects states that it takes children 2½ to 4 years of age an average of 36 minutes to get to sleep. College men, 13 minutes; middle-aged men, 15 minutes; the wives of middle-aged men, 13 minutes. Garvey found that children between two and five years of age require 30 to 35 minutes to go to sleep and that the intervals of sleep averaged 6 to 8 minutes.[1]

The Hygiene of Sleep.—Conditions must be favorable for sleep to the extent that the child is made comfortable, the house free from new and unusual noises, and the child's mind quiet and tranquil.

Comfort means a bed large enough to permit the child to stretch out freely in any position he pleases, a mattress that does not sag, and light, warm covering so arranged that it does not restrict freedom of movement (see page 420). Fresh air should be the rule both night and day.

Noise.—Children should be conditioned from the first to ignore the noises occasioned by the regular household machinery. New or unusually loud or sudden or harsh noises should be avoided if possible. It is a mistake to restrict the necessary activities of the family during the child's sleep except temporarily in case of illness.

Mental Quiet.—A wide-awake, excited brain cannot stop functioning abruptly. Exciting play, exciting stories, disciplinary conflict should be avoided in the late afternoon and evening. Quiet, happy stories, especially the monotonous repetition of favorites, quiet, happy conversation, or recitation of rhythmic poems will prepare the child's mind for sleep. Some parents believe it is better to accustom the child from the earliest establishment of habits to go to bed at the stroke of the clock and have the light turned out and be left alone as a matter of course. Both methods have their points. On the one hand, the bedtime

[1] Garvey, C. R., *The Activity of Young Children during Sleep*, The University of Minnesota Press, 1939.

hour may be the father's only opportunity to establish friendly contact, and the memory of the bedtime hour may be one of the child's life treasures. On the other hand, the child may be inclined, as he grows older, to prolong the delights of the situation, demand the light, drinks, more stories, and exploit the over-indulgent parent. From the reported observations as to the time it takes a child to go to sleep it would seem that the psychology of this drowsing off is important. The infant should become pleasantly accustomed to darkness and the older child to enjoying his own thoughts.

Basically, always, the child must be sleepy before he can go to sleep, just as he must be hungry before he will willingly eat. *The mother's real problem is the arrangement of a program that will bring her child to the table hungry and to the bed sleepy.*

In any event, the child should go to bed happy and at peace with the world. This is not accomplished by indulgence, as the indulged child is never tranquil or happy. The happy child is the one who is well fed, healthily tired, and as free from worry as a puppy, and one who accepts the established routines of his life because he has never discovered that things could be different.

Sleeping in the Dark.—Fear of the dark is an acquired and not an instinctive fear. Like all other difficulties of childhood, it is more easily prevented than corrected. Many children demand the light because they share the room with adults who commonly have the room lighted after the child has gone to bed. If a light is necessary at night, a very dim night light should be used, and a strong light should never be turned on the sleeping child's face. Neither should he be expected to go to sleep in a light room, for that is unnatural and tends to prevent deep and restful sleep. The psychology of fear of the dark is discussed on page 452.

Urinating at Night.—Children should be trained to get up regularly during the night to void urine. Not all children can safely and comfortably go 12 hours without emptying the bladder. Some older children will do this, but it may involve too much distention of the bladder and pressure upon other pelvic and abdominal organs. The other alternatives are wetting the bed, which is one of the most distressing and difficult and unnecessary problems of childhood; or waking early in the morning because of discomfort and finding it impossible to go to sleep again. This is most likely to occur with the high-strung child who most needs the sleep. Training the child at night involves training the parent during the first few years, but the habit of awaking regularly to conduct the child to the toilet becomes automatic and almost unconscious, and the child who is thus trained comes to take care of himself often by the age of four or five and will make the trip without fully waking.

Other Conditions.—The child who has a cold should have the nasal passages thoroughly cleaned with oil at bedtime and when he urinates in the night. This will help him to secure the restful sleep he especially needs to resist the infection.

No child should go to bed with the bowel loaded with fecal matter. If the bowels have for some reason not moved at the usual time, a small soapsuds, a normal salt solution, or an oil enema should be given before bedtime to minimize the absorption of toxins and to protect the nervous system from reflex irritation (see page 424).

Sleep in cool or cold air is most refreshing because it is more stimulating to respiration and circulation. In the Minnesota investigation it was found that the children slept best in a temperature of 55° to 58°.

It is needless to say that young children should never be taken to movies or permitted to stay up past the bedtime hour because of company or other special occasion in the home. It takes heroic courage to avoid this sometimes, but it saves much trouble in the end, both physical trouble for the child and disciplinary trouble for the parent.

"Tired Nature's sweet restorer, Balmy Sleep," is the friend of childhood.

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CHAPTER XXXVII

THE HYGIENE OF THE HEAD

The First Tooth
(Sister's Lament)

Through the house what busy joy,
Just because the infant boy
Has a tiny tooth to show.
I have got a double row,
All as white, and all as small;
Yet no one cares for mine at all.
He can say but half a word,
Yet that single sound's preferred
To all the words that I can say
In the longest summer day.
He cannot walk, yet if he put
With mimic motion out his foot,
As if he thought he were advancing,
It's prized more than my best dancing.

MARY LAMB.[1]

Teething and the Teeth.—The growth of the teeth is a continuous process from seven months before the child is born until the wisdom teeth reach full size. It is only when the teeth cut through the gums that we become aware of the development of the teeth. Except for the slight soreness that accompanies the pushing through the tougher outer layer of the gum, the process of "teething" which we see is no different from the process going on all the time which we do not see.

Teething should never make a child sick, although it may make him fretful and irritable, and he may not eat so well because his gums hurt. Since the teeth appear during a period when the child is changing his diet and is especially liable to digestive troubles, a superstitious notion has prevailed that the teeth were to blame for most of the illness the baby incurs during this period. This led to neglect of many serious conditions. A healthy child who is properly fed and cared for will seldom know

[1] From *The Works of Charles and Mary Lamb,* Vol. III, Books for Children. By permission of The Macmillan Company, publishers.

when his teeth come through or show any indisposition. Once in a long time a child may have abnormally difficult eruption of its teeth and suffer considerable pain. Special care should be taken in the feeding of such a child. It should be fed easily digestible food and given all the water it will drink, and taken to a doctor.

Time of Eruption.—The first teeth to show are usually the two central cutting teeth, or incisors, on the lower jaw, which appear between the fourth and sixth months. The two central upper incisors may come next between eight and twelve months. The two other cutting teeth on the lower jaw will usually come next, making eight cutting teeth (incisors) by the end of the first year. The first grinding teeth, or molars, come between twelve and fifteen months, one on each side, above and below. The "eyeteeth," or upper canines, and the "stomach teeth," or lower canines, appear between eighteen and twenty-four months. These come in at the "corners" or angles of the jaw, between the incisors and the molars. The second four grinders, or molars, appear between twenty-four and thirty months, making 20 temporary or "milk teeth" by the time the baby is two and a half years old.

FIG. 182.—Jaws of a six-year-old child showing the permanent teeth developing behind the temporary teeth. (*From Morris, Human Anatomy, P. Blakiston's Son & Co.*)

The first permanent teeth are the third set of four grinders, commonly called the "six-year molars," which come through between the fifth and sixth years. It is very important that the first permanent teeth should not decay. The shape of the jaw will be changed and the upper and lower teeth will never fit together correctly if any of these teeth are lost. Many parents do not know that these are permanent teeth and fail to appreciate their importance to the child.

The next quartet of permanent molars comes through at about twelve, and the last set, the "wisdom teeth," begin to erupt at about eighteen, making 32 permanent teeth. The child commonly loses all his milk teeth between the ages of six and twelve years.

Diet and the Teeth.—The pregnant woman who does not eat enough bone-forming food or receive sufficient vitamins and sunlight is robbing her unborn babe of good teeth. Many children have poor, soft teeth for this reason; also for the reason that such a mother cannot make good, bone-forming milk for

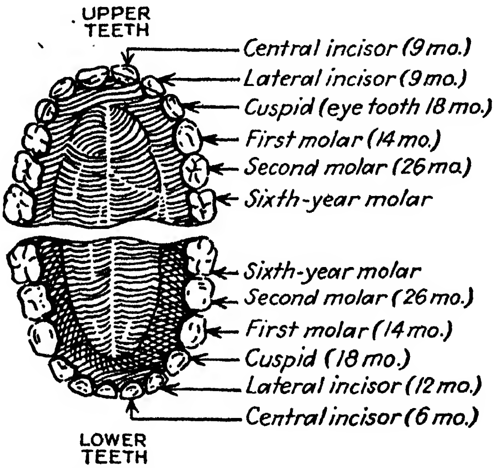

FIG. 183.—The temporary teeth with order of eruption; also the first permanent teeth, the "six-year-molars."

her babe after it is born. Bone-forming diet is important for both mother and child. All the "care" in the world cannot save poor teeth or make good teeth out of poor ones. Milk, whole-grain cereals, and plenty of fresh fruits and vegetables are necessary to good teeth. As we have seen in the chapters on food, vitamin D is essential to the utilization of bone-forming food. It is now known that vitamin C (see page 262) is of great importance in the growth and preservation of the dental structures by virtue of its control of connective tissue and intracellular cement. This is, of course, additional reason for liberal use of orange and tomato juice and leafy vegetables in the early diet of the child. In short, the *balanced diet* is essential to growth and health of the teeth, as is true of all other body structures.

