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PERSONAL AND COMMUNITY HEALTH

PERSONAL AND COMMUNITY HEALTH

BY

C. E. TURNER, A.M., Ed.M., D.Sc., Dr.P.H.

Professor of Public Health Emeritus Massachusetts Institute of Technology; Formerly Associate Professor of Hygiene in the Tufts College Medical and Dental Schools; Sometime Member of the Administrative Board in the School of Public Health of Harvard University and the Massachusetts Institute of Technology; Formerly Visiting Professor of Health Education, School of Public Health, University of California

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PREFACE

Health instruction at the university level is now generally recognized as desirable. The students face new health problems and need more extensive knowledge. Moreover, much is expected of them. Many will enter some occupation or profession concerned with health, with education, with social welfare, or with government. Most of them will have responsibility for the health of a family. All should acquire the standard of health knowledge appropriate for educated men and women—one which will enable them to meet their proper health responsibilities in the workplace, in the home, and in the community.

This book is planned for the various college-level groups. It seeks to present the essential, present-day knowledge of personal and community health within available time and space limitations and with enough anatomy, physiology, and other underlying sciences to clarify and support the health teaching. It is based upon many years of health instruction, not only to college men and women, but also to students in schools of public health, medicine, dentistry, and engineering, to teachers, nurses, dental hygienists, and to the various age levels in the public schools. Such an experience develops a realization of both the importance and the difficulties of health instruction. The field is broad; the science is advancing rapidly; and the motivation of health knowledge into student health behavior is difficult. These difficulties confront the writer of a textbook as well as the instructor in the course.

The present edition reflects the continued teaching experience of the writer and of many other teachers who have used the book and whose friendly and constructive suggestions are deeply appreciated. We should also acknowledge the debt of teachers and students everywhere to the many scientists from whose researches and studies our present knowledge of hygiene has been drawn.

References at the end of each chapter give brief lists of recent or older significant books on the specific topics. The instructor may wish to have at hand also such recent extensive bibliog-

raphies as *A List of Source Materials for Teachers of College Hygiene* developed by the Committee on Health Instruction of the American Student Health Association and available from the School Health Bureau of the Metropolitan Life Insurance Company, 1 Madison Avenue, New York City; also book lists available from the American Association for Health, Physical Education and Recreation, 1201 Sixteenth Street, N.W., Washington, D. C.; and references from the many voluntary health agencies listed in Chapter XXVIII. The *Health Instruction Yearbook,* prepared by Dr. Oliver E. Byrd and issued by the Stanford University Press, Stanford, Calif., each January, presents recent data on a wide variety of topics in a concise form which will be useful for either teacher or student reference.

The writer wishes to express his thanks to the many professional friends, associates, and colleagues who have offered specific criticism and helpful suggestions. These include J. Howard Beard, M.D., University Health Officer, University of Illinois, and various staff members and committees from The American Dental Association, The American Heart Association, The National Tuberculosis Association, The American Cancer Society, The American Social Hygiene Association, and The National Society for the Prevention of Blindness. May Millbrook, M.D., of the University of Illinois, and Ruth White Howe assisted materially in the preparation of this revision.

C. E. T.

Cambridge, Mass.

CONTENTS

PART I

PERSONAL HEALTH

CHAPTER I

PAGE

HYGIENE AND HEALTH - 17

Health Values, 19; Student Attitude, 19; What Is Health? 21; Habits and Health, 21; Habits and Personality, 22; Value of Hygiene, 23; A Guide for Health Appraisal, 23; Appearance as It Relates to Health and Attractiveness, 23; Health Status (in Terms of Normal Structure and Function), 24; Living Healthfully for the Protection and Promotion of Health, 24.

CHAPTER II

NUTRITION - 26

Classes of Food, 26; Water, 28; Carbohydrates, 28; Fats and Lipoids, 30; Proteins, 30; Mineral Elements, 32; Vitamins, 35; Acid and Alkaline Foods, 47; Meeting Dietary Needs, 48; Energy Requirement, 48; Gaining and Losing Weight, 52.

CHAPTER III

DIGESTION - 59

The Mouth and Esophagus, 59; The Stomach, 62; Small Intestine, Liver, and Pancreas, 63; The Large Intestine, 65; The Absorption of Food Substances, 66; Appetite, Hunger, and Thirst, 67; Digestion and Emotion, 67; Rest, 68; Regularity in Eating, 70; Water With Meals, 70; Digestive Disorders, 70; Indigestion, 70; Constipation, 71; Diarrhea, 74; Diseases of the Digestive Tract, 74.

CHAPTER IV

ORAL HYGIENE - 76

Form and Arrangement of the Teeth, 76; Development and Structure of Teeth, 76; Structural Abnormalities in the Mouth, 79; The Quality of the Teeth, 80; Caries, 81; Diseases of the Soft Tissues, 83; Care of the Mouth and Teeth, 84; Summary, 88.

CHAPTER V

RESPIRATION - 90

Oxidation, 90; The Path of the Breath, 91; The Mechanics of Breathing, 94; Breathing and Health, 97; The Hygiene of the Voice, 97; Mechanical Obstruction to Breathing, 98; The Effects of Mouth-Breathing, 99; Diseases of the Respiratory System, 100.

CHAPTER VI

PAGE

CIRCULATION - 103
The Blood, 103; The Heart, 105; Blood Vessels, 107; Circulatory Function, 110; Heart Disease, 110; Athletic Heart, 111; Defects in the Blood Vessels, 111; Defects of the Blood, 112; Loss of Body Fluids, 112; Hygiene of the Circulatory System, 114.

CHAPTER VII

THE KIDNEYS - 116
Structure and Function of the Urinary System, 116; The Hygiene of the Kidneys, 121; Kidney Disease, 122.

CHAPTER VIII

THE SKIN - 124
Structure, 124; Function, 126; Hygiene of the Skin, 128; Sun Baths, 130; Care of the Hands, 132; Care of the Face, 133; Care of the Hair, 133; Cosmetics, 134; Abnormalities, 136.

CHAPTER IX

ENDOCRINES - 138
Metabolism, 138; Ductless Glands, 139; Thyroid Gland, 139; Parathyroid Glands, 144; Adrenal Glands, 144; Pituitary Gland, 145; The Pineal Body, 146; The Pancreas, 146; Ovaries and Testes, 146; Thymus, 147; Hygiene, 147.

CHAPTER X

THE SENSE ORGANS - - - - - - - - - - - - - - - - - 148
Proprioceptors, 148; Cutaneous Receptors, 148; Taste and Smell, 149; Auditory Receptors or Hearing, 150; Defects of the Ear, 152; The Eye, 155; Deviations From Normal Vision, 158; Diseases of the Eye, 161; Causes of Blindness, 163; Hygiene of the Eyes, 163.

CHAPTER XI

THE HYGIENE OF THE NERVOUS SYSTEM - - - - - - - - - - 167
Structure and Function, 167; Habit, 171; Concentration, 172; Sleep, 173; Dreams, 176; Change of Work, 176; Overwork, 177; Bodily Defects, 177.

CHAPTER XII

MENTAL HYGIENE - - - - - - - - - - - - - - - - - - 179
What Is Mental Hygiene? 179; Mild Cases of Mental Disorder, 180; Psychoneuroses, 182; Serious Cases of Mental Disorder, 185; Mental Difficulties of Peculiar Persons, 186; Mental Health for Normal Children, 187; Mental Conflicts of Children, 190; Feeblemindedness, 191.

CHAPTER XIII

PAGE

NARCOTICS AND STIMULANTS - - - - - - - - - - - - - - - - 196
Alcohol, 196; Alcohol and Health, 196; Alcohol and Society, 200; Summary, 201; Narcotic Drugs, 202; Nicotine, 203; Caffeine, 205; Coffee and Tea, 205; Theobromine, 206.

CHAPTER XIV

THE HYGIENE OF BODY ACTIVITY - - - - - - - - - - - - - - 208
Bones, 208; Joints, 208; The Vertebral Column, 209; Muscles, 210; Physical Activity, 212; How Exercise Contributes to Health, 213; The Measurement of Physical Condition, 214; Choice of Physical Exercise, 215; The Adjustment of Activity to Age Level, 218.

CHAPTER XV

BODY MECHANICS - 222
The Importance of Posture, 222; Defects of Posture, 222; Causes of Poor Posture, 224; Effects of Poor Posture on Health, 224; Correction of Postural Defects, 225; What Is Good Posture and How Is It Secured? 226.

CHAPTER XVI

FOOT HYGIENE - 230
Structure, 230; Function, 231; Foot Defects, 231; Hygiene of the Foot, 234; Exercises for the Feet, 235.

CHAPTER XVII

HEREDITY AND HEALTH - - - - - - - - - - - - - - - - - - 237
Mendelian Inheritance, 237; Inherited Diseases and Abnormalities, 240; How Sex in the Offspring Is Determined, 240; Sex-Linked Characters, 241; Mentality and Heredity, 242; Feeblemindedness, 244; Heredity and Conduct, 245.

CHAPTER XVIII

THE HYGIENE OF REPRODUCTION - - - - - - - - - - - - - - 247
The Problem Defined, 247; Structure of the Genital Organs, 247; The Reproductive Process, 249; The Sex Hormones, 252; The Male, 253; The Female, 253; Diseases, 255; Sex Education, 255; Marriage, 256.

CHAPTER XIX

ADULT HYGIENE - 258
Medical Care, 258; Choosing One's Physician, 259; Health Insurance, State Medicine, Socialized Medicine, 260; Health Problems of the Adult, 262; Cancer, 263; Accidents, 268; Rheumatism, 268; Gerontology, 269.

PART II

COMMUNITY HEALTH

CHAPTER XX

PAGE

THE SCIENCE OF DISEASE PREVENTION - - - - - - - - - - - - 271
Early Theories of Disease, 271; Foreshadowings of the Present Theory, 272; Fermentation and Disease, 273; Pasteur, 273; Lister, 274; Koch and the Development of Bacteriology, 274; Progress Due to Bacteriology, 279; Viruses, 279; Preventing Disease, 280; Preventive Medicine, 280; Smallpox and Vaccination, 281; Immunity in Anthrax and Rabies, 282; Diphtheria and Antitoxin, 284; Use of Specific Chemical Substances in Fighting Germ Diseases, 285; Preventive Sanitation, 286; The Epidemic of the Broad Street Well, 286; Preventive Hygiene, 289; Summary, 290.

CHAPTER XXI

ESSENTIAL FACTS OF IMMUNITY - - - - - - - - - - - - - - 291
Immunity Defined, 291; Resistance, 292; Fatigue, 292; Exposure to Wet and Cold, 292; Alcohol, 293; Malnutrition, 293; Focal Infections, 293; Physical Defects, 293; Immunity, 293; Natural Immunity, 294; Acquired Immunity, 294; Carriers, 295; Disease Reactions, 296; Toxins, 296; Reactive Phenomena, 296; Immunization in Specific Diseases, 300; Tests of Immunity and Sensitivity, 301.

CHAPTER XXII

ALIMENTARY AND RESPIRATORY INFECTIONS - - - - - - - - - - 302
The Interrelationship of Plants and Animals, 302; Types of Communicable Disease, 303; The Alimentary Diseases, 304; Respiratory Diseases, 306; Common Cold, 307; Nature and Transmission, 308; Control, 310; Tuberculosis, 311; Prevalence, 311; Nature of the Disease, 313; Prevention and Control, 314.

CHAPTER XXIII

CONTACT AND INOCULATION DISEASES - - - - - - - - - - - - - 318
Contact Diseases, 318; Syphilis, 319; Nature of the Disease, 322; Reducing or Eliminating the Disease, 323; Other Venereal Diseases, 325; Inoculation Diseases, 326; Mosquito-Borne Diseases, 329; Mosquito Control, 330; Diseases Carried by Other Insects, 331; DDT (Dichlorodiphenyltrichloroethane), 332.

CHAPTER XXIV

FOOD CONTROL - 334
Food Adulteration, 334; Nature and Cause of Adulteration, 334; Pure Food Laws, 334; Law Enforcement, 337; False Advertising, 337; Food Sanitation, 337; Milk, 338; Remade Milk, 339; Con-

PAGE

densed, Evaporated, and Dried Milks, 340; Meat, 341; Dangers in Meat, 342; Food Infection and Poisoning, 343; Food and Restaurant Sanitation, 344; Food Preservation and Refrigeration, 346.

CHAPTER XXV

WATER SUPPLY - 347
What Is Good Water? 347; Sources of Water Supply, 348; Testing a Water Supply, 350; Environment, 351; Bacteriologic Study, 351; Physical Tests, 351; Chemical Tests, 352; Microscopic Analysis, 354; Water Purification, 355; Storage, 355; Filtration, 357; Chlorination, 358; Emergency Treatment of Drinking Water, 359.

CHAPTER XXVI

WASTE DISPOSAL - 360
Sewage Disposal, 360; Direct Disposal, 361; Chemical Purification, 361; Bacteriologic Purification, 362; Aerobic Processes, 362; Anaerobic Processes, 365; Final Disinfection, 367; Possibilities and Limitations of Sewage Purification, 367; Rural Sanitation, 369; Disposal of Garbage, 371; Disposal of Manure, 372.

CHAPTER XXVII

VENTILATION, HEATING, AND LIGHTING - - - - - - - - - - - - 374
Good Air Defined, 374; Temperature, 376; Moisture and Air Movement, 377; Odors, 377; Testing Air, 377; Ventilating and Heating, 379; Natural Ventilation, 379; Artificial or Mechanical Ventilation, 380; Relative Humidity, 381; Air Washing and Humidifying, 381; Cooling Air, 382; Infection and Sterilization of Air, 383; The Economic Value of Good Ventilation, 383; Lighting, 384; Artificial Illumination, 386; Standards for Lighting, 387.

CHAPTER XXVIII

PUBLIC HEALTH ADMINISTRATION - - - - - - - - - - - - - - 389
Public Health Authority, 389; Federal Public Health Functions, 389; Federal Authority, 389; The United States Public Health Service, 390; Other Federal Health Agencies, 392; State Health Functions, 393; Public Health Laws, 393; State Health Administration, 395; Administrative Functions, 395; Local Health Administration, 397; Authority, 397; Local Health Organization, 398; The Health Center, 400; County Health Unit, 400; The Health Officer, 401; Unofficial Health Agencies, 401.

CHAPTER XXIX

MATERNAL AND CHILD HYGIENE - - - - - - - - - - - - - - - 405
Maternal Hygiene, 405; Problems of Maternal Care, 406; Community Standards of Maternity Care, 407; The Infant, 408; Feed-

PAGE

ing the Infant, 411; Infant Care, 412; Community Standards of Child Welfare, 413; The Preschool Child, 414; The Health Program for the Preschool Child, 416; The Mental Health of the Preschool Child, 418.

CHAPTER XXX

SCHOOL HYGIENE - 420
Development and Scope of the School Health Program, 420; School Health Activities, 422; Maintenance of Sanitary and Hygienic Conditions in School, 424; Health Examinations, 426; Communicable Disease Control, 429; Correction of Physical Defects and Health Conservation of Defectives, 431; Special Classes, 435; Hygienic Arrangement and Administration of the School Program, 436; Physical Education, 438; Health Education, 439; Safety Education, 440.

CHAPTER XXXI

INDUSTRIAL HYGIENE - - - - - - - - - - - - - - - - - - 442
Hygienic Working Conditions, 442; Industrial Poisons, 442; Dusts, 445; Industrial Infections, 447; Accident Hazards, 447; Atmospheric Pressure, 449; Sanitation, Heating, and Lighting, 450; Noise, 450; Fatigue, 451; Health Administration in Industry, 451; Medical Activities, 453; Lunches, 454; Disease Prevention and Health Education, 455; Governmental Activities in Industrial Hygiene, 455; Child Labor, 456; Women in Industry, 456; Industrial Accident Insurance, 457.

APPENDIX A

THE CONTROL OF COMMUNICABLE DISEASES - - - - - - - - - - 458
List of Diseases, 458; Actinomycosis, 459; Anthrax, 460; Ascariasis, 462; **Bartonellosis (Oroya Fever, Verruga Peruana)**, 463; Chancroid (Soft Chancre), 463; Chickenpox (Varicella), 464; Cholera, 465; **Choriomeningitis**, 466; **Coccidiodomycosis (Coccidiodal Granuloma, "Valley Fever")**, 466; Common Cold, 466; Conjunctivitis, Acute Infectious (of the Newborn, Not Including Trachoma), 467; Dengue, 468; Diarrhea of the Newborn, Epidemic, 468; Diphtheria, 469; Dysentery, Amebic (Amebiasis), 470; Dysentery, Bacillary (Shigellosis), 472; Encephalitis, Infectious, 473; Favus, 474; Filariasis (Mumu), 475; Food Infections (Salmonellosis), 475; Food Poisoning: Bacterial Intoxications, 476; German Measles (Rubella), 477; Glanders, 478; Gonorrhea, 478; Granuloma Inguinale, 479; Hemorrhagic Jaundice (Icterohemorrhagic Spirochetosis, Weil's Disease), 479; Hepatitis, Infectious (Acute Catarrhal Jaundice), 480; Hookworm Disease (Ancylostomiasis), 481; Impetigo Contagiosa, 483; Influenza, 483; Kerato-Conjunctivitis, Infectious (Superficial Punctate Keratitis, Nummular

PAGE

Keratitis), 485; Leishmaniasis (American) Mucocutaneous Leishmaniasis, Espundia, Uta, Bubas, 485; Leprosy, 485; Lymphogranuloma Venereum (Inguinale) and Climatic Bubo, 486; Malaria, 486; Measles (Rubeola), 488; Meningococcus Meningitis (Cerebrospinal Fever), Meningococcemia, 490; Mononucleosis, Infectious (Glandular Fever), 491; Mumps (Infectious Parotitis), 492; Paratyphoid Fever, 493; Pediculosis (Lousiness), 494; Pemphigus Neonatorum (Impetigo of the Newborn), 495; Pertussis (Whooping Cough), 495; Plague, 497; Pneumonia, 498; Poliomyelitis, 501; Psittacosis, 502; Rabies, 504; Ratbite Fever (Sodoku), 505; Relapsing Fever, 505; Rheumatic Fever (Acute Rheumatic Fever, Acute Rheumatism), 507; Rickettsial Diseases (the Typhus Group of Fevers), 508; Epidemic or Classical Typhus (Louse-Borne), 508; Endemic or Murine Typhus (Flea-Borne), 509; Ringworm (Dermatophytosis), 512; Sandfly (Phlebotomus or Pappataci) Fever, 514; Scabies (the Itch), 514; Schistosomiasis, 515; Smallpox (Variola), 515; Streptococcal Infection—Respiratory, 517; Streptococcal Infection—Other Than Respiratory, 519; Syphilis, 521; Tetanus, 522; Trachoma, 524; Trichinosis, 525; Trypanosomiasis, American (Chagas' Disease), 527; Tuberculosis, Pulmonary, 527; Tuberculosis, Other Than Pulmonary, 529; Tularemia, 530; Typhoid Fever, 531; Undulant Fever (Brucellosis), 533; Vulvovaginitis in Children, 534; Yaws (Frambesia), 535; Yellow Fever, 535.

APPENDIX B

DISINFECTION AND DISINFECTANTS - - - - - - - - - - - - - 536
Disinfection Versus Sterilization, 536; Disinfection, 536; Natural Disinfection, 536; Chemical Disinfectants, 537; Antiseptics, 538; Deodorants, 538; Fumigation, 538; Common Disinfectant Procedures, 538.

PREFIXES, SUFFIXES AND COMBINING FORMS - - - - - - - - - - 540

GLOSSARY - 541

INTRODUCTION

The thoughtful traveler, who is to explore a new area or study a partially known country in greater detail, gives serious thought to the plan of his explorations before he undertakes the task. He knows what things he is seeking. He studies the best available map, scans the various regions to be covered, and contemplates the interesting things to be looked for in each.

The student of hygiene, who is about to make a more careful investigation of this field of knowledge, will find the opportunity more pleasurable if he gives some preliminary thought to the purpose and objectives of his scholastic expedition, if he sees in advance the natural divisions of the ground to be covered, and if he is told why the plan of procedure represented in the textbook has been used. It is not necessary that the precise sequence of any book should be followed, but the author and the instructor are the guides in this expedition, and a knowledge of their plans and viewpoints will be helpful.

We usually separate personal health from community health, although the boundary line cannot be sharp, since individuals make up the community. We must recognize also that a general course in personal and community health must exclude any attempt to teach skill subjects like first aid or food preparation, which can be learned only through practice.

As we study *personal hygiene* we ask ourselves, What are the fundamental bodily functions? Biologists say that animals have four: assimilation, sensation, movement, and reproduction. To a considerable degree personal hygiene is centered about these activities, for man does eat, think and feel, work and play, and reproduce. Health will depend, in considerable degree, on maintaining a normal metabolism (Chapters II through IX). This involves the proper selection, digestion, and utilization of food, inhalation of sufficient oxygen, the transportation of substances within the body, the prompt elimination of waste, and the control of cell activity and of body temperature.

Health involves the care of the nervous system and satisfactory mental and emotional adjustment (Chapters X, XI, XII). There

are dangers in the use of narcotics and stimulants (Chapter XIII). Health also involves the proper mechanical use of the body and a proper amount of suitable activity (Chapters XIV, XV, XVI). The hygiene of reproduction involves the control of racial health through the application of a knowledge of heredity and through sex hygiene (Chapters XVII, XVIII). One needs to recognize the distribution of responsibility for health maintenance between the individual, the physician, and the organized public health agencies (Chapter XIX).

In the field of *community health* we are concerned with the health of people as a group, and with the social and governmental activities responsible for environmental control and health promotion. Man has built up a science of disease prevention (Chapter XX) through which he has learned the nature of communicable diseases (Chapters XXI, XXII, XXIII, and Appendix A), the control of food, water, waste, and other sanitary problems (Chapters XXIV, XXV, XXVI), and the control of ventilation, heating, and lighting (Chapter XXVII). He has developed effective public health procedures in both rural and urban areas for health maintenance in the home, the school, and the factory (Chapters XXVIII, XXIX, XXX, XXXI).

This is the nature of the scientific knowledge which enables man to maintain vigorous health and to guard against disease. Your own health will depend in no small degree upon your mastery and application of the important facts and principles of hygiene, which racial experience and scientific research have brought together.

Part I
Personal Health

CHAPTER I
HYGIENE AND HEALTH

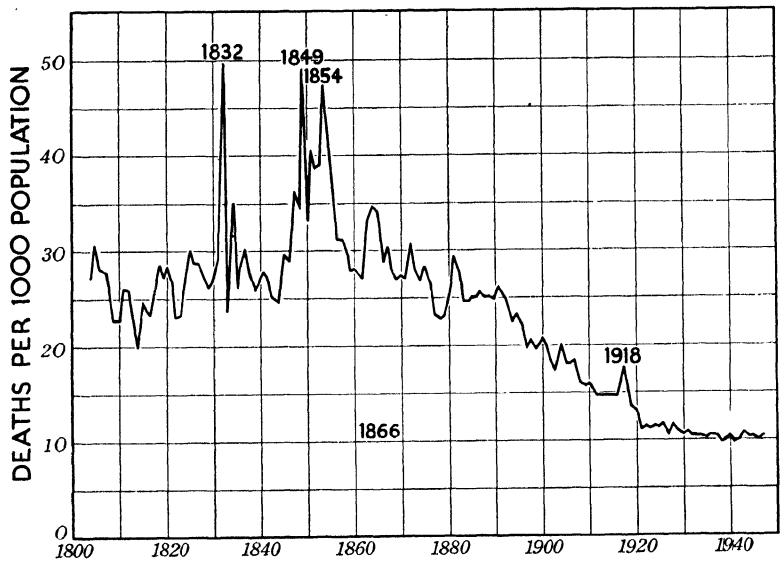
Throughout the animal world, except for man, early death is the rule and adult life the exception. Many lower animals produce hundreds or even thousands of young, but only two or three of them are likely to reach maturity and, in turn, produce offspring. In general, the higher the animal in the scale of evolution, the fewer are the offspring, the better the care of the young, and the lower the death rate.

Science indicates that man has lived upon the earth for about one million years. During most of his experience early death has been the rule. Among some of the most primitive tribes it is still true that the majority of offspring die in infancy and childhood; but as man has come to dominate the animate world, he has gradually reduced the death rate. During the last century progress has been rapid in many parts of the world. One hundred years ago the death rate in the large American cities was approximately 30 deaths annually per 1,000 people. Today the annual death rate in the same cities is well below 10 per 1,000. The probable length of life of a baby born today (about 66 years) is more than twice as great as that of one born in colonial days (about 29 years). In many cities only one-fourth as many babies now die during the first year in life as in 1900.

Man's gradual conquest of disease is also reflected in military experience. The United States Army disease death rate per 1,000 men in successive wars has been as follows: Mexican War, 110 (seven times the battle deaths); the War between the States (north), 65 (twice the battle deaths); World War I, 16 (one-third the battle deaths); World War II, 0.6. World War I was the first great war in which disease deaths were fewer than battle

deaths. Deaths among wounded men also dropped from 8.3 per cent in World War I to 4.5 per cent in World War II. These changes reflect advances in sanitation and preventive medicine (military hygiene) and, recently, such developments as DDT and Atabrine in mosquito control and the clinical use of whole blood and blood plasma.

Man has conquered famine by the skillful production and storage of food. He has learned to protect himself from the inclemencies of the weather. He has subdued or exterminated animals which were once his mortal enemies. His battle against disease in



The death rate for New York City. Cholera epidemics occurred in 1832 and in 1849. A smallpox epidemic occurred in 1854 and an influenza epidemic in 1918. In 1866 the City Health Department was established. (Courtesy New York City Health Department.)

all its forms is one phase of his continuing struggle to improve the security and the quality of existence. The knowledge he has collected concerning healthful living is *hygiene.* It is commonly divided into two phases: *personal hygiene,* which concerns the behavior of the individual; and *community hygiene,* which deals with the control of the environment and with the governmental and group activities for health promotion.

Health Values.—You recognize health as an achievement of man. You realize that only a strong and vigorous nation can survive. But what does health mean to *you?* How important is health in your present habit of life, and how important will it be in carrying out your plans for the future? Would you sacrifice health for other aims, or should other things in life be sacrificed for it?

Have you ever enumerated the things you would like to be, to do, to acquire—in other words, the important things you hope life holds in store for you—and then made a candid evaluation of the importance of health in relation to these matters? Do you know where you stand at present in the matter of your own health, and to what extent your habits of living affect it? These questions concerning your attitude toward health and the regulation of your daily life in reference to health are important. To learn facts regarding the health of individuals or communities is an educational, perhaps a cultural, process, but unless your habits of life and the quality of your citizenship are improved thereby you will have missed the greater part of the educational opportunity.

Student Attitude.—The history of student attitude regarding health has not been altogether a proud one. Students have too commonly left college for lack of health or graduated in wretched physical condition. It may be that the breakdown came in part as the result of inherited weakness. If there were physical limitations, the student should have learned of them from a health examination at college entrance and should have followed a life program within these limitations, either through a less strenuous course in college with particular attention to health improvement, or by entering some other field of activity. By far the more common cause of such a breakdown is a misuse of the body from following a program so neglectful of physical welfare that health cannot be maintained. A college or professional education is hardly worth while if it brings suffering, unhappiness, and physical incapacitation for the intended lifework. Persons who break down completely are few, however, in comparison with the number who are half well and move about in a gray haze of depression with only a fraction of the enjoyment which life could afford them.

Our problem is one of relative values. It is apparent from discussions of personal health with many college and professional



(H. Armstrong Roberts)

How would you define or evaluate health, attractiveness, efficiency, and personality?

school students that the man or woman in abundant health usually gives little thought to its importance. His eyes are fixed on other goals. It is only when he takes time to consider the relationship of health to his ambitions that he forms a normal estimate. On the other hand, the man who is struggling against sickness or disability invariably places an exceedingly high value upon it. He says, "Health is the most important thing in life." Those who have the least health value it most. The variation in evaluation comes from the difficulty of man to appreciate what he has always possessed. Contrast sharpens vision. Things lost take on new values.

Do you agree that health maintenance is a first consideration, or have you developed a philosophy of making any health sacrifice, of putting any unreasonable demand upon your body for the attainment of an immediate success? Or what is equally serious, have you laid out your daily program without regard to your physical improvement?

Health is obviously not the ultimate aim of life. There are more important things. Honor, integrity, justice, manhood, womanhood, and freedom have been maintained at cost of human life. Everyone has a normal ambition to do or to perform an important and useful service in life. This ambition may be worthy of a sacrifice of health, but certainly sacrificing health does not in itself accomplish the ambition. In fact, it usually defeats it.

What Is Health?—Health is much more than merely not being "sick in bed." Normal functioning of all parts of the body means joyousness, cheerfulness, and efficiency, as well as the ability to do a full day's work without more than a healthful fatigue. It means attractiveness, courage, and enthusiasm for life. We have come to realize how great is the difference between optimal nutrition and nutrition which is merely adequate to prevent obvious disease. War shows us the difference between the man who is fit for combat duty and the man who has only sufficient vigor to carry on a sedentary occupation. We need to build into our definition for health these ideals which we express by the term *complete physical fitness.*

This concept of health also extends beyond the proper functioning of the organs of the body to include a sound, efficient mind and wholesome emotions. In its various phases, and to the degree in which it is present, health makes possible a higher quality of living. The desire for a feeling of personal worth is, perhaps, the most important driving force in our lives. Health helps us to attain this end through making possible a higher quality of service.

Habits and Health.—Physical fitness demands freedom from defects in the organs of the body, but it is maintained only through a normal regimen of healthful living. Your health depends not upon what you know but upon what you do.

Knowledge alone will not improve your health, your physical efficiency, your attractiveness, or your personality. Good health is a state of complete physical efficiency. It is developed by *habit,* by *custom,* by *doing,* and not merely by *thinking,* or *wishing,* or *knowing.*

There is ample evidence of the effect of habits of life upon health. We see the effect of hygienic living in athletic and military training, and in the dietary treatment of malnourished children. We see it in the tuberculosis sanatorium where the benefits are secured, not through medication but by proper food and rest.

Faulty habits of living of the people at large are among the most important factors working against the national health and efficiency. The examination of military personnel showed thousands of defects which might not have developed under proper habits of living. Every health department is confronted with the spread of communicable disease because of faulty hygiene. In World War

II the greatest amount of sickness within the armed forces came from three groups of diseases (insect-borne diseases, filth or intestinal diseases, and venereal diseases) whose prevention is well understood. Thousands of these cases occurred because individuals did not make use of available information. The private practitioner of medicine, the hospital, or clinic can point out to you case after case of nervous breakdown, of organic or degenerative disease of middle life which came as a result of faulty habits.

Modern civilization has developed a strenuous competitive community life which often places a premium upon mental rather than upon physical labor. The struggle for social and material progress crowds out consideration for our physical well-being and we fail to maintain buoyant health.

Sanitation has nearly eliminated many diseases. Preventive medicine and curative medicine are making constant advances, but many communicable and organic diseases will be conquered only by hygienic living on the part of the individual.

Habits and Personality.—There is another reason for proper habits of living. In addition to their effect upon the body itself habits affect the personality, the impression produced by a person upon other people, and therefore one's success. The realization that one's mode of living is, in some respects, lower than that to be expected of a cultured and intelligent person makes one ill at ease, as does the wearing of clothes that are not suitable for the occasion. Conversely, proper habits produce not only physical and mental efficiency, but also confidence in meeting people. Students of the elements which go to make up personality recognize this. Dr. W. W. Charters, an expert in methods of training men and women for administrative positions, has listed the following twenty qualities, the presence or absence of which determines one's strength of personality:

1. Ambition.
2. Industriousness.
3. Persistence and patience.
4. Dependability.
5. Forcefulness.
6. Effectiveness of speech.
7. Self-confidence.
8. Friendliness.
9. Adaptability.
10. Tact.
11. Cheerfulness.
12. Good judgment.
13. Sensitiveness to criticism.
14. Ability to size up people.
15. Memory.
16. Neatness.
17. Health habits.
18. Discrimination.
19. Economy.
20. Capacity to delegate work.

Referring to health habits he says: "This is not a matter of your *endowment* of physical health. Severe illness may not mean that you are short in this trait. Ask yourself whether your *habits* are those that build for or against good health and how they tell on your working ability and mental attitude day by day."

Value of Hygiene.—The need for hygiene arises from the fact that we do not often find ourselves in an ideal environment. *Life is a process of continually adapting, fitting, adjusting oneself to surroundings.*

Whatever else may be expected of the college or professional man and woman, it would seem reasonable to expect that the advantages of a higher education have equipped them with both the knowledge and the habits for a healthful program of living. The student at the university level should have already acquired some knowledge of physiology and of hygiene. He should know, for example, the general structure of the body and its systems of organs. He should know something of the cells as the protoplasmic units of which the body is composed. He has heard much of health rules, but he is imperfectly aware of the scientific facts upon which they are based and their applicability to his own particular needs. This book seeks to extend the knowledge of practical hygiene and the necessary underlying sciences and to apply this knowledge to life now and later.

Health Evaluation.—We appraise the health of others by their *appearance* and each of us is appraised by others in the same way. Attractiveness is not purely a matter of health but the two are closely related. A more exact appraisal of health is secured by a check upon *structure and function* through a medical examination and our own observation. Our future health is largely determined by whether we are *living healthfully.*

There follow about 100 items grouped in three major areas under thirty-one headings. You may wish to use them in estimating the quality of your own health or you may like to prepare a rating scale of your own from these criteria.

A GUIDE FOR HEALTH APPRAISAL

A. Appearance as It Relates to Health and Attractiveness

1. *Skin:* Clear and smooth, including skin under the eyes; tissue firm?
2. *Hair:* Clean, glossy, and well kept?

3. *Eyes:* Shining and alert rather than dull and heavy; white of eye clear; no puckery lines or frowns?
4. *Mouth:* Happy expression; no mouth breathing?
5. *Teeth:* Clean, regular, good occlusion; no unfilled cavities?
6. *Hands:* Skin smooth, immaculately clean; nails and cuticle well cared for?
7. *Feet:* Toes point straight ahead; ankles straight, not rolled inward; feet arched, not flat?
8. *Proper shoes:* No extremes; everyday shoes conform to the shape of the foot with straight inner edge, sole broad enough to permit movement of foot muscles, heels of moderate width and height? (This does not apply to evening shoes.)
9. *Posture when standing:* Head poised and well back, chin in, shoulders level, arms relaxed, chest the part of the body farthest forward, back straight, abdomen flat, weight mostly on the balls of the feet?
10. *Easy and graceful seating position:* Head, neck and body in same relative position as in standing, whether one is sitting erect or bending forward from the hips as in writing; lower spine against back of chair, hands in repose, knees almost touching, feet parallel or one crossed over the other?
11. *Good carriage in walking:* Entire body carried easily and gracefully in good rhythm; toes pointing straight ahead; step elastic and firm, not heavy?
12. *Clothing:* Suitable to season and occasion, adapted in line and color to the individual?
13. *Weight:* Within reasonable range for age, height, and type? (Neither obese nor extremely thin—not more than 20 per cent above or 15 per cent below average for sex, age and height.)

B. Health Status (in Terms of Normal Structure and Function)

1. *Freedom from defects* of heart, lungs, posture, teeth, eyes, ears (hearing), tonsils, feet and from skin disorders, malnutrition, visceroptosis, faulty metabolism (shown by urinalysis or other tests)?
2. *Normal bodily function* as reflected in freedom from persisting or regularly recurring physical pain or discomfort, being only wholesomely tired at night and rested and refreshed in the morning, having regularity of bowel movement which occurs usually once daily?
3. *Mental and emotional health* as reflected in zest for work and play, by freedom from persistent worry, and by the ability to concentrate, to make decisions, to make friends and keep them, to get along pleasantly with persons you dislike, to accept disappointment without becoming bitter, to enjoy yourself with people and when alone?

C. Living Healthfully for the Protection and Promotion of Health

1. Have you been immunized against smallpox, diphtheria, and other diseases for which immunization is desirable and available in your area?
2. Do you eat regularly and have a balanced diet, with at least six glasses of fluid daily?
3. Do you get at least eight hours of sleep and rest daily?
4. Do you have at least three hours of vigorous exercise scattered through the week (preferably at least one-half to one hour daily out of doors)?

5. Do you brush your teeth properly at least twice daily?.
6. Do you have a daily tonic bath?
7. Do you receive regular medical and dental examinations with attention as needed, including the correction of all correctable defects?
8. Do you have some enjoyable recreation daily (social life, hobbies, reading, etc.)?
9. Do you secure suitable ventilation and lighting for work, play, and sleep in so far as they are under your control?
10. Do you avoid alcohol, tobacco, and drugs?
11. Do you take medicine only upon a physician's advice?
12. Do you plan your work and usually complete it on time?
13. Do you have a belief in something greater than yourself which gives purpose and meaning to life?

CHAPTER II

NUTRITION

Adequate nutrition is a vital health factor, important to nations as well as to individuals. Without it, health, vitality, working efficiency, contentment, and the enjoyment of life are reduced. Thus the diet of nations has economic, political, and international significance.

One cannot secure a proper diet by selecting the foods he likes best. If we were restricted to natural foods and ate only milk, fruits, vegetables, seeds, greens, and shellfish, together with the meat and glands of other animals, we would have a better chance of giving the body all the chemical compounds it needs. But one cannot meet his nutritional requirements with such human inventions as candy, soda pop, pickles, and pastry. To select a diet scientifically or to know where the unscientific method breaks down, we must understand the nutritional needs of the body.

A physiologist thinks of food as supplying material which the body needs (a) for energy, (b) for growth and repair, and (c) for regulatory control. The chemical elements of which the body is made include oxygen 65 per cent, carbon 18 per cent, hydrogen 10 per cent, nitrogen 3 per cent, calcium 2 per cent, phosphorus 1 per cent (total 99 per cent), and smaller amounts of sodium, chlorine, magnesium, potassium, sulfur, iron, and copper, with still smaller amounts of manganese, iodine, fluorine, cobalt, and zinc. The body secures all these elements from food, in suitable chemical form for digestion and use in maintaining its functions and chemical structures.

Classes of Food.—You have long known many of the essential facts concerning the important types of food substances—namely, proteins, carbohydrates, fats, vitamins, and inorganic salts or minerals. A new approach to the food needs of the body may begin with the consideration of those products of digestion which pass through the walls of the digestive tract. These include, in addition to water, (1) products of protein digestion (amino acids), (2) simple sugars, (3) products of fat digestion (fatty acids and



The large number of children who suffer from inadequate diet constitute one of the world's most important public health problems. (Courtesy Farm Security Administration, U. S. Department of Agriculture.)

glycerol), (4) minerals, and (5) vitamins. What is the use of each of these food materials in the body? Why and how must we provide a diet which will insure the proper amount of each?

For many years it was believed that water, proteins, fats, carbohydrates, and minerals would meet all the needs of the body. During the first decade of this century, Frederick Gowland Hopkins, of Cambridge University, England, carried out some animal feeding experiments which showed that there are other substances essential to life and health, although they are needed in very small amounts. His laboratory animals ceased to grow and thrive upon mixtures of purified proteins, fats, carbohydrates, and minerals; but they did thrive when a very small amount of milk or the alcohol extract of certain vegetables was added to the diet. From these studies a host of investigations have led to the discovery of the so-called vitamin substances and have demonstrated their essential functions in the body. The absence of any one of these substances may produce a definite "deficiency disease," perhaps death, while its presence in the diet in insufficient quantity may produce a lowered state of health. We must study, therefore, not only the longer-known constituents of food, but also these more recently discovered essential substances. We must

also recognize the difference between buoyant health with *optimal* nutrition and merely passable health with only *adequate* nutrition.

Water.—Water makes up two-thirds the body weight, and in active tissues, such as muscle, it is three-fourths the total weight. The body, moreover, has a liquid carrier system. The blood and lymph, which are mainly water, carry food to the tissues and remove from them the waste products of combustion. Waste nitrogen is eliminated from the body chiefly with the water that passes through the kidneys. In making thirst more insistent than hunger, nature makes a constant and insistent demand for water in the diet.

The amount of water excreted by an active man, from the lungs in the form of moisture, from the skin in the form of sweat, and through the kidneys in the form of urine, is more than two quarts a day. An adequate amount of water in the body tissues and the body fluids is essential for optimal function. Yet a deficiency of water in the diet, especially among persons engaged in a sedentary occupation, is a common and serious fault.

Water may be obtained in the body in a variety of ways. The greatest quantity, of course, is obtained through drinking water and other beverages, such as milk, tea, and coffee, but much also is obtained from the solid food. This is notably true in the case of fruits and vegetables, many of which contain over 90 per cent water. Watermelon is 98 per cent water. Soup and broth are also sources of water supply in the diet. About a half pint of water is produced daily in the oxidation of other foods. The amount of water necessary for proper waste elimination and for feeding the tissues in a person of average weight is four or five pints a day. Of this, at least six glasses should ordinarily be taken in the form of water.

Carbohydrates.—The simple sugars which the body secures from the digestive tract are the products of carbohydrate digestion. They are excellent fuel or energy-producing foods because, when they are oxidized or burned in the body, they are completely broken down into carbon dioxide and water, both of which are easily eliminated waste products. These simple sugars and all other carbohydrates are composed of carbon, hydrogen, and oxygen, there always being two times as many hydrogen atoms as oxygen atoms, just as there are in water.

The carbohydrates are divided into three groups or subdivisions: monosaccharides, disaccharides, and polysaccharides.

The *monosaccharides,* or "simple sugars," are of the $C_6H_{12}O_6$ type. The three most important from the standpoint of nutrition are glucose, fructose, and galactose. *Glucose* (dextrose, grape sugar, corn sugar) is found in grapes and certain vegetables. It is made commercially from cornstarch. It occurs in small amounts in the blood of animals. *Fructose* (levulose, fruit sugar) is found in fruit juices and in honey. *Galactose* (along with glucose) is formed when milk sugar is digested. All these monosaccharides are produced in the body when the higher sugars and starches are digested. They are absorbed in the intestine.

The *disaccharides,* or "double sugars," may each be broken into monosaccharides. *Sucrose* (cane sugar, beet sugar, saccharose) yields one molecule of glucose and one of fructose. *Lactose* (milk sugar) yields glucose and galactose. *Maltose* (malt sugar, from malt or germinating cereals) yields two molecules of glucose.

Polysaccharides are complex carbohydrates, each molecule of which can be broken into several molecules of monosaccharides. They include starches, dextrins, glycogen, and cellulose. *Starch* is the most common stored carbohydrate in plants. When digested, it is changed into *dextrins,* then into maltose, then into glucose. *Glycogen,* or "animal starch," is found mostly in the liver and muscles. *Cellulose* is found in the cell walls of plants and is not readily digested.

The digestion of cane sugar is simpler and more rapid than the digestion of starch. It furnishes a quick source of energy, but in high concentration it may be irritating to the walls of the stomach. Moreover, sugar takes away the appetite if it is taken just before a meal because it makes other foods taste insipid and satisfies stomach hunger for the moment. Eating sweets between meals may have devastating effects upon the general nutrition of the body if it results in failure to consume sufficient mineral-bearing and vitamin-containing foods, such as fruits, vegetables, whole-grain cereals, eggs, and milk. In 1830 the average per capita consumption of sugar in the United States was 10 pounds. Now it is over 110 pounds—to our disadvantage nutritionally.

Glucose is the form of carbohydrate that is transported and used in the body, and animal starch or glycogen is the storage form. The blood usually contains from 0.08 to 0.12 per cent sugar, and a reserve supply of glycogen is kept in the liver. The body is free to draw upon this reserve when more energy is

needed; therefore the amount of sugar in the blood may be increased when fear, anger, or other emotions press the body for vigorous action. Approximately 1 per cent of the weight of muscle is stored glycogen, available for instant use.

Fats and Lipoids.—The third type of food passes the walls of the alimentary canal in the form of fatty acids and glycerol, some of which are resynthesized to fat in the intestinal wall. The fats, like the carbohydrates, contain the elements of carbon, hydrogen, and oxygen, but the proportion of oxygen is less. Consequently, they may be regarded as fuel foods in a more concentrated form, since the same weight requires more oxygen for combustion and, therefore, is of great heat value. Fats produce about 2¼ times as much heat as equal weights of carbohydrates and proteins.

The true fats (triglycerides) yield upon digestion one molecule of glycerol and three molecules of one or more kinds of fatty acids. The diet contains many food fats from animal sources (such as butter, lard, suet, and some margarines) and from vegetable sources (for example, corn oil, peanut oil, soybean oil, coconut oil, cottonseed oil, and olive oil). The fats are not soluble in water but are soluble in chloroform and other so-called fat solvents. Commonly associated with fats and soluble in fat solvents or in the fat itself are certain other fatlike substances called *lipoids,* such as the *lecithins* and the *sterols.*

Fat is a good reserve food, since large quantities may be stored in the adipose tissues. To a large extent it is interchangeable in the diet with sugars and starches if the total amount of carbohydrates is not allowed to become too greatly reduced. The production of large quantities of butter fat by the cow, which subsists upon a protein and carbohydrate diet, is an excellent demonstration of the ability of the animal body to synthesize fats from these other types of food.

It has been found that certain unsaturated fatty acids, such as linoleic, linolenic, and arachidonic, are essential to the maintenance of health. Apparently man cannot synthesize these from other nutrients. It is entirely probable that the ordinary diet will furnish enough of these acids, since only a small quantity is needed and they are widely distributed among common foods.

Proteins.—The chief organic constituents of muscles and other tissues are substances called proteins, which contain nitrogen,

sulfur, carbon, hydrogen, and oxygen. The process of digestion changes proteins into chemically simpler fragments called amino acids. There are at least 21 different amino acids.* Each of the innumerable proteins contains a particular combination of many amino acids in its large and complex molecule.

Amino acids are sometimes called the building stones of tissue substances because they recombine inside the body (after passing through the intestinal wall) to form the typical proteins of body tissue. They are also used in the formation of the protein hemoglobin, various enzymes, and many proteins in solution throughout the body. Proteins contain carbon as well as nitrogen and are, to a certain extent, fuel foods, since part of the molecule can be oxidized to supply heat and energy.

At least eight amino acids are essential in human feeding. They are not synthesizable in the body. If one of these amino acids is lacking, normal function cannot continue; but if all eight are present in suitable quantity, the body can form from them the remaining amino acids it needs.

Proteins are sometimes designated as complete if they possess adequate amounts of all essential amino acids; they are called incomplete if they lack one or more of the essential amino acids.

The most complete proteins are found in lean meat, eggs, and milk. The diet usually contains many proteins so that they supplement each other.

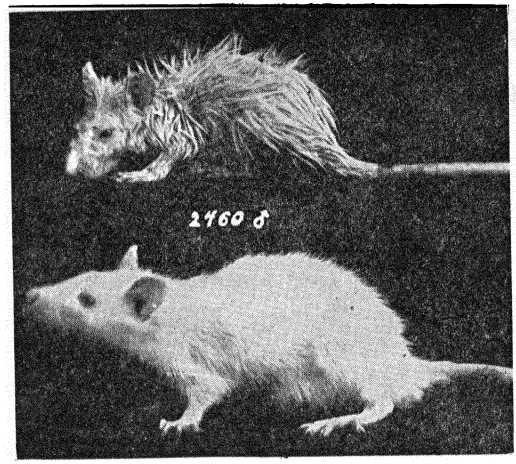
It has been found that whenever man is free to choose his diet, he usually eats enough protein. In some parts of India a characteristic protein deficiency has been found, and the effects among the members of the lower classes, where meat and fish are rare foods, include a lessened physical vitality and a dwarfed stature. The addition of protein to the diet of such people has been accompanied by striking improvement in physical efficiency. Studies indicate that protein deficiency may lower resistance to infection and delay wound healing.

Where protein is taken in excess, part of the carbon and hydrogen is used as fuel. Protein "burns" more rapidly in the body

*Glycine (glycocoll), alanine, *valine*, *leucine*, *isoleucine*, norleucine, *phenylalanine*, tyrosine, serine, *threonine*, cystine, *methionine*, aspartic acid, glutamic (glutaminic) acid, hydroxyglutamic acid, arginine, *lysine*, histidine, proline, hydroxyproline, and *tryptophane*. Those in italics are the "nutritionally essential" amino acids.

than other foods. The excess of nitrogen is excreted as a waste product through the kidneys in the form of urea.

The amount of protein needed by the individual can be easily determined. The nutritionist makes a chemical analysis of food and excreta to determine the amount of nitrogen entering and leaving the body. (Protein is approximately 16 per cent nitrogen.) Such nitrogen balance experiments show how much nitrogen the body needs in order to keep in equilibrium (intake and output the same). It has been found that, on the average, a man of 70 kilograms (154 pounds) uses about 44.4 grams of protein per day. A liberal allowance is usually made in planning diets, and it is common to recommend for adults one gram of food protein daily for each kilogram of body weight, with much more generous allowances for growing children, expectant mothers, mothers who are breast feeding their babies, and other individuals with special needs. Since animal proteins are more complete than vegetable proteins, one should try to consume at least one-third of the protein in this form.



The upper photograph shows the effect of a dietary deficiency of the amino acid, valine. The lower photograph shows the same animal after valine had been administered for twenty-five days. (From Rose and Epstein: J. Biol. Chem. 127: 683, 1939.)

Mineral Elements.—We speak of the mineral elements as inorganic constituents of foodstuffs, but we should remember that they are obtainable from organic as well as inorganic substances. Moreover, many mineral elements function in the body as components of important organic compounds. The accompanying table states some of the important facts concerning those minerals

which are of greatest concern to the nutritionist because they tend to be lacking in the dietary.

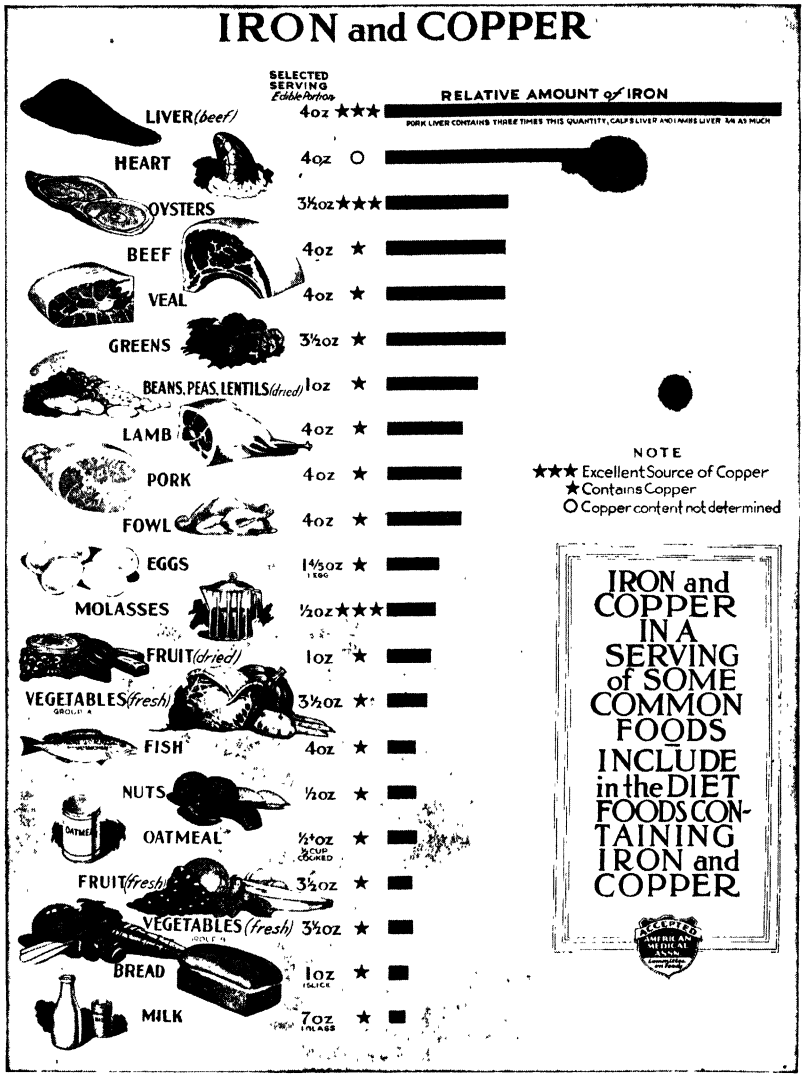
It is generally believed by nutritionists that if the body requirements of calcium, phosphorus, iron, and iodine are provided, the other materials required will also be obtained in sufficient quantity, because minerals do not appear isolated in various foods but are always in combinations.

MINERALS

MINERAL ELEMENT	RECOMMENDED DAILY AMOUNTS (ADULT)	NATURE OF CONSTRUCTIVE ACTION OR HEALTH PROMOTION	DISEASE OR SUBNORMALITY PREVENTED OR CORRECTED	SELECTED FOOD SOURCES
Calcium	0.8 Gm.*	Promotes normal growth and formation of bones and teeth. Necessary for normal function of muscle and nerve tissue, coagulation of blood, lactation and utilization of phosphorus	Faulty development of bone and tooth structure leading to stunted growth, deformities, rickets, decayed teeth. Tetany. Slow clotting of blood	*Excellent:* milk and cheddar cheese *Good:* cabbage, collards, kale, lettuce, turnip greens, dandelion greens, endive, broccoli, mustard greens
Phosphorus	1.2 Gm.	Essential for normal growth and development, for utilization of calcium, and for cell activity	Faulty development of bone and tooth structure leading to stunted growth, deformities, rickets, decayed teeth	*Excellent:* milk and cheese, liver, lean meat, almonds, dried beans, wheat *Good:* whole grains, bran, fish, eggs, oysters
Iodine	0.15 to 0.30 mg.	Essential to formation of thyroid hormone, and therefore to regulation of metabolism and growth	Faulty production of thyroxin leading to (1) cretinism, (2) goiter, or (3) myxedema	*Excellent:* iodized salt, sea foods, cod-liver oil *Good:* grains, fruits, vegetables, and dairy products (where iodine is in soil)
Iron	0.012 Gm. (12 mg.)	Necessary for formation of hemoglobin and for tissue respiration	Decreased hemoglobin. Iron deficiency anemia	*Excellent:* lean meat, liver, kidney, molasses, *Good:* whole wheat products, eggs, potatoes
Copper	0.003 Gm. (3 mg.)	Essential to utilization of iron to form hemoglobin	Faulty formation of hemoglobin leading to anemia	*Excellent:* liver, nuts, dried legumes *Good:* cereals, dried fruits, poultry, fish, animal tissues

*In pregnancy the requirement is 1.5 Gm. and during lactation it is 2 Gm.

Other minerals have important functions. *Chlorine* and *sodium*, which we secure in whatever amount we desire as table salt (sodium chloride), occur in the blood and other body fluids as electrically charged particles (ions); they have an important function in controlling the passage of water into and out of tissues, including



Iron and copper content of certain foods. (Courtesy National Livestock and Meat Board, Chicago.)

functioning glands. The healthy body adjusts the output of chloride to its intake except under conditions of profuse sweating. Then increased intake of salt in food or drink is desirable.

Potassium and *magnesium* also influence the function of body fluids, but they are even more important inside the body cells. The normal beating of the heart, with its contractions and relaxations, depends upon a balance between the salts of calcium and those of sodium and potassium.

Sulfur is a constituent of many essential compounds, including the two amino acids, cystine and methionine, and the vitamin thiamine. *Cobalt, manganese,* and *zinc* are believed to be essential, but their functions are not well understood.

We shall give further consideration to *iron* and *copper* in studying the physiology of the blood, to iodine in studying the ductless glands, and to fluorine in the chapter on oral hygiene. Very little has been established regarding the role of such elements as zinc, manganese, cobalt, and boron in the human body.

In considering the mineral needs of the normal adult, it should be remembered that there are differences in individuals. Growing children and expectant or nursing mothers require larger amounts of minerals, and persons with various disease conditions require special dietary adjustment. The body's ability to store different minerals varies with the adequacy of other elements in the diet and with the chemical form in which the mineral is ingested. The mineral value of food is not measured by the ash content but by the amount of the mineral that is available. For example, beet greens, chard, and spinach have a high calcium content, but they also contain oxalic acid which interferes with the utilization of calcium by the body.

Vitamins.—Vitamins occur in the body in minute quantities. Their deficiency causes grave conditions and their protective qualities are so far-reaching as to justify their careful study. The amounts needed in the diet are so small that they are measured in milligrams ($\frac{1}{28,000}$ ounce) or in agreed-upon standard "International Units."

A severe deficiency of any of the vitamins causes acute disease or death. Limited amounts maintain a passable health, while in many cases optimal amounts have been found to develop vigorous health with an accompanying high morale and work output. We should be as much concerned with the common, mild, or subclinical conditions as we are with the less frequent deficiency diseases.

The following discussion in the text supplements the accompanying table, the study of which on the part of the student is assumed.

Vitamins are widely distributed in natural foods but are either absent or present in insignificant quantities, in such products as pure sugar, white flour, and many processed or modified foods. It is *possible* to secure sufficient vitamins in the diet; yet studies have shown that the majority of people eat improper food combinations and examinations have commonly proved the presence of vitamin deficiency lesions.

A helpful recent development has been the production of "enriched" white flour and "restored" cereals by the addition of specified amounts of thiamine, riboflavin, niacin and iron. Whole grain products are still superior in several respects, however.

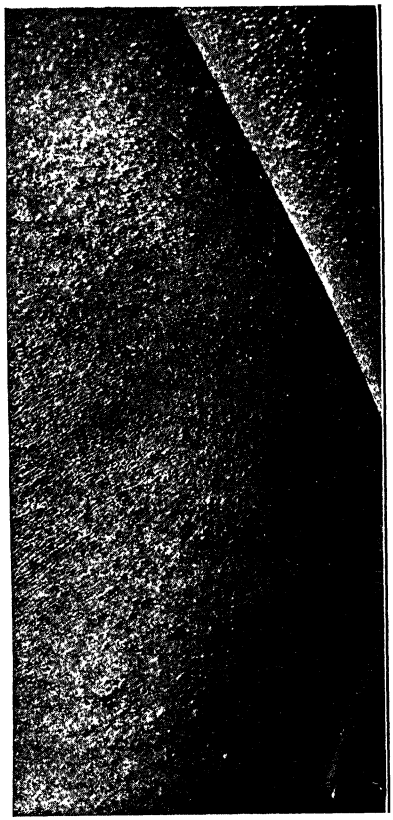
Vitamin deficiency may come either from failure to eat the right foods regularly or from the loss of vitamins in the preparation of food. For example, vitamins are rapidly reduced when plant foods wilt, dropping to as little as one-fourth of their original amount. Vegetables should therefore be fresh when purchased and should be used promptly or stored in a moist, cool place. Cut vegetables lose their vitamin content through enzyme action. Coleslaw, for example, should be cut just before serving for in twenty minutes nearly all of its ascorbic acid will have been destroyed. Leftover vegetables lose much of their vitamins. Foods lose much of their vitamin content by being kept on the warming plate or by other delay in serving. Cooking with the smallest amount of water is important, since a large part of the vitamin and mineral content soaks out in the cooking water. For this reason, cooking in a pressure cooker is preferable. Since some loss of vitamins is unavoidable during cooking, raw salads should be eaten often. Whenever possible, vegetables should be cooked in their skins. Overcooking should be avoided.

Infectious fevers, as well as pregnancy, lactation, and rapid growth, greatly increase the body's demand for vitamins. Most vitamins are now available as pure substances or as concentrates which may be used to meet special conditions or needs.

Vitamin A is a colorless, fat-soluble substance (or pair of substances, A_1 and A_2) found in animals but not in plants. The orange-yellow coloring matter of plant tissues has been found to contain precursors of vitamin A, the carotenes, which give rise to

vitamin A in the body. Although it is related to the health of the mucous membranes, vitamin A is not a specific in warding off infections.

Xerophthalmia (dry ophthalmia) is a vitamin A deficiency disease that is common in the Orient. It was widespread in Denmark in 1914-1918 due to the excessive exportation of butter, which was the most important source of the vitamin. It is endemic in mild form in some places in the United States. It is characterized by failure of the tear glands to function, followed in the severe cases by dryness, bacterial growth, and ulceration of the cornea. Extreme deficiency produces skin changes.



Cutaneous lesions in severe vitamin A deficiency in a Chinese patient before halibut-liver oil therapy had been given. (Courtesy Dr. C. N. Frazier from Sutton and Sutton: *An Introduction to Dermatology,* The C. V. Mosby Co.)

Nightblindness is an affliction characterized by an inability to see in dim light, especially after the eye has just been exposed to bright light. The condition disappears shortly after vitamin A is supplied. This vitamin is necessary, for it is part of the "visual purple," a compound which plays a vital part in the process of seeing.

Ordinary cooking does not materially diminish the potency of vitamin A. The body is capable of storing a supply for several months.

Thiamine (vitamin B_1) has a wide distribution in natural foods, but it is often deficient in the diet because people eat so much artificially refined food from which this vitamin has been removed. Considerable thiamine is lost in the cooking process. It is destroyed

NAME AND CHEMICAL FORMULA	RECOMMENDED DAILY AMOUNT* YOUTHS 16-20 YEARS		NATURE OF CONSTRUCTIVE ACTION OR HEALTH PROMOTION	DISEASE OR SUBNORMALITY PREVENTED OR CORRECTED	SELECTED FOOD SOURCES	MEDICINAL FORM OR CONCENTRATE
	FEMALE	MALE				
Vitamin A ($C_{20}H_{29}OH$) (Anti-ophthalmic vitamin) ("Anti-infective" vitamin)	5,000 I.U.	5,000 I.U.	Necessary for growth, formation of visual purple, and health of epithelium. Contributes to health of skin	Nightblindness: Dryness and scaliness of skin; injury to epithelial linings of body cavities and stomach, intestines, respiratory tract, urinary tract; conjunctival inflammation and corneal ulceration (xerophthalmia). Lowered resistance to infections, particularly of the respiratory tract	*Excellent:* fish liver oils, liver, whole milk, egg yolks, butter, dark green leafy vegetables, carrots, yellow sweet potatoes *Good:* asparagus, cabbage, tomatoes, green beans	Certain marine fish-liver oils and their concentrates. Carotene from green plants or carrots
Thiamine ($C_{12}H_{18}N_4OSCl_2$) (Thiamine chloride) (Vitamin B_1)	1.2 mg.	1.5 mg.	Essential for complete utilization of Carbohydrates. Necessary to maintain appetite, normal growth, good digestion, and health of nerves	Beriberi: Degeneration of peripheral nerves, muscular atrophy, dilatation of heart, weakness, paralysis, and edema. Loss of appetite, nausea, indigestion, constipation	*Excellent:* whole grain, muscle meat, peanuts, dried peas and beans, soybeans *Good:* liver, kidneys, green peas and beans, egg yolk, green leafy vegetables, oysters	Synthetic thiamine chloride. Yeast and its concentrates. Concentrates from wheat germ or rice polishings
Riboflavin ($C_{17}H_{20}N_4O_6$) (Vitamin B_2 or G) (Lactoflavin)	1.6 mg.	2.0 mg.	Essential to growth and normal nutrition. Necessary with thiamine for proper utilization of carbohydrates. Essential for health of epithelial tissue	Ariboflavinosis: Increased vascularity of cornea; soreness of lips with fissuring of their angles (cheilosis); red and sore tongue; scaly, greasy skin about angles of nose	*Excellent:* milk, cheese, liver, kidney *Good:* egg yolk, lean meat, whole grain products, green leafy vegetables	Synthetic riboflavin. Yeast concentrate. Concentrates from liver or whey

Niacin (C_5H_4NCOOH) (Nicotinic acid) (Vitamin P-P)	12 mg.		Necessary to normal cellular life and to health of epithelial and nervous system	Pellagra: (digestive disturbances with inflammatory reaction of mucous membranes, skin eruptions, and psychosis). May be degenerative changes of spinal cord and brain	*Best:* liver, eggs, kidney, lean meat, milk, whole grains, dark green leafy vegetables, salmon, lentils and peas	Synthetic nicotinic acid. Extracts from liver, rice polishings, or yeast
Ascorbic acid ($C_6H_8O_6$) (Vitamin C) (Cevitamic acid) (Anti-scorbutic factor)	70 mg.	75 mg.	Necessary to formation and maintenance of "cement" substances which hold cells together in blood vessels, teeth, bones, and other tissues. (Known to aid resistance to bacterial toxins in animals)	Scurvy: Anemia, weakness. Swollen and bleeding gums, subcutaneous and mucous membrane hemorrhages, sore extremities, slight edema, imperfect bone formation	*Excellent:* citrus fruits, tomatoes *Good:* potatoes, turnip, cauliflower, cabbage, cantaloupe	Ascorbic acid, synthetic or extracted from citrus fruits
Vitamin D ($C_{28}H_{43}OH$ as in viosterol) (Calciferol) (Antirachitic factor)	400-800 I.U. (When not available from sunshine)	400-800 I.U.	Aids proper absorption and metabolism of calcium and phosphorus necessary to normal bone formation	Rickets: Bone deformities, pot belly, restlessness, irritability Osteomalacia (in adults): pain, softening of bones Tetany or convulsions due to low serum calcium	*Excellent:* fish-liver oils *Good:* salmon, herring, mackerel, sardines, butter, cream, vitamin D milk, liver, egg yolk	Marine fish-liver oils. Irradiated ergosterol or viosterol Ultra-violet light. Calciferol
Vitamin K (Antihemorrhagic factor)			Essential to adequate prothrombin production necessary for normal blood clotting	Hemorrhagic disease of the newborn. Prolonged bleeding due to decreased prothrombin content of blood	Widely distributed but exact content in foods unknown. Found in all green leaves, egg yolk, tomatoes, liver	Synthetic vitamin K. Concentrates of alfalfa

*National Research Council, Reprint and Circular Series, No. 122, Rev. 1945, *Recommended Dietary Allowances for Moderately Active Persons*, Washington, D. C.

more easily in solution than in the dry state and more readily in an alkaline solution than in one that is slightly acid. The addition of soda to preserve the color in cooking vegetables greatly reduces the thiamine content. Thiamine has been called the antineuritic vitamin because its absence produces beriberi in man and a similar disease (polyneuritis) in experimental animals.

Beriberi is found in Asia among people who make polished rice a large part of their diet. It has also been found in Newfoundland and Labrador among people who subsist largely upon white flour. Many cases and several deaths occur in the United States each year. The *dry* type of beriberi is characterized by progressive emaciation; the *wet* type, by swelling in the limbs and trunk due to the accumulation of fluid in tissues and cavities. *Infantile beriberi* occurs among nursing infants when the mother has insufficient thiamine, regardless of whether the symptoms are demonstrable in her. It is one of the leading causes of infant mortality in oriental countries.

Up to the year 1883 it was common for more than one-fourth the sailors on Japanese battleships to suffer from beriberi. A navy physician, Dr. Takaki, suspected that the disease was of dietary origin and proved it by changing the diet on one ship. The addition of barley, vegetables, fish, meat, and canned milk to the ration, which had previously consisted largely of white rice, eliminated the disease. Takaki's work, however, did not then command as wide attention as it deserved. Medical authorities generally regarded beriberi as an infectious disease until army medical officers in charge of the Bilibid prison in Manila in 1902 demonstrated that it could be cured by dietary means.

Polyneuritis has been induced experimentally by feeding birds on polished rice. The birds showed inactivity, loss of weight, and muscular contraction; but when fed with an aqueous extract of rice bran, they immediately recovered. In the same manner the disease in human subjects has been stamped out by using unpolished rice or by introducing a mixed diet.

Riboflavin is a greenish-yellow, water-soluble pigment, widely distributed in plant and animal tissues. It is relatively stable to heat, mineral acids, and oxidizing agents but is sensitive to alcohol and is easily decomposed by light. Milk should be shielded from light and all foods should be covered during cooking or frying.

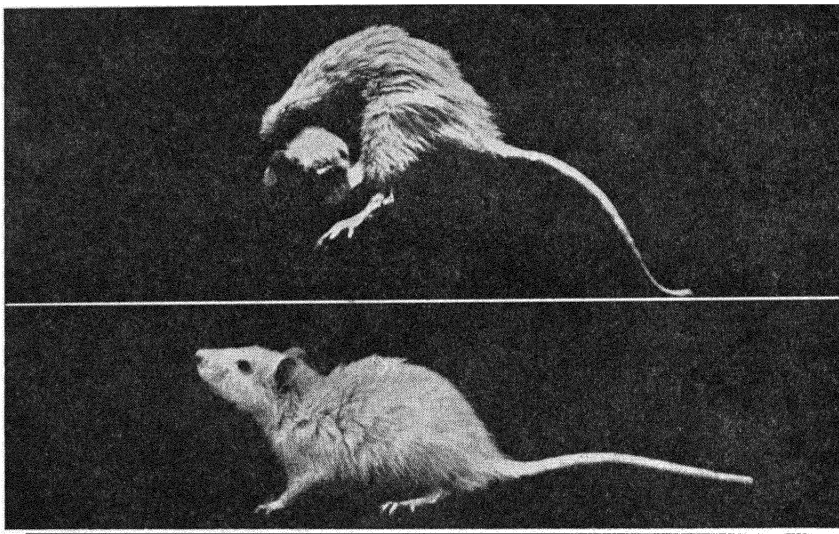
An 85 per cent loss of riboflavin has been reported during exposure of milk to bright sunshine for two hours.

The first symptoms of a deficiency in riboflavin are commonly burning, itching, and irritation of the eyes, with sensitiveness to light and visual fatigue with dimness of vision. One of the earliest and most common changes is the growth of blood vessels of the eye in the form of capillary loops at the edge of the iris. These are detected with the slit lamp with which it is possible to examine a very narrow strip of the eye surface. Soreness of the lips, tongue, and the corners of the mouth are characteristic skin symptoms.

Niacin deficiency is apparently a cause of *pellagra,* although deficiency in thiamine and riboflavin further confuses the clinical picture. This disease is usually characterized by the three D's—depression, dermatitis, and diarrhea. Bronzing of the skin on exposed surfaces, such as the arms and forearms, sore mouth, and gastric disturbances, are characteristic symptoms. As the disease progresses, these three conditions become increasingly serious. Pellagra occurs in many parts of the world. In the United States pellagra or the less serious subclinical stage of the disease appears where poverty or ignorance leads to the "fat pork, corn bread, soda biscuit and syrup" type of diet.

Ascorbic Acid.—Fresh fruits and vegetables furnish about nine-tenths of our supply of ascorbic acid *(vitamin C).* Studies of typical American diets show that about 37 per cent of the ascorbic acid is taken in the form of citrus fruits and tomatoes, while potatoes and sweet potatoes supply another 23 per cent.

When suitable amounts of ascorbic acid are absent from the diet, *scurvy* results. This disease has been serious and widespread at many times and places, before our newer knowledge of nutrition told us how to prevent and cure it. It was a scourge of the Crusaders. The explorer Vasco da Gama lost more than half of his crew from scurvy in his voyage around the Cape of Good Hope. The explorer Cartier lost one-fourth of his men from scurvy in 1535 (when he was obliged to winter in Canada) before the natives gave him a remedy in the form of decoctions of evergreen twigs and needles. The Russians used pine needle infusions during World War II.

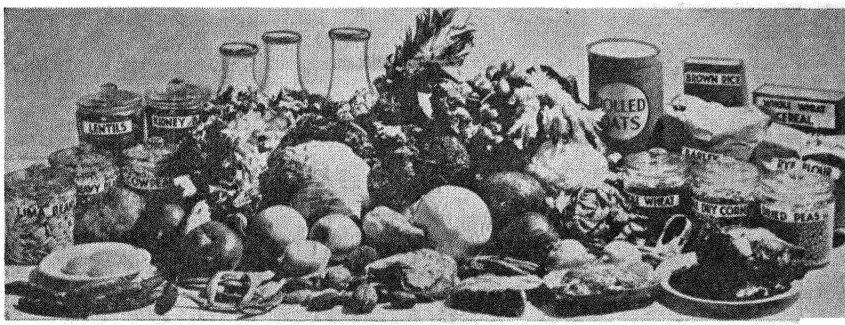


(Top) This rat did not have enough thiamine. The lack of muscle control is called spastic paralysis.

(Bottom) The same rat 24 hours later after receiving a food rich in thiamine. (Courtesy Bureau of Home Economics, U. S. Department of Agriculture.)

Early settlers recognized freshly fermented beer as a protection against scurvy. Beer as it was then made contained ascorbic acid derived from the sprouted malt. Beer is now highly clarified, however, and has no antiscorbutic property. As the use of the white potato became more widespread, scurvy became rare in Europe. The failure of the potato crop in Ireland in 1846 brought about a severe famine and a widespread epidemic of scurvy.

Recent studies have shown that mild subclinical scurvy is still common in many parts of the country, although the more severe form of the disease is now rare. An interesting example of such a situation occurred in a large boys' school in England. In midwinter the boys complained, and became irritable and listless. They exhibited a decline in athletic ability and in the quality of their work. Investigation showed that the diet was without raw fruits and vegetables, and that a nearby fruit shop, which had been generously patronized in previous years, was now closed. The condition of the boys improved immediately upon the introduction of fresh fruit into the diet.



Good sources of thiamine: milk, all forms, fruits, vegetables, whole grains, nuts, peas, beans and other legumes, liver and other edible organs, egg yolk, lean pork, oysters. (United States Department of Agriculture.)

As ascorbic acid deficiency becomes more severe, lassitude, weakness, and irritability are followed by pains in the muscles and joints, tiny hemorrhages in the skin, swelling and bleeding of the gums, rapid heartbeat, and shortness of breath; the teeth become loose and infection and ulceration of the gums develop.

Because scurvy frequently occurred among infants fed on pasteurized milk, vitamin C is now added to the infant's dietary in the form of orange juice or tomato juice. Scorbutic babies suffer pain and tenderness in the legs. The ends of the bones often become enlarged as they do in rickets.

There is considerable difference between individuals at any age both in their requirement of ascorbic acid in the body and in the particular symptoms of ascorbic acid deficiency which manifest themselves as a result of the interference with the intercellular cement substances of the tissues.

Ascorbic acid is the least stabile and the most easily destroyed of the vitamins. Prolonged cooking, drying, and storing destroy it. It is really destroyed by oxidation rather than by heat per se. Heat accelerates oxidation. The longer the exposure to heat and the higher the temperature, the greater the destruction. There is less destruction when air is excluded from the cooking process by steam or by vacuum. In cooking the loss is minimized by having the water boiling before the addition of food. Boiling removes dissolved oxygen. The destruction of vitamin C is hastened by the addition of soda or other alkali and by the presence of small amounts of copper. Slightly alkaline fruit juices lose ascorbic



The picture at the left shows typical lesions of ariboflavinosis, involving the upper and lower lips. At the right is the patient after a period of vitamin therapy. Investigation showed that the family of which this child was a member, subsisted principally on macaroni and potato, with fruits and vegetables being eaten only occasionally. Meat was served once weekly and a quart of milk was apportioned daily among six. (From *Therapeutic Notes*, Parke Davis & Co., Courtesy Dr. W. P. Shield and New England J. Med.)

acid slowly even at icebox temperatures when exposed to the air. Fruit should be served in whole sections whenever possible since unnecessary cutting and squeezing causes loss of ascorbic acid.

Ascorbic acid, like thiamine, dissolves readily in water and considerable amounts of both may easily be lost in the preparation and cooking of vegetables if the water in which they are cooked or canned is discarded. Often half of the ascorbic acid in a vegetable may pass into the cooking water. The immediate utilization of these vegetable juices in soups or in other ways is, therefore, desirable. Properly canned fruits and vegetables retain most of their ascorbic acid. Vitamin values are in general well retained in quick-frozen foods.

The body has little ability to store ascorbic acid. It must, therefore, be constantly supplied in the diet.

Vitamin D is not a single substance. There are several closely related compounds which have the same ability to prevent rickets. The provitamins from which they are derived belong to the group of chemical substances called sterols. Ergosterol is found in yeast and other plants, but not in animal tissues. Animal sterols can be activated by sunlight to form vitamin D substances by the action of the sunlight or ultraviolet light upon the 7-dehydro-cholesterol in the skin. Such animal D vitamins are fat-soluble, and are found in highest amount in liver, in egg yolk, and in milk fat. Fish liver oils furnish a particularly rich source.

Proper skeletal development can take place only when the blood contains sufficient calcium, phosphorus, and vitamin D. When one or more of these is lacking, rickets takes place. Vitamin D seems to be essential to aid the body in its use of the minerals and in the formation of bones and teeth. It not only makes a better skeleton but also improves the rate of growth.

Rickets was long a common nutritional disorder of early childhood in the temperate zones. It develops more rapidly during the winter months because the child is less exposed to sunlight and because the vitamin in the dietary is low. It usually appears during the early



Rickets. Characteristic signs include the square head and the enlargement at the points where ribs and cartilage join. (The so-called "rachitic rosary.") (From Marriott: *Infant Nutrition*, The C. V. Mosby Co.)

months of life, developing especially in the premature, the artificially fed, and even the rapidly growing breast-fed baby whose mother's diet is inadequate in vitamin D. He becomes restless, wakeful, constipated, and sweats profusely, especially on the head. In severe cases the head enlarges and becomes misshapen. Knobs or beads (the so-called rachitic rosary) appear at the junction of ribs and costal cartilages. Similar knobbing occurs at the ends of the long bones, producing enlarged wrists, ankles, and knees. The long bones of the legs may not be equal to the task of supporting the weight of the baby; they may curve, giving the child bowlegs and knock knees. The thorax may seem flattened on the sides, and the sternum depressed or protruding, forming the typical pigeon breast. Muscles and ligaments seem too lax to hold the body together. The child sags, grows pot-bellied, hollow-chested, and round-shouldered; the result is a child with poor posture. He is slow in teething, slow in walking, slow in developing.