Using the Teeth.—The baby should use his first teeth, at their earliest appearance, upon a hard crust or very hard cracker. Every day from that time on he should be given something upon which to practice chewing. *All through a child's growing years he should be encouraged to chew,* for chewing separates and spaces the teeth properly in the jaw, toughens the gums, stimulates circulation and development, and also aids in digestion.

Care of the Teeth.—From the time the milk teeth are all showing the child should be provided with a child's soft toothbrush and shown daily how to brush up and down, inside and out. This is the imitative age, and habits formed during these years last through life.

It is not necessary to use anything on the brush, as the natural fluids of the mouth are sufficiently cleansing, provided the teeth are mechanically cleaned and food is not left to decay between them. Children will enjoy the procedure more, however, if a little salt is placed on the brush, and this also tends to toughen the gums. There is no objection, however, to the use of good unsweetened tooth pastes and powders.

The soft brush should be replaced by slightly stiffer brushes as the child grows older. The parent should never neglect to see that the child has a good brush, frequently renewed, and that he takes care of it and uses it daily. A dirty toothbrush is much worse than none, since infective germs adhere to it and multiply in enormous numbers. Indeed, there seems to be a growing feeling that the toothbrush as ordinarily used may not afford the protection we have imagined.[1]

[1] Doctor Osborn describes a substitute for the bristle brush called *Re Vira* which consists of compressed pledgets of cotton which are inserted in a holder—each pledget used once and thrown away. A brush that is too stiff may leave small abrasions in the gums in which germs readily grow. The same may be said of the use of toothpicks and dental floss. In Dr. Osborn's opinion, thorough rinsing of the mouth after eating is better. OLIVER T. OSBORN, *What Every One Should Know*, p. 16, Charles C. Thomas, Publisher, 1929.

HIRSCHFELD, ISADOR, *The Toothbrush: Its Use and Abuse.* Dental Items of Interest Publishing Co., New York, 1939.

Some hygienists advocate having the child (and adult) end the meal with the chewing of a piece of raw fruit, celery, or other alkaline-producing chewy food, instead of, or after, the usual dessert or sweet. This stimulates secretions, mechanically removes sticky carbohydrate residue, neutralizes acids, and leaves the mouth clean and normal.

Dental specialists seem now to agree that dental decay in children is often associated with excess of sweets and carbohydrates, which also means corresponding deficiency in minerals and vitamins.[1]

Dentistry.—If the child is healthy and the teeth are never neglected from infancy onward, stain and tartar will not be likely to collect on them. If the teeth should collect stain that will not brush off, the mother may take burnt matches and try to scour it off, applying the charred end to each tooth in succession as daintily and thoroughly as if scouring a piece of jewelry. If she is still unsuccessful, the child should be taken at once to a dentist to have the teeth cleaned and polished, because such deposits hold and harbor germs and start spots of decay. Whenever the smallest cavity appears, it should be filled at once. A soft filling will stop the decay; it will not hurt to have it filled, and it may save ill-health, suffering, and money.

A mother should never go a second time to a dentist who says, "It is not worth while to fill milk teeth; they soon come out anyway." She should go at once to a more up-to-date man who appreciates the importance of good teeth for growing children. Modern dentists are keenly alive to the importance of the care of the teeth in pregnancy and infancy, and especially of the role of diet. The family dentist should be as much an "institution" as the family doctor. He should be paid to look after the teeth of all the members of the family regularly. calling them in at necessary intervals for this attention.[2]

The second teeth will seldom be better than the first teeth. It is now known that many of the serious diseases of later life are caused not only by neglect of teeth in later life but by neglect

[1] "Sugar and the Teeth," *Journal American Medical Association*, November, 1938.

[2] "Preventive Dentistry," pp. 189–191, *American Journal of Public Health*, June, 1931.

in childhood. No parent who realizes this will permit a child's teeth to decay.

The Nose and the Sinuses.—*The nose* is the organ of air control. It is more complex and more important than is commonly understood. The hygiene of the nose is especially important in a climate that exposes its mechanism to extremes of temperature, humidity, and dust content. It is important that the child should have and keep a normal air organ, since disease and

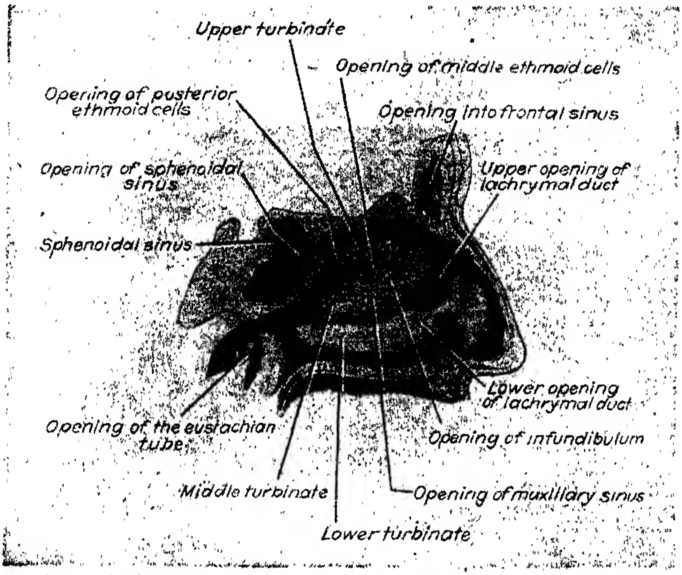

FIG. 184.—The left wall of the human nose showing the various openings.

impairment of the nose in childhood may persist in various chronic derangements.

The septum, or partition, between the nostrils (nares) is sometimes incompletely developed and sometimes becomes bent or displaced by a fall or a blow. It is important to have this condition corrected, since the interference with the circulation and the pressure upon nerves may cause pain and obscure headache and also create a condition favorable to the development of infection.

Projecting from the external walls of the nostrils are three shelflike structures, called *turbinates* (see Fig. 184). These are cleverly arranged for the purpose of creating a maximum surface of exposure to the inspired air and of slowing down the passage of air through the nose, giving it time to become warm, moist, and clean. The entrance to the turbinate passages is guarded by coarse hairs, which strain out larger particles of foreign matter from the air.

Opposite the posterior openings of the nares, on the back of the naso-pharynx, or upper part of the throat, is found the adenoid mass described on page 133, against which the air strikes as it is forcibly drawn through the narrow turbinate passages.

The turbinates and nasal walls are covered with a ciliated mucous membrane, under which lie many secretory glands, which keep the surface moist at all times in health. When irritated by chemicals, bacteria, heat, or cold, these glands can, on occasion, such as when pepper is inhaled, or during an acute cold, pour forth copious amounts of fluid secretion. Normally the nasal secretion is small in amount, highly viscid, and midly antiseptic. The cilia of the membrane are always in motion, waving toward the exterior like a wheat field in the wind, thus bringing dust and irritants out of the interior of the cavity to be expelled in the nasal secretions.

The blood supply to the membrane is generous. It is found in part in a spongy erectile tissue, which becomes congested quickly, thus closing off the narrow passages between the turbinates. This reaction is doubtless protective in shutting off the entrance of air that is injurious, such as very cold air or air containing irritant gases, or during acute "cold" infection, or air containing the pollen proteins that cause hay fever.[1]

It will be seen that air when inhaled is strained, washed, warmed, sterilized, and moistened during the instant in which it is being drawn through the nares. The individual who must draw his air through his mouth has none of this protection. By actual experiment, the air which leaves the nose to pass into the lungs is shown to have had an incredible number of bacteria destroyed, as compared with the air as it entered the nose.

The hygiene of the nose is chiefly the hygiene of ventilation. Of all the possible faults of ventilation, dryness with heat is perhaps the most injurious to the nasal structures. The dryness

[1] Kirkpatrick and Huettner, *Fundamentals of Health*, pp. 297–299, Ginn and Company, 1931.

of freezing air is stimulating, increasing the flow of secretion in order that the inhaled air may be brought near to the body temperature before entering the lungs. The dryness of hot air, however, debilitates these protective mechanisms, small abrasions or cracks occur, and the entrance of the great variety of respiratory infections is invited. *It is very important that the young child shall breathe only cool, moist, moving air, free from dust and disease germs.*

The sinuses are hollow places in the skull (dead-air spaces) which are connected with the nasal cavity by tubular passages. The principal sinuses are those over the eyes (frontal sinus) and in the cheek bone (the antrum) (see Fig. 184). Infection may pass from the middle ear (via the eustachian tube) into the mastoid cavities behind the ear. Infection may also reach ethmoid and sphenoid cells behind the nose; and traverse the tear ducts, which carry secretions from the corners of the eyes to the nose. Infective secretions may be readily forced from the nose to these various parts in the small child, as the passages are relatively larger and more direct than in the adult.

Care of the Nose.—In a state of health the nose of the infant or the child should be left alone. The natural secretions will keep it in a sanitary, clean condition. When the small child has an acute cold, the care of the nose is often difficult, if he is too young to cooperate or if he has not yet learned to "blow the nose." There should be no force used in this procedure (as will be readily seen by looking at Fig. 184) because of the danger of forcing infective material into the inner ear, the frontal sinus, the antrum, the eye, or the sphenoidal cavities. It is no longer considered good practice to use atomizers or syringes in cleansing or treating the nasal cavities, nor should one teach or permit a child to hold one nostril shut while blowing forcibly through the other. The child should be taught to blow with both nostrils open.