The successful preventive treatment of rickets should begin early in the life of the infant by administering daily doses of fish-liver oil, or (if the baby is bottle fed) vitamin D milk, and by exposing the child's body to the direct rays of the sun.

Vitamin D milk is produced by irradiating the milk (irradiated milk), by mixing purified concentrates of animal vitamin D (fortified milk), or by feeding irradiated yeast to the cow (metabolized milk).

Children living in the arctic regions, where whole fish and fish-eating animals constitute the chief diet, seem immune to this disease. These foods contain a pro-vitamin of vitamin D. Children of the tropics also seem protected by the action of the sun's rays on the ergosterol in the skin.

Vitamin K occurs in more than one form of closely related fat-soluble substance. Its importance to the coagulability of the blood, and hence to the prevention of serious hemorrhage, lies in the fact that it is part of the prothrombin molecule. It has important and valuable medical uses, but we are as yet without adequate information as to its importance as a nutritional problem.

The following vitamin substances are less well known, because they were more recently discovered and are not as deficient in the dietary. Their im-

portance has been demonstrated in experimental animals, but their importance to man and their food sources need further investigation.

1. *Pyridoxine* ($C_8H_{11}NO_3$; vitamin B_6).
   Deficiency causes a skin disorder in rats. Evidence suggests it may be necessary for man. Found widely in plant and animal food. Good sources: yeast, rice polishings, germ and bran of grains.
2. *Pantothenic acid* ($C_9H_{17}NO_5$; suggested as an "anti-gray hair factor").
   Water soluble. Deficiency causes a skin disorder in chicks; growth disturbance and gray hair in rats. Evidence suggests it may be necessary for man. Found widely in plant and animal food. Good sources: liver and kidney, bran of wheat, rice, and other seeds, yeast.
3. *Choline* ($C_5H_{13}O_2N$).
   Water soluble. Often considered a member of vitamin B group. It has been established as important to man, but it may be synthesized from certain amino acids. Absence causes disturbance of fat metabolism. Evident function in maintaining normal tissue structure shown in rats. Found widely in foods.
4. *Inositol* ($C_6H_{12}O_6$; anti-alopecia factor for mouse).
   Lack of it causes loss of hair in small animals. Deficiency not shown in man. Found in living tissue. Good sources: grains, citrus fruits, and green leaves; especially abundant in cereals as a phosphate called phytin.
5. *Biotin* ($C_{10}H_{16}O_3N_2S$; vitamin H).
   Water soluble. Sulfur-containing compound of the B-vitamin group. Powerful growth stimulant. Has been reported to be necessary to man. Found widely in plant and animal food.
6. *Folic acid.*
   Water soluble. Lack of it interferes with liver function and the metabolism of iron. It is thus related to certain anemic conditions. It is found in liver, yeast, and leaves.
7. *Vitamin E* ($C_{29}H_{50}O_2$; tocopherols; antisterility factor).
   Stable, fat soluble. Substance essential (as is vitamin A) for reproduction in experimental animals. Muscular, nervous, endocrine, and growth disturbances reported in animals. No deficiency proved in man. Found widely in foods. Good source: germ oils of seeds as wheat-germ oil.

Acid and Alkaline Foods.—Foods differ with respect to the acidity or alkalinity of the residue left in the body upon oxidation. In general, meats, fish, and grain products are "acid-forming" foods. Base-forming elements occur in milk, fruits, and vegetables. The acids of citrus fruits are alkaline in metabolism because their organic acid elements are burned in the body.

Although it has been suggested that fruits and vegetables are desirable because of their alkaline elements, the well person probably does not need to worry about the acid-base balance. When

acids are produced in metabolism, the kidneys secrete a more acid urine. Through this and other adjustments the blood remains neutral in reaction, although there may be some depletion of its alkaline reserves.

The swinging of the acid-base balance slightly toward the acid side is not *acidosis;* this is a medical term properly used to describe the incomplete oxidation of fatty acids in the body. It is not a common and debilitating condition as pernicious advertisements sometimes imply. It does occur in diabetes and in some other conditions where it is a medical rather than a dietary problem.

Meeting Dietary Needs.—The study of dietary needs shows the desirability of variety in diet, the danger of subsisting too largely upon refined foods of the pastry type, and the importance of including in your diet liberal allotments of the so-called protective foods, namely, milk and milk products, eggs, meats, fruit, and vegetables. Hard foods which require chewing contribute to the health of the teeth and associated structures.

Clearly, one cannot maintain health by eating merely whatever his appetite dictates. We must first be sure we are giving the body the food it needs. Having done this, we may fill the balance of the diet with whatever wholesome foods we wish. We need a simple daily dietary pattern, such as the following, to meet the needs of the average adult:*

Milk	1 pint
Egg	1 daily, if possible. (On days not used, beans, peanuts, cheese or more milk or meat to be used instead)
Meat, fish, or fowl	1 or more servings
Potato	1 or more
Vegetables	2 or more servings.
Fruits	2 or more. One citrus fruit or tomato or other good source of vitamin C
Cereals and bread	Whole-grain or enriched

Other foods as needed to complete the meals.

Energy Requirement.—The diet needs to be adjusted to meet the energy requirement of the body as well as its chemical needs. The body is constantly expending energy; certain functions like circulation and respiration are going on even when we are at rest.

*From *Recommended Dietary Allowances,* National Research Council Reprint and Circular Series, Number 122, January, 1945.

This energy output is so largely in the form of heat that nutritionists use the heat unit, or calorie, in measuring it. A large calorie is the amount of heat required to raise the temperature of a kilogram of water one degree Centigrade, or the temperature of a pound of water approximately 4 degrees Fahrenheit. (A small calorie, one thousandth of a large calorie, is also used as a unit of measurement but usually in literature on nutrition and always in this book the word calorie refers to the large calorie.)

It is possible to measure the heat content of any food by drying it and burning it completely in a bomb calorimeter, consisting of an oxygen chamber (bomb) surrounded by a water jacket to take up and register the heat of combustion. The foodstuffs in each group vary somewhat in content, but recent studies indicate that, on the average, the body obtains heat as follows:

From Carbohydrates	4.0 calories per gram or 1,814 calories per pound.
From Proteins	4.0 calories per gram or 1,814 calories per pound.
From Fat	9.0 calories per gram or 4,082 calories per pound.

For convenience, handbooks of dietetics carry tables showing the calorie content of the usual serving of various foods or tables giving the size of hundred-calorie portions. Examples of hundred-calorie portions are:

1 oz. sugar
1⅛ oz. bread
½ oz. butter
1 tablespoon mayonnaise dressing
3½ oz. lean meat
1-inch cube of cheese
1 medium-sized banana (5½ oz.)
1 medium-sized potato (5 oz.)
1 large orange (10 oz.)
33 large leaves of lettuce

Note the variation in value according to the chemical composition and the water content of the foodstuff.

The rate of energy expenditure or heat loss varies among persons and with the same person at different times. Obviously, it goes up when one has a fever. It varies not only with health status but also with age, body build, and the nature of the diet. The energy expenditure for a healthy person lying still, awake, twelve to fourteen hours after taking food (the *basal metabolic rate* or

basal energy metabolism), is about one calorie per hour per kilogram of body weight, or about 0.45 calories per hour per pound. The basal metabolism rate is determined under carefully standardized conditions and is only slightly higher than the rate of metabolism during sleep.

The most important factor in determining the day's energy expenditure is the amount of one's activity. Note the difference in the estimated rates of heat loss per hour per pound of body weight under the following conditions:

Activity	*Calories per hour per pound*	*Activity*	*Calories per hour per pound*
Sleep	0.43	Bicycling at moderate speed	1.59
Lying still, awake	0.50	Walking at 3¾ miles per hour	1.95
Sitting still	0.65	Dancing a foxtrot	2.18
Standing at laboratory work	0.74	Swimming	3.25
Dressing and undressing	0.77	Rowing at top speed	7.65
Driving an automobile	0.86		
Typewriting rapidly	0.91		

From these data and a record of the amount of time spent in various activities you would be able to compute your own approximate daily food requirements in terms of calories. Figures are commonly given for a woman of average size (56 kilograms or 123 pounds), suggesting a calorie requirement of some 2,100 to 3,000 calories per day, according to whether she leads a sedentary or a very active life. Similar figures for a man of average size (70 kilograms or 154 pounds) suggest a range from 2,500 to 4,500 calories per day.

Does it make any difference whether this energy is secured from proteins, carbohydrates, or fat? If we look to nature for an

AVERAGE COMPOSITION OF HUMAN, COW'S, AND GOAT'S MILK*

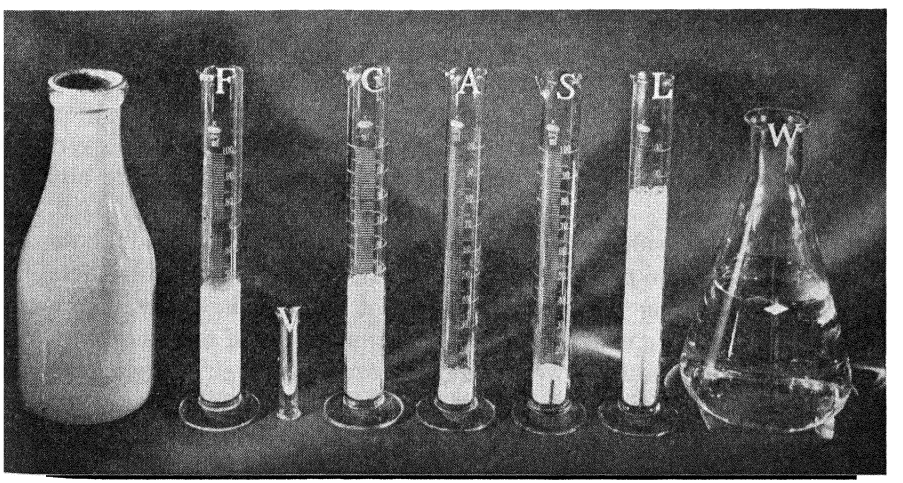
KIND OF MILK	WATER (%)	PROTEIN (%)			FAT (%)	CARBOHYDRATES (MILK, SUGAR) (%)	MINERAL MATTER (%)	APPROXIMATE FUEL VALUE PER OZ. (CALORIES)
		CASEIN	ALBUMEN	TOTAL				
Human	88.3	0.4	0.7	1.1	3.3	7.0	0.3	18
Cow's	87.0	2.8	0.5	3.3	4.0	5.0	0.7	20
Goat's	85.7	3.5	1.0	4.5	4.7	4.4	0.8	22

*From Sherbon: *The Child.* Courtesy of McGraw-Hill Book Co.

answer, we would examine the one substance which nature has produced to serve no other purpose than that of a food. This substance is milk. It represents a nearly complete diet for the young infant.

One notes rather wide differences between the composition of human, cow's, and goat's milk. Adults have even wider variations in the proportion of different foodstuffs eaten, as is seen by contrasting the diet of the vegetarian, whose only source of protein is vegetables, and the diet of those persons who have subsisted successfully upon very little besides meat.

You recall that protein is needed for the growth and repair of tissues and that excess protein is burned in the body. Nutritionists recommend one gram of protein per day for each kilogram of body weight for the average adult. This represents about 10 per cent of the total calories in the form of protein for the sedentary individual. More generous allowances are needed for the growing child and for the woman in pregnancy or lactation. The greater calorie need arising from a cold climate or from extreme activity on the part of the individual may be met by carbohydrate or fat. However, people usually eat more of their regular diet as their



(Fritz Goro)

A quart of milk is one-fifth solids and four-fifths water. The solids shown from left to right are 37 gm. fat, 35 mg. vitamins, 24 gm. casein, 7 gm. albumin, 9 gm. salts, and 50 gm. lactose.

activity increases. In planning food for families, nutritionists commonly make sure that the calories are adequate and then check to see that 10 to 15 per cent of the calories are in the form of protein.

Carbohydrates and fats are essentially interchangeable as fuel foods in the normal diet. Foods containing fat stay in the stomach longer and thus postpone hunger sensations. Fat should furnish at least 20 to 25 per cent of the total calories in the average dietary. This amount adds to one's sense of satisfaction after eating, without producing a continued feeling of fullness.

Gaining and Losing Weight.—When fuel foods are eaten in such quantities that more calories are taken than the body requires, fat is stored for future use. It is estimated that 4,000 extra calories produce an added pound of reserve body fat. On the other hand, when the diet provides less calories than are needed, the body must call upon its reserves to supply the demand.

The weight of the body is a matter of universal interest. Aside from its relation to personal appearance, emaciation, or obesity, it may have an important bearing on health. Optimum weight depends upon body build. It may be defined as that weight which permits the body to function most efficiently and at the same time provides satisfactory fat reserves for possible emergencies. Accumulations of fat in the body have a still further function in serving as a protection against jars and bruises and as padding for the support of internal organs, holding them in the position in which they can best function. Excessive food intake and overweight have been found to be associated with heart failure and with diabetes.

There is considerable difference in the ability of individuals to store fat. Some persons exhibit a tendency to obesity and others to thinness. For the great majority of persons, however, it is a relatively simple matter, through the application of hygienic principles, to maintain the weight at a satisfactory level. As we have seen, the quantities of food required for body maintenance vary with the build, temperament, age, and sex of the person, as well as with the amount of time spent in sleep and the type of activity maintained throughout the day.

Height-weight-age tables are of general interest in connection with this subject. It should be pointed out that the weights given

AVERAGE HEIGHTS AND WEIGHTS OF COLLEGE MEN*

HEIGHT	AGE 16	17	18	19	20	21
56 inches	94	96	98	100	101	102
57 inches	97	100	101	104	105	106
58 inches	100	103	104	107	108	109
59 inches	104	106	108	110	111	112
60 inches	107	110	112	113	114	115
61 inches	111	113	115	117	118	119
62 inches	114	116	118	120	121	122
63 inches	117	119	121	123	125	126
64 inches	121	123	125	127	128	129
65 inches	124	126	128	130	131	132
66 inches	128	130	132	133	135	136
67 inches	131	133	135	136	138	139
68 inches	134	137	139	140	141	142
69 inches	138	140	142	143	145	146
70 inches	141	144	145	146	148	149
71 inches	145	147	149	150	151	153
72 inches	148	150	152	153	155	156
73 inches	151	154	156	157	158	160
74 inches	155	157	159	160	162	164
75 inches	158	161	163	164	165	167
76 inches	162	164	166	167	168	171
77 inches	165	167	169	170	172	174

*Courtesy Dr. H. S. Diehl.

AVERAGE HEIGHTS AND WEIGHTS OF COLLEGE WOMEN*

HEIGHT	AGE 16	17	18	19	20	21
56 inches	96	97	97	97	97	97
57 inches	98	99	100	100	100	100
58 inches	101	102	103	103	103	103
59 inches	104	105	106	106	106	106
60 inches	108	109	109	109	109	109
61 inches	111	112	112	112	112	112
62 inches	114	115	115	115	115	115
63 inches	117	118	118	118	118	118
64 inches	120	121	122	122	122	122
65 inches	124	124	125	125	126	126
66 inches	127	127	128	128	129	129
67 inches	129	130	131	131	131	132
68 inches	132	133	134	135	136	136
69 inches	135	136	137	138	139	139
70 inches	138	139	140	141	142	142
71 inches	141	142	143	144	145	146
72 inches	144	145	146	147	148	149

*Courtesy Dr. H. S. Diehl.

are average weights and that such an average does not represent a "normal" weight for any particular person. As has been indicated, weight depends upon skeletal build as well as upon nutrition. Heavy bones or slender bones may make a difference of several pounds in the weight of two persons of the same height. Each person should try to determine for himself what his own normal weight is and then should attempt to maintain it through proper dietary control. Sudden marked deviations from this normal are not desirable and usually indicate some abnormal condition.

The tendency to become *overweight* is no doubt constitutional, although adipose tissue can be acquired only by the continued consumption of more fuel than is used by the body. Glandular disorders may be responsible for obesity in some cases. Treatment should always be undertaken under the direction of a physician.

There are two ways to combat overweight: by reducing the amount of food or by increasing the oxidation. When we are not eating, we are losing weight at the rate of about one ounce an hour. Fasting will reduce weight, but the fasting regime is extremely unpleasant and may be dangerous. The oxidation of food may be increased by exercise, but, unfortunately for the person who is trying to reduce, exercise is followed by an increased appetite and too often by a greater consumption of food.

A *reducing diet* is one in which the total number of calories is less than the person is consuming in body maintenance. The body must utilize some of its reserve fat in the production of energy. It is necessary to include the protective foods for the vitamins and minerals, and to use less of the starches, sugars, and fats.

The extent to which the energy foods should be limited depends upon the amount of weight to be taken off. Rose suggests reducing up to one-fourth the total required calories if one is only a little overweight. Thus, if the person requires 2,400 calories daily, the reducing diet would provide only 1,800 calories. For the greatly overweight person the physician may reduce the calorie content of the diet as much as one-half. There is danger of vitamin, protein, and mineral deficiency when less food is eaten. A balanced diet must be maintained. Weight should be lost slowly.

Sugar, salad dressings, gravies, cream sauces, pastries, and candy are energy-producing foods which can be eliminated satisfactorily. Less starchy vegetables may be substituted for potatoes.

The quantity of butter or fortified margarine may be reduced, provided enough fat-soluble vitamins from other foods are secured. Clear soups should be chosen instead of cream soups. Bread and cereals should be reduced in quantity. Fresh fruits are preferable to pastries for desserts.

The foods taken out of the diet should be replaced by others that are bulky but low in calorie value, such as tomatoes, spinach, cucumbers, cauliflower, lettuce, cabbage, string beans, celery, chard, asparagus, Brussels sprouts, and all kinds of greens. Choose foods with high vitamin and mineral content and low fuel content. Such fruits include orange, grapefruit, peach, pineapple, strawberries, watermelon, and cantaloupe. Their bulk in the stomach helps to prevent hunger. The drinking of water when hungry also assists in allaying hunger pangs temporarily.

Persons often become discouraged when, after a week or two of strenuous restriction in the diet, the weight has not been changed. It has been established that water may be retained in the tissues to such an extent that the body weight remains constant for as long as sixteen days under a reduced diet. At the end of this period water is suddenly lost, so that the weight drops in accordance with expectations.

A gradual reduction in weight is desirable, since it is less likely to disturb general health. Under no circumstances should advertised antifat remedies be taken. They often contain the powerful drug thyroxin, which is too dangerous to be used in self-medication. A number of deaths have been reported from the use of antifat remedies containing dinitrophenol.

The normal body apparently has a mechanism by which weight is controlled, so that after weight is lost (through fasting or illness), it is replaced. When normal weight is regained, the increase ceases and excess food is burned. In the obese person the excess food is readily stored owing to some defect in the mechanism for burning excess food, while in the slender person this mechanism functions so effectively that every bit of excess food is oxidized.

It is well to remember that extensive weight reduction is not a task to be undertaken lightly without medical advice and expert supervision.

Undereating is not uncommon. Many people suffer the loss of physical and mental vigor because they fail to secure the food that

they should have either through carelessness in their eating habits or through lack of means. Women, particularly, often fail to secure suitable and nourishing food because it may be expensive, its preparation may be time-consuming, or it may contribute to weight increase.

Eating no breakfast is a foolish fad. After the long fast, extending over twelve hours, there is something wrong with the stomach that rejects the next meal. The student who rushes to class without an adequate breakfast is not in condition to do his most efficient work.

The underfed person is in many respects the exact opposite of the person who is overfed. He is likely to be underweight, pale, sensitive to cold, morose, querulous, and pessimistic. He sleeps lightly and works without enthusiasm and without surplus energy. The overfed person is perhaps not very diligent, but he is commonly cheerful, and optimistic, has a ruddy countenance, and is a sound sleeper. To secure the golden mean in diet is greatly to be desired.

While people who are well above 30 years of age should guard against overweight, it is a distinct advantage to those under 30 to have a slight surplus of weight. The reserves thus provided take care of the extra demands that are constantly made upon the body by the great variety of interests which accompany this period of life.

Underweight is frequently the result of excessive nervous excitement, glandular disturbance, or a focal infection rather than undernutrition. Accordingly, the correction of underweight calls for freedom from physical defects, longer hours of rest, rest before and after eating, a restricted program of exercise, and frequent relaxation periods, as well as the use of a diet carefully planned to increase weight and to provide the necessary energy for activities.

A *weight-gaining diet* is one which provides more calories than are required for daily maintenance, so that the surplus energy foods may be stored. A difficulty encountered in this diet, unless care is taken to keep up the thiamine content, is lack of appetite. It often happens, too, that owing to a long period of undereating, the stomach has accustomed itself to such small quantities of food that it cannot take additional food without discomfort.

Various methods of overcoming these difficulties may be used. The food should be prepared attractively and eaten under favorable surroundings. Midmorning and midafternoon lunches and a glass of milk at bedtime are helpful. The discomfort which accompanies taking larger amounts of food must be accepted with as much grace as possible until the stomach adjusts itself to its new task.

The goal in planning a weight-gaining diet is to tuck in more calories without increasing the bulk. For example, a dessert of plain gelatin can be increased in calorie value by the addition of nuts, fruit, and cream. An extra pat of butter or fortified margarine added to a serving of steak, the addition of nuts and rich dressing to a salad, or the use of raisins or dates in a dish of cooked cereal all add calories to the diet. Vegetables and fruits which have a moderately high calorie content are potatoes, peanuts, parsnips, peas, Lima beans, sweet potatoes, bananas, apricots, dates, figs, prunes, and raisins.

A reducing diet or a weight-gaining diet must be continued over a long period of time if results are to be obtained. It is always easier to keep the body in a normal state than to regain this condition once it has been lost. Good nutrition requires intelligent planning. A man may starve himself into emaciation. He may eat himself into obesity or indigestion. He may secure for himself any one of several diseases by omitting necessary elements from the diet. Conversely, he may eat wisely to the maintenance of health and vigor. A wide variety of foods, both good and bad, is available to modern man. Only through the application of a sound basic knowledge of nutrition will he secure a suitable diet.

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CHAPTER III

DIGESTION

The types of food and their digestive products have been studied. We are now ready to consider the process and hygiene of digestion. The food tube is about thirty feet in length, and it usually takes from twenty-four to forty-eight hours for a meal to pass through it. The mouth, esophagus, stomach, small intestine, and large intestine, together with the digestive glands associated with the food tract, play distinctive parts in the digestive process.

The Mouth and Esophagus.—Through mastication the solid foods are refined, moistened, thoroughly mixed with saliva, and then (for swallowing) formed into a bolus or pasty mass by the action of the cheeks and tongue. If a piece of meat the size of a marble is cut into particles the size of coarse sand by proper chewing, the surface area available for digestive action is tremendously increased.

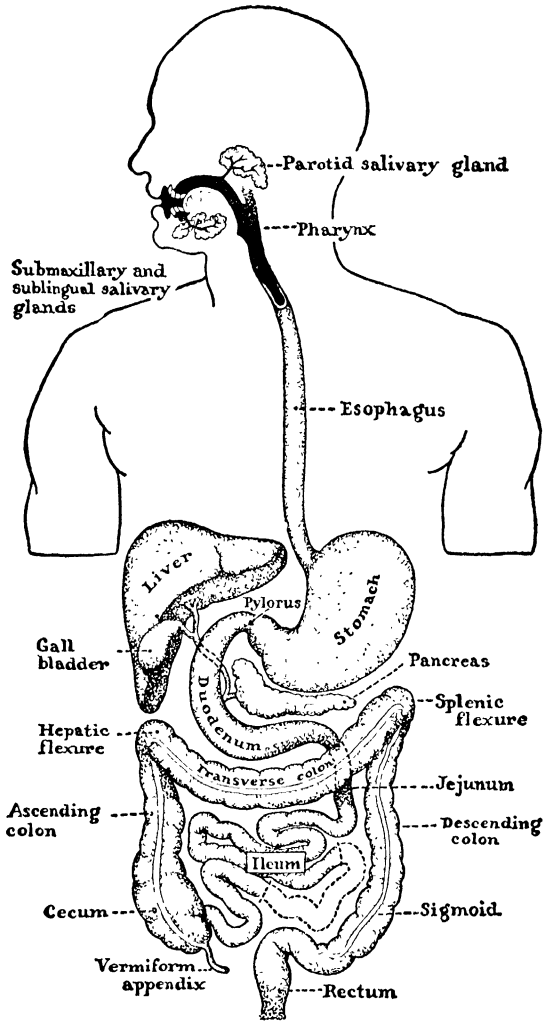
The *ptyalin* of the saliva begins the digestion of starches and dextrins. There are three pairs of salivary glands: the parotid glands, located in front of each ear at the angle of the jaw; the submaxillary glands under the jaw; and the sublingual glands under the tongue. About three pints of saliva are produced daily and discharged by ducts into the mouth.

In addition to water and the effective agent, ptyalin, saliva contains small amounts of other substances, including mucin and certain inorganic salts. Some salivas are slightly alkaline; some are slightly acid. Saliva varies also in physical characteristics, from a rather thick mucilaginous substance to a thin watery one. Its secretion is stimulated psychically by the sight and thought of attractive savory food; chemically by the aroma and pleasing taste of food; and mechanically by the movement of the jaw in chewing.

Mastication is the one process of digestion that is directly under conscious control. It is pleasurable, and the thorough chewing of food is of definite hygienic value in starting the flow of the digestive fluids in the stomach and intestines. An extensive starch digestion

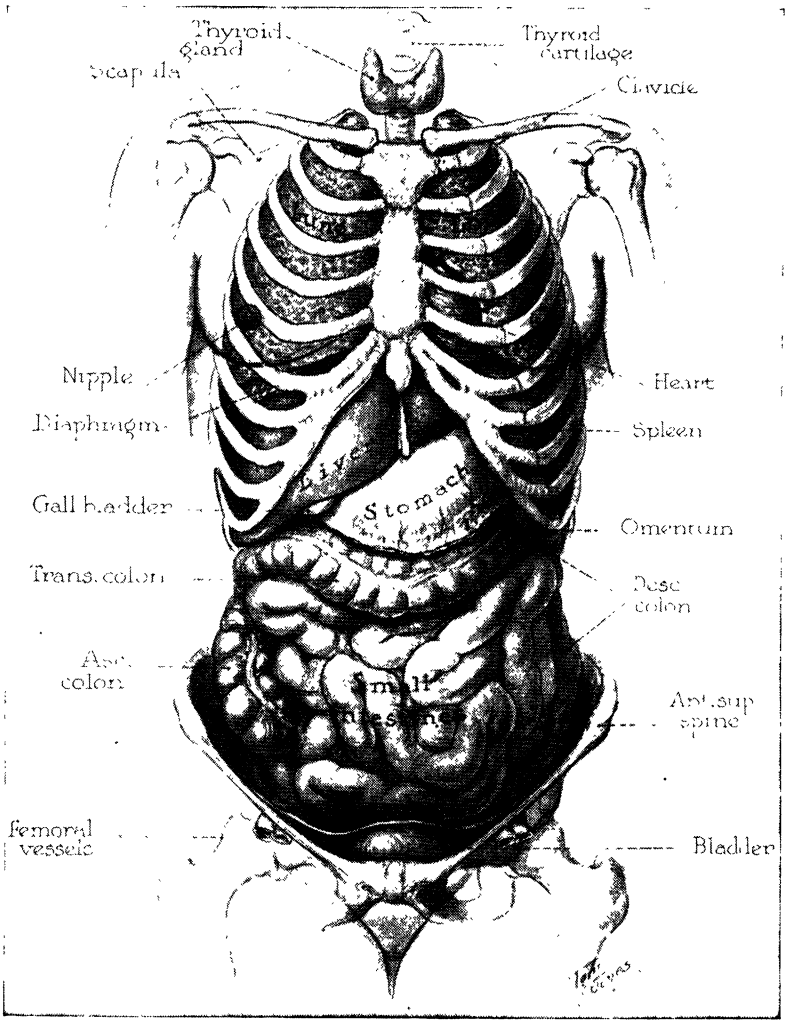
at this point is doubtless desirable, although we realize that this process will be completed in the small intestine in any case.

Through the action of swallowing, liquid foods and masticated solid foods are forced into the esophagus by the contraction of the muscles of the throat. The esophagus passes from the throat



The relationships of the different parts of the digestive system. Only a small part of the small intestine is shown.

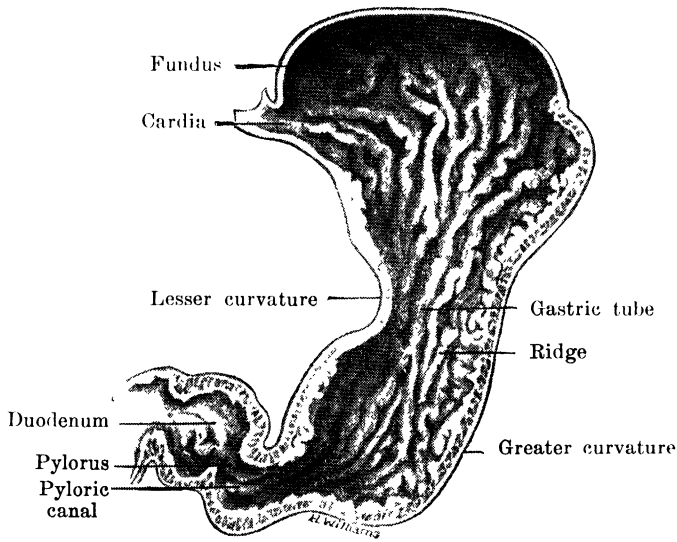
through the chest to the stomach. It pushes the food along by the peristaltic contraction of muscles just behind the food bolus.



Organs of the body shown in their relation to the skeleton. (From Camp: *Anatomical Studies.*)

The food travels this tube from the mouth to the stomach in about six to seven seconds.

The Stomach.—The stomach serves as a receiving chamber in which the food is normally stored from a few minutes to four and one-half hours and in which a limited number of digestive changes occur. When distended with food, it will hold from three to five pints. When it is empty, the muscles contract and the organ is greatly reduced in size, but it does not completely collapse because it always contains some air which has been swallowed. This air is useless, and with increased pressure within the stomach, some of it may be expelled by belching. It is this air, rather than gas formed by fermentation, that is ordinarily raised from the stomach.



The inside of the stomach showing the nature of the lining. (From Francis *Fundamentals of Anatomy,* The C. V. Mosby Co.)

The esophagus opens into the larger or cardiac portion of the stomach. The outlet of the stomach, the pylorus, is at the small end and is controlled by a sphincter muscle.

When the food reaches the stomach, the salivary digestion of starches is still going on, and this continues until the *hydrochloric acid* of the gastric juice terminates the process. This acid also prevents food from fermenting in the stomach through bacterial action. The gastric juice contains two other important substances.

One is *rennin* which has the ability to curdle milk, and the other is *pepsin* which acts upon proteins in an acid medium, splitting them into simpler substances. The gastric juice changes solid proteins to liquids. From three to five pints of this secretion are produced daily. The food is mixed by waves of contraction which arise near the middle of the stomach and move to the pylorus where they stop. During active digestion these waves may move along the lower part of the stomach as often as once every ten seconds.

Many factors influence the emptying time of the stomach and the state of the pyloric sphincter. One of these is the motility of the stomach. Anything which tends to increase or to decrease gastric muscle tone will appreciably shorten or lengthen emptying time. The consistency of food, i.e., the extent to which it has been made fluid or semifluid, is another factor. A high osmotic pressure such, for example, as might result from eating a large amount of sugar would delay evacuation. The extent of fullness or emptiness of the duodenum affects the state of the pyloric sphincter. It has been found that an inflammation of the cecum or appendix, as well as certain emotional states, influences the emptying time of the stomach. Finally, the position of the body modifies gastric evacuation, it being more rapid when the individual is lying on his right side than in other positions.

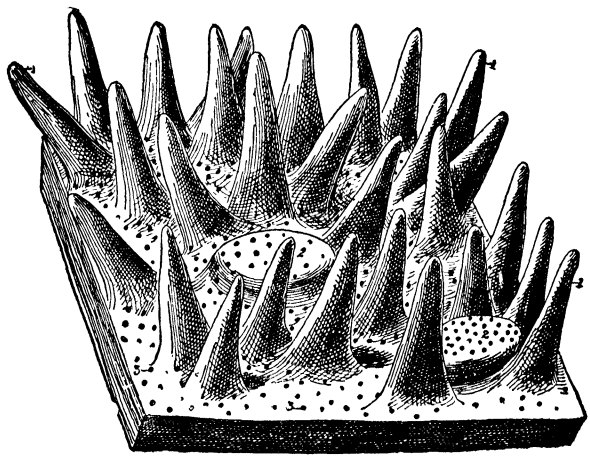
There is no appreciable absorption in the stomach except for alcohol and certain poisons. Salts and simple sugars may be absorbed to a slight degree when they are in high concentration.

Small Intestine, Liver, and Pancreas.—The small intestine is a greatly coiled tube, about twenty-three feet in length, and about one to two inches in diameter. Its upper portion, about ten inches in length, immediately following the stomach, is called the *duodenum.* It partly encircles the pancreas. The duct from the pancreas and that from the liver open into it. The *jejunum* (about eight feet in length) follows the duodenum. The remaining thirteen to fourteen feet is called the *ileum.*

The coils and folds of the small intestine fill a large part of the abdominal cavity. They move over each other to a considerable degree, and are held in place by a fan-shaped sheet of tissue called the *mesentery,* which is attached to the dorsal wall of the abdominal body cavity. Arteries, veins, and lymphatics, as well as the

nerves that carry sensory and motor impulses, lie in the mesentery and are supported by it.

The lining of the small intestine is continuous with that of the stomach. It has innumerable minute, fingerlike projections called *villi,* which are about $\frac{1}{25}$ inch in height and give the lining somewhat the structure of a fine velvet. The wall of each villus is of columnar epithelial cells. The villus contains capillaries, a lacteal, and unstriped muscle. The tiny muscles in the villi enable them to contract and to move along their absorbed materials. Circular folds in the lining of the small intestine further increase its inner surface.



The mucosa of the small intestine, highly magnified. *1,* Intestinal villi; *2,* solitary follicles; *3,* openings of crypts of Lieberkuehn. (Testut.)

The most important processes in digestion and absorption take place in the small intestine. The pancreas, an accessory digestive gland about six or seven inches long, lying behind and below the lower curve of the stomach, supplies an important digestive fluid. This contains two important active enzymes: (1) *diastase* or *amylase* for converting starches into simple sugars, and (2) *lipase* or *steapsin* for converting fats into glycerin and fatty acids. It also contains one inactive enzyme, *trypsinogen,* which is changed into the powerful proteolytic (protein dissolving) enzyme, *trypsin,* in the intestinal tract.

The activation of trypsinogen depends upon contact with *enterokinase,* an enzyme in the secretion of the intestinal glands, located between the villi in the intestinal wall. In addition to enterokinase this secretion contains *erepsin,* a mixture of enzymes, which completes the digestion of proteins. It also contains the enzymes *invertase* or sucrase, *lactase,* and *maltase,* which complete the digestion of sugars.

The liver, the largest organ in the body, lies just below the dome of the diaphragm, above the stomach on the right side. It extends downward to the edge of the ribs. It is important in the storage of glycogen, in the elaboration of urea from the nitrogenous waste of the blood, and in the decomposition and excretion of the pigments set free by the disintegration of red blood corpuscles. Its digestive functions are effected through the production of *bile,* which is poured into the duodenum through the bile duct. The bile salts facilitate the action of lipase in fat digestion. They also promote intestinal peristalsis.

A small, slightly muscular sac, the gall bladder, is connected by a tube to the bile duct. It acts as a temporary reservoir for the storage of bile, which is produced continuously by the liver. It concentrates the bile and makes possible an intermittent, rather than a continuous, flow of bile into the intestine.

Food is pushed along the small intestine by *peristalsis* at the rate of one-half inch to one inch per minute. Sharp contractions of the circulatory muscles, called *rhythmic segmentation* movements, mix the food with the digestive juices. An occasional *peristaltic rush* rapidly carries the food along several inches. Food ordinarily remains in the small intestine for four or five hours.

The Large Intestine.—The large intestine is about five feet long and one and one-half to three inches in diameter. It is divided into three parts: the cecum, the colon, and the rectum. The *cecum* is a blind pouch, located in the lower right-hand side of the abdominal cavity just above the hip bone. The small intestine (ileum) empties into the cecum through an opening guarded by a sphincter muscle and forming the ileocecal valve. The vermiform process, or *appendix,* a blind tube three to nine inches long and one-quarter inch in diameter, opens out of the cecum. The *colon* is divided into ascending, transverse, and descending sections, the latter emptying into the rectum, which discharges in-

testinal waste through the anus. Its outer layer contains three long ribbons of longitudinal muscle the contraction of which forms pouches in the colon. There are no villi in the large intestine, but mucous glands are found nearly everywhere.

The intestinal content is about the consistency and appearance of thin pea soup when it enters the large intestine. In addition to water it contains the residue of plant fibers (cellulose), the bodies of bacteria, most of them of the colon bacillus type (variously estimated as furnishing up to 30 per cent of the bulk), and some of the body secretions, such as the bile residues. The right half of the large intestine absorbs a large part of the water. The left half is primarily a storage reservoir from which at periodic intervals waste is sent on for temporary storage in the rectum.

The Absorption of Food Substances.—The products of digestion are almost entirely absorbed from the lower two-thirds of the small intestine. The end products resulting from fat digestion pass into the lymphatic tubes of the villi and make their way along the lymphatics of the mesentery as a milky fluid called "chyle." In this form they are carried to the thoracic duct and thence to the large veins just above the heart.

The products of protein and carbohydrate digestion are picked up by the capillaries of the villi and carried to the portal vein which runs to the liver, there to divide into another set of capillary channels. Here the blood gives up most of its newly absorbed dextrose, the end product of carbohydrate digestion, to the cells of the liver which transform it into glycogen and store it as this compound. When the blood is in need of sugar, this process is reversed. Glycogen is also stored in the muscle cells of the body where it is available for immediate use in the production of energy. About 1 per cent of the weight of the muscle is glycogen. The storage and utilization of sugar are in some way controlled by a substance called "insulin," which is produced in the pancreas and picked up directly by the blood stream. The failure to produce insulin results in diabetes.

After passing through the capillary network in the liver, the blood, which earlier had come through the capillaries of the small intestine, enters the general circulation.

The amino acids, the final products of protein digestion, are taken from the blood by the body cells wherever they are needed

for growth and repair. Cells build amino acids into the protoplasmic structure in only slight excess of actual needs.

Appetite, Hunger, and Thirst.—We have not yet discussed those elemental and universal sensations which make us seek food and drink—appetite, hunger, and thirst. *Appetite* results from the memory of pleasant past experience. It is further strengthened by "appetizing" odors and the taste of food we enjoy. It is not to be confused with *hunger,* a more primitive sensation. Contrary to appetite, hunger may even make us eat that which actually offends our senses. It is produced by strong contractions in the muscular wall of the stomach, causing a dull pain or ache in the lower chest or upper abdomen. These contractions may be so insistent as to prevent sleep. Chewing or swallowing movements or smoking will partially ally them. Strong emotions or strenuous exercise will stop them temporarily. There is physiological basis for the advice to "tighten your belt" when hungry, for this does, indeed, cause partial or complete cessation of the sensations of hunger for a short time.

A very different sensation is *thirst,* which is due to the drying of the mucous membranes of the pharynx. This condition arises from any situation that reduces the fluid supply of the salivary glands, as, for example, hemorrhage, sweating, fright, or inability to secure water. Hunger contractions cease to be painful after some hours. Thirst, on the other hand, becomes increasingly more agonizing until water is supplied.

Digestion and the Emotions.—From the use of the x-ray and the fluoroscope, from the study of experimental animals, and from the observation of a few rare cases in which, because of surgical operation, the inside of the stomach could be observed, we have gained considerable information concerning the relationship between the emotions and the secretion of digestive juices. We have long known that the sight or smell of a favorite food will make the mouth water. The observations mentioned have shown that it will also make the stomach water.

This initial psychic secretion of gastric juice is important because it starts protein digestion in the stomach, and the resulting partially digested proteins seem to incite the larger gastric secretions necessary for continued protein digestion. Slight gastric secretion is continuous; the increase that comes from "eating

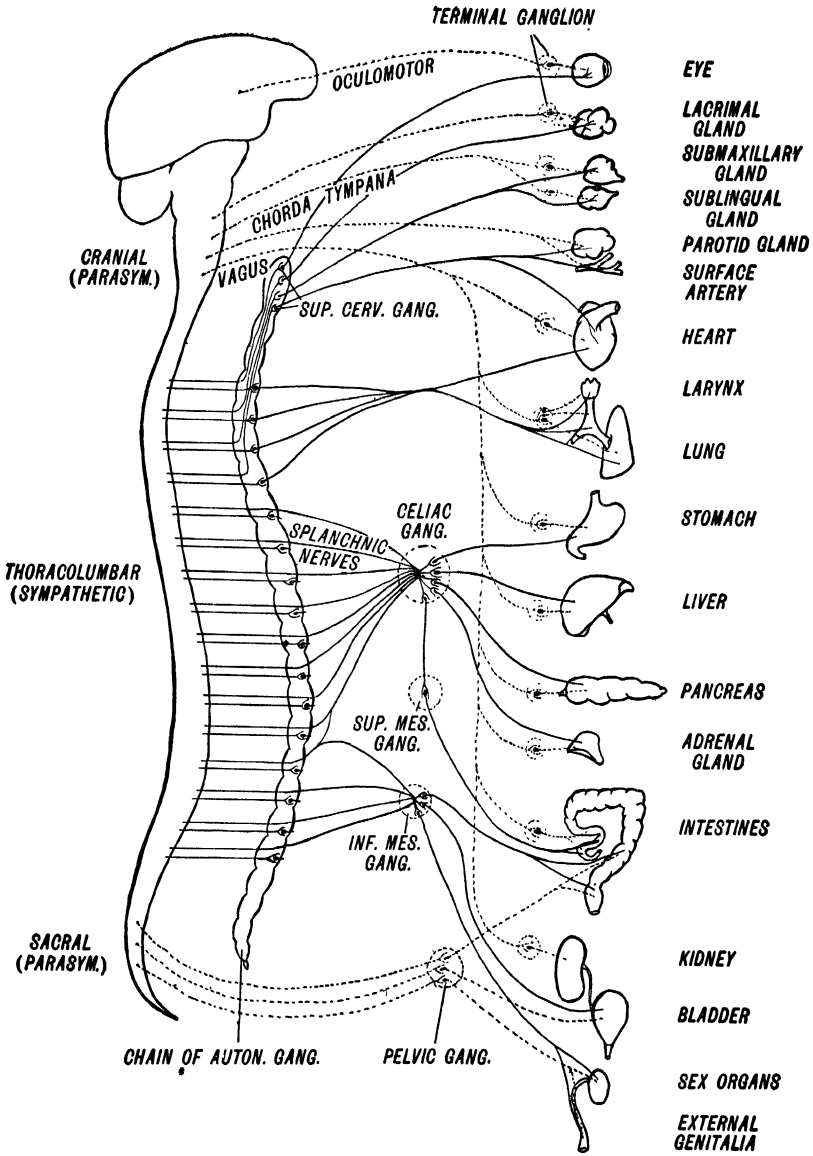
with appetite'' ends about twenty minutes after eating is discontinued, but the augmentation that is stimulated by partially digested foods may continue until the stomach is empty—for six or more hours—if conditions are favorable.

Digestion ensues much more readily if the food eaten is appealing in sight, odor, and taste. For persons who, because of illness or for some other reason, have dainty appetities, attractive, small servings are best. The forced feeding of children, the unnecessary punishment of children at the table, and the feeding immediately after the child has been emotionally upset, are all unhygienic. Among adults it is equally important that the meal should be pleasant and free from anxiety, worry, and ill-feeling. Otherwise, a vicious cycle will be set up, and the man who begins by worrying at his meals or thinking intensely upon the problems of his work will set up a mild indigestion, which will in turn lower his efficiency and further aggravate his worry.

The unfavorable, and sometimes inhibitory, digestive effects of psychic disturbances are very striking. Strong emotions, such as pain, fear, and rage, have been shown to check not only the flow of gastric juice, but also the pancreatic juice and bile. They may also prevent the normal contractions of the stomach and intestines. Dr. Cannon has shown in studying the cat by means of the fluoroscope that all stomach contractions and all peristalsis cease abruptly when a dog is brought into the room.

Physicians who treat great numbers of digestive disorders frequently get a clinical history of indigestion with symptoms of heaviness in the stomach after eating, as though the food failed to pass on to the intestines. Such a case exhibits an increasingly aggravated condition. This type of nervous or *emotional indigestion* in specific cases has been shown to be definitely related to unfavorable mental states. The accompanying diagram shows the way in which the autonomic nervous system reaches and affects the digestive tract and other parts of the body. These nerve structures operate automatically under the influence of the emotions.

Rest.—Due to the diversion of blood from the digestive tract to the muscles in the case of hard manual labor, and, to a less extent, to the brain in the case of mental work, we may conclude that an after-lunch rest period, postponing for at least one-half



The arrangement of the autonomic nervous system. The parasympathetic fibers are shown in dotted lines; the sympathetic fibers, in continuous lines. (From Hickman: *Functional Human Anatomy*, Prentice Hall, Inc.)

hour the return to work, is highly desirable. If one is unduly tired, it is also well to rest before eating, otherwise the digestive processes may suffer and nutrition may be impaired. Bathing at temperatures other than that of the body also diverts blood from the digestive organs. It is, therefore, inadvisable to indulge in a bath for an hour after eating.

Regularity in Eating.—It has generally been found beneficial to digestion to have regular hours of eating. However, the ideal number of meals and the times for eating are not necessarily the same for all people. Some students of the problem believe that eating more often than three times a day is desirable. When ready energy is necessary, carbohydrates will supply it more quickly than other foods. Greatest working efficiency results when there is a ready supply of carbohydrate food. Eating just before a large meal may upset the appetite, but there is no physiological evidence for the popular belief that eating between meals is harmful to the digestive tract.

Water With Meals.—There seems to be no reason why water taken with the meals should be injurious, unless it is used to wash down dry food in order to save the person the trouble of chewing or unless it is taken at so low a temperature and in such quantities as to cool the stomach and slow up the action of secreting tissues of the stomach wall. Iced beverages or desserts should be taken slowly so that the stomach will not be chilled.

Digestive Disorders

Common digestive disorders are "indigestion," constipation, and diarrhea.

Indigestion.—Indigestion is a popular, rather than a scientific or medical term. It is commonly applied to conditions associated with abdominal pain, vomiting, belching of gas, and a bad taste in the mouth.

Hurried eating results in the swallowing of an excessive amount of air and in imperfect mastication, thus prolonging digestion. Overeating distends the digestive organs, produces discomfort, and, to some extent, reduces the completeness of food absorption.

Fried foods digest rather slowly because of their coating of fat. There is, however, little basis for the common belief that all fried

foods are unwholesome. Food fried in hot deep fat so that little fat is absorbed is probably not more difficult to digest than foods prepared in other ways.

Pickles, an excessive amount of condiments, or highly seasoned foods may be irritating to the digestive tract and may cause discomfort.

The wrong emotional state and extreme fatigue inhibit the digestive process. Moderate exercise (except directly after eating) facilitates the secretion and activity of the digestive organs, but extreme exertion halts the process of digestion. Sugar, if eaten in large quantity, is irritating to the stomach. An immoderate amount of alcohol, or its continued use, causes irritation of the stomach, with the excessive production of mucus, hydrochloric acid, and muscular activity.

Heartburn is a common digestive difficulty, characterized by a burning sensation in the chest. The highly acid gastric secretion is thrown up into the esophagus, causing irritation and discomfort. It is associated with "nervous indigestion," brought on by worry, excitement, overwork, or the excessive use of alcohol, tobacco, coffee, and tea. The heart has no relation to "heartburn." The taking of baking soda or other alkaline substance is often suggested to relieve this condition. Usually the need lies in an adjustment of the hygiene of the nervous system and an avoidance of foods which irritate the stomach.

Belching is the eructation of air that has been swallowed with food or unintentionally when food is not being taken. Eating slowly will help to avoid the first difficulty. The habit of air swallowing may be broken by holding the mouth slightly open with some small object placed between the teeth.

Constipation.—Constipation is too slow a movement of food along the digestive tract and the failure of the bowel to empty itself thoroughly and regularly. There are two types of constipation: atonic, in which the intestinal muscles lack tone; and spastic, in which they are in spasm. Headache, lassitude, depression, irritability, and difficulty in the accomplishment of mental work are commonly associated with constipation. These common effects of constipation appear to be due, in part at least, to the pressure of feces in the rectum. Investigations have shown that

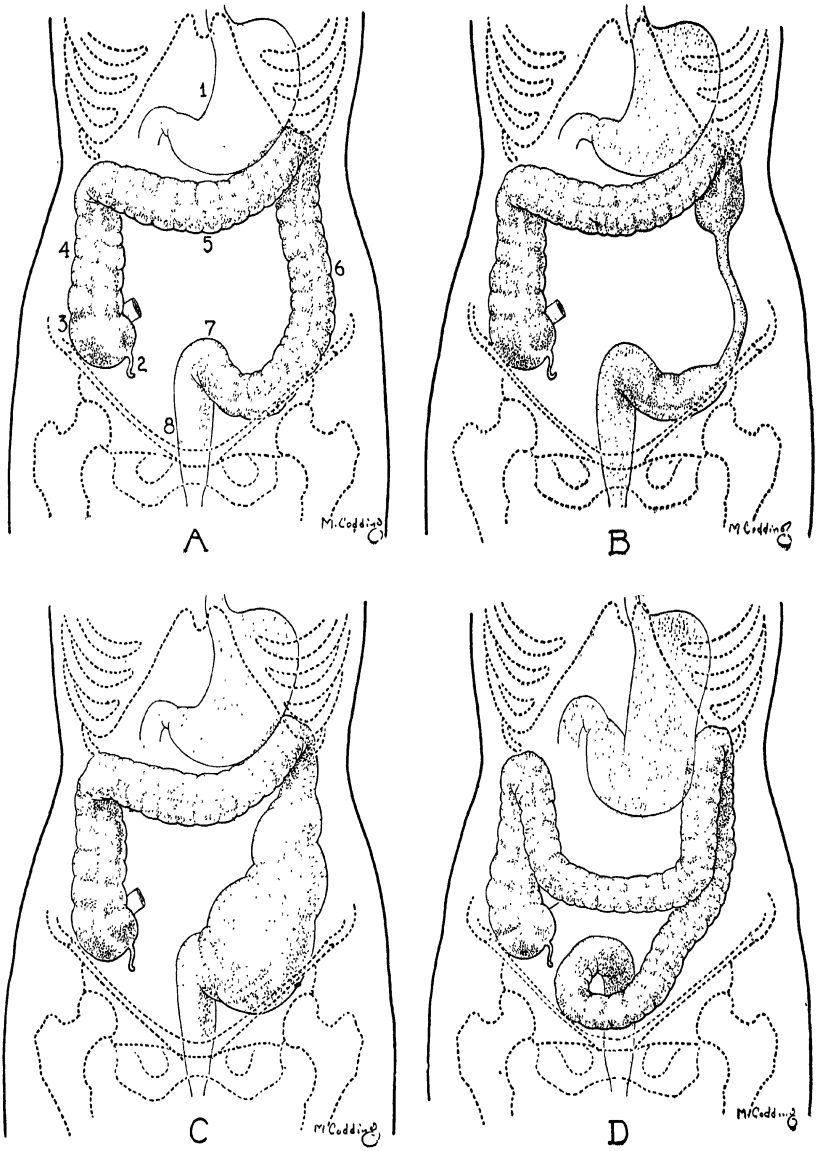
packing the rectum with cotton produces the symptoms of constipation.

The common causes of constipation are: (1) failure to establish the habit of evacuating the rectum at a regular time each day when feces enter it from the large intestine and produce a desire for defecation; (2) lack of thiamine and lack of roughage or indigestible fiber in the diet; (3) lack of sufficient exercise to provide beneficial jarring and change of position for the intestine; (4) ptosis, or sagging, of the intestine and stomach, due to flabby abdominal muscles and reduced abdominal pressure. Lead poisoning or the use of excessive amounts of bran may produce sufficient irritation to contract the muscles of the intestines and cause spastic constipation, a condition in marked contrast to the more common atonic type. An infected appendix, or some other internal difficulty demanding medical attention, is sometimes the cause of constipation.

Constipation is overemphasized in the ever-present advertisements for cathartics. The condition is harmful and should be avoided by drinking plenty of water, by eating suitable foods, and by exercising. At least one bowel movement a day at a regular time is a desirable habit for most persons. A glass of hot or cold water upon arising and special abdominal exercises may help in establishing this habit.

The *diet* useful in correcting and preventing constipation is one containing (1) foods which provide bulk, (2) foods which have a tendency to form gas in the intestines, and (3) foods which contain thiamine. The planning of a diet to eliminate constipation is an individual matter. In most cases the adoption of hygienic measures is sufficient to correct the condition if there is no organic disease. *Laxatives* relieve constipation temporarily, but they do not correct the underlying condition. Their continued use is undesirable and unhygienic. Today some drug companies that make laxatives are frank enough to caution the user against the indiscriminate use of their products. One laxative bottle bears the label stating: "Caution: . . . Avoid prolonged use since the 'laxative habit' is dangerous to health."

Mineral oil makes the bowel evacuate easily by preventing the excessive reduction of liquid from the feces, but when constantly



The large intestine under different conditions. *A*, The normal large bowel or colon in the proper position in relation to other structures. (*1*) The stomach; (*2*) the appendix; (*3*) the cecum; (*4*) the ascending colon; (*5*) the transverse colon; (*6*) the descending colon; (*7*) the sigmoid flexure; (*8*) the rectum. *B*, Spastic constipation. *C*, Atonic constipation. *D*, Ptosis or sagging of the transverse colon, accompanied by the displacement of the stomach.

used, it interferes with the absorption of fat-soluble vitamins. An excess of the oil may result in "leakage" or involuntary passage of some feces with oil.

Salts, such as Epsom salts, Rochelle salts, and magnesium citrate, extract water from the mucous membranes and flush the intestines. This effect upon the lining of the intestine is likely to bring on further constipation.

There are certain *irritative drugs,* such as castor oil and cascara, which stimulate the activity of the large intestine. They must be used in increasingly large doses to remain effectual, and they may produce a mucous colitis.

Suppositories may be useful in developing an evacuation habit. They consist of soap and glycerin and are placed in the rectum where they soften its contents and facilitate elimination.

In using the *enema* or internal bath, a pint to a quart of warm soapsuds is injected into the rectum. An enema is usually effective, but it is not a cure for constipation, since the dilation of the rectum is undesirable and its sensitivity is reduced.

Diarrhea.—Diarrhea is a condition in which the feces is fluid or semifluid, peristalsis is violent, evacuations are frequent and accompanied by more or less pain. It is caused by chemical, mechanical, or nervous irritation of the intestine. It may be initiated by food, cathartics, bacteria, or unstable emotions. If protracted, diarrhea is injurious in that it leads to reduced absorption of food and loss of water and salts from the body.

Diseases of the Digestive Tract.—*Communicable diseases* of the digestive tract will be discussed later. Sensitiveness to particular foods, or *food allergy,* will be discussed in the chapter on immunity.

Appendicitis is an inflammation of the vermiform appendix. Its cause is imperfectly understood, but neglected constipation and habitual overeating are thought to be contributory. The pain is usually in the lower right side of the abdomen, but it may appear early in the upper part of the abdomen or as general cramps. Usually there is vomiting with appendicitis, and occasionally, the person makes the mistake of assuming that the attack is merely one of indigestion.

The use of cathartics in appendicitis is distinctly dangerous. It has been estimated that in a single year more than 12,000

deaths in the United States were caused by taking laxatives for abdominal pain when an inflammatory condition existed in the appendix. Laxatives increase peristaltic action. When the appendix is seriously inflamed, this excessive intestinal activity may cause it to rupture. The question of whether the appendix is inflamed can best be determined by a physician. The rule "never take a cathartic in the presence of abdominal pain" would, if followed, save many lives. Early diagnosis and treatment are necessary to reduce the high mortality from appendicitis.

Some of the other not infrequent disorders of the gastrointestinal tract are caused by gastric ulcer, gallstones, and hernia. These maladies are matters of medical rather than of hygienic interest.

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CHAPTER IV

ORAL HYGIENE

Parts of the digestive apparatus that demand further attention are the teeth and the soft tissues of the mouth.

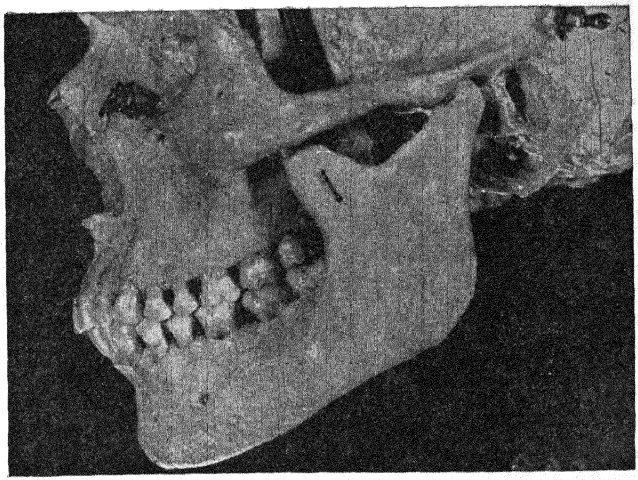
Form and Arrangement of the Teeth.—There are four classes of teeth: the incisors or cutting teeth, the canines or tearing teeth, the premolars or tearing and grinding teeth, and the molars or grinding teeth. The first set, the primary teeth of childhood, has eight incisors, four cuspids, and eight molars, a total of twenty teeth. The second, or permanent, set has a total of thirty-two teeth, including, in addition to the eight incisors and four cuspids, eight bicuspids and twelve molars. They are appreciably larger than the primary teeth.

When the teeth are in normal alignment, each tooth touches the one on each side of it. This contact keeps food from crowding upon the soft tissues between the teeth. *Normal occlusion,* or proper relationship between the upper and lower teeth, is shown in the accompanying illustration.

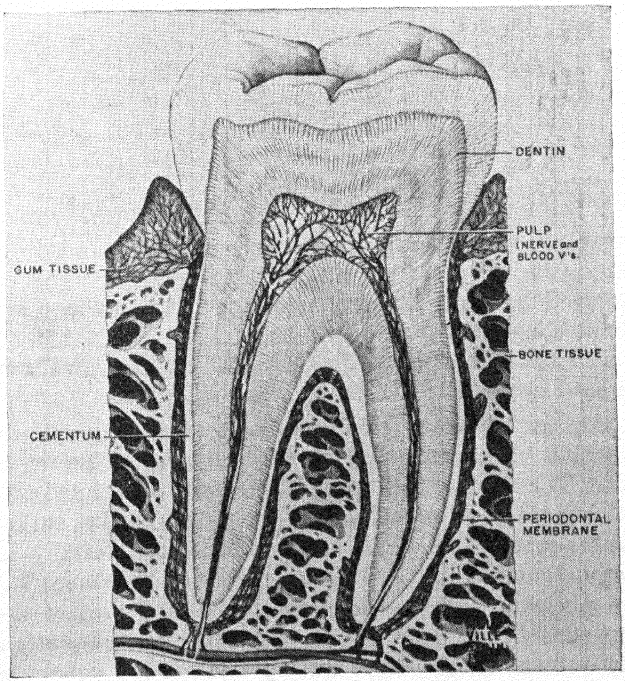
Development and Structure of Teeth.—Modern knowledge shows that the tooth is a living and changing structure, and its relationship to the rest of the body is direct and intimate.

Although teeth are set in bone, they are not a part of the bony system but are formed within the soft tissue, where the enamel and dentin are produced from different sources. The enamel is secreted by an enamel organ, made up of cells from the same layer (ectoderm) which forms the skin and the lining of the mouth. Cells from this layer grow down into the soft tissue in the shape of a thimble and secrete the enamel substance on their inner surface. This enamel is the hardest substance in the body and is made up almost entirely of phosphate and carbonate of calcium. It becomes the covering of the crown or exposed part of the tooth but it does not cover the root.

While enamel is forming, the dentin organ, a finger-shaped mass of dentin-forming cells (odontoblasts) from the mesoderm layer,



Normal occlusion. Buccal view of ideal occlusal arrangement. (From Dewey-Anderson: *Practical Orthodontics,* The C. V. Mosby Co.) (Atkinson.)



Diagrammatic drawing of a section through a normal tooth. (Courtesy American Dental Association.)

pushes into the thimble area and begins to deposit the dentin. Dentin is composed of calcium phosphate and calcium carbonate and in addition contains considerable organic matter.

The enamel organ eventually disappears. The dentin-forming cells, however, form the lining of the pulp cavity of the tooth and from each odontoblast living protoplasm extends into the canal of the dentin tubule which this cell has formed.

The first teeth are partly formed beneath the gums at birth. The sequence of eruption of the teeth is shown in the following table:

APPROXIMATE AGE AT WHICH TEETH ARE USUALLY ERUPTED

Deciduous Teeth	
6 to 8 months,	4 central incisors
8 to 10 months,	4 lateral incisors
12 to 16 months,	4 anterior or first molars
16 to 20 months,	4 cuspids
20 to 24 months,	4 posterior or second molars
Permanent Teeth	
6 to 7 years,	4 first or sixth-year molars
7 to 8 years,	4 central incisors
8 to 9 years,	4 lateral incisors
10 to 11 years,	4 first bicuspids
11 to 12 years,	4 second bicuspids
11 to 12 years,	4 cuspids
12 to 13 years,	4 second or 12-year molars
15 to 21 years,	4 third molars or wisdom teeth

Lower teeth erupt before upper teeth as a rule and, in general, teeth appear a little earlier in girls than in boys. The crown is fully formed before the tooth erupts, but the formation of the root is not completed for many months afterward. Although the eruption of teeth is a normal process, a child may have some pain, soreness and swelling of the gums.

The pulp of the tooth contains blood vessels, lymphatics, and nerves which enter and leave through a foramen at the apex of the root. The root of the tooth is covered by a hard substance called "cementum," attached to the bone by its surrounding periodontal membrane. This membrane is considered one of the most important of all tooth structures. It not only holds the tooth in place but also serves as a cushion to protect the tooth pulp and the brain from severe jars during mastication. The slight movement of the teeth during mastication causes a gentle



(H. Armstrong Roberts)

Contrast the size and shape of the first and second teeth.

The Quality of the Teeth.—There is an appreciable difference in the hardness of the teeth of different persons. The development of hard and well-formed teeth requires proper metabolism. Sufficient calcium and phosphorus salts are necessary and we have seen that some vitamins are necessary for the best use of these salts in the body.

The diet of the mother probably has little effect upon the future dental health of the unborn child. For one reason, most of the enamel of the primary teeth and all the enamel of the permanent teeth are formed after birth. Moreover, the body resources of the mother can be utilized to some extent, although to her own detriment, in developing the teeth of the child. The diet of the mother is important to her own general health and to that of the baby.

Proper diet from birth to about the age of 13 years is most important in the development of good teeth. Sometimes malnutrition, especially a deficiency in vitamin A, a fever, or other

suction on the vessels in the pulp and stimulates the flow of blood and lymph, thus aiding in the maintenance of healthy tooth structures. The soft tissues of the gum (gingivae) are attached to the teeth at the junction of the cementum with the enamel that covers the crown. During health a crest of this soft tissue lies closely against the enamel.

Structural Abnormalities in the Mouth.—Various structural abnormalities interfere with health, appearance, or normal function. Well-developed jaws, with a full complement of beautiful, even teeth, contribute to the symmetry of the face and to personal attractiveness. A high roof of the mouth, protruding teeth, widely separated or missing teeth, and failure of the upper and lower teeth to meet properly interfere with clear speech, particularly the pronunciation of *s* sounds. Irregular teeth may prevent proper mastication and lead to digestive troubles. Such teeth are hard to keep clean.

Nearly half the children in the United States have some type of *malocclusion* (irregularity of the teeth with imperfect relationship between the upper teeth and the lower teeth). There are various causes for malocclusion, including illness, malnutrition, mouth breathing, and thumb-sucking or lip-biting in childhood. The primary teeth serve as guides to help the permanent teeth erupt in their proper position. If primary teeth are lost too early, this guiding function is apt to suffer. The dentist often places a *space retainer* in the mouth when a primary tooth is lost, to keep the dental arch from changing shape until the permanent tooth is ready to come through the gum. The premature loss of either a primary or a permanent tooth is likely to result in the drifting and irregular arrangement of the remaining teeth.

Many deformities, such as those already mentioned, can be adjusted by the use of special appliances, or bands, to widen the jaw and to move the teeth slowly into proper position.

Our jaws are smaller than those of our remote ancestors and sometimes there is not enough space for the wisdom teeth to erupt. They become impacted or wedged into the jaw in abnormal positions. Often they do no harm, but if they cause pain the dentist can locate them with the x-ray and remove them if necessary.

illness during the period of enamel formation causes *hypoplasia,* or imperfect development of the enamel. Minute pits and fissures occur, at the bottom of which the dentin of the tooth may be exposed.

Ascorbic acid deficiency may result in defective dentin, degeneration of pulp tissue, imperfect calcification, loosening of teeth, and absorption of the alveolar or bony processes in which the teeth are set (periodontal disease or periodontoclasia).

Studies with animals have shown that vitamin D is important in guaranteeing the formation healthy teeth.

In localities where the drinking water contains fluorine in a concentration greater than one part per million, a tooth defect known as *mottled enamel,* or dental fluorosis, occurs. Dark brown, light brown, or chalk-white patches appear on the permanent teeth. There is evidence that a drinking water content of about one part per million of fluorine aids in the development of hard, decay-resistant teeth. Further studies are in progress upon the effect of fluorine upon both the teeth and the general health.

The health of teeth is closely related to general health, and the hygiene of developing good teeth involves the avoidance of disease, particularly the communicable diseases of childhood, as well as the procurement of a diet rich in such protective foods as milk, meat or fish, eggs, fruits and vegetables.

Caries.—Next to common cold, tooth decay is probably the most common disease of man. About 96 per cent of children have some decay by the age of 5 years. The caries rate is highest in teen-age children and higher in girls than in boys. More than nine-tenths of all permanent teeth lost during school age are sixth year molars.

In spite of its prevalence one can hardly conclude that caries is a natural or unavoidable condition. Tooth decay is not common among the lower animals. It has been by no means universal in man. Groups of persons may still be found in various parts of the world among whom tooth decay is practically unknown. And yet we must admit that we do not have sufficient knowledge to prevent it, although it can be controlled or checked successfully with adequate dental supervision.

The general nature of tooth decay is well understood. First, a chalky white area appears on the enamel which becomes decalcified and washes away. Then a small cavity appears, and this

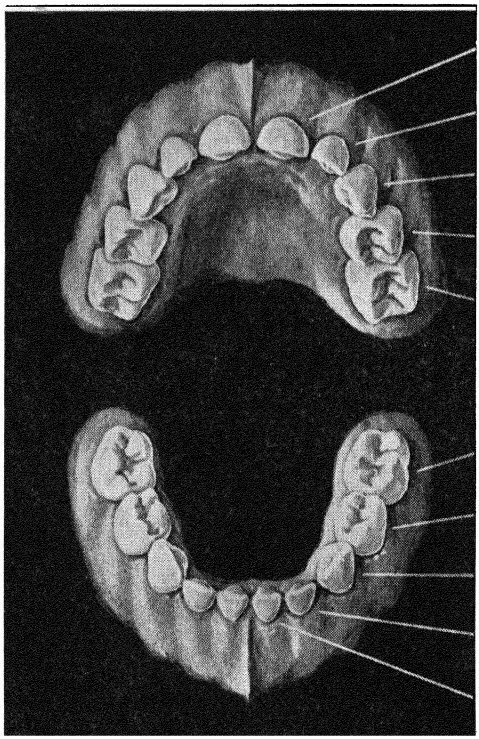


Chart of the twenty primary (first) teeth. (Courtesy American Dental Association.)

continues into the softer dentin where it spreads in all directions. Decay may start in a pit or fissure where imperfect enamel formation has left the dentin exposed. Bacteria are present and penetrate into the dentin tubules. They form acid which dissolves the tooth structure. Unless the process is arrested, bacteria reach the pulp; the nerve and blood vessels are disintegrated and frequently an abscess, producing swelling and intense local pain, develops at the tip of the root of the tooth. Tooth decay progresses more rapidly in some persons than in others.

We are much less certain of the immediate cause of tooth decay. Acid formation in the mouth by the action of certain bacteria was early suggested as the cause. Diet has been studied in relation to sugar, starch, amino acid content, inorganic salts, and vitamins. It is possible that heredity, systemic disease, malnutrition, faulty tooth construction, endocrine disturbances, the nature of the

saliva, and still other conditions may be contributing causes of tooth decay.

Diseases of the Soft Tissues.—Inflammation of the gums, or *gingivitis,* is sometimes mild and easily curable, and sometimes much more serious. It is commonly associated with vitamin C deficiency (see discussion of ascorbic acid deficiency and scurvy). Other causative factors are lack of oral cleanliness, tartar deposits, malocclusion, bacterial infections, systemic diseases, and such chemical poisons as mercury, lead, and phosphorus.

Periodontal disease, often called pyorrhea, is an infection of the gums with pus-forming organisms. The red and tender gums recede. They bleed easily and exude pus at the margins. Foul breath and digestive disturbances are common accompaniments. It is usually, but not always, associated with lack of oral cleanliness. The cure of the condition lies in adequate dental treatment, and not in the use of any particular tooth paste or powder. Ade-

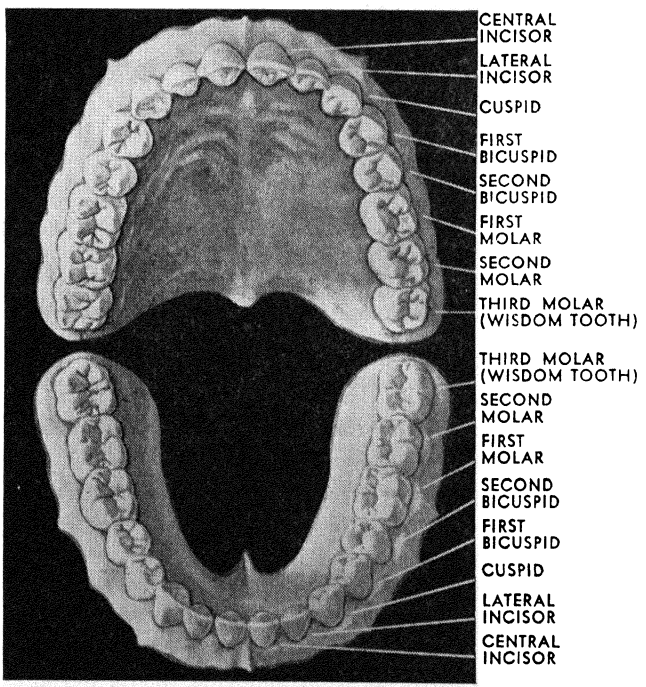
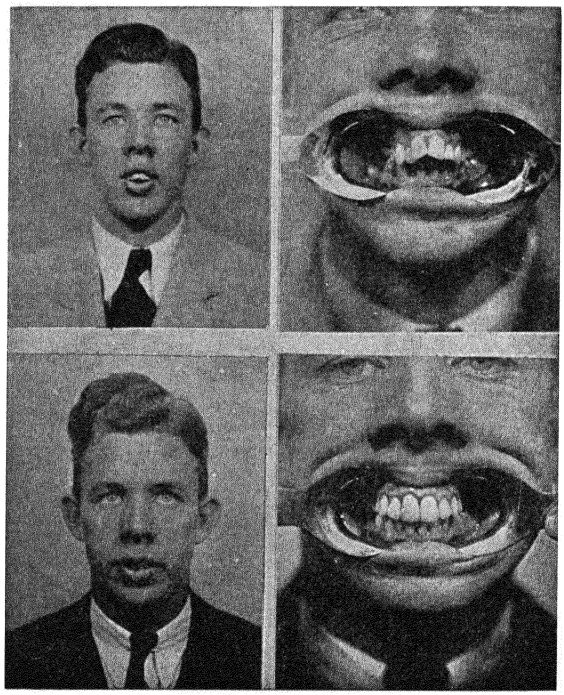


Chart of the thirty-two permanent (second) teeth. (Courtesy American Dental Association.)

quate diet with sufficient ascorbic acid is important.

Trench mouth, or Vincent's infection, is a serious and communicable oral disease.

Care of the Mouth and Teeth.—The care of the mouth and teeth with the control of tooth decay has three phases:



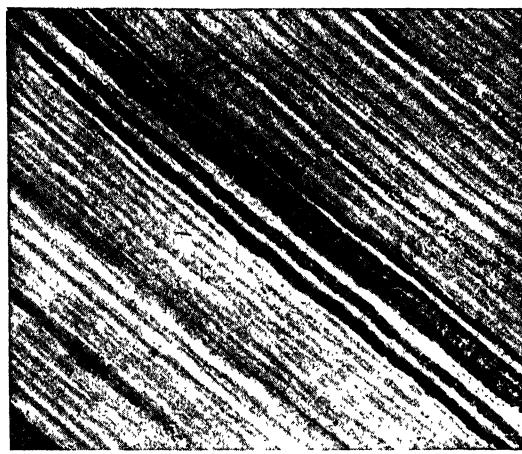
Poor occlusion corrected by orthodontic treatment. (From Dewey-Anderson: *Practical Orthodontics.*)

1. *Regular Dental Care.*—One looks to his dentist for guidance in all matters that pertain to the well-being of his oral structures. Regular visits every three months, or at such periods as the dentist recommends, should begin when the child is 2 years of age and continue throughout life. By direct exploration and by the use of the x-ray the dentist discovers, early, minute cavities and other undesirable conditions.

Prompt corrective treatment of these small cavities is instituted with little or no discomfort to the patient, with minimum

loss of tooth structure, and at minimum expense. To delay treatment and allow tooth decay to progress would result in pain and probably in the loss of the tooth.

In the case of the child the dentist watches the development of the dental arch, and prevents or corrects malocclusion. In later life lost teeth are replaced to prevent unsightly gaps and the development of wrinkles on the face. When the natural teeth are lost, artificial teeth restore chewing power and normal speech, and improve the appearance. New artificial dentures are needed from time to time due to the gradual shrinking of the jawbone.



Microscopic section through a decayed tooth, showing tubules packed with bacteria. (Miller.) (From Fones: *Mouth Hygiene.* Courtesy Lea & Febiger.)

Today the expectant mother visits her physician and her dentist early in pregnancy and follows their advice in having dental work done and in the home care of the teeth.

2. *Diet and Nutrition.*—Although our knowledge of the relation of nutrition to decay is incomplete, there is some evidence that a well-balanced diet during childhood gives considerable protection. This protection may come through proper development of the teeth. It may come through helping the teeth to erupt in their proper positions, thus facilitating the cleansing of the teeth and giving less opportunity for the retention of quickly fermentable sugars and starches. The restriction of sugar in the diet is widely recommended.



(H. Armstrong Roberts)

An attractive smile is an asset.

Important also is the habitual use of fibrous foods requiring vigorous chewing. They stimulate the circulation in the tissues around the tooth. Hard breads, raw vegetables, certain fruits, and meat are such foods.

3. *Mouth Hygiene.*—Cleanliness of the mouth probably aids in the control of tooth decay by removing fermentable food debris. Fermentation in the mouth begins within a few minutes. Therefore, the ideal procedure would be to clean the teeth after each meal with a satisfactory toothbrush, a safe dentifrice, and dental floss, followed by a thorough rinsing of the mouth with water.

A tooth paste, powder, or liquid dentifrice is used merely to aid the brush. So far as is known, none of them contains any substance which will in itself prevent tooth decay. We have no specific caries preventive. Several agents including fluorine, tryptophane, and other drugs are being studied. Ordinary table salt or baking soda, or a mixture of equal parts of each, may be used effectively in place of a commercial tooth paste.

Rinsing helps to remove the food particles after brushing and to keep the mouth clean and sweet. Salt and water or water alone is a good rinse.

Brushing the teeth should be started when the child is about 2 years old and the mother should brush the child's teeth daily with a very small brush until he is old enough to do it himself. For adults dentists commonly recommend a brush with a straight handle and a head with two rows of not more than six bristle tufts each, set fairly well apart so that they can be easily cleaned.

A good toothbrush will not shed its bristles in the mouth. It is a good plan to have two toothbrushes for alternate use so that they can become thoroughly dry before use and retain their stiffness.

The teeth should be brushed away from the gum with a rolling or sweeping motion. The grinding surfaces should be brushed with a slight backward-and-forward and side-to-side motion. The tooth surfaces next to the tongue should be brushed as carefully as those next to the cheeks.

The teeth should be brushed after each meal, care being taken to cleanse all the surfaces. Thorough brushing will help to prevent the accumulation of *plaques* or jellylike patches of mucin from the saliva. Even careful brushing of the teeth may not keep them entirely free from a limelike deposit called *tartar,* formed by mucin and minerals from the saliva. For this reason, *oral prophylaxis* is desirable at least once or twice a year. At this time the dentist or dental hygienist removes tartar and stains, and polishes the teeth.

Dental floss, used under instruction from the dentist, helps to remove any particles that may remain between the teeth after brushing. The silk should be passed through the contact points, held closely to the surface of the teeth and carried upward or downward as far as the gums. Care must be taken not to injure the soft tissues. It is rarely necessary for children under 10 or 12 years of age to use dental floss.