If the child's nose must be cleansed for him, toothpick swabs very carefully made, or bits of cotton held with small forceps, may be used. While any bland, sterile oil may be used (see page 707), it is better to ask the child's physician for a special preparation for the purpose. The nose of the child who has a cold should be thoroughly cleaned before he eats or sleeps.[1]

[1] **Following the reaction against the nasal atomizer, for a period of time,**

As with gargling (see page 685), the child should learn to blow his nose properly and to care for a handkerchief when he has no cold. He should do this as soon as he becomes imitative and do it as a frolic. Convenient pockets should be provided, and the child should be taught from his first acquaintance with a handkerchief to care for it properly. During an acute infection he should use paper squares, such as toilet paper, or paper napkins cut in pieces, or the soft paper kerchiefs now on sale, or the popular face tissue, and should be given a small paper sack in which to put these when used, and he should be trained to wash his hands after blowing his nose.

Needless to say, he should be trained to "cover up each cough and sneeze" *and to kiss no one upon the mouth.*

The Tonsils and Adenoid. *Where and What They Are.*—The tonsils and adenoid are composed of lymphoid or glandular tissue. It is strictly correct to speak of "the four tonsils." The two faucial, palatine, or "throat tonsils" are arranged in small masses on either side of the throat; the adenoid, pharyngeal, or "nasal tonsil" is found where the nose and throat join.[1] It is so located that inhaled air strikes against this glandular, cauliflowerlike mass as it is deflected into the bronchial passages to the lungs (see page 133). Although the adenoid is really one mass, it is often referred to in the plural on account of its lobed structure. Another careless expression is, "This child has adenoids," which implies that normally he should have no such structure, when the meaning is that he has an enlarged or diseased adenoid mass. There is another small, thin mass on the back of the tongue, called the *lingual* or *tongue tonsil.* These four glandular masses touch each other during swallowing and form a closed ring through which everything swallowed must pass (see Fig. 70 for location of the tonsils).

The tonsilar tissue is lymphoid or glandular in character and contains a variable number of white blood corpuscles, called

specialists advocated dropping oil up the nostrils while the child, with the head thrown back, lay on the mother's lap. At the present time, there is a reaction against this, particularly with infants, since the oil itself may be injurious if it enters the various openings mentioned (p. 678). The mother should ask for definite instruction for the particular situation.

[1] Cooke, W. E., "The Pharyngeal Tonsil" (Adenoid), *American Journal of the Diseases of Children*, February, 1928.

lymphocytes or *phagocytes*, which help to catch and destroy germs; these glands stand as a ring of sentinels stationed to guard the port of entry to the body from infection.[1] The tonsils drain into the lymphatic vessels and glands in the neck, which become enlarged and "beaded" when the tonsils are infected or diseased.

Enlarged and Diseased Tonsils and Adenoid.—When any part of the body is constantly exercised, it increases in size; the blacksmith's right arm, the enlarged heart of the athlete, and the goiter of hypothyroidism are examples. So with this glandular tissue in the tonsils and adenoid. When it must work all the time to take care of germs and dust that are constantly inhaled, and especially when it is repeatedly infected with cold germs and irritated with dry, hot inside air in winter, it grows or "hypertrophies" until it can grow no larger, and somewhere along the way it is likely to break down and become diseased or chronically infected. Then instead of being a protection it becomes a danger, and the blood absorbs germs and poisons, which are very likely to produce rheumatism, heart disease, and other ailments.

Tonsils that are large but not diseased may not injure the health, and it is worth every effort to save them until the child arrives at puberty, when they naturally tend to shrink. The fact that these structures are larger and apparently more active during the growing years leads to the inference that they must have important functions associated with growth, and that the child should not be unnecessarily deprived of them.

Adenoid tissue that is enlarged, however, interferes with breathing and presses on delicate structures in the nose and at the base of the brain. The adenoid should always be removed if it is large enough really to interfere with free breathing when the mouth is closed.

Diseased tonsils should be under the care of a specialist. If they have careful and constant treatment and are not too badly diseased, they can sometimes be saved. Too often, however, there is nothing to be done but have them removed. Certainly they should be removed at once if the child begins to complain of joint pains or show any signs of rheumatism. The germs characteristic of chronic tonsilar infection also have an affinity for the

[1] Kaiser, Albert D., "Significance of the Tonsils in the Development of the Child," *Journal of the American Medical Association*, Oct. 5, 1940.

heart valves and joint coverings. This is the reason diseased tonsils, valvular heart disease, and rheumatism so often go together.[1]

The Causes of Enlarged and Diseased Adenoid and Tonsils.—1. Hot, dry, dusty indoor air in winter. The antiquated custom of keeping little children indoors all winter "to prevent their taking cold" was the surest way for them always to have congested mucous membranes and sniffling, running noses. The air in the average house in winter time is by actual test drier than the Sahara desert, and it is never entirely free from dust. If a child living under such conditions does chance to get a breath of cold, outside air in his breathing passages, which are dry and debilitated and therefore entirely unable to accommodate themselves to the sudden change, of course they become congested and fall easy prey to cold germs.

2. Living on the floor. The baby who creeps and toddles lives in a different climate from that 5 feet higher where the family lives! Every mother should put her face frequently close to the floor to see what kind of air her baby breathes. Not even then can she see or feel the dust which her feet keep constantly stirring around the baby. Even if the floors are kept very clean and the mother uses dustless methods of cleaning, she and others constantly go and come from the street and yard and bring much dust with them on shoes. The poor tonsils and adenoid do their best and grow and fight as long as they can, the baby becomes a mouth-breather, ultimately infectious germs gain entrance, and trouble begins in earnest.

3. Deficiency diet. As nutrition work with children advances, it becomes more and more apparent that lack of vitamins and minerals in the diet lowers the general resistance of the child and makes him an easy mark for all diseases, particularly respiratory and glandular infections. Conversely, the balanced diet, which has been described in these pages, not only protects the child from rickets, scurvy, and the other specific diseases mentioned, but also makes the child more resistant to colds, dental decay, tonsilitis, diseased tonsils, bronchial pneumonia, and tubercu-

[1] Kaiser, Albert D., "The Relation of Tonsils and Adenoids to Infections of Children," *American Journal of the Diseases of Children*, March, 1931; also, editorial in *Journal of the American Medical Association*, May 23, 1931.

losis. Sun baths, foods rich in vitamin and mineral content, especially vitamin A (see page 256), calcium, and phosphorus,[1] pigmented vegetables, whole cereals, and milk are therefore necessary in order to protect the child from diseased tonsils.

Symptoms of Enlarged Adenoid and Tonsils.—Holding the mouth partially open in order to breathe, snoring or breathing noisily while sleeping, frequent colds, dark circles under eyes with a heavy, listless expression, fullness of the bridge of the nose, alteration of the dental arch, usually as an "overbite," but occasionally as an "underbite," are some of the usual symptoms of nasal and throat obstruction due to adenoid and tonsil hypertrophy.[2] A child with an enlarged adenoid is in a condition comparable to that of an adult who should pack both nostrils full of cotton and wear this obstruction night and day while eating, sleeping, and talking. The adult would soon discover that his ability to think was impaired and that his sleep, appetite, and nerves were seriously disturbed.

Operation.—There is a growing conservatism on the part of good specialists about removing these glandular structures.[3] As has been said, tonsilar growth must not be removed unless there is a probability of its being not only enlarged but diseased. As the foci of infection are sometimes hidden deep within the crypts and not easily visible, it is in such cases difficult to be certain about the presence or the degree of infection. Hence one doctor may advise removal and another advise delay. The only thing for a parent to do is to select a specialist in whom he has confidence and follow his advice. While the removal of tonsils is sometimes regarded as a minor operation, there is no operation requiring more delicacy of technique and nicety of judgment, and

[1] Interim Report of the Medical Committee on Enlarged Adenoids and Tonsils of the English Board of Education, 1929.

[2] The Interim report of the Medical Committee on Adenoids and Enlarged Tonsils says: "Adenoids may occur as early as the first year of life, they seldom develop after the eighth year. Educational retardation is a fairly common result of adenoids, especially in the higher age groups. The cause in a certain number of cases is the defective hearing which so often accompanies this condition; in others there is a certain mental lethargy which may be due to some interference with the cerebral circulation."

[3] "Tonsillectomy in the United States," editorial, *Journal of the American Medical Association*, Oct. 20, 1928.

no child should be operated upon by any one but a trained specialist.[1] Irreparable injury has sometimes been done by bungling work with these exceedingly delicate structures.

Conservation of the Tonsils.

1. Use a play pen for the creeping and toddling child, and keep him from underfoot, and out of drafts from under doors.
2. Let every child play out of doors every day in the sunshine.
3. Protect the legs and feet with one-piece leggings if the floors are cold.
4. Keep the indoor air cool and moist. It may be necessary to keep pans of water evaporating on stoves and radiators.
5. Look at the child's throat often, and teach him to gargle as soon as he begins to imitate.[2]
6. Supply plenty of vitamins and minerals in the diet and allow free exposure to sunlight.