When the toothbrush and dental floss are not available, a toothpick is often used to clean the proximal surfaces of the teeth after eating. An orangewood pick, with a smooth flat blade or a quill is preferred, and care should be taken not to injure the soft tissues or to push the gingivae away from the surfaces of the teeth. It is this danger that leads many dentists to advocate that no toothpick be used under any circumstances. Too often people blindly and violently thrust the toothpick between the teeth in an attempt to relieve some slight irritation, and bleeding of the gums results. Another vicious and unsightly habit is the prolonged use and chewing of the wooden toothpick from which splinters detach and irritate the membranes of the mouth and throat.

The eating of a raw, slightly acid fruit, such as an apple, orange, or grapefruit, at the end of a meal or at bedtime has been

recommended as hygienic in scrubbing the teeth, stimulating the mucous membranes and the flow of saliva, and leaving the mouth in a condition in which acid-forming bacteria are less likely to multiply.

Summary.—The following items might be set up in an ideal mouth-hygiene program for the family:

1. Proper dental care, oral hygiene, and diet for the expectant mother.

2. Breast feeding for the infant, if possible, in order to obtain optimal growth and development. The vigorous use of the oral structures in nursing may also aid in their development.

3. The avoidance of thumb-sucking in childhood and mouth breathing, both of which tend to narrow the dental arch and deform the jaws.

4. The provision during infancy, childhood, and adult life of a diet which is adequate in calcium, phosphate, and vitamins A, C, and D. This means that the diet of the mother must be adequate in the case of breast-fed infants. For the baby who is not breast fed, cow's milk must be supplemented with such fruit juices as may be necessary to provide normal metabolism. After being weaned, the baby should have a diet rich in protective foods with very little sugar.

5. Daily use of such fibrous foods as meat, apples, raw cabbage, celery, or carrots to cleanse the teeth by natural means.

6. Regular dental attention every three to six months in order that pits and fissures of the teeth may be filled as these teeth erupt, in order that structural abnormalities may be early detected with the establishment of corrective measures, and in order that teeth may be cleaned and repaired as necessary.

7. The regular and thorough brushing of the teeth in an approved fashion to reduce the accumulation of tartar, and keep the mouth clean.

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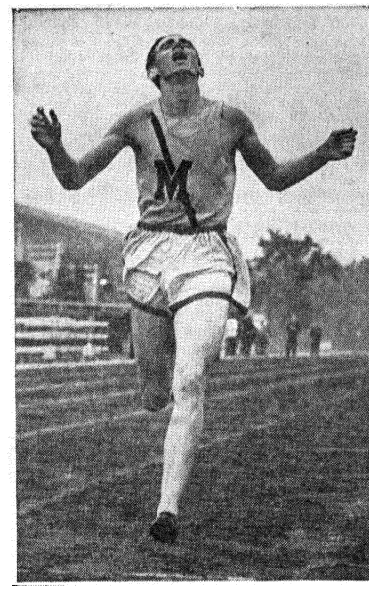
CHAPTER V

RESPIRATION

Oxidation.—The energy developed by animals is the result of oxidation within the living cells. This is the most fundamental chemical activity of living things. Life is dependent on the presence of oxygen. The jellyfish is so thin that all its cells can easily secure some of the oxygen dissolved in the water. In man, most of the body cells are remote from an oxygen supply, since they are bathed, not by ocean water but by the salty fluids of the body itself, and the process of *internal respiration* whereby the body cells exchange oxygen and carbon dioxide with the blood must be supplemented by a second process. This is known as *external respiration* and involves bringing air into contact with the blood stream in the moist tissue of the lungs where an exchange of the gases involved in oxidation can take place.

The air we inhale is a mixture containing approximately 79 per cent of the inert gas, nitrogen, which plays no part in the chemistry of respiration, and nearly 21 per cent of oxygen, together with 0.04 per cent of carbon dioxide and traces of certain other gases. The air in the lungs is unchanged in its nitrogen content, but the oxygen content drops to about 16 per cent, and the carbon dioxide content rises to about 5 per cent. The exhaled air is immediately diluted in the atmosphere so that the actual proportion of gases in the air we breathe does not vary greatly. Research has shown that the oxygen in the air may drop to 14 per cent and carbon dioxide may rise to 3 per cent before the body is unfavorably affected. Such proportions never occur in the air under ordinary circumstances.

The blood provides the fluid medium that carries oxygen to the body cells. The oxygen in the lungs is dissolved by the fluids of the moist epithelial tissues and is picked up by the red blood cells in the lung capillaries. Oxygen unites in an unstable chemical compound with hemoglobin from which it readily detaches itself in the capillaries of the body tissues. Carbon dioxide, one of the waste products of oxidation, leaves the tissues and is car-



(*Acme*)

Oxygen hunger.

ried back to the lungs. Both carbon dioxide and oxygen are present in the blood at all times, but the proportions vary in arterial and venous blood.

The Path of the Breath.—In normal breathing the air passes through the two nostrils into the nasal chambers. These chambers are separated from each other by a cartilaginous partition, the *nasal septum*. Dust is removed from the air by hairs just inside the nostril and by the ciliated mucous membrane lining the air passages. This ciliated surface is moistened by small glands, which produce the clear, sticky mucus. The waving of the cilia themselves carries dust particles toward the nostril.

It is important that the air be warm and moist as well as clean before it reaches the lungs. The surface of the nasal chamber is increased by the shelves on its outer wall, formed by the *turbinate bones* which, with their covering epithelium, protrude into the passage. The maxillary, sphenoidal, ethmoid, and frontal *sinuses* communicate with the breathing passage through relatively small openings and provide an extension of the warm, moist membrane with which the air may come in contact. These sinuses or chambers also reduce the weight of the bones in which they are located and serve as resonators for the voice.

From the nasal cavity the air passes into the *nasal pharynx*—that part of the pharynx which communicates with the nose and lies back of and above the soft palate. Here, on the right and left sides, are the openings of the *Eustachian tubes.* On the dorsal surface is the *pharyngeal tonsil,* the enlargement of which produces adenoids.

The air now reaches the oral pharynx that lies beyond the mouth and communicates with it. On the right and left sides of the pharynx are the true, or *faucial, tonsils.*

The surface of the tonsils is not smooth but contains small depressions or crypts. The tonsils consist of lymphoid tissue and communicate with the *lymph nodes* in the neck. These lymph nodes are commonly swollen when the tonsils are infected. It is thought that the tonsils protect the body from bacteria by retaining and destroying some of the microorganisms that enter through the nose and mouth.

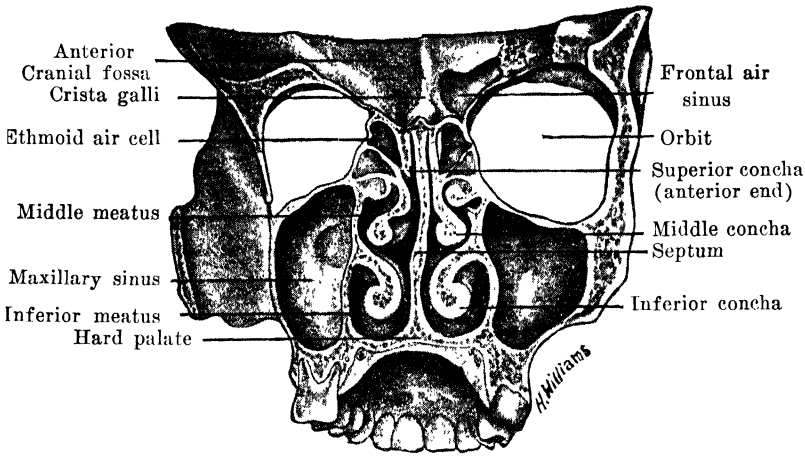


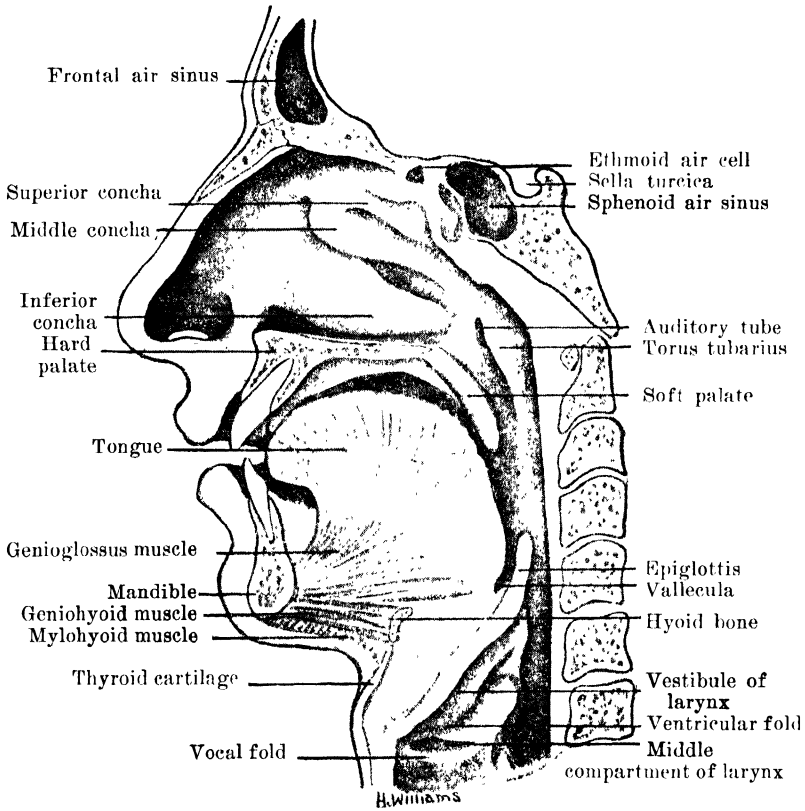
Diagram of a vertical section through the nose showing how the surface of the breathing passages is increased by sinuses and turbinates. The turbinates, or nasal conchae, are scroll-like processes of bone. The maxillary sinuses, the ethmoid air cells, and the right frontal sinus are shown. (From Francis: *Fundamentals of Anatomy.*)

The small *lingual tonsil* is located at the back of the tongue. The chronic cough which frequently results from excessive cigarette smoking may be due to the irritation and swelling of this tissue.

In the oral pharynx the paths of food and air cross. The air moves on to the laryngeal portion of the *pharynx,* past the *epiglottis* into the *larynx,* or voice box. The epiglottis is a small fold of tissue that closes the opening to the larynx during the act of swallowing. While food is prevented from entering the air passages except in rare cases, it is inevitable that food in being swallowed will carry some air into the esophagus.

The air passes over the *vocal cords* within the larynx and goes on to the *trachea* which divides into the left and right *bronchi.*

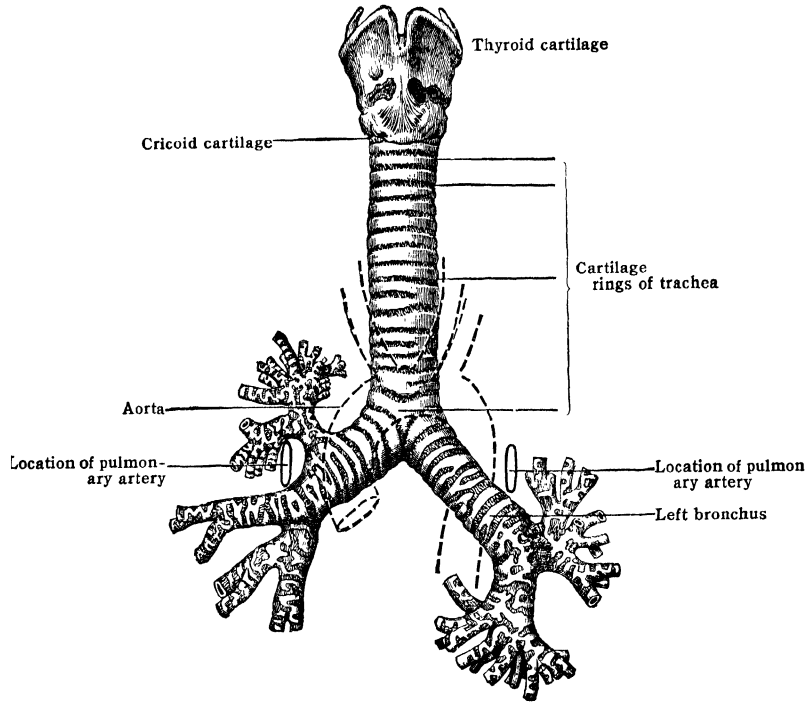
These divide into tubes which, in turn, subdivide into numerous smaller tubes called *bronchioles,* leading to the thin-walled air sacs, or *alveoli,* of the lung. The shape of the larynx and the circular form of the trachea and bronchi are maintained by rings of cartilage in the wall. You will be able to follow the path of the breath by referring to the following illustration.



Anteroposterior section of face and neck showing the path of the breath. A frontal sinus, a sphenoid sinus, and an ethmoid air cell are shown. Note the location of the Eustachian or auditory tube. (From Francis: *Fundamentals of Anatomy.*)

The *lungs* are interesting for their delicate spongy structure and for the remarkable elaboration of surface which is secured by the formation of the thin membranes into a great many small sacs. If

the lining membrane of the air sacs from the three lobes of the right lung and from the two lobes of the left lung could be stripped off and made into a continuous sheet, it would produce a surface approximately one hundred times the area of the skin that covers the body.

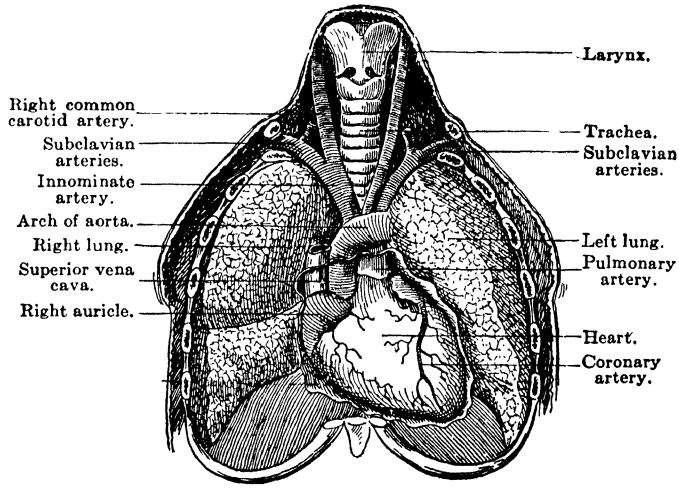


Larynx, trachea, and bronchi. (From Weeder: *Bundy's Anatomy and Physiology*. Courtesy The Blakiston Co.)

The only point of attachment for the lungs is at the entrance of the bronchial tubes and blood vessels. The lungs are not attached to the chest wall. Each lung is surrounded by a delicate serous membrane (the pleura), which also lines the chest cavity. A serous secretion keeps the pleura moist and smooth so that there is little friction during the movements of the chest walls in breathing.

The Mechanics of Breathing.—In principle, the chest cavity operates like a bellows, the lungs playing a passive role. Its rhythmic changes in size are brought about by muscular activity.

About 500 c.c. of air are drawn into the lungs and expelled in a normal respiration, while 1,500 c.c. of reserve air are ordinarily left in the lungs at the moment expiration is complete.



Organs of the thoracic cavity. (Ingals.)

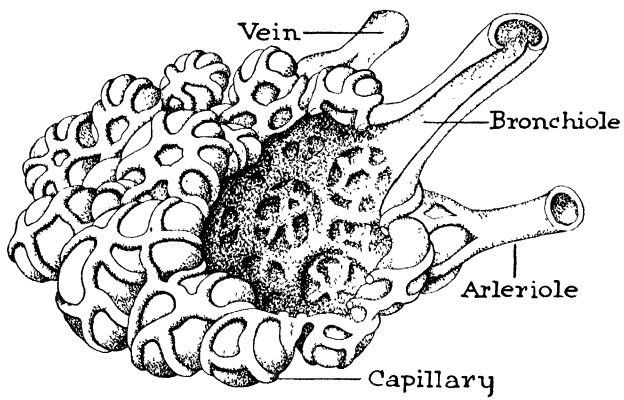
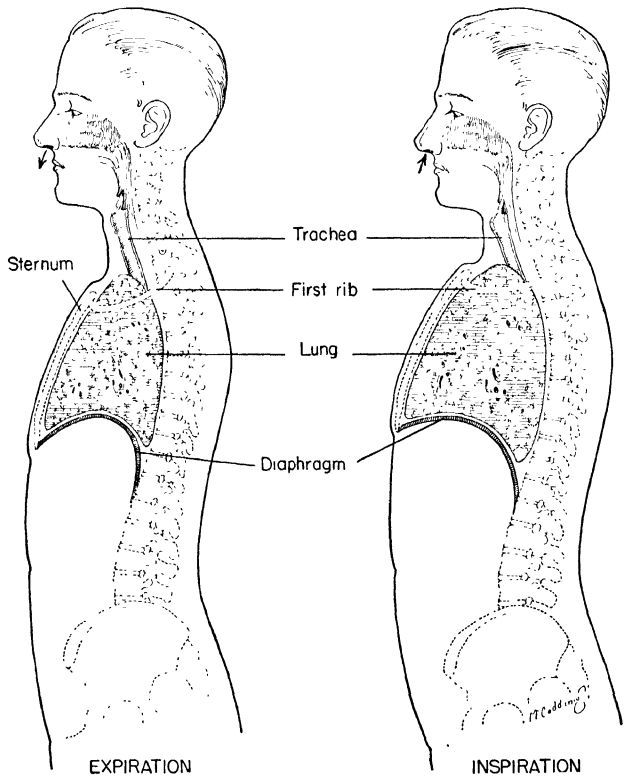


Diagram showing structure of an alveolus.

Many muscles are involved in the breathing movements, the most important of which is the *diaphragm.* It is a dome-shaped structure, containing radially placed fibers and forming the floor of the thoracic cavity. As it contracts, it flattens down, increasing

the size of the chest cavity and pressing against the abdominal organs. At the same time, other muscles pull the ribs outward and upward to increase further the size of the chest cavity. In expiration the ribs drop downward and inward, and the relaxed diaphragm is pressed upward by the abdominal organs as the muscles of the abdominal wall contract. Expiration is largely a passive movement except when forced.



The mechanics of breathing showing the position of the diaphragm and ribs at expiration and at inspiration.

We see that normal breathing involves a considerable movement of the organs of the abdomen, and this serves digestion indirectly. The diaphragm has been called "the piston of the body." It is certainly important that we should train this muscle to function properly and that we should maintain the posture which will per-

mit it to do so. The round-shouldered position, with its dropped chest and protruding abdomen, interferes with the mechanics of normal breathing. The ribs are pushed downward and the normal expansion of the lungs is prevented.

The rate of breathing varies with the individual and with his state of activity, the usual being 16 to 18 respirations per minute. Some persons breathe as slowly as twelve times per minute and others as rapidly as twenty times. The rate and the depth of inspiration are both controlled by the *respiratory center* in the medulla oblongata, which acts primarily in response to changes in the carbon dioxide content of the blood. We know that carbon dioxide is the result of cell activity and that it is produced in greater quantity as the rate of oxidation increases under the conditions of bodily exercise. Due to the action of the breathing center, the end result of this condition is an increase in the depth and frequency of breathing so that more oxygen is provided to the cells of the body for their increased rate of oxidation.

Breathing and Health.—Proper breathing carries air to all portions of the lungs so that there are no "inactive" areas. It provides the blood stream with enough oxygen to meet the full needs of the body cells. It provides enough movement of the visceral organs to aid in digestion. During active exercise nature takes care of the process of breathing without any thought on our part. Breathing becomes more vigorous, circulation more rapid, and oxidation in the body cells more extensive. The muscles of breathing, as well as other muscles of the body, are toned up and strengthened. The sedentary worker needs some vigorous exercise daily.

Benefits have been claimed for deep-breathing exercises, but opinion is divided as to their value. It is, of course, desirable to learn to breathe properly. The person who uses only the upper chest in breathing, or whose body mechanics make normal breathing difficult, needs to train himself to put the body in the right position and to use the muscles properly, developing both the abdominal and chest muscles. It is undoubtedly better to secure deep breathing by suitable and interesting outdoor exercise than to try to do it by the conscious control of breathing.

The Hygiene of the Voice.—The organs of breathing, together with the vocal cords, are the agencies of speech. Few persons

give thought to the hygiene of the voice, yet a pleasing voice is one of the most important social, business, and professional assets of a person. Moreover, the proper use of the voice is directly related to the health of the vocal organs.

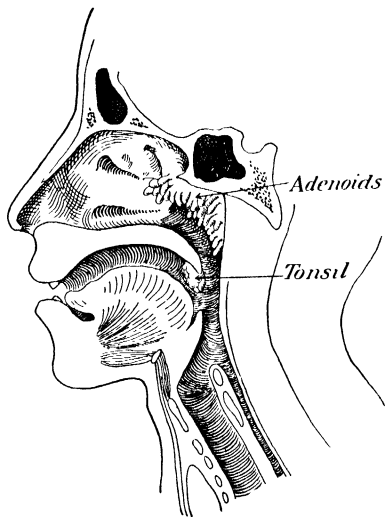
The *vocal cords* are like the reeds of a wind instrument. The tone is determined, not by the amount of air which rushes past them, but by their state of contraction and by the shape and resonance of the air passages of the mouth and nose. When speech is carried on with the lungs well filled, the air movement initiated by the diaphragm, the throat relaxed, and the upper part of the respiratory tract free and vibratory, the voice may be made clear and musical, with adequate carrying power and without fatigue. The difference between the proper and improper use of the voice is often noted in persons whose tones are poor in ordinary conversation but good in sudden exclamation or in longer expressions when joyous emotion provides automatically the proper conditions for speaking. Indeed, there are some persons with poor speaking voices but fairly good singing voices. Training in the proper method of speaking plus good general health will usually produce a voice of pleasing and satisfactory quality.

Mechanical Obstruction to Breathing.—Various conditions interfere with normal nasal breathing. During acute stages of a cold we are unable to breathe through the nose, and chronic colds may produce sufficient hypertrophy of the mucous membrane to make nasal breathing difficult. Dust and smoke in the air or excessive smoking may have the same effect. There may be a deviation of the septum of the nose resulting from injury or very uneven growth before birth. Sometimes a spur of bone is formed by the irregular growth of the septum on one side. Occasionally, small bodies of soft tissue called "polyps" are found hanging in the nasal passage by small stems or stalks from the mucous membranes. Adenoids and enlarged tonsils offer obstructions in the breathing passage that commonly cause mouth-breathing and should receive medical attention.

The body has various mechanisms for removing fluid or other foreign materials which may accumulate in the breathing passages and obstruct respiration. The sneeze is an involuntary muscular reaction to such foreign materials in the upper respiratory tract. The lower air passages have three mechanisms for remov-

ing offending substances: (1) the action of cilia, which are able to move fluid or dust particles toward the mouth; (2) muscular or peristaltic movements of the bronchioles to push materials into the larger bronchi; and (3) the cough reflex. Thus, coughing should be regarded as a protective device.

The Effects of Mouth-Breathing.—Habitual mouth-breathing may have several unfortunate results. The voice is likely to be nasal; sinus and middle ear infections commonly result from the continued congestion of the nose and throat; and the person is likely to have more protracted colds.



The air passages of the mouth and nose showing their relationship to the adenoids and tonsils.

Mouth-breathing is particularly unfortunate for the child. The lower jaw drops, the tongue falls away from the palate, and the cheeks press inward. The facial contour changes. The palate becomes high, the chin narrow, and the nose small and narrow from disuse. The voice takes on a nasal quality, and the face acquires an expression of dullness. The open mouth further contributes to this unfortunate appearance. The failure of the body to secure enough air may result in mental dullness and imperfect nutrition. Difficulty in breathing is likely to cause disturbed sleep.

Diseases of the Respiratory System.—The diseases of the respiratory system may be logically divided into three groups. One group includes those illnesses that arise from industrial, working, or environmental conditions, such as caisson disease, injuries due to dust inhalation, mountain sickness, asphyxia, and carbon monoxide poisoning (see Index for specific references).

The second group represents the important communicable diseases which are discussed later with respect to their nature and community aspects (common cold, pneumonia, tuberculosis).

The student and instructor may or may not prefer to consider some of the diseases of the first and second groups in this chapter. It does seem logical to consider here the third group which comprises certain chronic diseases.

Sinusitis, an inflammation of one or more of the sinuses, develops through the spread of infection from the nasal passages into the area in question. An acute infection of this type not infrequently follows common cold and produces headache with pain centering in the region of the invaded sinus. Where the opening to the sinus is narrow, a chronic sinusitis is particularly likely to develop. This inflammatory condition may be either catarrhal or suppurative, and may exist for a long period without being recognized, since local symptoms are not always present. An x-ray examination is helpful in detecting the inflammation.

Many cases of sinusitis would probably be avoided if persons took prompt care of ordinary colds and were careful to blow the nose gently. Water that enters the breathing passages while swimming is undoubtedly responsible for some of the cases.

A catarrhal or suppurative *inflammation of the middle ear* may be produced by the spread of an infection through the Eustachian tube. Fluid may collect, produce pressure on the eardrum (earache), and perhaps cause a break in the eardrum and a "running ear." The infection may spread to the mastoid cells or spaces in the temporal bone of the skull, since these are connected with the middle ear cavity. In some cases, a mastoid abscess is formed which demands surgical treatment.

An infection of the nose and throat may extend down into the larynx or the bronchi, producing a *laryngitis* or a *bronchitis,* which may be either acute or chronic. The incorrect use of the voice

or the irritating effect of smoke may also cause an inflammation of the vocal cords.

The infection of the tonsils, *tonsillitis,* is usually accompanied by a rise in temperature, a sore throat, and by difficulty in swallowing. Sometimes an abscess develops near the tonsil (quinsy sore throat or peritonsillar abscess) and produces acute pain until the pus is released. Enlarged tonsils are found in many children. As a rule, they tend to shrink after childhood, and they are not necessarily injurious. If they obstruct breathing or predispose the person to acute infections of the throat, their removal is usually advised. Acute tonsillitis sometimes causes rheumatism and endocarditis by setting up a secondary infection in the joints or on the heart valves.

Pleurisy is an inflammation of the pleural membranes lining the chest (usually caused by bacteria), commonly producing a dry surface, so that the two layers cause pain as they rub against each other. When pus forms, the condition is known as *empyema.*

Hay fever is a distressing, and often a disabling disease, coinciding with the pollination of certain plants. It is due to irritation caused by a protein in the pollen from some plant. The localized symptoms are itching, burning, weeping, and sneezing. The patient complains of congestion of the nose, of constant secretion from mucous membranes, and often suffers from asthmatic breathing. Hay fever is likely to be augmented when wind widely disperses the pollen. It is often relieved when rain washes the air free of its disturbing presence. Air conditioning in homes and offices removes pollen from the air. Some progress has been made in eradicating ragweed and other offending plants in certain areas.

The first step in prevention or cure is to discover the particular sensitizing pollen. This is done by placing dilute solutions of different pollens upon a series of shallow scratches made in the skin of the forearm. The pollens to which the person is sensitive, or allergic, produce transient swellings which look somewhat like mosquito bites. Others produce no reaction. Once having discovered the offending pollen, the person may be able to keep away from it. If not, it is worth while for him to seek treatment with a series of inoculations with the pollen in question, beginning a couple of months before its season. These treatments may need

to be repeated for a few years, and the degree of improvement may vary with different persons, but definite benefits are usually obtained.

Symptoms similar to those of hay fever may also be produced by wind, dust, dry hot air, very cold air, sudden chilling when warm, and by the reaction to certain foods, as well as by the common cold.

Asthma is a general term loosely applied to difficult breathing. It is a condition arising from inhalation, ingestion, or absorption of some of the proteins of pollens, foods, epidermis (including dried skin, dandruff, hair, feathers), or bacteria. Like hay fever it is a protein reaction and is subject to the same principles of prevention and treatment. Direct medication with such a substance as Benadryl often provides relief from some of these respiratory allergies. (See further discussion of allergy in the chapter on Immunity.)

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CHAPTER VI

CIRCULATION

Structurally, the circulatory system consists of a fluid medium, the blood, a muscular organ which serves as a force pump, the heart, and a closed system of branching tubes through which blood circulates, the arteries, capillaries, and veins.

The Blood.—The blood with its various constituents makes up approximately 7 per cent of the weight of the body. Its volume in the adult usually varies from four to five quarts. Blood carries two groups of constituents: (a) substances which are specific parts of the blood, and (b) nutrients and waste materials in transit. The specific parts of the blood include inorganic salts, plasma protein, immunizing agents, blood cells, blood platelets, and water.

Inorganic salts function in determining the osmotic pressure of the blood, which must be kept in equilibrium with that of the body cells and the red blood cells. Calcium is essential in producing the chemical changes necessary in the coagulation of blood and in influencing the rate of the heartbeat. Phosphorus helps to maintain the neutral state of the blood. Iron is the essential constituent of the oxygen-carrying compound in red corpuscles.

Plasma protein makes up from 7 to 8 per cent of the weight of the plasma, or liquid portion of the blood. One of the plasma proteins, fibrinogen, is essential in the clotting of the blood. A number of chemical changes are involved in the formation of a clot, but essentially it is brought about by the precipitation of fibrinogen as a fine network of fibrin needles whenever blood passes outside a blood vessel and comes in contact with other surfaces. The accumulation of red corpuscles in this mesh produces the clot.

The *immunizing agents* present in the blood consist of (1) foreign, water-soluble proteins which act as antigens, and (2) colloidal substances of unknown chemical nature, the antibodies. The latter are produced by the body cells following stimulation by an antigen and give partial or complete immunity to the specific disease.

The *blood cells* include red corpuscles (erythrocytes) and white corpuscles (nucleated blood cells). There are approximately five million red corpuscles per cubic millimeter of blood in healthy adult males and four and one-half million in females. Their cells are small, pale red, biconcave disks, about $\frac{8}{1,000}$ millimeter in diameter. They are not nucleated but are composed of a stroma that has the same composition as living protoplasm. The meshwork of the stroma of the red cell holds hemoglobin, a complex protein containing iron.

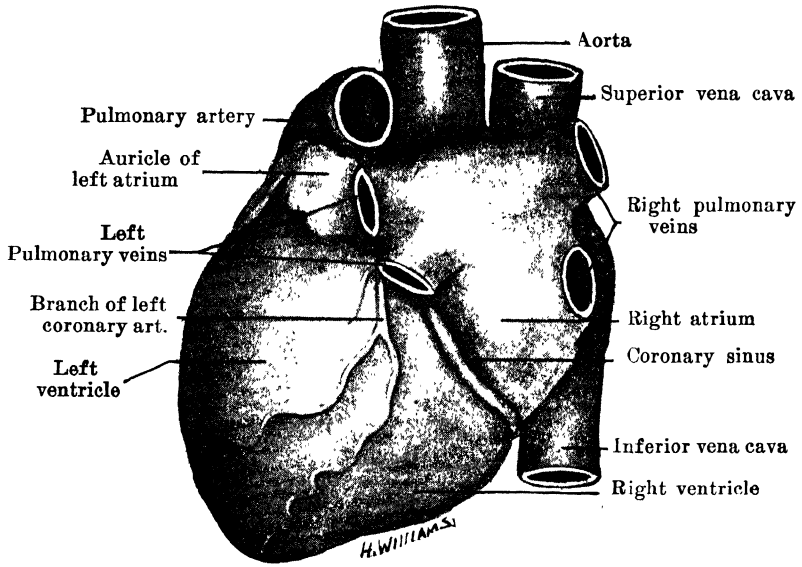
Red blood cells originate in the red marrow of the bones. About one billion red cells per minute are given off into the blood stream to balance the cells which are constantly disintegrating. The spleen aids in this disintegration and the liver in the conversion of the red cell constituents into substances that can be used again in the body. The function of erythrocytes in respiration has already been discussed in Chapter V.

White blood corpuscles (leucocytes) are living cells, averaging only about 5 to 7 thousand per cubic millimeter of blood. An increase in number is termed *leucocytosis* and a decrease, *leucopenia.* Changes in the number of white cells accompany certain diseases, and for this reason, the blood examination is important in diagnosis.

Some types of white corpuscles are manufactured in the blood-forming cells of the marrow of bones, while others are produced in the lymphoid tissue of lymph nodes. From 60 to 75 per cent of them, commonly termed phagocytes, are capable of ingesting and destroying bacteria (phagocytosis). An invasion of bacteria into the body immediately attracts a swarm of these ameboid cells to the site of the infection. The attraction is chemical and is termed chemotaxis. The leucocytes pass out of the blood stream between the endothelial cells of the capillary walls. This is possible due to their ameboid nature. The pus which forms consists of white corpuscles, bacteria, and an exudate from the blood or from injured body cells. It is an indication of the defensive procedures going on and is usually accompanied by the signs of inflammation—swelling, heat, redness, and pain in the tissues.

Blood platelets are fragments of certain cells from the bone marrow. They disintegrate when the blood is exposed to the air and function in the clotting of blood.

The Heart.—The heart is a hollow organ, about the size of the person's fist, made up of cardiac muscle, that contracts automatically from before birth until death. The amount of work it accomplishes is prodigious, the total weight of blood pumped daily being estimated at ten tons.

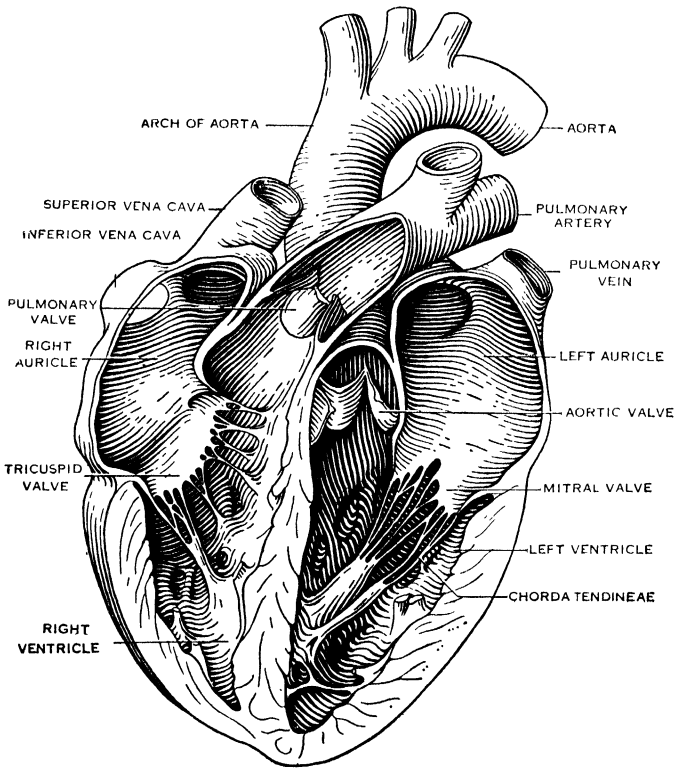


Heart, front view. (From Francis: *Fundamentals of Anatomy.*)

The impulse for the heartbeat comes from within the muscle itself, and is dependent upon the presence of certain salts, particularly calcium, in the fluids in contact with the muscle. The rate of its beat is regulated by two sets of nerve fibers: the accelerator and the inhibitor nerves. The rate of the heartbeat varies somewhat in different persons and in response to specific demands of the organism at different times. In the adult it is usually from 65 to 75 per minute. In children it is much higher. Following each beat the heart has a period of relaxation. This rest period is shorter during greater activity and longer when the body is not active. On an average, the heart muscle works, i.e., is in a state of contraction, about one-third of the time.

The heart is really a double pump, each side composed of two chambers, an auricle and a ventricle. The left side of the heart

discharges the blood received from the pulmonary circulation through the large aorta to the systemic circulation. The right side of the heart discharges to the lungs, through the pulmonary arteries, blood received from the systemic circulation. It is the ventricle in each case which serves as the force pump. The auricles act as receiving chambers only, and their contraction, which sends the final portion of the blood into the ventricles, is comparatively slight.



Longitudinal section of the heart. (From Haggard: *Man and His Body.* Courtesy Harper & Brothers.)

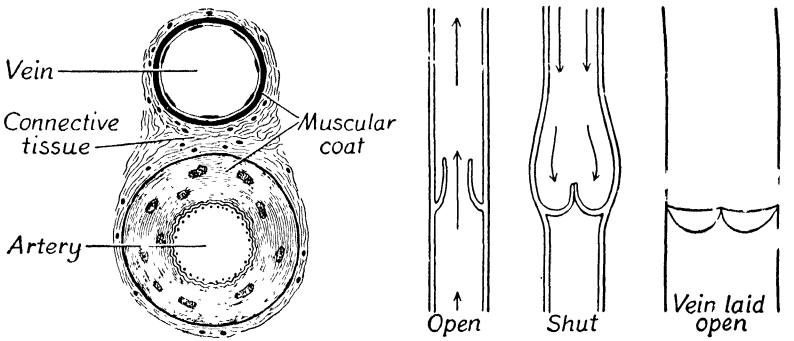
Valves are located at the entrance and exit of each ventricle. The sounds heard in the heart are due to the closing of the valves.

The heart and the blood vessels are lined with a continuous serous membrane termed *endocardium* and *endothelium,* respec-

tively. A similar membrane, the *pericardium,* covers the heart. The term *myocardium* is applied to the muscular tissue of the heart.

Blood Vessels.—The tubes leading from the heart are *arteries.* They have thick elastic walls made up of layers of smooth muscle and connective tissue. They branch into smaller arteries or arterioles, with much thinner walls. The inner coat of all blood vessels, *endothelium,* is the only layer of cells in the walls of the capillaries.

When the blood that is forced out of the heart by the contraction of the ventricle passes through the artery, it causes an impact against the elastic walls and produces a distinct beat, called the *pulse.*



Left, cross sections of a vein and an artery. Notice the difference of thickness in the walls. *Right,* valves of the vein.

The pressure exerted by the blood on the walls of the arteries is termed *blood pressure.* It depends not only upon the force of the heartbeat, but also upon the elasticity of the walls of the arteries, and the resistance offered by capillaries to the escape of blood into the veins. Blood pressure is measured in millimeters of mercury. It varies with age and other conditions. From 100 to 130 mm. is considered normal in the young adult. Physical exertion and emotional stress increase blood pressure. Inactivity, fatigue, and undernutrition tend to lower it. Blood pressure is usually taken during the physical examination. Persistently high or low pressure may be abnormal.

The relaxation or contraction of the circular muscles in the walls of the arterioles increases or restricts the flow of blood to

any organ in accordance with its needs. The muscles of the arterioles are controlled by constrictor and dilator nerves of the autonomic system. Except in the brain, the heart, and the kidneys, the arteries and arterioles communicate freely with each other.