If every child were protected from "dust and its dangers" and breathed only fresh, cool, inside air in wintertime, and spent much time out of doors all the year round, and were fed food rich in vitamins, the incidence of diseased tonsils and enlarged adenoids would be greatly lessened, if not obliterated, in one generation.

Hygiene of the Ear.—A look at Fig. 185 reveals an intricate mechanism consisting of a receiver, the external ear, cleverly adapted to collect and transmit the maximum amount of sound wave through the canal, which is bent to prevent the entrance of dust or injurious substances. Lining the canal is a membrane, which secretes "earwax," a substance exactly adapted to the

[1] KAISER, ALBERT D., "Results of Tonsillectomy," *Journal of the American Medical Association*, Sept. 20, 1930.

[2] This can be done as a frolic with drinking water; the family may have "gargling parties." It is a great safeguard for a child to grow up with the idea that it is fun to gargle, and also to know how to open his throat to inspection and how to gargle thoroughly and well. It thus becomes possible to discover and treat the child's throat in the beginning of trouble, and if it goes on to a more serious condition it will be far easier to care for the throat than it will if the child must have his mouth pried open and have his throat forcibly swabbed. One such procedure is enough to inspire terror of doctors in a child for years; and the struggle with a sick child may be very injurious in itself. This is just one more instance where the mother should seize the psychological moment to fix valuable habits for life.

purpose of keeping an open passage moist and clean, and of preventing the entrance of disease germs.

Stretched across the inner end of the canal is the eardrum (tympanum), which transmits sound, even the most delicate shadings of tone, to the exquisitely adjusted ossicles (little bones) which strike like the hammers of a piano upon the nerve strings of the inner ear. The ossicles are contained in a tiny compartment (the middle ear), much as fine scales are kept in a glass case in a scientific laboratory. The nerves of hearing spread out over the lining of the beautifully curved cochlea or "snail shell" and receive the impacts from the ossicles. Since equilibrium of air pressure is essential to the correct performance of this appara-

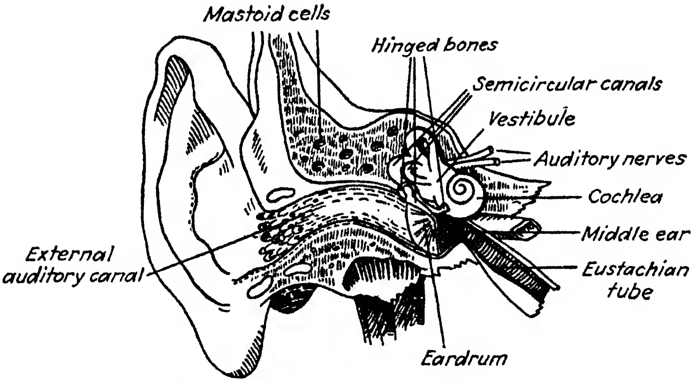

FIG. 185.—Diagram of the structure of the ear.

tus, we find an air tube (the eustachian tube) passing from the middle ear to the back of the throat, where it will receive, not external air (if that would do there would have been a little hole in the drum, which would have been much simpler), but *warm, moist, sterilized* air, which has been "processed" (see page 679) in passing through the nose. In connection with the inner ear we find three semicircular canals filled with fluid which provide the balancing mechanism by which the body maintains its equilibrium. Both the hearing and balancing mechanisms communicate directly with the brain.

It will be noted in the picture that the bone in which this wonderfully delicate machine is imbedded is spongy or porous, an arrangement which provides a certain important resilience to force. Behind the ear is a prominence in the skull known as the *mastoid*, composed of very porous spongelike bone, full of communicating air cells which open into the middle ear. Thus an air cushion is provided behind the ear which, in cooperation with the eustachian air tube, maintains a standardized air situation within the middle ear, so that sounds may be clear as they reach the brain.

It will be apparent from looking at the diagram that nature has made it difficult for infection or mechanical injury to reach the hearing apparatus, and has so arranged the structure that temperature, moisture, and pressure are relatively uniform during every moment of life.

Infections can reach the inner ear only by way of the eustachian tube, which is lined with a ciliated mucous membrane waving toward the exterior and providing an antiseptic secretion. The eustachian tube in the child is relatively straight and open, and infectious secretions from the nose do traverse the tube to the middle ear, causing earache and abscess, which frequently rupture the drum. Hearing may be permanently impaired because of adhesions or stiffness remaining in the delicate hinges of the ossicles. A permanent opening may remain in the ear-drum, thus interfering with the movement, air balance, temperature, and moisture in the middle ear. An abscess in the inner ear should be lanced and not go on to spontaneous rupture, as the small, clean incision closes quickly, while the ragged tear will heal more slowly and less perfectly, with a possibility of permanent adhesions.

When pus forms in the restricted space of the middle ear it is very painful and, if not promptly drained by incision of the drum, it may be forced into the mastoid cells, producing the dreaded "mastoid abscess," which often must be drained by opening the bone from the outside.

Hygiene of the ear begins with the nose. Every effort should be made to prevent nasal infection by providing an immunizing diet, including an abundance of vitamin A (see page 256); by providing moist, moving, cool indoor air in winter; and by preventing contact with infected persons.

If a child does have infected nasal passages with purulent secretions, the passages should be kept as open and clean as possible, as described on page 680 in the discussion of adenoids.

The outer ear should be protected from violence, and foreign substances especially should never pass the bend in the ear canal.

No attempt should be made to cleanse the canal beyond this point; neither should anyone but a physician attempt to remove a foreign body that cannot be seen, as it is much more likely to be forced against the drum than it is to be removed. Hardened earwax may be softened by dropping warm oil into the canal and removed by very gently swabbing with small cotton pledgets. It is better to have this done by a physician. A child showing any discomfort whatever in the region of the ear should be taken to a physician, as even the accumulation of hardened earwax may injure hearing and cause nervousness.

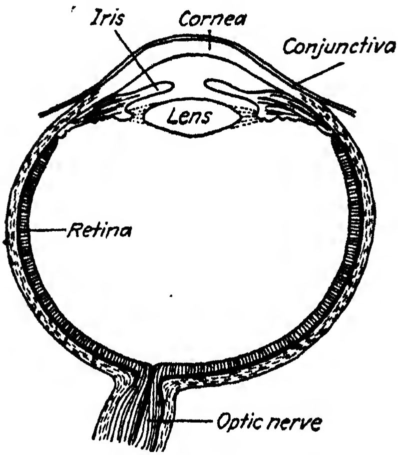

FIG. 186.—Diagram of the structure of the eye.

Hygiene of the Eye.—The eye is the most delicate camera ever created. Through its complicated and marvelously adjusted lens it photographs images of the external world upon the elaborate extensions of the brain known as the optic nerves, which spread out on the wall of the "dark room" (seen as the black center or "pupil") behind the blue, brown, or gray iris curtain.

This precious mechanism is set back in the sockets with their projecting "brows" and is protected by the lids with their "quicker-than-a-wink" muscular reactions. The lids have a fringe of hair (lashes) which prevent an incredible amount of dust from coming into contact with the eyeball camera. Mucous glands and tear (lachrymal) glands provide lubrication, and an ever-ready warm "normal salt" solution for bathing the eye and removing harmful substances. Instead of overflowing the face, these secretions are drained off at the lower inner angle of the eye through the tear duct, which empties into the back of the posterior nares, where they may be harmlessly swallowed or conveniently removed by blowing the nose.

Infection of the eye may occur through the medium of the tear duct, which may convey germs from the nose to the eye.

Or germs may be conveyed from hands, a towel that has been used by someone having an infection, or from infected dust.

Children should be trained very early to avoid rubbing the eyes with their hands, which are never free from infectious microorganisms, and to be scrupulous about using individual towels and washcloths.

Fig. 187.—Protecting the baby's eyes.

Eye strain in infants and young children is, of course, difficult to detect. No one yet knows the precise effect of exposing the eyes of infants to direct light in the modern furor for sun baths. It is the part of wisdom, certainly, to avoid subjecting the eyes of the infant and the young child to conditions which we know would be harmful to the eye mechanism of the adult. *The eyes at any age should be protected from direct light and from excessive brightness or cross lights.*

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CHAPTER XXXVIII

ARTIFICIAL FEEDING

Milk Song

Father, it is Thy kindness
Gives us milk to drink,
Milk, how pleasant tastes it,
Very good we think.
In the cup or basin,
It is white as snow;
Sweet as the flowers
(That) In the fields grow.
Milk the red cheek freshens,
Makes the mind serene.

Beautifies the sunshine
Brightens all the green,
Yes, it is Thy kindness
Ever great and good,
Gives the milky treasure,
Children's sweetest food.
Father, may we never
Be denied this food;
Nor seek after other.
While this is so good.

LOWELL MASON.[1]

Artificial Feeding a Problem.—Whenever it becomes necessary to feed a baby something in place of its mother's milk, the child becomes a problem. What will agree with one may not agree with another. A food may not cause acute indigestion or actual illness and yet the baby may not make good bone, muscle, and blood out of it. A baby may not appear to be sick and still may not make a normal gain in weight. He may be unable to digest the fat in cow's milk, or the protein (curd) may disagree, or the sugar used in modifying the milk may cause diarrhea and distress. It takes medical skill and experience to make the proper diagnosis. A baby may lay on soft fat and be oversized, and still not have good muscle or be strong. *Every bottle-fed baby should be fed under the directions of a medical specialist, who should see him often.* It is much safer to prevent trouble than to cure it.

It is desirable for a mother to be sufficiently informed on the subject of artificial feeding to cooperate with the pediatrician in an understanding way. She will never under any circumstances take the responsibility of directing the artificial feeding of her infant. The leading methods are here presented in brief

[1] From an old book of *Little Songs for Little Singers,* 1840, quoted by Crumbine and Tobey in *The Most Nearly Perfect Food,* The Williams & Wilkins Company, 1929.

form for the use of the student or mother if the information is needed or desired.

Fresh-milk Feeding.—Cow's milk and goat's milk are usually the best substitutes for mother's milk. *There is no perfect substitute for mother's milk.* The best imitation that anyone at present knows how to make is made from cow's or goat's milk. Usually fresh cow's milk is the most accessible and the cheapest food, and it is usually satisfactory for the infant who cannot have his mother's milk. Milk that is given to any child should come from sources well known to the parents. Grade A certified milk should be used if it can be obtained. The pediatrician is usually informed as to the local supply and will recommend a satisfactory source. The cows must be tested for tuberculosis and for undulant fever, fed on vitamin-rich food, and housed and milked under sanitary conditions.

Milk from Holstein or Ayrshire cows is more like human milk than that from Jerseys or Herefords. Jersey or Hereford milk is too concentrated in fats but may be used with part of the cream removed. Milk from a healthy herd tends to be more uniform and is ordinarily better than milk from one cow, unless it is important to feed soft-curd milk.

Soft-curd milk is offered by some dairies that specialize in milk for infants. One of the reasons cow's milk sometimes disagrees with infants and others having delicate digestive systems is that the cow's curd (protein) is made up of a larger percentage of casein and a smaller percentage of lactalbumin than human milk and makes a hard curd when it is "curdled" by the acid gastric juice. Occasionally a cow is found in all breeds that has a high percentage of lactalbumin and gives milk with a "soft curd." Holstein-Friesian and Ayrshire cows more frequently give soft-curd than do other breeds. There are practical curd tests that can be applied in any diary, and it is probably desirable to use soft-curd milk in all cow's-milk feeding.[1]

Milk is the most valuable and indispensable of human foods. It is the one best growth-producing food for children. It must be remembered, however, that *not only children, but other living things thrive and grow on milk, among which are germs, both good*

[1] "Milk for the Family," *Farmers' Bulletin* 1705, U. S. Department of Agriculture, July, 1933.

and bad. Disease germs multiply by millions in warm milk. A few from the foot of a fly, the udder of the cow, a dirty milk pail, or from contaminated water with which the milk utensils may have been washed will multiply to millions within a few hours if the milk is not kept cold. *Cleanliness and cold are the watchwords for safe milk.* Milk should be cooled quickly after milking and be kept below 50°F. until prepared for the baby's use.[1]

Preparations of Cow's Milk.—*Sweetened condensed milk* is preserved by heating, partial evaporation, and addition of sugar (18 to 20 pounds per 100 pounds of milk) as a preservative and to prevent freezing. This method is said to have been originated for the use of Napoleon's armies, and its use was introduced in this country at the time of the Civil War. It has doubtless had great value in certain food emergencies. Because of its convenience it once had a vogue in infant feeding in this country. The recent advance of nutritional science, however, clearly shows the use of sweetened condensed milk as an infant food to be a faulty procedure, which is now universally condemned by pediatricians.

Some infants who have a high sugar tolerance apparently thrive and grow fat on sweetened condensed milk. The flesh is soft ("waterlogged"), the osmotic balance of the body cells is disturbed, and more than a normal amount of fluid is stored in the tissues. For the same reason, the bowel movements of the child so fed are loose and frequent. Infants seldom have constipation while taking this diet, but almost always suffer a reaction and sometimes have serious trouble when they are later changed to plain milk. The bowel has become habituated to and dependent upon this constant stimulation.[2] Another reason for the soft, flabby flesh is the relative deficiency of sweetened milk in protein. Unless the child is greatly overfed, he does not receive a correct protein quotient, since a large percentage of the calories in his diet will be carbohydrate (sugar) calories. Because of the relatively low vitamin and mineral content of condensed milk the bone formation is poor, and resistance to infections, especially respiratory infections, is notably low.

[1] CRUMBINE and TOBEY, *The Most Nearly Perfect Food*, The Williams & Wilkins Company, 1929.

[2] RUPE, WAYNE A., *Extension Lectures in Pediatrics*, University of Kansas, 1928.

Evaporated milk (*unsweetened condensed milk*) is fresh, whole milk which is reduced by heating in a vacuum to a consistency at which the butter fat will not separate when shaken in handling, and also to a degree which insures sterility. Recent experiments indicate that this form of preserved milk is free from the objections to sweetened condensed milk just stated, and also indicate that this form of milk may have a distinct value in infant feeding. Dr. McKim Marriott says:

> Unsweetened, evaporated milk possesses a number of advantages over ordinary cow's milk for the preparations of milk formulas. . . . It has already been completely sterilized and because of the heat treatment it forms very fine curds in the stomach. The fat present has been homogenized so as to form very fine globules. It is of uniform composition, easily obtainable and is cheap.[1]

These points are confirmed by Dr. C. G. Kerley in *The Archives of Pediatrics.*[2]

Dr. Frank E. Rice says:

> In the transformation of raw cow's milk into evaporated milk, the protein and fat are given physical properties like the protein and fat of breast milk. These are the constituents causing the greatest difficulty in infant feeding. Laboratory tests, therefore, would indicate that unsweetened evaporated milk is the best form of cow's milk for preparing the feeding formula.[3]

Dr. Icy Macy in a review of infant feeding reports that in an extended series of hospital cases those infants receiving evaporated milk did better than those fed other foods, that none of them developed digestive disturbance, and that scientific tests showed no deficiencies in their growth and development.[4]

Dr. James A. Tobey reports that more than a billion pounds of evaporated milk are now conserved annually in the United

[1] Marriott, McKim, "The Simplicity of Infant Feeding," *Journal of the American Dietetic Association*, June, 1928.

[2] Kerley, Charles Gilmore, "Evaporated Milk in Infant Feeding," *Archives of Pediatrics*, January, 1932.

[3] Rice, Frank E., "Recent Developments in the Use of Evaporated Milk in Infant Feeding," *Archives of Pediatrics*, October, 1930.

[4] Macy, Icy, "New Facts on Baby Feeding," *Parents' Magazine*, June, 1931.

States; that it is cheaper than any other form of milk, fresh or concentrated, and that the biological properties are relatively unaffected by evaporation. He says vitamin C is destroyed and vitamin B is slightly reduced, but that vitamins A, D, E, and G are present in their original potency.[1] Dr. Tobey gives the following table of dilutions for feeding evaporated milk.

TABLE FOR MODIFYING CONDENSED MILK

Age	Average weight, pounds	Evaporated milk, ounces	Water, ounces	Cane sugar or pure corn syrup		Number of feedings per day	Each feeding, ounces
				Ounces by weight	Level tablespoonful		
1 week.....	7	6	15	1	2	6	3½
1 month....	8½	8	16	1½	3	6	4
2 months...	11	9	14	1½	3	5	4½
4 months...	14	11	20	2	4	5	6
6 months...	16	13	22	2	4	5	7
8 months...	18	15	20	1	2	5	7
12 months...	21	16	16	0	0	4	8

Dried Milk or Powdered Milk.—Whole milk, of good quality, when dried under modern methods in a vacuum suffers little if any alteration in composition, vitamin content (except vitamin C), or minerals. The addition of water in proper proportion is all that is necessary to produce milk that is apparently the full equivalent of fresh milk.

There is no objection to the use of dried milk in infant feeding as far as the food value is concerned. It does deteriorate on opening if not kept cold and dark and dry, and it is, as yet, relatively expensive. Dried milk of the kind specified has the same virtues as evaporated milk; it is easily digested because the heating breaks the curd into fine particles. It is sterile when opened and is considered by some pediatricians to be more reliable than and preferable to ordinary pasteurized or boiled fresh milk.

[1] TOBEY, JAMES A., "Infant Feeding with Evaporated Milk," *Medical Women's Journal*, June, 1931.

The various kinds of dried milks have many qualities to recommend them for infant feeding. Each of them—whole, skimmed, partly skimmed, and modified—is a sanitary product of fairly uniform composition. When properly prepared and used immediately, reconstituted dried milk is very low in bacterial count. Its flavor is pleasing and not very different from that of fresh milk. It is easily digested, a quality which is always an asset in infant feeding. The quantity to use in making up the formula for an infant depends upon the kind of dried milk selected, and the age of the child, and should usually be determined by a physician. For infants, it is especially important to supplement the vitamin content of the dried milk with other foods.[1]

Goat's milk varies slightly in composition from cow's milk, as will be seen from the following table. The fat droplets are smaller and, because of finer emulsification, do not rise to the top in cream as in the case of cow's milk. The curd is said to be finer in texture.