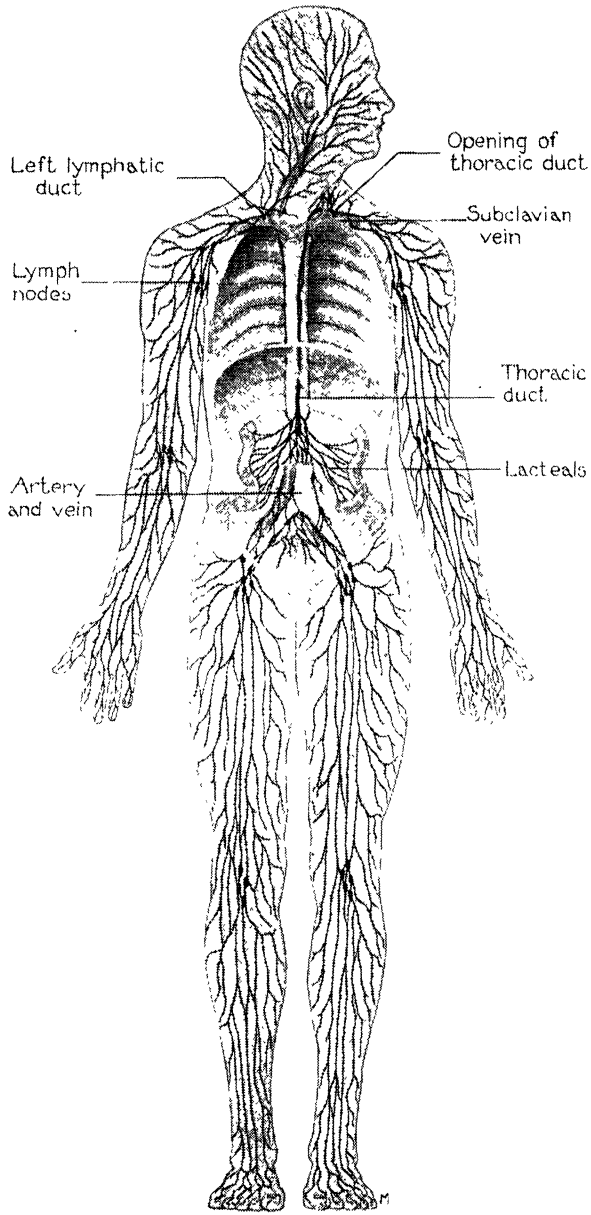
The thin endothelial walls of the *capillary network* permit a constant interchange of materials between the blood and the tissue fluid surrounding the cells of the body tissues.

The rate of flow of the blood within the capillary is very slow. Each capillary is approximately 0.75 of a millimeter long, but it requires almost two seconds for the blood to pass through. The complete circuit of the blood through both pulmonary and systemic circulation requires approximately thirty seconds.

The blood passes from the capillaries to the small *veins*. Veins like arteries have the power of contracting and relaxing. Their walls are impermeable, due to an added layer of connective tissue. The prompt return of the blood to the heart is an important factor in determining the force of its beat.

There are several factors that aid in returning the blood to the heart. The pressure due to the oncoming stream from arteries and capillaries serves to push it forward. Valves in the veins prevent the blood from moving back toward the capillaries. Bodily movements produce pressure upon the soft tubes of the veins and this forces the blood onward in the direction of the heart. The chest, in breathing, acts as a bellows which constantly changes the pressure in the thoracic cavity. A decrease in pressure allows the blood from the smaller veins to flow into the large veins of the trunk. Each inspiration renews the pressure and forces the blood onward. Exercise and deep breathing serve to stimulate the flow of venous blood back to the heart.

The tissue fluid does not return directly to the blood stream but passes into a closed system of tubes known as the *lymphatics*. The fluid in the lymphatics is termed *lymph*. After it is collected from various parts of the body, it is poured into the venous blood stream through two large ducts at points near the heart. Movement of lymph through the lymphatics is similar to the flow of venous blood toward the heart, and is influenced by the action of valves, the pressure of bodily movements, and changes in thoracic pressure. The swelling that occurs in connection with sprains



The lymphatic system. Note the points where the thoracic duct and the left lymphatic duct pour their contents into the blood stream.

and bruises is due to the accumulation of more liquid in intercellular spaces than can be drained off readily by the lymphatics.

Along the course of lymphatic ducts are masses of lymphatic tissue known as *lymph nodes.* The enlargement of lymph nodes near the site of an infection suggests that they may have the function of catching and destroying bacteria or other harmful substances.

Circulatory Function.—The functions of the blood may be summarized as: (a) the transfer of nutrients from the assimilation areas of the digestive system to the tissues where they are utilized; (b) the transfer of oxygen and carbon dioxide; (c) the removal of the waste by-products of metabolism from the region of the cells to organs of excretion; (d) the transfer of endocrine compounds to the specific organ or tissue which requires their stimulation for proper functioning; (e) the regulation of the heat of the body so that it is maintained at its optimum temperature; and (f) an aid in the development of immunity to disease.

Heart Disease.—Heart disease is today the leading cause of death in the United States registration area, producing about 16 per cent of all deaths. It is ordinarily an affliction of the old but it may occur in youth. With the improvement in the control of childhood diseases more people now reach those age groups from which heart disease takes its greatest toll.

Deaths from heart disease may occur with startling suddenness, but the disease itself is preventable to some extent at least. A hygienic life makes defects of the heart and blood vessels less likely. Even after a defect appears, proper regimentation in living will enable one to correct or to compensate for it, either wholly or in part. Heart defects should not cause undue anxiety. Moreover, not all cases of pain or discomfort in the region of the heart indicate heart trouble. A regular physical examination by a competent physician will do much to dispel unnecessary worries and at the same time make possible proper safeguards for the care of the heart.

Among the common types of heart disease are the infections that occur in the inner lining of the heart (endocarditis), in the valves (valvular defects), in the heart muscle itself (myocarditis), and in the outer covering (pericarditis), when pathogenic organisms are swept into the blood stream during such acute infections

as rheumatic fever, tonsillitis, or scarlet fever. Chronic infections, such as syyphilis, may cause impairment of the heart function. Coronary thrombosis is the formation of a clot in a branch of the coronary arteries which supply blood to the heart muscle.

Functional heart disease occurs when, despite the absence of an organic defect, the heart fails to perform properly. It may result from impaired nerve stimulation, from endocrine disorders, or from the use of drugs, such as the heart depressants found in headache tablets. The effects of alcohol and tobacco on the heart will be considered later.

Athletic Heart.—It was formerly thought that participation in competitive athletics places such a heavy demand upon the heart muscle that it eventually becomes enlarged or hypertrophied. Such a condition was called "athletic heart." To be sure, vigorous physical activity does increase the work of the heart, and enlargement does appear, but both these changes are normal and desirable. It has never been satisfactorily demonstrated that athletes as a group have a shorter life span due to heart injury.

Participation in athletics may be seriously injurious to the person with a diseased heart or to the otherwise normal person who is suffering from an acute infection, such as tonsillitis. Medical supervision of athletes is, therefore, important. The man or woman with a normal heart, however, should not forego athletics through fear of developing an enlarged heart which will injure health in later years.

Defects in the Blood Vessels.—You are familiar with the terms high blood pressure or "hypertension" and "hardening of the arteries," or "arteriosclerosis." Long-standing *hypertension* leads to a constant constriction of the blood vessel walls, which in time show the increased amount of fibrous tissue and calcareous deposit characterizing *arteriosclerosis.* A sudden, unexpected mental or physical shock may throw undue strain upon these stiffened, inelastic vessel walls. A ruptured blood vessel wall in the brain causes a cerebral hemorrhage with apoplexy and possible paralysis. Although arteriosclerosis may occur independent of other diseases and be of unfathomable origin, it is nevertheless often associated with the heart, as coronary heart disease.

When the venous blood to the heart is obstructed, either because of constriction or because of pressure, *varicose veins* develop. Veins

under these conditions tend to dilate and to lengthen. *Hemorrhoids,* or piles, are enlarged veins in the anus, formed as a result of undue pressure. The condition is sometimes improved by correcting constipation, though in severe cases surgical treatment may be necessary. Varicose veins may also occur in other places as, for example, in the veins of the spermatic cord (varicocele) or in the veins of the ligaments that suspend the ovaries (ovarian varicocele).

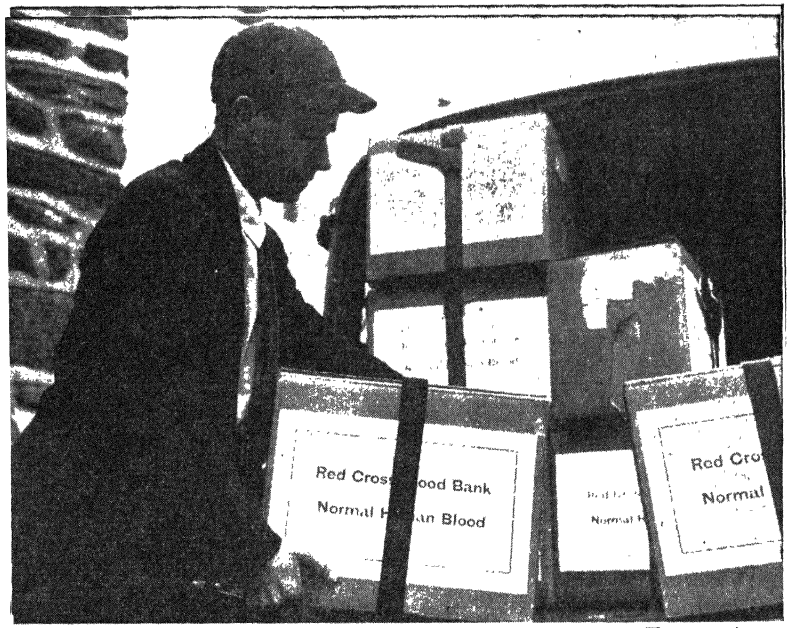
Defects of the Blood.—One of the most common defects of the blood is *anemia,* a deficiency in hemoglobin, due to a reduction of red corpuscles or to the quantity of hemoglobin they contain. The result is *anoxemia,* or lack of oxygen in the blood. Anemia may also be caused by hemorrhage, by destruction of the red blood cells from such parasites as those that produce hookworm or malaria, or by bacteria found in acute or chronic infections.

Hygienic habits play a large part in the prevention or cure of anemia. One needs a diet rich in green vegetables and foods containing iron compounds, exercise to stimulate the production of red cells through the increased demand for oxygen, and sunlight to aid in the formation of hemoglobin.

In pernicious anemia, formerly regarded a fatal disease, the red blood cells continued to decrease in number until other symptoms developed and death finally resulted. It is now controllable as a result of the discovery that the red marrow is able to produce red blood cells only in the presence of an "anti-anemia" substance. The exact chemical nature of this substance is unknown but it is produced from some element in food by the action of an enzyme in the stomach. It is the absence of this enzyme that causes the anemia. Any excess "anti-anemia" substance formed is stored in the liver. The disease can be controlled either by the addition of liver or liver extract to the diet or by the enzyme itself, obtained from the tissues of the pig's stomach.

Loss of Body Fluids.—The blood contains only one-fourteenth of the total body water. Yet when more than 30 per cent of it is lost and not replaced, death usually occurs. The volume of blood in the body may be reduced by dehydration, by anemia, and by hemorrhage.

Excessive loss of water from the body is called dehydration. Some of its causes are (1) lack of liquid intake, (2) excessive loss



(Keystone)

Packages of bottled blood are rushed to the laboratory where the blood will be converted into dry plasma.

of water in urine, through sweat, or through prolonged vomiting or diarrhea; and (3) excessive loss of salt from the body. Dehydration is followed by thirst, rise in body temperature, drying and wrinkling of the skin, loss of weight, and disturbances in body chemistry.

Certain materials are available for combating dehydration and restoring blood volume. Salt solutions, administered orally, intravenously or subcutaneously, are useful primarily to combat the loss of body water. Whole blood, given by the familiar blood transfusion, is used in hemorrhage or in any other condition where there is marked reduction of blood cells. Both donor and recipient must have the same "type" blood. Either whole blood or plasma may be used in the treatment of shock from wounds or burns.

Blood plasma lends itself well to storage and transportation and may be shipped great distances for use in remote battle areas.

The large Red Cross Donor Centers collect blood, separate the plasma, and pool it in a "blood bank."

Hygiene of the Circulatory System.—Nutrition and rest both play an important part in the hygiene of the circulatory system. The heart muscle receives the same nourishment that is sent to other parts of the body, and its proper functioning is dependent upon the general state of nutrition. The pulse rate, which is normally from 60 to 90 per minute, may be as high as 150 or above during vigorous exercise and may slow down to 60 during sleep. Obviously, the demands on the heart muscle are increased when hours of sleep are curtailed. Lack of sufficient exercise may result in a less efficient heart muscle.

Sluggish circulation, with its resulting anoxemia, leads to certain bodily disorders. Martin and Weymouth describe the results of long-continued partial anoxemias as varying from "merely a dulling of the senses and intellect and the judgment with marked fixation of ideas" to "pronounced depression together with gastrointestinal disturbances as seen in mountain sickness. In severe cases epileptiform seizures, pressure paralysis, and coma may occur. If the anoxemia is prolonged, cardiac, renal, and other symptoms may develop."

Other factors besides sluggish circulation may produce anoxemia. When carbon monoxide, a product of incomplete combustion, is inhaled, it combines to form carbon monoxide hemoglobin in the red blood cells. These cells are then unable to absorb oxygen.

In high altitudes the blood is not able to pick up sufficient oxygen due to the low air pressure, and anoxemia results. Most persons react normally in altitudes up to 6,000 feet. In aviation oxygen is artificially supplied above this level. People who live at high altitudes tend to become acclimated so that they do not suffer from lack of oxygen. This acclimatization results from an increase of hemoglobin in the blood and a change within the red corpuscle that effects an increase in the percentage of oxyhemoglobin formed.

A normal mental attitude toward health is particularly important in maintaining the hygiene of the circulatory system. A state of apprehension regarding one's heart is both undesirable and unnecessary. Hereditary tendencies toward heart disease can be largely overcome, and organic or functional defects can be compensated or corrected by proper care. To know one's limitations

and to adjust one's daily regimen to these, giving due attention to regular suitable exercise, adequate nutrition, and sufficient rest, are all important in maintaining general health through the proper functioning of the organs of circulation.

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CHAPTER VII

THE KIDNEYS

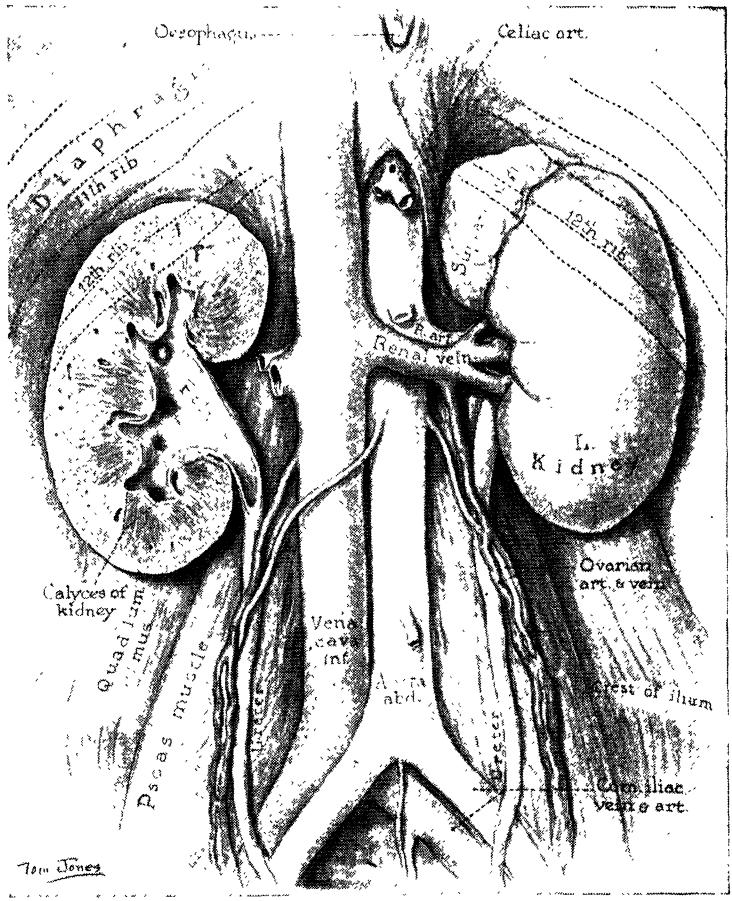
In considering the metabolic processes of the body we have not yet discussed the elimination of protein waste. Nitrogenous wastes produced in the tissues are converted into urea by the liver and, to some extent, by all body cells. This urea is taken from the blood by the kidneys and is discharged from the body in the urine. In addition the urine contains considerable quantities of inorganic salts.

The kidney is one of four channels for excreting waste substances from the body. The others are the skin, the alimentary canal, and the lungs. The skin ordinarily throws off little besides water and salt. The alimentary canal eliminates certain salts and bile pigments. Carbon dioxide and water vapor are discharged by the lungs.

Structure and Function of the Urinary System.—The kidneys are a pair of bean-shaped organs, each a little smaller than the fist and weighing about a quarter pound, lying at the back of the abdominal cavity and outside of the peritoneum at the level of the lower ribs. They are surrounded by pads of fat and are well protected by the large muscles of the back, which lie outside of them. They are rarely injured except by sudden, sharp blows. The circulating blood goes through the kidneys. The renal arteries and renal veins are shown in the accompanying illustration.

The kidneys continuously prepare urine from the various waste products taken from the blood and pass it on through two long, slender tubes, the ureters, to the bladder. This sac stores the urine from both kidneys until a considerable quantity is gathered, when it is discharged. The capacity of the bladder is about one pint. Micturition is controlled by two muscles. The first is an involuntary muscle in the wall of the bladder where it opens into the urethra. It opens when the bladder has filled to a certain pressure. The second valve around the urethra after it has left the bladder is under voluntary control. This control is obtained

by training in infancy. It may be lost during unconsciousness The bladder is a muscular organ. It is made tense by excitement or anxiety. If micturition is prevented, the bladder may subsequently relax for a time.



The kidneys and their blood supply. (From Camp: *Anatomical Studies.*)

The kidney has other functions besides the excretion of nitrogenous wastes. It is important in the maintenance of the acid-alkali balance of the body, in holding the proper salt concentration in the blood, and in detoxicating certain compounds.

The outer portion of the kidney, the *cortex,* is made up of some 2,000,000 functional units, each consisting of a knot of capillaries (glomerulus) surrounded by a two-walled capsule from which conducting tubules lead into the basin or *pelvis* of the kidney.

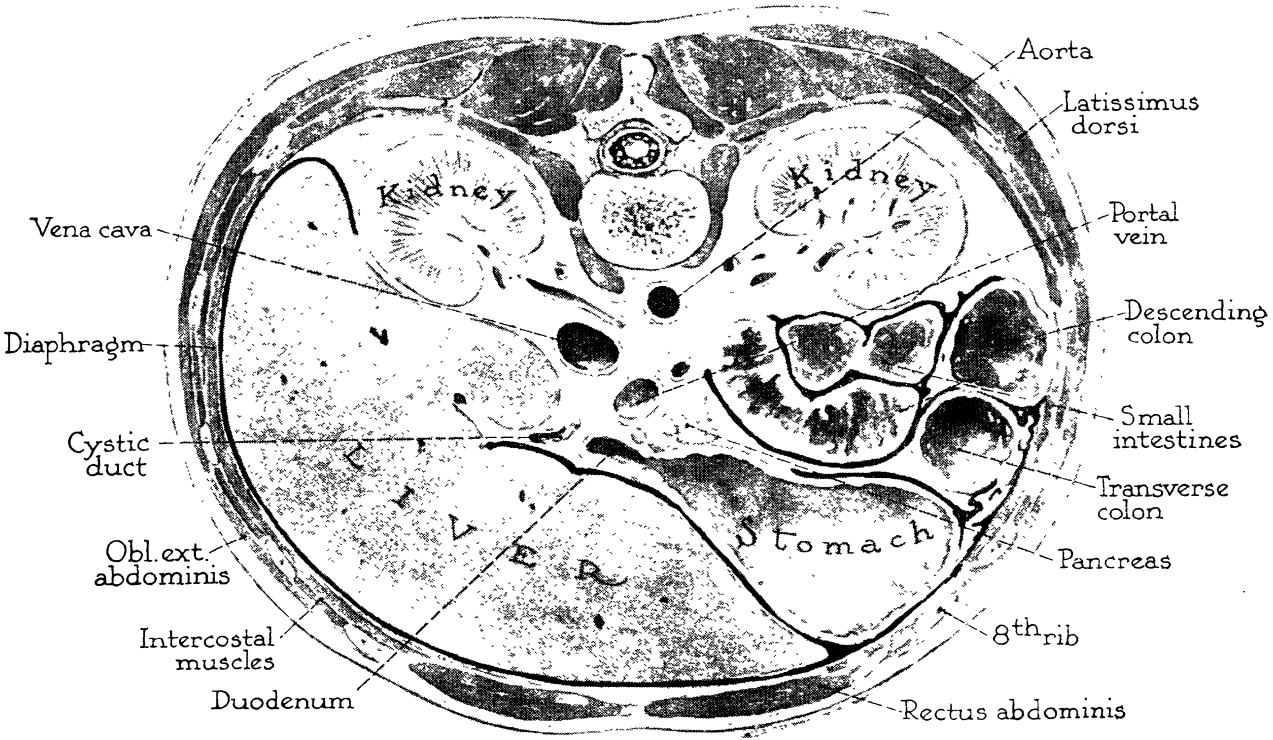
The exact physico-chemical nature of the kidney function is not understood. The fluid from the blood stream, with its dissolved substances (except proteins and phosphatids), passes through the walls of the capillaries and makes its way through the inner wall of the capsule. It then flows along a convoluted tubule. The cells in the walls of the tubule are glandular in appearance and are richly supplied with blood. By absorbing some substances and by secreting others they change the composition of the fluid to that of urine.

Capillaries surrounding the tubule reabsorb some of the water, and thus concentrate the waste substances in the urine. The excretion of waste through the kidneys is thus seen to be something more than a mere mechanical filtration process.

The amount of urine secreted is determined in part by the amount of liquid in the diet. Usually from two to three pints of urine are secreted every twenty-four hours. We know that a liberal water intake is an aid to normal kidney function. This is particularly true during illness from such diseases as tonsillitis, diphtheria, and scarlet fever, where toxins are liberated into the blood and need to be eliminated from the body. Moreover, fever, which is characteristic of these diseases, leads to undue loss of water from the body through perspiration. A liberal water intake is necessary to combat this water loss.

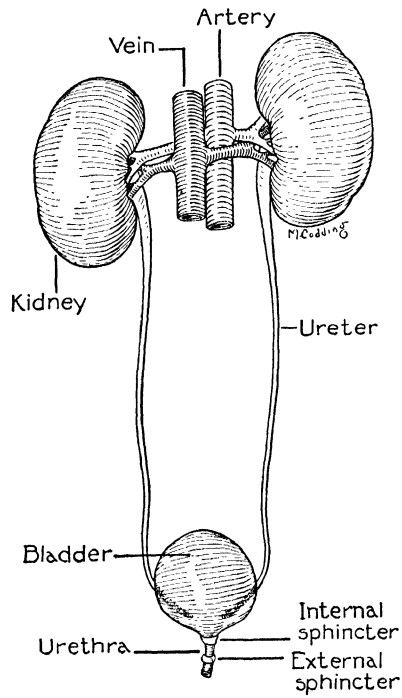
Another factor that influences the rate of kidney secretion is the pressure of the blood passing through the kidneys. This, in turn, may be modified by certain mental and physical states. Thus worry or strenuous athletics, by increasing blood pressure, may augment the rate of urine secretion.

A cold external temperature increases the amount of urine secreted by sending the blood from the skin to the internal organs; conversely, muscular activity with sweating reduces the amount of urine by eliminating a considerable amount of water from the skin. Too rapid cooling of the body after exercise may lead to congestion of the kidneys. This explains why it is advisable to



Cross section of body at the level of the kidneys. (From Camp: *Anatomical Studies.*)

protect the body with a wrap following strenuous athletics. Certain chemical substances (diuretics), including tea, coffee, alcohol, and certain drugs, increase the secretion of urine. The hormones adrenalin and pituitrin exert suppressing and stimulating effects, respectively, on the rate of kidney secretion.



The urinary system.

In health the constituents of the urine do not vary greatly, but unusual conditions of the body can often be detected by looking for certain end products in the urine. When certain substances in the blood, as sugar, acids, or alkali, are increased to concentrations above normal, they are eliminated by the kidney. Both albumin and sugar may be present following periods of intense anxiety or excessive exercise. Chemical study of the urine sometimes discloses the presence of much sugar which, together with other symptoms, suggests diabetes. Albumin may indicate disease. Microscopic study makes it possible to see evidences of bacterial

infection in the urinary tract. Thus urinalysis is so valuable in helping to determine the person's state of health that it usually accompanies the health examination.

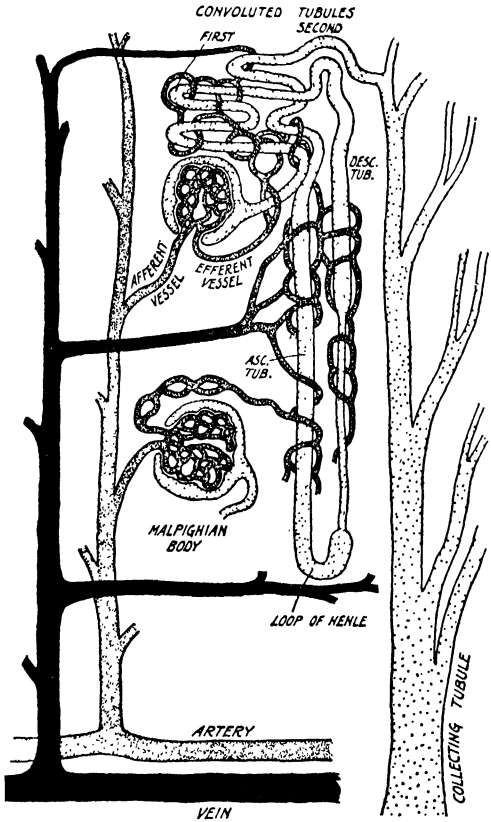


Diagram illustrating blood supply to renal tubule. (From Zoethout-Tuttle: *A Textbook of Physiology.*)

The Hygiene of the Kidneys.—We have already mentioned the desirability of sufficient water to keep the kidneys flushed. Normal exercise is beneficial to the kidneys, primarily because it improves circulation. The continued eating of a great excess of protein food may put an undesirably heavy burden upon the kidneys, if they have been damaged by disease. Eskimos normally

get 45 per cent of their calories in the form of protein as compared with 10 to 15 per cent in our diet. This fact suggests that a diet which is well balanced does not provide too much protein for normal kidneys.

It is believed that "hollow-back posture" may sometimes interfere with normal kidney function and produce albumin in the urine. Frequent urination and burning sensations in the urethra may follow the excessive use of foods or beverages containing large amounts of pepper, ginger, and other spices. Acid urate or alkaline phosphate crystals may produce a similar irritation if the acid-alkaline balance of the diet is destroyed by too much acid-producing food or too much alkaline-producing food.

Kidney Disease.—The term "Bright's disease" is used to describe a number of pathological conditions of the kidney due to varied causes and resulting in interference with normal kidney function. This disease now ranks third among all causes of death in the United States. One of these conditions is *acute nephritis,* which may follow scarlet fever or other infectious diseases in childhood. It usually yields to rest, proper medical care, and the avoidance of high protein foods, tobacco, alcohol, or other stimulants. It is sometimes produced by mercury poisoning; this type is often fatal. Another condition is *chronic nephritis* that commonly occurs in older persons. It usually follows a persistent local infection, such as may occur in teeth, tonsils, or sinuses. Nephritis, either acute or chronic, is not due to bacterial infection of the kidney but apparently to toxins which come to the kidney from other parts of the body.

There are various other disorders of the excretory system, including those due to enlargement of the prostate gland in elderly men or to kidney or bladder stones. Kidney disease, however, is not as common as the patent medicine advertiser frequently implies. Some symptoms most frequently stressed in this advertising, such as pain in the back or sugar in the urine, are not necessarily characteristic of kidney disease. Hygienic living, periodic health examinations, and medical service instead of self-treatment are the common-sense procedures in avoiding the development of diseases of the kidneys.

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CHAPTER VIII

THE SKIN

The skin is a special organ which forms the buffer through which the individual contacts the world outside, and behind which he normally rests secure from invasion by enemy organisms and from painful contacts with rough or irritating surfaces. Life is dependent upon the integrity of the skin, and the destruction of much more than a third of it is followed by death.

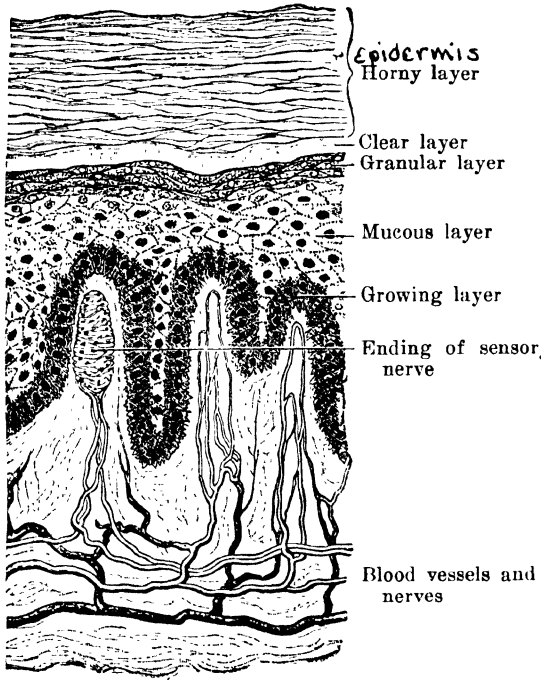
The skin is an organ of beauty and much time and millions of dollars are expended annually on its care. Intelligent care presupposes some knowledge of its structure and functioning and the ability to distinguish between sound and unsound claims that are made for various artificial aids to skin beauty.

Structure.—The outer portion of the skin is known as the *epidermis* and consists of external horny layers of dry, dead cells, and a deeper growing layer, the Malpighian cells, from which the outer layers are produced. As new cells are pushed outward, they lose their nuclei, flatten, develop thick walls, and eventually contain only dead materials. These are constantly being removed from the body surfaces by friction. Blood vessels do not enter the epidermis.

The germinative layer produces nails and hair as outgrowths of the epidermis. The color of the skin is due in part to pigment deposits found in the Malpighian layer and in part to the translucent nature of the skin which permits blood in the capillaries to show through. The amount of the pigment determines the color of different races.

The *dermis,* or true skin, is a tough, fibrous, living tissue, just beneath the epidermis. Embedded in it are capillaries, lymph vessels, nerve endings, sense organs, sweat glands, sebaceous glands, and roots of hairs. The dermis is not flat on its outer surface but takes the form of tiny projections or papillae. These papillae are nutritive or sensory, depending upon whether they contain a capillary knot or a sensory nerve ending.

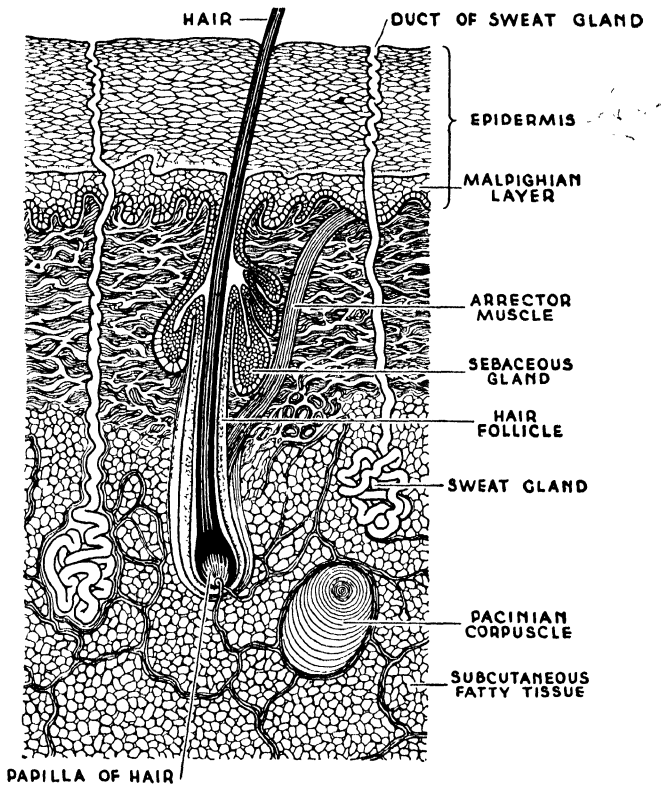
Below the dermis occurs a layer of *subcutaneous tissue.* This tissue serves as a storage place for reserve fat and acts as a cushion for the protection of the body. Its elasticity permits freedom in the movement of the skeletal framework and muscles that lie under the skin.



Section of the skin showing the detailed structure of the epidermis and the structure of blood vessels and nerves of the dermis. (From Sutton and Sutton: *Diseases of the Skin.*)

The surface of the skin is kept moist and soft by the *sebaceous glands* which pour an oily substance called "sebum" into the hair follicle, and the *sweat glands* which exude their liquid secretions directly on the surface of the skin. There are from two to three million of these sweat glands in the surface of the body, and the amount of liquid given off in twenty-four hours varies from less than a quart to three times that amount. The production of sweat is dependent upon the quantity of blood flowing through the capillaries that surround the sweat glands, and upon the direct nerve stimulation to the gland cells.

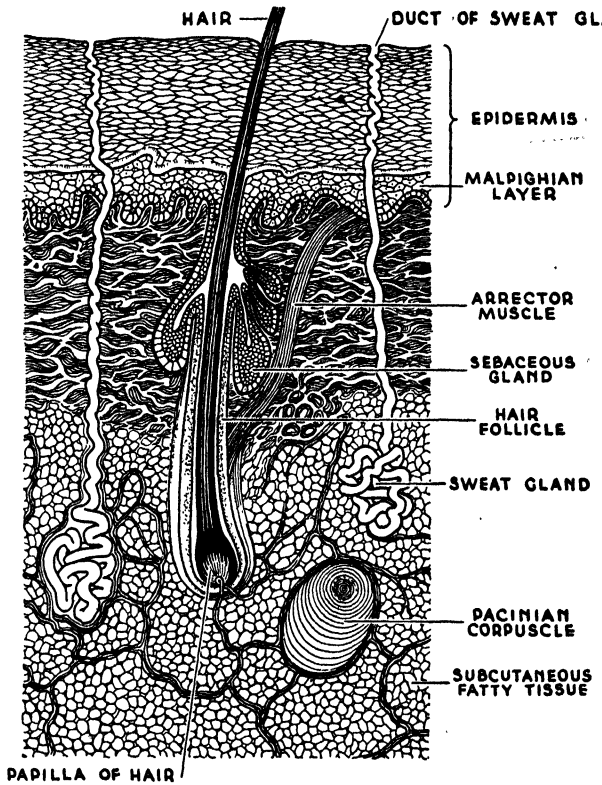
In the heat stroke of a worker in a very hot and humid atmosphere or in sunstroke, with its hot dry skin, evaporation of perspiration is inadequate and heat loss does not keep pace with heat production. The temperature-regulating machinery has broken down and the temperature may rise to 107° F. or even 110° F. First aid to reduce it must be prompt. Persons who do not perspire readily are especially subject to heat stroke.



Vertical section of the skin (schematic); modified from Cunningham. (From Zoethout and Tuttle: *Textbook of Physiology*, The C. V. Mosby Co.)

Warm air, which is dry and moving, evaporates perspiration more rapidly than still or moist air and, therefore, seems cooler at the same thermometer reading. On the other hand, cold air when it is dry is not so chilling as when it is moist. Heat loss at low temperature takes place by convection and not by evapora-

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tion. Damp air is a better conductor of heat than dry air.

While the primary purpose of perspiration is heat dissipation, sweat contains small amounts of a number of waste products from the blood; namely, inorganic salts (principally sodium chloride), and small amounts of organic compounds (chiefly urea and certain ammonium compounds). These remain on the skin after the evaporation of the liquid. Although the skin aids somewhat in the removal of waste from the blood, it does not, under normal conditions, play an appreciable part in the excretory functions of the body.

Hygiene of the Skin.—Clothing, heated houses, and inactivity all tend to interfere with the normal adjustment of the skin in regulating body temperature. Satisfactory functioning of the skin requires attention to hygienic practices pertaining to clothing, to bathing, and to exercise.

Although *clothing* serves other purposes, it is used chiefly as an artificial aid in the regulation of body temperature. It retards heat loss because it retains air between garments, in the mesh of the woven fabric or between the fibers of which the fabric is made. Air is a poor conductor of heat. The warmth of a garment then will be determined by the type of fiber of which it is made and the nature of the weave.

Woolen fibers are rough, scaly, and round. When woven into cloth, they readily enclose air within the meshes. Wool fabrics are warm. On the other hand, cotton fibers are flat and silk fibers are smooth. They do not retain air so readily. There is considerable difference, however, in the weave of fabrics, and woolen fibers may be so woven as to reduce their warmth, while cotton and silk may be used to produce a fabric which is fairly useful in the retention of body heat. This is also true of the various new artificial fibers.

Woolen clothing is suitable for the person who is doing out-of-door work or riding in the open during winter weather. It is an undesirable fabric for underclothing for persons who are working indoors in the city unless room temperatures are kept low. At the end of four or five hours in the office the garment is saturated with perspiration, and all the spaces formerly filled with air will have become filled with water. The underclothing is now a very good conductor of heat, and when the person emerges into the

cold air, the water in the garment cools and the person is chilled in his cold, damp clothes. For the person who lives in town, therefore, it is much better to wear light underclothing and to put on heavy outer garments when emerging into cold air. If he walks briskly and keeps up his bodily activity while outdoors or waiting for a car, he augments his bodily heat by increasing the oxidation in the tissues.

The wearing of rubber garments for more than short intervals is unhealthful, since rubber is not porous and prevents the normal evaporation of moisture from the skin, with consequent overheating of the body. Raincoats and rubbers should be removed when not actually in use.

Too much warm clothing does away with the necessity of body adjustments to slight changes in temperature, with the result that the process of heat regulation is ineffective when needed. On the other hand, the use of insufficient clothing to supplement the heat-regulating apparatus is undesirable because the body loses too much heat. Persons who wear light clothing need a high calorie diet in order to maintain a balance between heat production and heat loss. Clothing should be selected which will not offer mechanical interference to normal body functioning.

Light-colored clothing for summer is cooler than dark clothing because it reflects the sun's rays whereas dark clothing absorbs them.

Clothing worn next to the body accumulates the waste products of perspiration, together with scaly portions of the epidermis and dust particles. Moreover, the ability of clothing to absorb moisture and to conduct heat is altered by the presence of these substances. If it is not washed frequently, clothing may become a source of danger to the body, for it may have collected infectious organisms which will enter the skin when a break occurs.

Bathing is a primary means of keeping the skin both clean and in proper muscle tone. We recognize that daily bathing is desirable, not only for the feeling of well-being it gives but also for the increased self-confidence that comes from the consciousness that one is socially acceptable. Two kinds of baths are used: (1) the cleansing bath, and (2) the bath for stimulating the muscles, nerves, and circulation in the skin.

Due to the oily nature of the substances on the skin, the cleansing bath is most effective when good soap is used with warm water at a temperature of from 96° to 100° F. Friction is desirable in order to remove the dead particles of epidermis. The complete elimination of unpleasant body odors requires thorough daily soaping and cleansing of those parts of the body, such as the feet and armpits, which perspire freely.

Aside from its function in cleansing, the warm bath is sometimes used for its relaxing effect to induce rest. A hot bath or a hot foot bath may relieve congestion in the head or chest by bringing the blood to the skin. Such a bath followed by bed rest is recommended at the first signs of a cold. Special care must be taken following such a bath to prevent chilling before getting into bed. A hot bath should never be taken before going out into the open air unless it is followed by a cold one.

In using the cold bath every person should determine for himself the temperature at which he can obtain the desired reactions; namely, a warm glow in the skin, deep breathing, and a general feeling of well-being. Unless this reaction is obtained a cold bath produces a chilling which may be injurious.

Having determined the optimum temperature at which this stimulating bath can best be taken, the time allowed for it should not be prolonged over one minute. It should be taken in a warm room when the skin is warm. A quick dash under the cold shower or a plunge into the tub should be followed by a good rub with a coarse towel. The best time for a cold bath is on rising in the morning. Neither a cold bath nor a hot bath should be taken within one hour after eating. A cold bath is similar to exercise in its general bodily effects. It increases the circulation of the blood and the production of heat. It stimulates the nervous system.

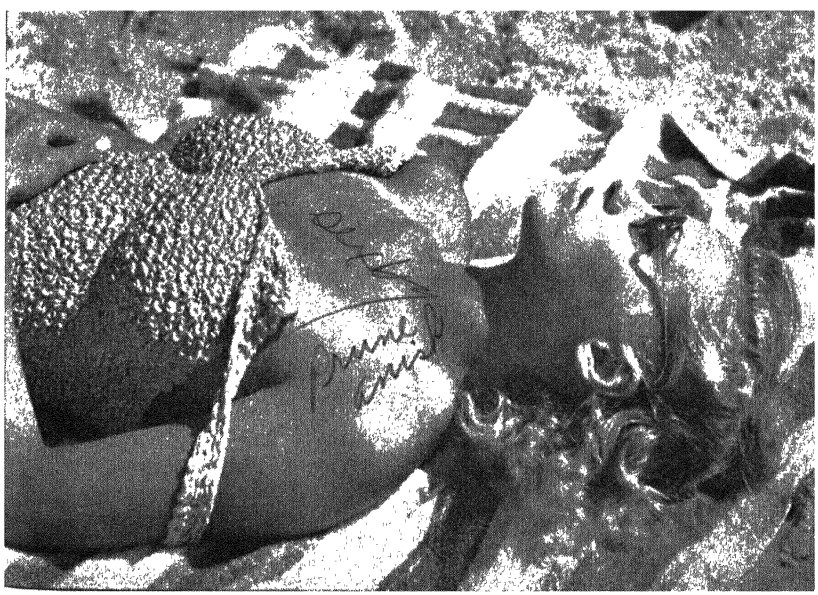
Sun Baths.—From our knowledge of physics we recall that radiant energy from the sun, electric arcs, filament lamps, x-rays or radium is essentially the same, differing only in frequency and wave lengths. Light is the visible portion of the spectrum; it has wave lengths varying from 3,900 to 7,700 Angstrom units (the Angstrom unit equalling one ten-millionth of a millimeter). Longer wave lengths are the infrared and shorter wave lengths

are the ultraviolet radiations. Both of these are invisible. The solar spectrum has wave lengths from 2,200 to 40,000 Angstrom units. Some of the radiations useful to man do not occur in sunlight, but are produced from other sources.

APPROXIMATE LIMITS OF VARIOUS REGIONS IN THE SPECTRUM

RADIATION	WAVE LENGTHS IN ANGSTROM UNITS		
Gamma rays	0.07	to	1.3
X-rays	0.10		150.0
Ultraviolet rays	136.0		4,000.0
Visible rays	4,000.0		8,000.0
Infrared rays	8,000.0		4,000,000.0

Tanning of the skin is caused by ultraviolet radiations. The naked skin when exposed to bright sunlight reddens, or sunburns, with the accumulation of a great quantity of blood in the exposed area. As tanning progresses, the amount of melanin, the normal coloring matter of the skin, increases. Although the darker races have a large amount of this pigment, the white man has normally very little. The physiological increase in melanin following sunburn is apparently a protective mechanism against further injury to the skin by strong actinic light.



The pigment is manufactured by specialized cells in the Malpighian layer of the skin from a "chromogenic" material of the blood. Freckles are produced in the same manner as "tanning." In taking sun baths the time of exposure should be limited to a few minutes at first and increased gradually from day to day. The wearing of colored glasses to protect the eyes is desirable.

One of the most remarkable chemical changes produced by ultraviolet radiations on the skin is the manufacture of vitamin D from cholesterol in the living tissues. Sun baths for babies help reduce the prevalence of rickets. Ultraviolet light also stimulates the production of red blood corpuscles, and aids in the cure of certain diseases, such as tuberculosis of the skin.

Sunlight is not always equally potent, for the ultraviolet rays are screened out by clouds, rain, dust, and smoke in the air, and by ordinary window glass in the house. The rays are stronger in the summer than in the winter. Many types of "sunlamps" have been devised, not all of which are equally successful. Infrared or heat rays, which have a warming effect upon the body, are useful in medicine to relieve pain, to relax muscles, to dilate the surface blood vessels, and to relieve internal congestion.

Care of the Hands.—The problem of keeping the hands clean is not one of aesthetic significance alone. No other part of the body comes so frequently in contact with infective organisms. There is obvious reason for washing the hands after going to the toilet, before eating or handling food, or whenever they become dirty. It has been found that the clean skin has considerable self-disinfecting power. A dirty skin harbors bacteria.

Nails are horny outgrowths of the epidermis beneath the cuticle. As the nail grows outward it should be filed in order to keep its length such that it does not interfere with the usefulness of the fingers. The cuticle should be pushed back gently with the towel while drying the hands. Cuticle that is not cared for attaches itself to the nail and tears as the nail grows out, forming *hangnails.* If these develop, they should be carefully cut rather than pulled, since infection may easily occur if the delicate tissues are injured.

Well-kept fingernails are not only objects of beauty, but are necessary to the functioning of fingers. Bitten fingernails are unsightly, and the habit of nail biting is one which endangers the health of the individual through the introduction of dirt into the

mouth. The habit is ordinarily associated with nervousness and requires attention, especially in children.

Care of the Face.—The thorough cleansing of the face at night to remove the accumulations of dirt from the day's exposure is the first requirement in its care. Warm water and a pure soap free from alkali are the best cleansing agents unless there is some particular reason that soap cannot be used. A good soapy lather should be gently and thoroughly applied with the clean finger tips to massage the face. The use of plenty of clean water, followed by a cold rinse for its stimulating effect, is important. The face should be patted dry rather than rubbed vigorously. Care of the face in the morning may require only the application of cold water for its stimulating effect, if one sleeps in an atmosphere free from dust and smoke. Otherwise cleansing in the morning is just as essential as at night.

Care of the Hair.—Hair, like the nails, is an outgrowth of the epidermis. Each hair grows out of a depression or hair follicle which extends downward into the dermis or into the subcutaneous tissue. At the end of the hair follicle are found the growing cells. These cells are nourished by blood vessels surrounding them. The shaft of the hair that extends outward is composed of dead horny cells. A cross section of the hair shows three distinct layers, an inner core surrounded by a cortex and an outside layer of overlapping cells or cuticle. The color of hair is due to a pigment that is deposited in the intercellular spaces of the cortex during the growth of the hair. When hair turns gray, there is a reduction in the amount of pigment and an increase in the light-reflecting air spaces between the cells.

Hair is kept soft by the outflow of oil from the sebaceous glands into the hair follicle. The condition of the hair reflects, to some extent, the general health and nutrition of the body. Nourishment for the hair comes entirely from the blood stream through living cells in its roots. The growth of hair takes place at the root and cannot be stimulated by cutting or singeing the hair shaft. The nutrition of the hair can be improved by stimulating the flow of blood to its roots by vigorous combing and brushing and by massaging the scalp with the finger tips.

The frequency of shampoos depends upon the kind of hair and the condition of the atmosphere as well as upon one's activities.

Oily hair accumulates dirt more quickly than dry hair. Thick hair is harder to brush clean than thin hair. Persons who live in smoky cities, in dusty areas, or who work in dust, require more frequent shampoos than they would otherwise need.

The shampoo requires plenty of warm water and soap. The scalp should be vigorously rubbed to loosen the dirt. After it has been washed with a good lather, the hair should be thoroughly rinsed with warm water to remove the soap, and then the whole process should be repeated. The scalp and hair should be dried by rubbing with a towel in the warm sunlight or a warm room.

Baldness (alopecia) may be associated with the internal secretions of some of the endocrine glands, or it may be due to an hereditary sex-linked tendency. In experimental animals it has been produced by a deficient diet. It is not, as generally believed, due to the starvation of the growing hair cells through interference with circulation to the scalp. The stimulation of efficient circulation in the scalp and cleanliness of the scalp are commonly recommended for the prevention of baldness. They are hygienic practices, but there are no known or certain means of preventing or curing this condition.

Cosmetics.—Cosmetics are not to be regarded as a hygienic necessity. Healthy hair and teeth, bright eyes, and a clear complexion require proper diet, regular elimination, cleanliness, outdoor exercise, and adequate sleep. For these there is no substitute. At the same time it must be recognized that the use of cosmetics has assumed an important place in modern life.

Cosmetics have sometimes contained injurious substances. It may be that some of them still do, although laws regulating their sale are now reasonably effective.

While many types of face cream, such as vanishing creams, cleansing creams, and nourishing creams, are urged upon the public, cold cream is the only one that is needed. Essentially, this consists of lanolin, almond oil, spermaceti, and beeswax in various combinations with other ingredients. On the whole it is believed to be a reasonably safe product. Its function is that of lubrication. Ordinarily, the oil produced by the sebaceous glands of the skin provides sufficient lubrication, but for those whose skin is very dry, cold cream prevents roughness and chapping.

While liquefying or cleansing creams are probably harmless, soap and water are safer and more effective cleansing agents. Vanishing creams are basically soap and are undesirable because of their drying effect. It is not possible to "feed" skin tissues by the application of "nourishing" creams.

The highest quality of *talcum powders* consists of pure ground talc with the addition of some perfume. Since it is impossible to remove all mineral impurities from talc, some of these cause irritation to certain skins.

Face powder that has rice starch, wheat starch, or orris root is undesirable because it contains certain proteins to which some persons are allergic. Hygienists believe that the danger from using face powder is not so much from the powder itself as from the use of unclean powder puffs. It is preferable to use a puff only once. Bits of cotton that are destroyed after using provide the most satisfactory method for applying powder.

Many commercial *hand lotions* are very much overpriced and tend to extract moisture from the skin. Either lanolin or olive oil is effective in the prevention of chapped or rough hands.

Astringents are valueless, expensive, and sometimes dangerous. The use of cold water to stimulate muscle tone in the skin is more effective and can produce no harm. While some *deodorants* are harmless, those that completely prevent the flow of perspiration usually depend for their efficacy on aluminum chloride. This has been known to induce rash and other mild skin troubles that may cause great discomfort.

The claims made for *depilatories* are overdrawn, and there is grave danger in the use of many of the much advertised hair removers. The destruction of the hair root with the electrolytic needle is the only safe and permanent method of removing unwanted hair, but this is not safe except in the hands of an expert technician under medical supervision. The rate of hair growth is not affected by shaving.

Polish remover tends to dissolve the fats in the skin and to produce a dry cuticle. The same is true of cuticle removers which dry the skin around the nails. Cold cream or olive oil keeps the cuticle soft.

Abnormalities.—A great variation exists in the texture and resistance of the skin. It may be thin, tender, easily chapped and broken, or it may have quite the opposite characteristics.

A localized overgrowth of the outer horny layer produces *corns* and *warts.* These may sometimes be removed by daily application of suitable preparations, though a safe method is by knife or electric needle in the hands of a doctor.

A *mole* results from an undue growth of the end apparatus of the sensory nerves of the skin. It may or may not be pigmented. Undisturbed moles are unlikely to cause trouble, but irritation or accident may start an abnormal growth with cancerous characteristics. Only a physician or surgeon should attempt their removal.

A *birthmark* or "port-wine stain" is a congenital, sharply defined bright red patch, consisting of a conglomeration of tiny blood vessels, usually level with the surface. It may occur very extensively on the exposed skin, as, for example, the face. When any such disfiguring marks appear on the face, they may be masked by the application of certain suitable cosmetic preparations specially designed for this purpose.

The bane of the adolescent is *acne,* with its greasy skin, blackheads (ducts choked with oily plugs of dust or soot), and pimples. Prevention of this condition is easier than its cure. A well-regulated diet of citrous and other fruits, green vegetables, and whole cereals, and rigid attention to the bowels are indicated. Cleanliness, both internal and external, is essential. The individual should drink large quantities of water and should keep the skin scrupulously clean. The use of some other detergent instead of soap benefits some skins. Hot applications alternated with cold will stimulate a vigorous circulation and more active elimination in the skin. Dietary and endocrine relationships are being studied. Medical treatment is needed for persistent cases.

Boils may arise from tampering with pimples. They are produced by an infection of the hair follicle with bacteria, usually staphylococci. They should be protected with sterile cotton or gauze in order to prevent an extension of the infection. When pus formation is complete, the boil is opened and dressed with the usual surgical precautions.

The essential facts concerning the important skin diseases, ringworm, scabies, and pediculosis are presented in Appendix A. *Ring-*

worm is caused by a fungus (mold). Ringworm of the foot (commonly called athlete's foot, although it is in no way restricted to athletes) is a common form of this disease. It is characterized by more or less itching and the formation of watery blisters. In foot hygiene it is commonly recommended to dry the skin between the toes thoroughly after bathing and to use a powder of nine parts talcum and one part boric acid. *Scabies,* or itch, is due to infestation of the skin by the itch mite. *Pediculosis* is an infestation of the scalp by the head louse. The body louse and the pubic louse are also external human parasites. The body louse lives upon the blood of man but lies concealed in the seams of his clothing rather than on his skin. It has been found to transmit the germ of typhus fever, so that the sterilization of clothing and other measures to prevent the infestation have become important military measures.

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CHAPTER IX

ENDOCRINES

The *endocrine glands* of the body manufacture and discharge into the blood stream certain substances which profoundly affect cellular activities. Before turning to a study of the individual endocrine substances, we shall review the essential facts concerning the work of cells.

Metabolism.—The term metabolism is applied to all the chemical processes involved in life, in growth, and in carrying on body functions. It consists of the constructive phase in which substances are built up (anabolism) and the destructive phase in which substances are broken down (catabolism).

These processes of growth, repair, and combustion vary at different times and in different persons. Differences in metabolism are most clearly demonstrated by measuring the metabolic rate when the body is at rest, that is, by determining the basal metabolism. *Basal metabolism* involves only those chemical reactions required in the maintenance of the living state. These take place in the respiratory mechanism which constantly supplies oxygen and removes waste products; in the heart which never ceases to keep blood in circulation; in the heat-regulating mechanism, the secreting glands, and the nerves which constantly control all bodily functions. Though skeletal muscles may be inactive, the visceral muscles never cease their rhythmical contractions. The expenditure of energy necessary to keep up these basic activities of life is known as basal metabolism.

In studying basal metabolism the person to be tested is fasting and at rest. The rate of oxidation is determined by putting the subject in the calorimeter and measuring the heat yield directly, or, more conveniently, by using a respiration apparatus and measuring the oxygen consumed and the carbon dioxide given off by the individual. The rate of metabolism, according to Du Bois, increases about 10 per cent for each degree Centigrade the body temperature rises above normal. It is reduced somewhat in sleep,

presumably because of the decreased tonus of skeletal muscle. The ingestion of food, especially protein, increases metabolism.

In addition to basal metabolism the body carries on *growth* metabolism by means of which new structures and protoplasm are produced, and *functional* metabolism by means of which activities, such as muscular contraction, glandular activity, and the functioning of nerves and sense organs, are performed.

Ductless Glands.—The extent and rate of activity of the metabolic processes are in part determined by certain substances produced by ductless gland tissue. These are absorbed directly into the blood and are carried to other parts of the body where they effect significant changes.

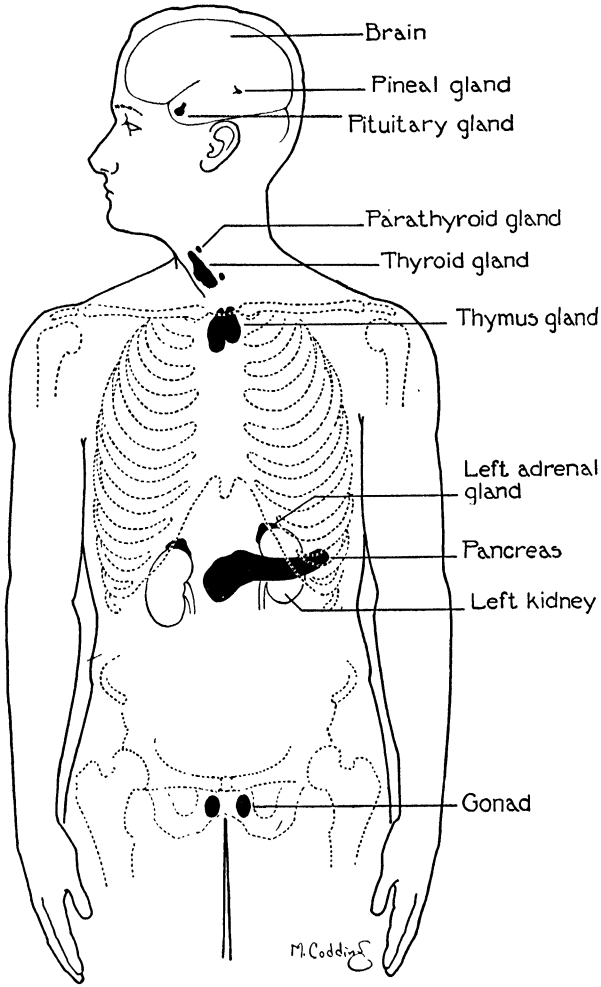
The products of the ductless or endocrine glands have been called *hormones* (*hormao,* I excite), a name suggested by the fact that those first discovered had the effect of excitation. The name is not entirely suitable, for it is now known that some products of endocrine glands depress rather than excite and others do neither. The term "endocrine principle" or "endocrine compound" has been suggested as preferable to "hormone."

Considerable research has been done on the effect of hormones or endocrine compounds on basal, growth, and functional metabolism in specific tissues or organs remote from the point of origin of the secretion. Although these chemical agents are only partly understood, and the factors that influence their activities are still obscure, we shall do well to review briefly the available knowledge concerning the endocrine system and its relation to the normal life of the organism.

The ductless, or endocrine, glands include the thyroid, the parathyroid, the thymus, the adrenals, the pituitary, the pineal, the pancreas, and the sex glands. The hormone of each gland plays its own part in supplementing the action of other glands and tissues. The student is asked to read the table carefully in connection with each gland studied.

Thyroid Gland.—The *thyroid gland* consists of two lobes, from two to three inches in length, connected by an isthmus and located in front of the larynx. It produces thyroxin, a chemical substance containing iodine, which it discharges into the blood stream. A part of its function can be learned by observing what happens

when this hormone is lacking (hypothyroidism) or when an undue amount of it is thrown into the blood stream (hyperthyroidism).

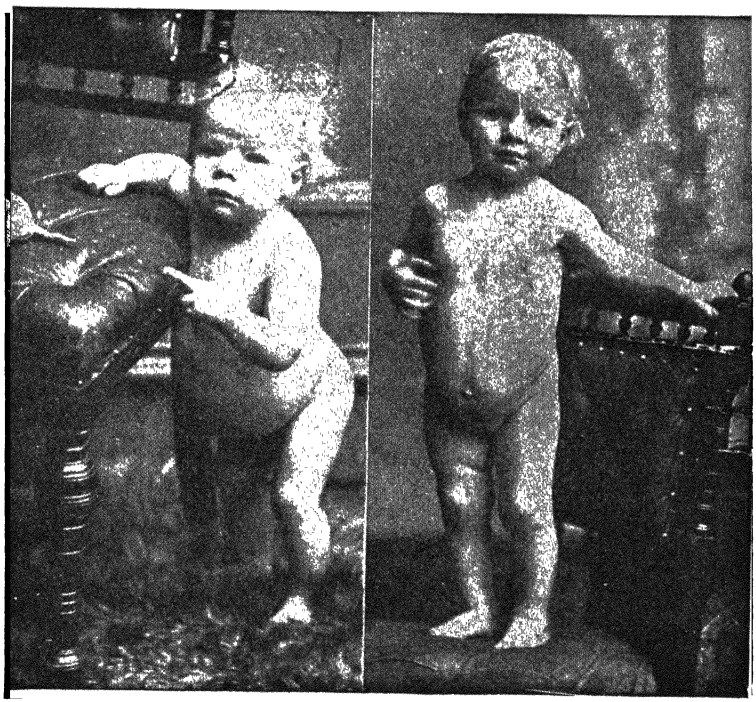


Distribution of endocrine glands.

When thyroid tissue is absent from birth, due to congenital atrophy of the gland, *cretinism* results. The condition is characterized by feeble-mindedness and retarded growth. An adult with marked deficiency of thyroid gland secretion, either from removal

of the gland or degeneration changes, suffers from a condition termed *myxedema.* It is characterized by low basal metabolism, sluggish mentality, sensitivity to cold, thickened skin and gain in weight.

These conditions often respond markedly to animal thyroid extract administered under proper supervision. Such treatment must be continued throughout life in order to maintain the normal state. Mild hypothyroidism, not myxedema, sometimes occurs in late adolescence and in adult life, resulting in "general poor health."



A. *B.*

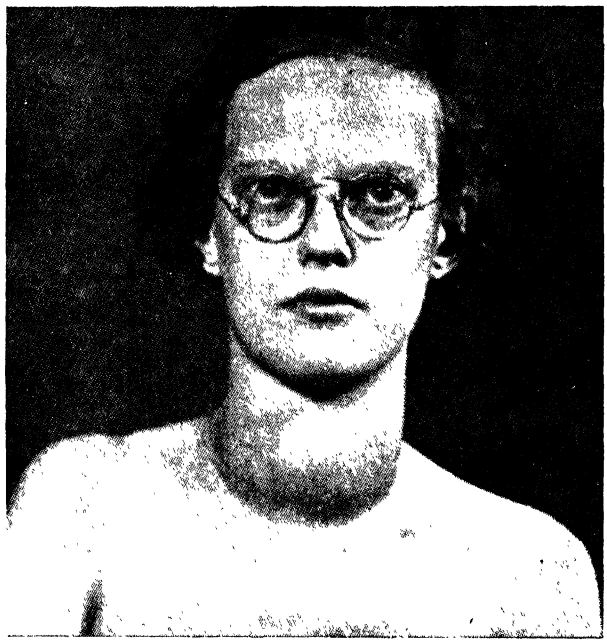
Cretinism, *A,* and the recovery, *B,* after the administration of thyroid gland. (Nicholson.)

As already discussed in the chapter on Nutrition, a deficiency of iodine in the diet results in *simple goiter,* a common condition in some of the midwest, and mountain states where the amount of iodine in the soil and water is negligible. The thyroid gland en-

HORMONES

GLAND	SECRETION	PROBABLE FUNCTION	HYPO-FUNCTION	HYPER-FUNCTION
Adrenals or Suprarenals	1. Cortin	Suggested by hypofunction Helps regulate metabolism	Addison's disease	Develops male characteristics
	2. Adrenin	Reserve mechanism for emergencies	No effect observed	Undesirable "emergency adjustment"
Ovaries	1. The estrogens	Regulate reproductive system	Ovarian deficiency: infantilism, decreased fertility	
	2. Progestin	Regulates menstruation, lactation, and reproductive system		
Pancreas	Insulin	Controls carbohydrate metabolism	Diabetes mellitus	Hyperinsulinism
Parathyroid	Parathyrin	Regulator of calcium metabolism	Tetany	von Recklinghausen's disease
Pineal	?	May help to regulate rate of development		
Pituitary	1. Anterior lobe		Dwarfism	Gigantism Acromegaly
	a. Somatotropin	Growth promoting		
	b. Thyrotropin	Thyroid stimulating		
	c. Gonadotropins	Sex gland regulators		
	d. Corticotropin	Adrenal cortex regulator		
	e. Mammotropin	Mammary gland regulator		
	f. Metabolic hormones	Help regulate metabolism		
	g. Diuretic hormone	Promotes urine formation		
	2. Posterior lobe		Diabetes insipidus	
	a. Pitressin	Stimulates smooth muscle		
	b. Oxytocin	Stimulates uterine contraction		
Testes	Testosterone	Regulates reproductive system	Imperfect sex development	Precocious maturity
Thymus	?	Endocrine status uncertain		
Thyroid	Thyroxin (65% iodine)	Influences oxygen consumption rate	Cretinism Myxedema Simple goiter	Exophthalmic goiter, or Graves' disease

larges; its secretion is plentiful but poor in quality. In most cases general health is maintained, although in other instances symptoms of hypothyroidism appear in varying degrees. The condition is improved by the addition of iodine-containing foods, such as sea foods, to the diet. Perhaps the simplest and most approved method of its prevention in goiterous areas is through the use of iodized table salt.



Exophthalmic goiter of eight years' duration in girl, aged 17 years. (From Hertzler: *Diseases of the Thyroid Gland,* The C. V. Mosby Co.)

Overactivity of the gland (hyperthyroidism), in which an increased amount of thyroxin is thrown into the blood, is known as Graves' disease or *exophthalmic goiter.* This condition is marked by increased oxidation, excessive nervousness, a rapid heartbeat, increased blood pressure, and characteristic bulging of the eyes. A person suffering from the resulting increased metabolism is usually high-strung and irritable. The causes of hyperthyroidism are still not clearly understood. Relief may be given by surgically removing enough of the gland to restore endocrine balance.

Parathyroid Glands.—The parathyroid glands are four small bodies, immediately back of the thyroid. The removal or degeneration of these glands produces "parathyroid tetany," which may vary in severity from the spasmodic contraction of a few muscles to severe convulsions and death. This condition is associated with decreased calcium in the blood and increased irritability of muscles and nerves. A high calcium intake in the diet is helpful. Meat, due to its high phosphorus content, may aggravate the condition.

The injection of excessive amounts of parathyrin in experimental animals produces an undue concentration of calcium in the blood and may result in death. High blood calcium, associated with bone deformity and loss of muscle tone, sometimes occurs in man as a result of hyperfunction of the parathyroid glands, and is known as von Recklinghausen's disease.

Adrenal Glands.—The adrenal, or suprarenal, bodies are flattened glands, one lying on the outer, upper extremity of each kidney. They consist of two distinct parts, the cortex and the medulla, each producing its own characteristic secretion.

When the hormone produced in the medulla, *epinephrine* or *adrenin,* is thrown into the blood stream, it causes marked changes in the circulatory system. The rate of heartbeat is quickened, blood pressure is increased, sugar is thrown into the blood stream from the glycogen reserves in the liver, and the blood is able to clot more rapidly. The pupils dilate. Blood vessels of the skin constrict. Digestion is inhibited. There is an increased flow of blood to the muscles. Muscle fatigue is delayed. Adrenin has been termed by Cannon "the emergency hormone," since it brings into play the body processes on which self-preservation depends.

Only minute quantities of adrenin are normally present in the blood, the increased output being controlled by nervous excitation. Under the influence of strong emotions, such as fear, anger, joy, or grief, adrenin is thrown into the blood stream in increased amounts, and the body is instantly made ready for the performance of unusual physical feats. When these physiological effects are being produced continually as the result of persistent worry, they are undesirable.

The secretion from the cortical tissue, *cortin,* is essential to life, since removal of the cortex is fatal; but its exact function in the

body is not known at present. Hypofunction results in a disorder known as Addison's disease. The normal behavior of inorganic salts in the body is disturbed and the basal metabolic rate is depressed. There is defective excretion of nitrogenous wastes and tissue growth is slowed up.

Oversecretion of cortin appears to develop male characteristics in the female and to hasten development in the male.

Pituitary Gland.—The pituitary gland is attached to the brain and lies in the region back of the orbits of the eyes. It contains an anterior and a posterior lobe, producing numerous hormones, each of which differs in function (see table on Hormones). It has been called the "master gland" because its effects are so widespread.

The hormones of the anterior lobe regulate growth, the metabolism of protein, fat, carbohydrate, and water, and the formation of milk and urine. They influence the activity of other endocrine glands, including the thyroid, adrenals, and gonads. There are two sex gland regulators found in the secretion of the anterior lobe. These are the follicle-stimulating hormone, which aids in the development of ovarian follicles and sperm cells, and the luteinizing hormone, which acts upon the ovarian follicle after the ovum has left it and on the interstitial or supporting cells of the testes.

The hormones produced by the posterior lobe that affect the functional metabolism of the body are pitressin and oxytocin. *Pitressin* is a smooth muscle stimulant. By its action on the muscle tissue of small arteries and arterioles, pitressin raises the blood pressure. It also checks the flow of urine, its function apparently being to conserve water when dangerous loss of the latter from the body is imminent. *Oxytocin* has a stimulatory effect upon the muscle of the uterus and is important in preventing hemorrhage following childbirth. Posterior lobe extract (both fractions) has also been shown to influence carbohydrate metabolism.

Underactivity of the anterior lobe of the pituitary leads to *dwarfism.* Sometimes the failure apparently involves only the growth hormone, but at other times the gonadotropic hormone is also deficient.

Gigantism, the converse of dwarfism, is caused by an overactivity of the anterior lobe during youth. When the hyperfunction develops in adulthood, *acromegaly* results. In this disorder overgrowth of bony and soft tissue involves principally the head, spine, hands, and feet.

The Pineal Body.—The pineal gland is also attached to the brain and is thought to help regulate body development and the onset of puberty. This belief has not, however, been definitely established.

The Pancreas.—In the pancreas are situated groups of endocrine cells known as the islands of Langerhans. These cells produce *insulin,* a hormone enabling the liver to retain sugar and to form glycogen. Failure of the islands of Langerhans to secrete insulin causes the disease, *diabetes mellitus,* characterized by excessive thirst, appetite, and urination, high blood sugar, emaciation, and the appearance of sugar in the urine. Diabetes is most common between the ages of 40 and 60 among people who are overweight. The discovery that insulin can be extracted from the fresh pancreas of animals and that, when injected into the blood stream, it provides the necessary hormone for the proper retention of sugar and storage of glycogen has made possible the successful treatment of diabetes.

Some people develop disturbances due to hyperfunction of the islands of Langerhans. The disorder may result in dizziness, sweating, and nervousness when the blood sugar level reaches an unduly low level. These symptoms are controlled by regulating the intake of carbohydrate food.

Ovaries and Testes.—Several hormones are produced by the gonads. These control the various steps in the normal development and functioning of the organs of reproduction and the appearance of secondary sex characteristics in hair and voice, in muscles, bones, and body proportions.

The ovaries secrete *estrogens* which are necessary for normal function of the female reproductive system. *Progestin* regulates menstruation and lactation. Deficiency of ovarian hormones leads to retarded development of the secondary sex characteristics and to decreased fertility in the female. Lack of balance of these hormones contributes to the symptoms of the menopause.

Testosterone is necessary for the normal function of the male reproductive system. Its deficiency leads to imperfect sex development and its excess, to early maturity.

The gonads of each sex contain rudiments of the gonad structure of the opposite sex. Occasionally, both types of gonad tissue develop in the same individual, producing bisexuality or hermaphroditism.

Thymus.—The thymus is a mass of tissue located behind the sternum. It ordinarily begins to atrophy at adolescence. Endocrinologists are not entirely certain that it is an endocrine gland, although recent research indicates that it may contain an active endocrine growth-accelerating principle, which Asher terms "thymocrescin."[1]

Hygiene.—It is interesting to note that there seems to be an interrelationship between the various endocrine glands, and that disturbances in the function of one gland are reflected in the activities of certain others. Cases of mild disturbances of the endocrine system are constantly being found. These respond well to treatment, and persons should realize the importance of seeking the best medical care obtainable. The consequences of treatment by any one other than an expert are fraught with danger. Research continues, and each year adds new chapters to our knowledge of the endocrines and the possibility of correcting abnormalities in their functioning. No measure beyond the maintenance of general good health is known for promoting the well-being of the ductless glands. You will appreciate that some of the personality characteristics of the individual may be the result of mild endocrine dysfunction.

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CHAPTER X

THE SENSE ORGANS

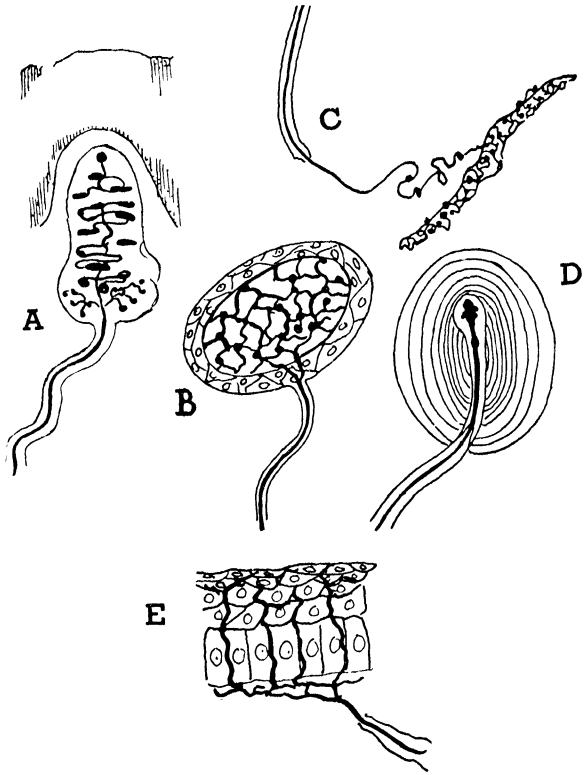
We are already more or less familiar with the general features of the central nervous system. It will be interesting to approach a more detailed study of this part of the body through a consideration of the receptors by means of which the central nervous system keeps in touch with the outside world. Receptors, whether simple like those in the skin or highly complex like the eye and the ear, initiate all reflex movements and sensations.

Proprioceptors.—The body is able to maintain posture and to accomplish locomotion because of the functioning of receptors located in the skeletal muscles, the tendons, and about the joints. They give the sensations of motion and position—the kinesthetic or muscle-joint sense.

A second set of receptors found in the semicircular canals of the internal ear are stimulated by the relative position of the head with reference to the pull of gravity and thus aid the body in maintaining its equilibrium. Motion sickness is due mainly to the unusual stimulation of these receptors when the body is moved upward and downward in direction of its long axis. Lying down reduces these vertical movements and may prevent nausea.

Cutaneous Receptors.—The skin contains five types of receptors or nerve endings (see illustration) which are sensitive to *cold, touch, warmth, pressure,* and *pain,* respectively. Each receptor sends only its one kind of sensation to the brain. Those of each type can be located as "spots," pinpoint or larger in size, and can be mapped on the skin. Touch spots are most numerous over the tips of the fingers and at the tip of the tongue. The lips are more sensitive to heat than the hands. Some surfaces, such as the back, upper arm, and thigh, have relatively few receptors. The sensation of pain is transmitted from bare nerve fiber endings and may be produced by a mechanical, thermal, electrical, or chemical stimulation if it is intense enough. The receptors for the other four sensations each respond to one type of stimulus.

The reflexes due to pain are protective and have the right of way over other reflexes. Through the autonomic system, pain stimulates the secretion of adrenin, the effects of which we have already discussed. Pain is a powerful aid in preserving the life of the individual.

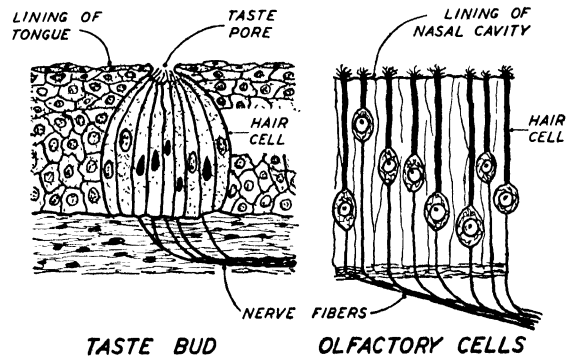


Cutaneous receptors. A, Meissner's corpuscle (touch); B, Krause's end bulb (cold); C, Ruffini's end organs (warmth); D, Pacinian corpuscle (deep pressure); E, bare nerve endings in cornea (pain). (After *Starling's Principles of Human Physiology*, J. & A. Churchhill, Ltd., London.)

Taste and Smell.—*Taste receptors* or taste buds of four kinds develop the sensations of the basic tastes (sour, salty, sweet and bitter) from taste-producing substances in solution. They are located mainly on the tongue but are also on the pharynx, epiglottis, and roof of the mouth. They are unevenly distributed, bitter being more readily perceived at the base of the tongue, sweet at the

tip, and sour at the sides. The "taste" of many finer flavors includes not only combinations of these fundamental taste sensations, but also sensations of smell and sensations produced by differences in the temperature and texture of food upon other nerve endings in the mouth.

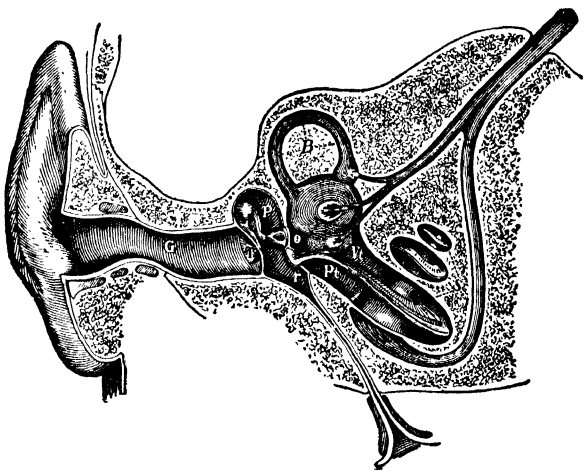
The *olfactory receptors* are extremely sensitive and are localized in the upper part of the nasal cavities, above the stream of respired air. This prevents drying of the sensitive area; but "sniffing" brings the chemicals in the air in direct contact with the sensitive cells. The olfactory epithelium is bathed in liquid which dissolves these soluble substances. If the change in concentration is rapid enough, it constitutes a stimulus, otherwise it does not. This explains why one quickly becomes unconscious of the odor when there is a constant amount of an odorous substance in the air.