Goat's milk must be modified in a manner similar to that for cow's milk. As far as the composition is concerned, goat's milk is probably just as suitable for infant feeding as cow's milk but no more so. It is valuable in the case of infants who are sensitized to cow's milk. In some localities where satisfactory fresh milk is not available it may be possible to keep milk goats. Goats are very resistant to tuberculosis and can be pastured on a small tract of ground. Goats are susceptible to Malta fever.

THE AVERAGE COMPOSITION OF HUMAN, COW'S, AND GOAT'S MILK[1]

Kind of milk	Water, per cent	Protein, per cent			Fat, per cent	Carbohydrates (milk sugar), per cent	Mineral matter, per cent	Approximate fuel value per ounce, calories
		Casein	Albumin	Total				
Woman	88.3	0.4	0.7	1.1	3.3	7.0	0.3	18
Cow	87.0	2.8	0.5	3.3	4.0	5.0	0.7	20
Goat	85.7	3.5	1.0	4.5	4.7	4.4	0.8	22

[1] Adapted from Milk and Its Uses in the House, U. S. Dept. of Agriculture, *Farmer's Bulletin* 1359, and L. EMMETT HOLT and others, "A Chemical Study of Woman's Milk," *American Journal of Diseases of Children*, October, 1915.

[1] "Milk for the Family," *op. cit.*

Modifying Milk.—"Modifying milk," or "humanizing" it, as the process is aptly called in New Zealand, consists in combining milk, water, and sugar in the proportions which, experience has taught, best suit the needs of the human baby at different ages.

Cow's milk contains about the same amount of fat as does the average human milk, but it contains less sugar and more and harder milk curd. On this account water must be added to reduce the protein. Since, at the same time, the fat is reduced, some top milk or cream is sometimes added. This is not always necessary because milk fat is rather likely to disagree, and the child usually thrives better on limited milk fat at first. Experience seems to indicate that it is better for the bottle-fed baby to get part of his energy calories from the addition of cereal waters at about two months than to depend upon the milk fat for a full quotient. Then, since the human baby needs relatively more milk sugar than a calf, and because the sugar has also been diluted by the water, some kind of sugar must be added to the mixture. The proportions must vary at different ages and in different conditions in order to agree with the child and keep him growing.

The mother must not assume that the child cannot take cow's milk because the standard mixture may not agree with it. It may need less fat or sugar or curd, or it may need more of one of those, or less of one and more of another, to meet its own particular digestive capacity.

For this reason the mother must weigh the baby every week; if it should lose or stop gaining, she should weigh it every day. She should watch the bowel movements closely and be able to tell the doctor about them with great exactness, and she should take the baby to a well-baby clinic, or to the best baby doctor she can reach, regularly once a month and between times if the baby stops gaining or appears out of health. She should follow the directions of the doctor. If she cannot possibly reach a competent physician, she should follow the advice of the nearest public health nurse, or write to the Division of Child Hygiene of her State Board of Health.

Milk is modified by two principal methods, utilizing respectively percentage milk and whole milk. By the percentage method one must use separated milk and cream, or milk whose exact percentage of fat is known. The milk, cream, etc., are combined to duplicate human milk as exactly as possible. This is laborious, uncertain in lay hands, and is seldom employed in ordinary cases. One proprietary food, S. M. A. (Synthetic Milk Adapted), is made by a very exact percentage formula, requiring only the addition of stated amounts of water to be ready to use.

The other and more commonly used method, which is found to agree with most infants, is by simple dilution of whole milk with water and the addition of sugar.

Sugar is added to the milk as a food and not to give it a sweet taste. The sugars employed in milk modification are milk sugar; cane sugar; karo; malt sugars, such as Bercherdt's, Mead's, etc.; and commercial modifiers, such as Mellin's Food, Imperial Granum, Nestle's Food, etc. As the weight per ounce measure of the different sugars varies greatly, one should have explicit directions as to the amount *by weight* of the particular sugar used.

Nothing about modifying milk requires nicer judgment than determining the kind and amount of sugar. If too much is used, the baby may have diarrhea; if too little, he may be constipated (there are many other causes for both constipation and diarrhea, however).

About 1/8 ounce per pound of body weight is the average amount of cane sugar up to a total of 1½ to 2 ounces. No child, at any age, should receive over 2 ounces of cane sugar or its equivalent in 24 hours. As more milk is given, the child gets more sugar in the cow's milk; therefore the amount of sugar added is decreased as the child grows older, and is discontinued when whole milk is given.

Amount of Milk.—In general a baby will need about 45 to 50 calories of food per pound of his normal body weight (or 100 to 110 calories per kilogram—2.2 pounds). This may be attained nearly enough by giving about 1½ ounces of milk per 24 hours for every pound that the baby weighs, provided that it weighs about what it should for its age and height. If it is much underweight or overweight, a physician's advice should be asked, as otherwise one might overfeed a baby already too fat, or fail to give a puny baby enough to gain on, and it might be a difficult matter to adapt the food to the digestion of an underweight baby.

In general, there is a tendency to feed more liberally than formerly.

Morse and Talbot have the following to say about the variableness of the infant's caloric needs:

> In general, babies require from 100 to 120 calories per kilogram of body weight during the first six months in order to gain, and in the neighborhood of 100 calories during the rest of the first year. Most young babies will just about hold their weight on 70 calories per kilogram; a few will gain regularly on this amount, while other babies need as much as 140 calories per kilogram in order to gain. Babies that have been underfed, or that are convalescing from a severe illness whether acute or chronic, need more calories than do normal babies. Babies that are fatter than the average baby will gain on fewer calories than will the average baby. The fatter the baby is, the fewer calories he needs, a very fat baby often needing only 90 calories per kilogram. Conversely, the thinner or more atrophic a baby is the more calories it needs, many extremely emaciated babies requiring as much as 160 calories per kilogram.[1]

Estimating Amount of Food Required.—To estimate the calories to be provided in the day's ration, multiply the number of ounces of milk by 20 (calories per ounce of milk) and the number of ounces of sugar by 120 (calories per ounce of sugar). There is a negligible number of calories in the cereal water. The day's feeding for a young baby weighing 7 pounds would be computed as follows: $7 \times 50 = 350$ total calories. Subtracting 120 calories for 1 ounce of sugar leaves 230 calories, which will be supplied by approximately 12 ounces of milk. Diluting this by an equal amount of water gives 24 ounces to be divided into six or seven equal feedings according to the feeding interval.

Orange juice, cod-liver oil, vegetables, and cereals are given to the baby on sweet-milk feeding much in the manner indicated for breast-fed babies (Chap. XXIII), except that all are given somewhat earlier. The accessory foods must, of course, be figured into the caloric estimates.

Pasteurizing versus Boiling Milk.—There is now considerable difference of opinion concerning the routine pasteurizing of milk. Pasteurizing milk kills most disease germs, including those of

[1] MORSE and TALBOT, *Diseases of Nutrition and Infant Feeding*, The Macmillan Company, 1920.

AMOUNTS FOR DIFFERENT AGES ON BOTH 3- AND 4-HOUR FEEDING SCHEDULE[1]

	Amount for 4-hour intervals, ounces	Amount for 3-hour intervals, ounces
First week	2½	2
Second week	3	2½
Third week	3	2½
Fourth week	3½	3
Second month	5 (or 4 if 2 A. M. feeding is given)	4
Third month	5½	4½
Fourth month	6½	5½
Fifth and sixth months	7	*
Seventh to twelfth months†	8	*

[1] From *Infant Care*, p. 93, Children's Bureau, U. S. Department of Labor, Washington, D. C., 1933.

* After the fourth month most babies are fed at 4-hour intervals, even if they have been fed at 3-hour intervals up to then.

† In the tenth, eleventh, and twelfth months, the feedings are of milk unmixed with water or sugar.

undulant fever, and also kills the lactic-acid bacillus, which causes the normal souring of milk, but putrefactive organisms may survive. Milk that does not sour is not necessarily good milk. Pasteurizing will make milk somewhat safer during hot weather, but dirty milk cannot be made absolutely safe by pasteurizing or any other process, and the word *pasteurized* may give a false sense of security.

Pasteurizing consists in heating milk to a degree that will destroy most disease germs, but will not destroy the essential vitamins. It is now known that the addition of orange and vegetable juices to the bottle feeding replaces these vitamins. There is a present tendency to feed milk that has been brought to a quick boil ("the flash boil") rather than pasteurized. Unless one is absolutely certain of the correctness of pasteurization, it is safer to flash boil even pasteurized and certified milk! The doctor should be consulted as to this.

Utensils and Their Care.—A certain shelf should be set apart for the equipment used in modifying the milk. Everything used about the baby's milk should be kept by itself and used for nothing else whatever. All utensils should be filled with cold water as soon as emptied, as milk should never dry on anything. As soon as is convenient, the utensils should be washed in hot water and soap, rinsed and boiled, drained out of the boiling water without wiping, and placed away from dust until used.

Rubber nipples should be rinsed with cold water, scrubbed, and boiled, always taking care to turn them wrong side out and cleanse both sides. They may then be kept dry in a covered jelly glass or other container that has been boiled. The milk should never be touched by anything that has not been scoured and boiled and kept in a perfectly clean place. The small things may be washed in a special saucepan. They should not be washed with other dishes or utensils.

The following utensils will be needed for modifying milk: A 3- or 4-quart saucepan of aluminum or enamel; a tablespoon kept for this purpose only; a glass or porcelain funnel; a measuring glass, or graduate; seven rubber or glass corks to fit the nursing bottles; seven nursing bottles; a dozen nipples; a bottle brush; a fork.

Preparing the Daily Supply.—In the morning the mother should prepare the entire day's feedings at once. This is an economy of time and saves needless handling of the milk, which is always liable to contaminate it.

The mother should scrub her hands and put on a perfectly clean apron before she starts to prepare the milk. She should then assemble everything she is going to use. If she uses bottled milk she should wipe the outside and top of the bottle with a clean cloth, turn the bottle upside down several times to mix the cream evenly with the milk, take the boiled fork and stick one prong into the center of the cap, lift it, and stand the fork so that the under side of the cap touches nothing.

She may then pour the necessary amount of milk into the glass measuring cup or graduate, replace the cap, and later place the bottle in the icebox for family use. If the milk is produced at home, fresh milk should be used and prepared at once after the morning milking. After addition of the necessary amount of water and sugar, it is stirred well, poured into the saucepan, and

[1] Rose, Mary Swartz, *Feeding the Family*, Chap. VII, Food for the Baby, p. 173, The Macmillan Company, 1940.

brought quickly to a boil. It should boil for 3 minutes, with constant stirring to avoid the forming of scum, or it should be steamed in a double boiler for 15 to 20 minutes. The milk is then poured into the freshly boiled bottles through the funnel, the amount to be poured into each bottle being carefully estimated. The sterile glass or rubber stoppers are added, and the bottles may be stood in the saucepan filled with cold water until they are cool enough to put into the icebox. They should be cooled as quickly as possible and kept cold until the moment of using.

FIG. 188.—The proper way to give the bottle to a baby.

Cereal water should be made from finely ground whole grain flour. To make 1 pint of 3 per cent solution, mix 2 level tablespoons of flour with a little cold water to form a paste, then stir this slowly into a pint of boiling water. Cook 20 minutes, stirring well. Water should be added to replace evaporation. Cool and keep cold. Even on ice it should not be kept longer than 24 hours. Cornstarch, oatmeal, barley, or wheat flour may be used.

How to Give the Bottle to the Baby.—When feeding time comes the mother should take one of the bottles, replace the cork with a nipple, and stand it in a pan filled with hot water. It should be tested by letting a few drops fall on the wrist. When it feels warm to the wrist, it should be given at once to the baby.

The mother should take the baby in her arms much as if it were going to nurse from the breast, and she should hold the bottle all the time (Fig. 188). She should not prop the bottle up and leave the room, as the baby might strangle, lose the bottle, or suck air from an empty bottle. If the baby draws the milk too fast, she should take the nipple out of his mouth occasionally and lift him to her shoulder to enable him to expel swallowed air. If he is inclined to play or sleep, she should keep him busy until done. When he has finished taking the bottle, she may again hold him against her shoulder and gently pat him until he raises any air he may have swallowed, then lay him quietly down. A baby should never be jarred or shaken after nursing.

Caution.—In traveling, the baby's milk may be carried cold in a thermos bottle. *It should never be carried warm,* neither should the mother try any devices for keeping the baby's milk warm at night in order to save herself the trouble of getting up to prepare it. The mother must never forget that disease germs grow rapidly in warm milk, and that in spite of every precaution a few germs of a kind that cause bowel trouble may possibly get into the milk and increase to millions within a few hours.

In traveling, a suitcase of suitable size should be set apart for the feeding equipment of the artifically fed baby. This should include the equipment specified, with the addition of a quart-size thermos bottle and a sterno outfit. The milk should be modified in the morning, as usual, and then cooled and carried cold in the thermos, and the required amount poured out and warmed at each feeding.

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CHAPTER XXXIX

THE SICK CHILD

Equipment for Illness.—In every home there should be a minimum equipment, kept in a suitable cupboard space *set apart for this use and no other.* All medicines and substances of a poisonous nature that are absolute necessities among the supplies should be methodically kept out of reach of children. The following items are essential; others may be advisable if the family lives far from a drugstore or a doctor.[1]

1. Clinical thermometer.
2. Equipment for giving enemas (see page 424).
3. A hot-water bag or electric pad.
4. Skin antiseptic, such as Mercurochrome or iodine.
5. General, all-purpose antiseptic, such as Dakin's solution.
6. Tube of sterile lubricant.
7. Roll of adhesive tape.
8. Several bandages: 1-inch and 2-inch widths.
9. A package of absorbent cotton and a small package of surgical gauze.
10. A bottle of bland (see page 415) nasal oil.
11. A bottle of milk of magnesia or some other mild laxative recommended by the pediatrician.
12. A splinter forceps.
13. A small basin for antiseptic solutions; a medicine glass, an eyecup.
14. A roll of paper toweling or a package of paper napkins.
15. A package of paper tissue.

Minor Illness.—The first signs of illness in children are vague and rarely are diagnostic of the cause of illness. The child droops, is not interested in food or play, and whimpers or whines. It may lie around, or it may make an attempt to play. Usually it wants to be held. If old enough, it may say that its head or "tummy" or ear hurts. It may only say "hurt" without being able to say where the pain is. The eyes will be dull, the forehead may feel hot and dry, the cheeks may be flushed or pale. Respiratory infection, of course, makes itself obvious through nasal

[1] Sherbon, Florence Brown, *The Family in Health and Illness*, p. 280–281, McGraw-Hill Book Company, Inc., 1937.

discharge, sneezing, coughing, and hoarseness. Children, however, seldom complain of sore throat or chest pain. The mother who has a drooping child should do several things.

Undress the child, place him on a table or a large bed in a good light, and note the following points. (1) Does he assume a protective position, *i.e.*, draw up the right leg to protect an infected appendix or liver, turn the head to protect a sore ear or mastoid, lie with the back bowed to protect a tender spine? (2) How does the skin of the body feel—dry, moist, hot, cool, etc.? Is there any eruption? (3) Press very gently over the abdomen, back, and joints, also the neck and back of the ears to discover any tender areas. Note whether the abdomen is distended as with gas or fecal matter. (4) Examine the throat. If the child has not learned to open his throat for inspection, the mother may have to do this by force. She may wrap the infant in a towel to prevent his grasping her hand. She should place her left hand about the back of the child's head, while with a spoon handle held between her right thumb and forefinger, with the child's chin resting in the palm of her hand, and while a second person directs a flashlight beam into the throat, she presses the tongue down and gets one clear quick look into the throat. The blade of the spoon should rest firmly upon the very back of the tongue, otherwise the tongue will slip from under the spoon, and gagging and struggling will result. Great care must be taken not to pinch tongue or lips against the teeth, and the whole procedure should be over so quickly the child does not have time to gag or resist. The mother should note any redness, swelling, or patches of gray, white, or yellow exudate on the tonsils. (5) Take the temperature. If the mother has never used a clinical thermometer, she should ask her nurse before leaving the case when the baby is born to teach her the technique of taking a baby's temperature by rectum. Older children very readily learn to have the temperature taken by mouth.

The mother should place the child in bed in a quiet, airy room. She is now in a position to judge whether or not she should call the doctor. She should take no chances if she observes any of the following symptoms:

1. Discolored or ulcerated spots on the throat.
2. Pain in the region of the ear.
3. Tender spots in the abdomen, particularly on the right side.

4. Tenderness of spine or joints.
5. Extreme sensitiveness to light.
6. Temperature above 101°.
7. Any eruption on neck, chest, or abdomen.
8. Any distress in breathing.

General Care.—If the mother seems justified in concluding that the illness is only a mild cold or indigestion, the indicated initial treatment for both is about as follows: rest in bed, quiet, isolation, plenty of water (all that the child will drink), fruit juices and milk as relished, little or no solid food. If the bowels have not moved recently and fully, a small oil or soapsuds enema may be given, with the administration of one small dose of a very mild cathartic. Doctors in general do not use catharsis as much as formerly. If the child has regular elimination there is no reason for disturbing this natural rhythm because the child is ill. The idea that excessive action of the bowel "will carry off the poisons" is without logical foundation. While appendicitis rarely occurs under five, any tenderness in the abdomen, especially if accompanied by vomiting and fever, should be reported to a physician, and no carthartic and no food should be given until the child has been seen by the doctor.

In head cold and mild sore throat, the child should breathe only warm, moist air. He should be kept at a uniform temperature, comfortably warm, but should not perspire. The nose should be cleared of secretions before the child nurses, eats, or sleeps. Some physicians approve of dropping bland oil (never mineral oil or pungent oil) up the nose while the child lies across the lap with the head thrown back. Others approve only of swabbing the nostrils very gently with oiled cotton swabs. Toothpick swabs may be used for this (see page 348). Only perfectly bland sterile oil should be used, as infants sometimes react unfavorably to volatile oils commonly used in nasal solutions. Medication of any kind should not be used without a doctor's orders.

Convulsions.—Convulsions in children are occasionally caused by indigestion, with constipation or diarrhea, brought on by improper eating; but usually convulsions are caused by the same conditions that produce a chill in an adult at the beginning of fever and infections. The convulsion in this case is always followed by fever and the temperature may rise very high. A child coming down with a contagion may have several convulsions. When later symptoms of the disease occur, such as breaking out, the temperature usually falls and the convulsions cease. Convulsions also occur in some kinds of poisoning—especially with strychnia. They occur in certain illness, such as tetanus (lockjaw), tetany, and some kinds of meningitis. A child on going into a convulsion becomes stiff and rigid and may show congested face and spasmodic movements.

Treatment.—It is always in order to send for a doctor in haste. In the meantime, undress the child if the clothing can be easily removed; otherwise let the clothing remain and quickly place him in a warm bath. *Do not have the water too hot;* test it with an elbow or a thermometer (*not with the hand*) and do not forget to keep the child's head cool by wrapping it in a cold, wet towel. Take the child out as soon as he is relaxed, remove any clothing, pat him dry with a towel, and wrap him in a warm, dry sheet or blanket. Do not put on even a nightdress until the patient is fully recovered and rested. As soon as the child is taken from the bath give a copious soapsuds enema. Give it very gently and without excitement, using a bedpan, but be sure that the bowel is well cleansed. If the first results are doubtful, repeat the enema in 30 minutes to 1 hour.

Cautions.—Convulsions are terrifying, but fortunately they are seldom fatal. The mother should compel herself to be calm and go about the above program in an orderly and efficient manner. Every mother should rehearse this in her mind many times: "I must not burn the baby; I must keep its head cool; and I must wash out the bowel." Some books advise adding mustard to the bath. This is painful later and entirely unnecessary, and *should never be used on the tender skin of a young child.*

The convalescent child becomes a problem in management[1] and entertainment.[2] The mother is fatigued and finds it difficult to be patient and resourceful. The child is restless and exacting, and wants to get up too soon. Changing the scene, moving the child from room to room, providing frequent change of occupation, from active employment to passive listening to reading, storytelling, or music—all enter into successful management.

[1] *Ibid.*, pp. 372–377, Special Problems in Nursing Sick Children.

[2] *Ibid*, Chap. XXXVII, Entertainment and Occupation for Convalescents.

Guarding the convalescent child against excitement and fatigue is often extremely important.

Emergency Treatment.—Every homemaker should have in her medicine cabinet a book on home nursing and first aid. Space does not permit adequate instruction here. Among the points of general importance the following may be noted. Most accidents are not likely to be immediately fatal. One can usually take time to consider the best plan of action. *In many situations hasty, panicky action may do much harm.* The situations in which one does need an action pattern *ready to use* are in particular: hemorrhage, suffocation, poisoning, electrocution, and rescuing from flames and burning clothing.

Hemorrhage.—Everyone should have a vivid mental picture of the circulatory system (see page 130). Remembering that all large blood vessels lie near bones, anyone can check hemorrhage by pressing the large vessels the branches of which have been severed against the bone that protects them. Any Red Cross manual or first-aid text has illustrations covering this point. While holding the thumbs in the proper place, one can consider calmly the next step to be taken.

Suffocation demands fresh air, loose clothing, and artificial respiration. All parents and older children should know the technique of the Shaeffer method of administering artificial respiration which is described in all first-aid and nursing texts. An infant who has been accidentally smothered or overcome with carbon monoxide can be resuscitated by even the most untrained person, using the old classic method of applying the mouth of the adult to the mouth of the infant and breathing gently into the mouth to inflate the lungs. Then, removing one's mouth, bend the child's body with its chest held over the open palm, to press out the air; and repeat the treatment at about the regular rate of adult breathing. The special precaution is not to breathe with too much force, as the delicate air cells may be ruptured. Any artificial respiration may need to be performed for some time, and should be continued certainly as long as the body remains warm and flexible. Keeping the body warm to facilitate circulation of the blood is extremely important.

Household poisoning is likely to involve common alkalies, such as lye, ammonia, or washing soda. The treatment is the instantaneous administration (or application, if there is a surface burn) of a weak, nonpoisonous acid, such as very dilute vinegar or lemon juice. Poisoning with acid, such as carbolic, oxalic, hydrochloric or muriatic, calls for instant use of mild, nonpoisonous alkali, such as dilute solution of soda, alcohol, or lime water.

For match heads, rat or insect poison, or unknown poison, some of which may remain in the stomach, the stomach should be washed out by the very simple procedure of forced drinking of warm water until vomiting is produced. This process, as efficacious as pumping the stomach, is much less disagreeable and can be administered without delay. No oils should be given in phosphorous poisoning, as phosphorous is highly soluble in fat.

The poison most often resulting in the death of children is strychnia. The dose is very small, $\frac{1}{60}$ to $\frac{1}{40}$ grain. The tablets usually are highly soluble. By the time the accident is detected there is no hope of recovering any from the stomach. Any effort in this direction might only precipitate fatal convulsions. To provide for absolute quiet, copious drinking of warm fluids to hasten fluid elimination, and getting a doctor with all speed is all that the family can do.

Rescure from Fire and Burns.—Wrapping one's nose, mouth, and hair in a sopping wet towel, and crawling on the floor, where the air is the clearest, are the two things to remember in entering a burning building for rescue, or in escaping from one. Even a small child should be taught that he should roll and not run if his clothes catch fire.

First-aid treatment of burns consists in prompt immersion of the part injured, or of the whole body, in water. Soda or salt may be added if procurable. *Under no circumstances should any insoluble substance such as salve, grease, flour, starch, carron oil, or any such thing be applied to a burn.* Water will shut away the air just as completely and will not have to be very painfully cleansed from the burn by the doctor when he applies a permanent dressing. Tea or tea leaves or a wet soda compress is adequate dressing for a small surface burn.

Bites and Stings.—The adult should remember that strong, healthy persons seldom die from the bites even of poisonous snakes or the black widow spider. Although the victim may be very ill, he will usually recover. Lasting, or even permanent, injury may result from bungling tourniquets that shut off circulation from foot or hand. *Also, contrary to tradition, it is now accepted that alcohol in any form is never to be used in these cases.* Sucking the wound and spitting out the saliva is about as much as one can do in the way of treatment at a picnic or on an excursion, where such accidents usually occur. The child should be taken to a doctor with all speed, as there are antivenom serums that are quite certain in effect.

In the case of a child's being bitten by a dog, the usual antiseptic dressings should be used and a physician consulted. Neither the child nor the dog should be frightened. The possibility of the dog's having rabies should be determined and, in any case of possible doubt, antirabic serum should be used.

Every puncture wound, even a small one, should be seen by a physician, who will decide whether or not the antitetanus serum should be used.

Foreign bodies in the eye can be flushed out with warm salt water in an eyecup, or by pouring the water from a small pitcher. *In the ear,* they may be flushed out with warm oil or water. *In the nose,* sneezing may be provoked by inhaling a very small amount of pepper, *while a wet cloth is held over the eyes. In the throat,* bones, etc. can be removed with the splinter forceps while the mouth is held open and the tongue held down, as in looking down the throat. If a foreign body is drawn *into the windpipe or the lungs,* the child will not choke to death unless an extraordinarily large object has been inhaled. Again, panic is to be avoided and the child induced to relax and discover that he can breathe. If the object actually reaches the lungs, measures must be taken to have it removed by a bronchoscope specialist.

Falls, Shocks.—If a child falls from a height and is rendered unconscious, *the greatest care should be used in picking up the child, keeping in mind that there may be skull or spine injury or broken bones.* The body should be very gently straightened and the legs and arms manipulated to discover possible breaks. If there are none, the left hand of the rescuer should be spread to support the child's head with great care, as there may be concussion. With the right arm, support the entire body and so move it to a suitable place slowly and with gentleness. If there is indication of broken bones or head injury, the child should be very carefully slipped onto a flat board or stretcher, and not handled in the moving.

Electric Shock.—With the greatly increased use of electrical equipment, an increasing number of deaths from electric shock are reported. The one fact to be stored, ready to use, in everyone's mind, is that *moisture conducts and dryness repels electricity.* Add to this the well-known fact that metals and living (moist) tissues of every sort conduct, while dry leather, rubber, fur, feathers, glass, and wood are nonconductors. A victim is rescued by employing nonconductors to shove, push, or lift him from live-current contacts. The shock is treated by rest and stimulant, as in any other shock. Artificial respiration may be used.

Immunization.—The normal infant is born with considerable immunity to many diseases to which he later becomes susceptible. This birth immunity begins to fade rapidly at about six months. It has been proved that artificial immunity to smallpox and diphtheria may safely and successfully be established between six and twelve months of age by inoculation with smallpox vaccine and with toxin-antitoxin or with toxoid. Both these diseases are highly fatal to young children. It is now strongly advocated by all pediatricians and public health authorities that all infants be so protected before they are one year old. This immunity is usually life long.

Inoculation with scarlet-fever serum confers immunity for a less certain period of time. It is commonly advised that young children receive scarlet fever serum only if they have been exposed to the disease or if it occurs in the family.

Whooping-cough serum (pertussin) seems to make the attack of the disease shorter and milder. Immunity following inoculation requires several months to develop. There is still difference of opinion as to the advisability of routine inoculation.

Convalescent serum secured from persons who have had the disease is being successfully used in the prevention and treatment of measles. The immunity is brief, but it is valuable for the protection of younger children when an older child in the family has the disease.

Convalescent serum is also being used in infantile paralysis, but its protective value is not yet well established.

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