Taste and olfactory senses. (From Carlson and Johnson: *The Machinery of the Body,* Courtesy University of Chicago Press.)

Auditory Receptors or Hearing.—About one-eighth of all our impressions reach us through the ear. The structures concerned with hearing include: (1) the outer ear; or pinna, which receives sound waves; (2) the middle ear which conveys the sound waves; (3) the cochlea with its auditory receptors. The receptors for hearing are "hair cells" found in the cochlea of the inner ear in which the fibers of the auditory nerve terminate. The semicircular canals of the ear have already been mentioned as being associated with the sensation of position.

From the standpoint of hygiene a knowledge of the structures of the outer and middle ear is important. The *external meatus,* which conveys sound from the pinna to the eardrum, is a canal lined with skin, the glands of which produce a waxlike secretion called *cerumen.* This wax, as well as the tortuous canal, serves to protect the delicate eardrum, or tympanic membrane, from dust or other foreign substances. A chain of three small ossicles in the middle ear, loosely attached to the eardrum and joined together by ligaments, serve to convey the sound vibration to the membrane of the oval window (which separates the middle and the inner ears) and thus to the lymph of the inner ear.



Section through the right ear (Czermak); G, external auditory meatus; T, membrana tympani; P, tympanic cavity or middle ear with the auditory ossicles stretching across it and the auditory tube entering it from below; O, oval window; r, round window; B, semicircular canal; S, cochlea; Vt, upper canal (scala vestibuli); Pt, lower canal of cochlea, (scala tympani). (From Zoethout and Tuttle: *A Textbook of Physiology.*)

The middle ear is lined with a mucous membrane which is continuous with that of the pharynx through the Eustachian tube. This lining is also indirectly connected with the mastoid cells that lie in the spongy mastoid portion of the temporal bone. Only a thin portion of the skull bone separates this mastoid tissue from the brain and from a large blood vessel, the sigmoid sinus, which empties into the internal jugular vein. Any injury to this tissue

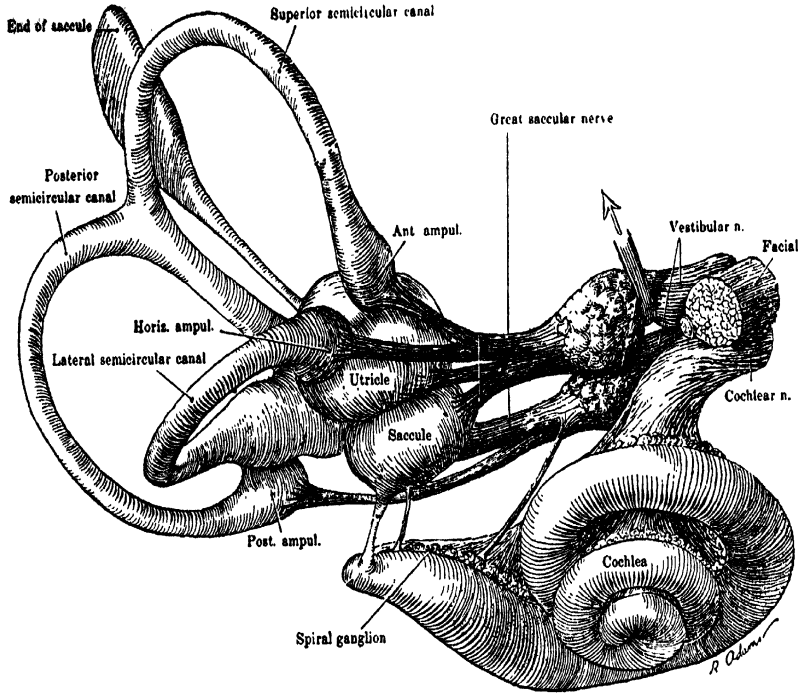
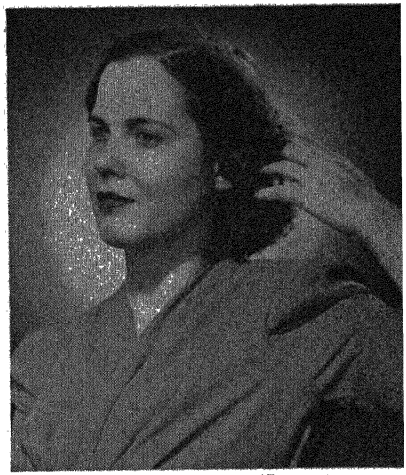


Diagram of inner ear and nerves running from it. (From Mettler: *Neuroanatomy*, The C. V. Mosby Co.)

is, therefore, fraught with danger. The Eustachian tube is shorter and wider during childhood than during adult life, thereby favoring drainage if infected, but at the same time providing an easy path for the entrance of infection from nose or throat.

Defects of the Ear.—Only recently, with the development of the audiometer, an instrument used to test the hearing of large groups of persons, has the appallingly large number of unrecognized cases of partial deafness been revealed. The totally deaf person is readily recognized, but the person suffering from slightly impaired hearing may himself be unconscious of his own defect, although it definitely handicaps his efficiency. It is estimated that from 3 to 5 per cent of the total population of the United States suffer from some degree of hearing loss.



(Keystone)

Modern hearing aids are efficient and inconspicuous.

The person with progressive deafness should learn lip reading before his hearing is entirely lost. There has been great improvement in the quality of hearing instruments in recent years, and experts believe that their early and intelligent use will help in the maintenance of a normal voice and in the ability to interpret correctly what is heard.

Deafness is sometimes due to failure of the auditory nerve, but it is more commonly due to mechanical interference in the transmission of sound to the middle ear. Otologists believe that the great majority of hearing defects come from colds and contagious diseases in which the ear has been neglected. Due to the ease with which an infection of the nose or throat can be transmitted to the middle ear through the Eustachian tube, the ear should be carefully watched during and following cold or other diseases, such as scarlet fever, measles, and diphtheria, in which these tissues are involved. Infection from the nasal passages may sometimes be forced through the Eustachian tube into the middle ear by too vigorous blowing of the nose.

Purulent *otitis media* (middle ear infection) is accompanied by pain, congestion, bulging of the eardrum, and pus formation. Pain is relieved when the eardrum ruptures, allowing the pus to drain, or when a physician punctures the eardrum to facilitate drainage. Drainage through the Eustachian tube may sometimes occur in which case the infection may be unrecognized. Unless proper treatment follows, the infection, although no longer painful, may continue for a long time. Such a chronic condition in the middle ear will cause stiffening of the joints between the ossicles, and eventually produce permanent deafness.

The catarrhal form of otitis media may result from a common cold, chronic nasal trouble, enlarged tonsils, or adenoids. There are inflammation and swelling in the mucous membrane of the middle ear and Eustachian tube. The tube may become closed, and a partial vacuum may be created in the middle ear. A watery



A dog's sight is not remarkable but his sense of smell and sense of hearing are unusually acute.

(Harold M. Lambert)

exudate leaves the mucous membrane to relieve the negative pressure, and the eardrum is drawn in rather than bulged. Though pain, head noises, and diminished hearing accompany the condition, it may often be overlooked if the pain is not severe. This condition may persist for months and finally result in permanent thickening and retraction of the eardrum, with adhesions and displacement of the ossicles interfering with the transfer of sound through the middle ear. Chronic catarrhal otitis media is the commonest of all types of ear disease and the chief cause of progressive deafness. Early removal of infected tonsils and adenoids, correction of nasal obstruction, and prompt medical care when an earache occurs are important preventive measures.

Another cause of impaired hearing may be the excessive secretion of *wax* and its impaction in the auditory canal. Painful boils in the canal may be caused by attempts to remove wax, and the delicate eardrum may be pierced by clumsy manipulations. Impacted wax should be removed by the physician at the time of the annual physical examination or as needed.

Particular care of the ear is desirable for those who swim often. Water that gets into the ear ordinarily drains out rather quickly, but in the case of a damaged eardrum it may enter the middle ear and result in serious injury. It is advisable to use some form of *ear plugs* when swimming under water or diving.

Various forms of *mold* or fungi find ideal conditions for growth in the outer ear canal. Such infections may result from water in the ear following swimming. They are painful and should be given careful medical treatment. Foreign objects should never be introduced into the outer canal because of the danger of injuring the eardrum or of carrying infection into the ear canal.

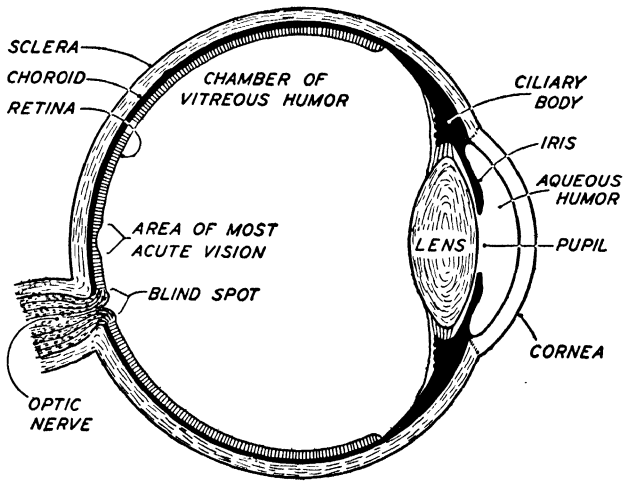
The Eye.—It is estimated that more than three-fourths of all impressions come through the eye. The optic nerve is the largest afferent nerve in the body and contains approximately half a million fibers. About one-half of all the sensory nerve fibers in the body are visual.

The visual receptors occur as a layer of photosensitive cells imbedded in the *retina* lying at the back of the eyeball. The receptor cells are rods and cones. At the axis of the eyeball is the *macula lutea* (yellow spot), the region of most distinct vision. Cone-shaped cells are most abundant in this area. Its central depression (fovea centralis) is formed entirely of cones. It is here that form and especially color are best detected. In reading or in other close work the eye moves so that rays of light from the object being studied are focused directly on the macula.

The rod-shaped cells are more abundant near the periphery of the retina. They detect movement and are useful in the recognition of moving objects far to the side. They are necessary in twilight vision. This is associated with a photolabile substance known as *visual purple,* or rhodopsin, a purplish or rose-colored substance, that bleaches on exposure to light. When vitamin A is lacking in the diet, especially where there is excessive light as in the snow of Labrador or in the sun of the tropics, this visual purple in the retina loses its power of regeneration after it is normally bleached. Thus vision in faint light as at twilight becomes impossible. This condition, known as night blindness, can be corrected by the use of a diet rich in vitamin A.

The act of seeing depends upon the formation of images on the retina or photosensitive layer of the eyeball, a process very closely

analogous to the formation of images in a camera. The *lens,* a semifluid or jellylike body, is enclosed in an elastic capsule. This capsule is attached by the numerous fibers of a suspensory ligament to the *ciliary process.* The thickness of the lens can be altered by releasing the tension on the capsule through the contraction of a circular muscle (ciliary muscle) which pulls forward the choroid coat of the eyeball, thus loosening the suspensory ligament. Since the lens is semifluid, it tends to become rounder as this tension is released. By means of this change in the lens,



Section of the eye. (From Carlson and Johnson: *The Machinery of the Body.* Courtesy University of Chicago Press.)

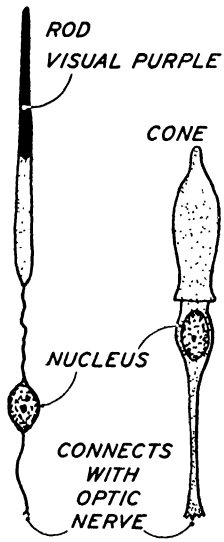
rays of light from varying distances can be brought to a focus on the stationary retina. The adjustment made by this contraction of the ciliary muscle is termed *accommodation.* It is necessary in seeing objects closer than twenty feet.

During childhood the lens is very elastic, but with increasing years it becomes firmer and its ability to alter its curvature decreases, producing a condition termed *presbyopia.*

The pigmented *iris* contains smooth muscle tissue arranged to form radial and sphincter muscles by means of which the intensity of light falling on the retina can be regulated. The radial muscles act as dilators, making the pupil larger and allowing more

light to enter. The sphincter muscle lessens the opening at the center of the iris and tends to exclude light. This adjustment of the amount of light is necessary for clear vision.

The bony socket or orbit in which the eyeball is located is cone-shaped, lying very close to the sinuses. Any inflammation of the mucous membranes in these cavities may cause trouble in the eyes. It is not uncommon to trace the cause of an inflamed eye to an infected sinus or tooth.



Rods and cones. (From Carlson and Johnson: *The Machinery of the Body.* Courtesy University of Chicago Press.)

The orbit permits only the front third of the eye to be exposed. Protective fat cushions support the eye at the rear. The nerves and blood vessels traversing this cushion of fat are tortuous, thus allowing enough slack so that their normal function is unaffected by eye movements.

The eyebrows and eyelashes protect the eye from the perspiration of the forehead, from dust and foreign particles in the surrounding air and, in some measure, from excessive light. Plucked eyebrows may, accordingly, be termed unhygienic to that extent.

Six external muscles enable the eyeball to roll on an axis and to be turned in any direction so that objects do not appear tilted

when the head is held on one side. They increase the range of vision. They are used in the eye movements which bring the words in reading into the region of clearest vision.

Deviations From Normal Vision.—Common defects of the eye are refractive errors (myopia, hyperopia, and astigmatism), muscle imbalance (cross-eye or squint), and cataract.

Myopia (nearsightedness) is caused by an abnormally long eyeball which places the retina far back so that rays of light focus in front of it. When an object is held nearer the eyes, the image moves back onto the retina so that vision becomes possible. Myopia may be corrected by the use of properly fitted concave lenses.

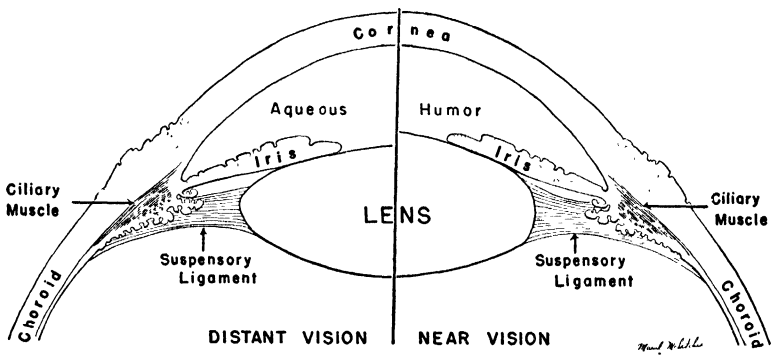


Diagram illustrating the changes which take place during accommodation in the eye.

Children are usually born farsighted. It has been stated that less than 3 per cent of them are born with myopia. The increase in nearsightedness among children from grade to grade may indicate that the schools require excessive use of the eyes under improper conditions, to the detriment of the vision. Constant use of the eyes for close work develops nearsightedness among adults.

The cause of myopia may be a combination of inherited tendency and strain due to excessive use of the eyes, particularly when inflamed. The eyeball is normally under pressure due to the fluids within it. This pressure is increased under the action of the external muscles and the ciliary muscle when the eye is used for near vision. If for any reason the coats of the eyeball are weak, either from poor health or poor nutrition, the eyeball may tend to elongate.

The requirements of a good reading position include attention to distance, to the angle at which the book is held, and to the height of the book. Eyes vary and the distance at which the book is held should be suited to their specific needs. From twelve to eighteen inches will usually meet the proper requirements. The book should be held at an angle of from 45° to 70°, measured from horizontal, and high enough to bring all parts of the page equidistant from the eye.

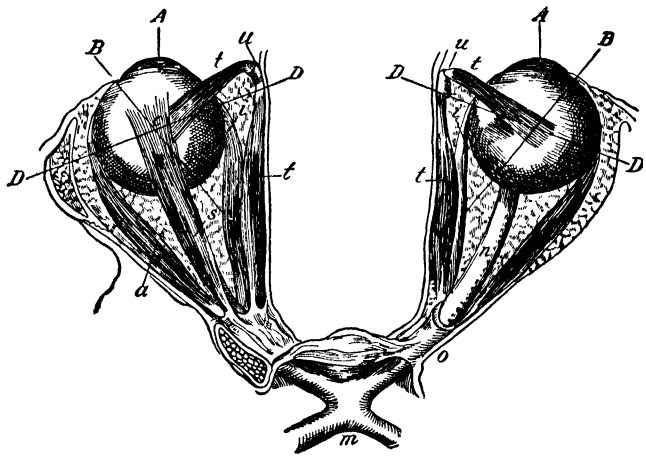


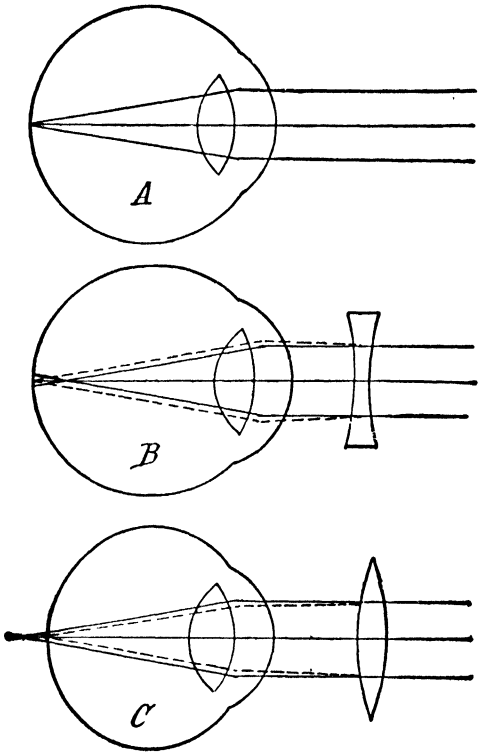
Diagram to show external eye muscles. *n*, optic nerve; *m*, the optic chiasma; *A*, cornea; *a*, the external rectus; *i*, the internal rectus; *s*, the superior rectus; *t*, the superior oblique, and *u*, its pulley; the inferior rector and oblique are not shown. (Gariel.)

Hyperopia, or farsightedness, occurs when the eyeball is too short from front to back, and the image is formed behind the retina. The ciliary muscle must constantly be brought into action in order to round the lens and bring the image forward onto the retina. This results in eyestrain. Hyperopia may be corrected by the use of properly fitted convex lenses.

Astigmatism is due to irregular curvature of the cornea or the lens. In this condition the image formed on the retina is blurred or distorted. Vision in certain places is distinct while in others it is not. Astigmatism is usually congenital, although it may result from an injury or an inflammation. Severe symptoms of

eyestrain usually accompany astigmatism, and a large percentage of functional headaches are caused by it.

A long list of symptomatic conditions, including dizziness, convulsions, rapid heartbeat, indigestion, constipation, and pains in the various parts of the body may be ascribed to astigmatism. Chil-



Errors in refraction. *A*, The normal, or emmetropic, eye is of the proper depth and the image forms upon the retina. *B*, In short sight, or myopia, the eyeball is too long and a concave lens is needed to make the image fall on the retina. *C*, In long sight, or hyperopia, the eyeball is too short and a convex lens is needed to make the image fall on the retina. (From Bard: *Macleod's Physiology in Modern Medicine*, The C. V. Mosby Co.)

dren suffering from astigmatism may develop lateral curvature of the spine from the tilting of the head and shoulders in an effort to secure a clear image. The use of properly fitted glasses is the only method of relieving this condition. Correction should be undertaken before the child is six years of age.

Muscle Imbalance (Cross-Eye or Squint).—The eyes of the child at birth do not work together, but by the end of the first year they are fairly well coordinated. Coordination depends upon the action of the six pairs of external muscles. If these are not well

balanced, there is a constant effort required to hold the eyes in alignment during waking hours. During sleep the eyes resume an attitude of rest out of line. If the muscle imbalance is great enough, the muscles fail to hold the eyes properly even during waking hours, and the eyes seek their position of relaxation with only one eye functioning. The squint may be internal, with the eye crossed inward, the most common form of "cross-eye"; or external, with one eye turned outward.

The cause of cross-eye is usually congenital farsightedness, but it may also be due to defects in the external eye muscles. In many of these cases there is unequal vision in the two eyes. If it is not treated, the vision of one eye becomes permanently impaired, and the person not only suffers a disfigurement but also goes through life with monocular, rather than binocular, vision.

The majority of cases of cross-eye can be corrected if treated early in life by a properly qualified physician. The treatment may be occluding the good eye, glasses, exercise, or an operation. The prospect of ultimate success is better if the treatment is given before the child is six years of age.

Cataract is any opacity of the lens. It is fairly common in old age (senile cataract) where the accepted treatment is surgical removal of the lens with the subsequent use of an artificial lens in front of the eye. Congenital cataract is relatively rare and has a different type of surgical treatment.

Diseases of the Eye.—In addition to these defects of vision there are other eye disorders.

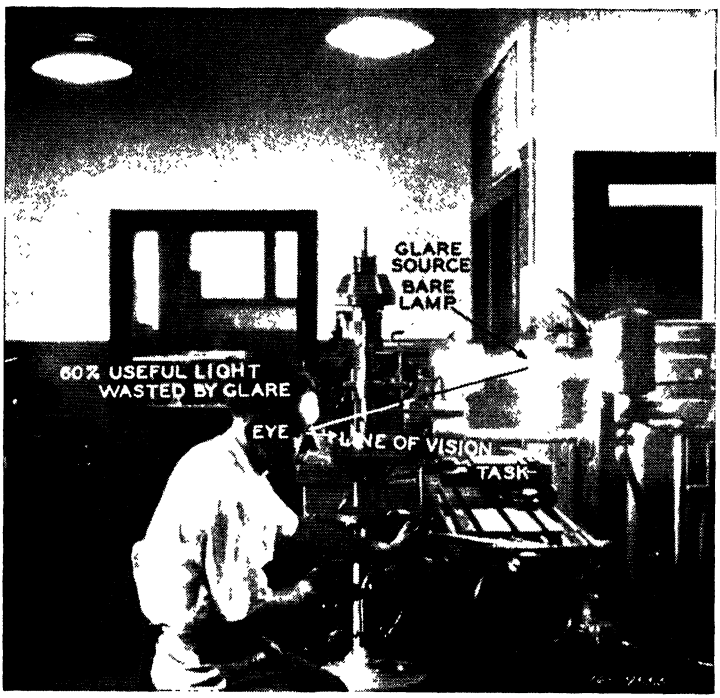
Blepharitis is an inflammatory condition of the eyelids in which the edges are covered with small white or gray scales consisting of dried, hardened secretions. It usually occurs in poorly nourished children, especially if eyestrain already exists. It requires careful treatment, since severe cases may cause retraction of the lid so that the lashes rub against the eyeball.

A *stye* is an infection of one of the small oil glands which occur along the margin of the eyelid. It is commonly associated with poor general health or with eyestrain. Proper treatment and care to prevent multiple infections are important.

Conjunctivitis is an inflammation of the conjunctiva, the mucous tissue which lines the eyelid and covers the front of the eyeball.

It frequently accompanies colds. Blepharitis, styes, and conjunctivitis are all more likely to occur if the body is in poor health and the eyes are subject to strain.

Trachoma is a chronic contagious form of granular conjunctivitis. It is believed to be due to a virus that produces inflammation and causes the formation of so-called trachoma granulations on the inside of the upper lid. These granulations ultimately form scar



An illustration of glare. (Courtesy General Electric Co.)

tissue and may result in permanent injury and blindness. Trachoma is believed to be conveyed mechanically to the eye by the use of common washcloths, towels, handkerchiefs, or fingers. It occurs most frequently in unsanitary surroundings and among populations that are overcrowded and underfed. The sulfa drugs have proved very helpful in treating this disease. We are not sure whether it acts chiefly on the virus or the secondary invaders (see Appendix A for further public health facts).



(Harold M. Lambert)

Glasses do not reduce attractiveness.

Ophthalmia neonatorum is an inflammation of the conjunctiva during the first two weeks of a baby's life. Any one of several pathogenic organisms may be the cause. It is due to infection which the child contracts during birth or through contact with contaminated fingers or other objects later. (See "Conjunctivitis" in Appendix A.)

Glaucoma is a disease of the eye which usually occurs in persons over 45 years of age. The cause is not well understood. It is characterized by intense intra-ocular pressure or hypertension resulting in hardness of the eye. Atrophy of the retina and blindness often take place.

Causes of Blindness.—The types of conditions which cause blindness and their relative importance are indicated in the following table:

CAUSES OF BLINDNESS

CAUSE	PER CENT OF TOTAL	
	CHILDREN	ADULTS
Infectious disease (Ophthalmia neonatorum and syphilis being the two most important)	23.1	23
Trauma	6.9	13
Poisonings	0.2	1
Neoplasms	3.6	1
General diseases	1.4	6
Prenatal origin	55.0	10
Undetermined or not specified	9.8	46
Total	100.0	100.0

Hygiene of the Eyes.—The chief problems of vision occur in using the eyes for reading or other close work. In distant vision very little, if any, strain occurs.

Most of us fail to realize the tremendous amount of precise, rapid, and coordinated muscular activity involved in reading. The external muscles must move the eyes so that they follow

along each line. This is done in a series of jumps, for the region of clear vision is short. The eye must then jump back to the beginning of the next line. If difficulties are encountered, other movements are added. At the same time constant effort is necessary to keep the two eyes exactly centered on the same point with every movement. The very delicate ciliary muscles controlling the convexity of the lens must be kept in constant tension in order to keep the visual images clearly focused on the retina. This is also true of the muscles controlling the regulation of light through the iris. The efficiency with which these muscles do their work is remarkable, and the fact that eyestrain follows when they are required to labor under unfavorable conditions is not surprising.

If one feels that he must read while lying down, he should take precautions to create as favorable conditions as possible. In the first place, the body should be placed in a semisitting position. The book should be propped up on a level with the eyes, and the light should be arranged so that it comes from the head of the bed.

A practice that cannot be too strongly condemned is that of reading while traveling in a moving car. The motion of the car which produces a constant variation in the distance of the eye from the book and the constantly varying intensity of the light tend to create an enormous strain upon the muscles of accommodation in the eye, the external muscles, and the muscles controlling the action of the iris.

Glare may be defined as any light that causes discomfort and interferes with clear vision. A light from an unshaded source shining into the eye without illuminating the object toward which vision is directed (a too glossy paper or too shiny furniture) tends to produce eyestrain. Direct sunlight reflected from a printed page is particularly injurious. The iris reacts to this light and in contracting reduces the visibility of the object being studied. Light should fall upon one's work from over the shoulder. Otherwise strain results and headaches may follow.

Caution should be used in protecting the retina of the eye from direct rays of the sun. If one looks directly at the sun, the lens of the eye serves as a burning glass, and the rays of the sun may actually destroy portions of the seeing area of the retina just as the same rays brought to a focus on a bit of paper would scorch it.

The brilliant light of the arc in a welding machine is injurious to the eye because it produces ultraviolet radiation. In this case, the eye should be protected completely from all reflections of the light as well as from the direct rays.

The hygiene of the eye is closely related to nutrition and the condition of the general health of the body. Poor physique is quickly reflected in the eye, which seems less able to withstand the strain under which it works. Exercise increases the metabolism of the whole body, including that of the eyes. We have already referred to the relationship between night blindness and vitamin A.

Frequent examination of the eye by a skilled operator is important. Those who are trained to examine the eye come under two classes, and it is well to be able to differentiate clearly the ability of the two groups.

An *oculist,* or ophthalmologist, is a physician who has specialized in the study of the eye. As a physician he knows the body as a whole and is able to make a diagnosis of conditions in the eye in relation to the health of the body. He sometimes uses drops of belladonna or atropine to dilate the pupil and quiet the ciliary muscle, thus facilitating the examination. Only a physician can use this method.

An *optometrist,* on the other hand, is one who has made a study of the eye itself, particularly its measurement for refractive errors. He is not a physician and cannot consider the eye in relation to the general health of the body, although he is competent to make a careful examination or refraction of the eye itself.

An *optician* is one who has been trained to make and grind lenses and to make and adjust glasses.

There are many fake "eye specialists" who advertise themselves extensively for the fitting of glasses. There is danger in allowing an improperly qualified person to treat an organ so delicate as the eye.

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CHAPTER XI

THE HYGIENE OF THE NERVOUS SYSTEM

The nervous system in man climaxes in design and capabilities all other human mechanisms. It is composed of highly specialized excitable tissue, capable of receiving and transmitting impulses and providing the structural basis for memory and reason. Through the recording of experiences and emotions it provides the basis for personality and social adjustment.

Structure and Function.—Two closely associated structures constitute the nervous system. The *cerebrospinal system* consists of the brain and spinal cord with their attached nerves, and controls all voluntary and certain usually involuntary functions, such as breathing.

The *autonomic system,* lying in front of the vertebral column, consists of a connected series of ganglia (groups of nerve cells) running parallel to the spinal column and scattered through the head, chest, abdomen, and pelvis. Subject to influences from the emotions, the autonomic system controls automatically certain digestive, circulatory, and other vital processes. If you will refer to the diagram on page 69, you will note that the autonomic nervous system is composed of two main subdivisions; the *sympathetic* and the *parasympathetic.* These two sets of nerves produce opposite reactions in many parts of the body. For example, the sympathetic nerves speed up the heart action, the parasympathetic nerves slow it down; the sympathetic nerve dilates the pupil of the eye, the parasympathetic nerve constricts it. The autonomic system is connected with the central nervous system through connections with the spinal nerves.

The unit of nerve structure, the nerve cell, or *neuron,* consists of a cell body with two or more threadlike extensions. The main extension, called the *axone,* is longer than any other and sometimes extends three or four feet beyond the cell. The much-branched, shorter extensions are called *dendrites.* A nerve impulse passes from the axone of one cell to a dendrite of another at a contact point at their tips called a *synapse.* Dendrites char-

acteristically pick up sensations and carry them to the cell body, while axones carry impulses away from the cell body. The cell bodies of neurons are grouped in the brain, spinal cord, and in the ganglia. Some neurons (sensory or afferent) conduct nerve impulses from sense receptors to the central system; others (motor or efferent) bear impulses from the central system to the periphery, as in the stimulation of muscles or glands. A third group of neurons (association or intermediate), found only in the central nervous system, connect the other two.

Nerves consist of bundles of nerve fibers, either axones or dendrites, or both. Pairs of nerves extend from the brain and spinal cord in an orderly fashion to various parts of the body. The cranial nerves innervate the most important sense organs. Motor nerves to one side of the body originate, for the most part, in the opposite side of the brain.

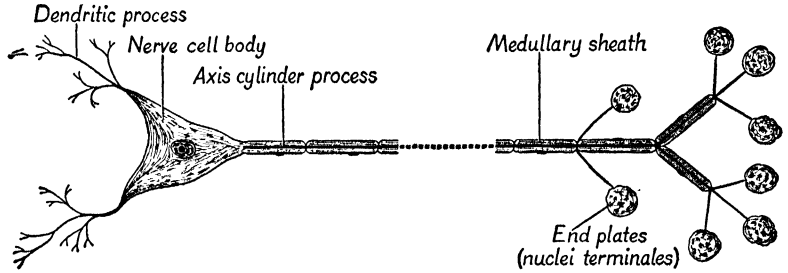
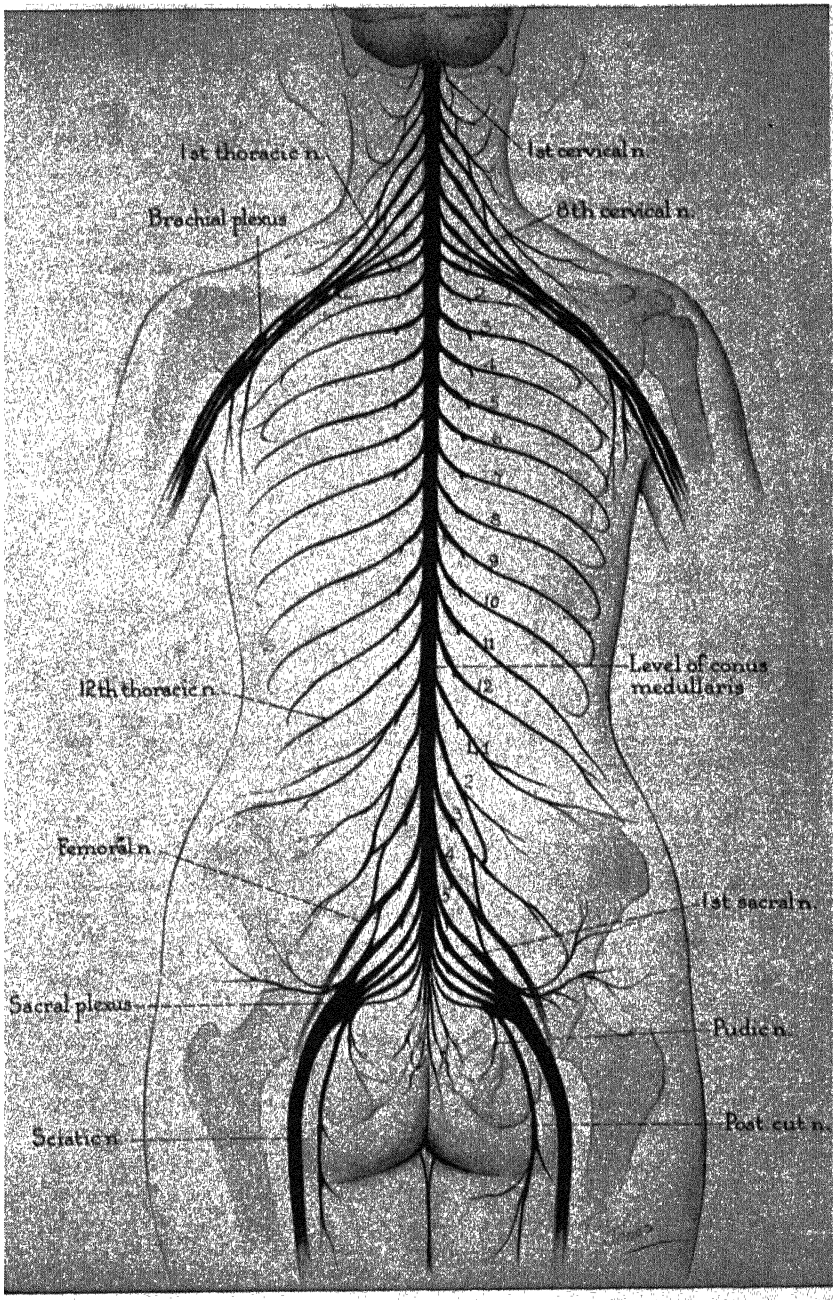


Diagram of a nerve cell. Dotted line indicates that only part of the axone, or axis cylinder process, is shown. (After Pitzman.)

The exact nature of the nerve impulse is not clearly understood. It is similar in some respects to an electric current, although it travels much more slowly—less than 100 meters per second.

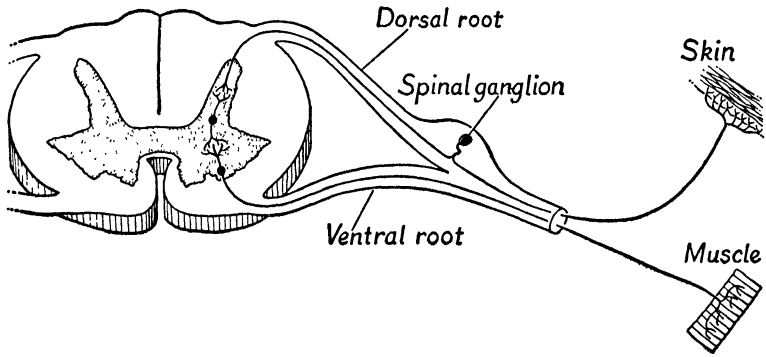
The *spinal cord* is made up of a core of grayish material, composed of cell bodies surrounded by a white substance consisting of layers of nerve fibers. In a simple reflex like that of withdrawing the hand from a hot object, the impulse set up by the heat stimulus passes along the nerves from the skin to the spinal cord. Here each impulse is transferred from the first cell body to one that sends an outgoing motor message to the muscle. Thus the hand is pulled away from the hot object. Although the reflex is made in the spinal cord before the transfer of the stimulus to



Distribution of spinal nerves. (From Camp: *Anatomical Studies.*)

the brain, we may later become conscious of the sensation of heat. The nerve path of a reflex (the reflex arc) is shown in the accompanying diagram.

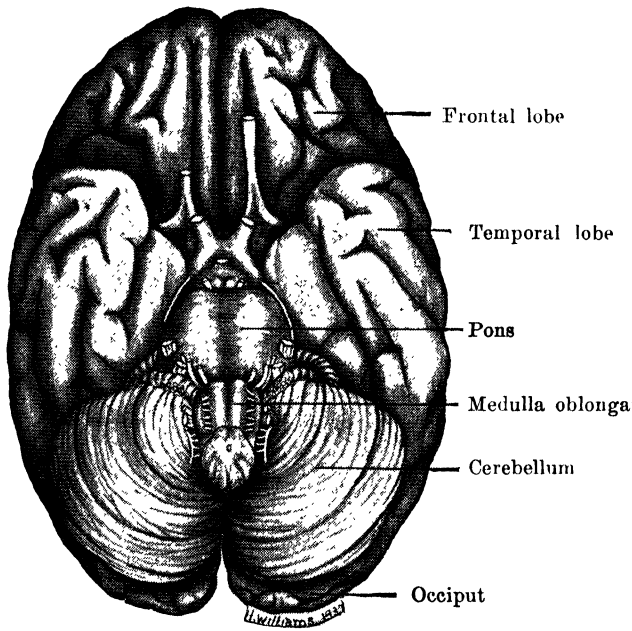
Many reflexes are established at birth and are called inborn or unconditioned reflexes. Other reflexes, known as conditioned or acquired, arise through experience. Their pathways are not fully established at birth but develop by training.



A simple reflex moves the hand from a hot object. Trace the path of the nerve impulse from the skin which receives the stimulus, through the cross section of the spinal cord to the muscle which moves the hand.

The *brain* consists of the cerebrum, which is the largest part and the center of consciousness; the cerebellum, which is more directly concerned with details of motor activity; the pons, which serves as a pathway between the cerebrum and cerebellum; and the medulla, which joins the main portions of the brain to the spinal cord. The most important part of the cerebrum is the "gray matter" or cortex, the wrinkled outer layer composed mainly of cell bodies, which provides elaborate interconnections and gives us the power of appreciating sensations, initiating acts, thinking, remembering and reasoning. There is evidence to indicate that, to a considerable degree, special functions, such as sight, hearing, language, emotion, taste, and smell are related to particular areas in the cortex. That part of the cerebrum lying beneath the cortex consists primarily of nerve fibers. Our consideration of the problem of hygiene does not demand an exhaustive study of the structure of the spinal cord and the brain.

The nervous system is composed of living cells which increase in efficiency through use. These cells, however, demand rest between periods of great activity. They become tired at the end of the day's work, and if overused or abused, become hypersensitive. Consequently, the system is unable to function normally, and the person becomes irritable.

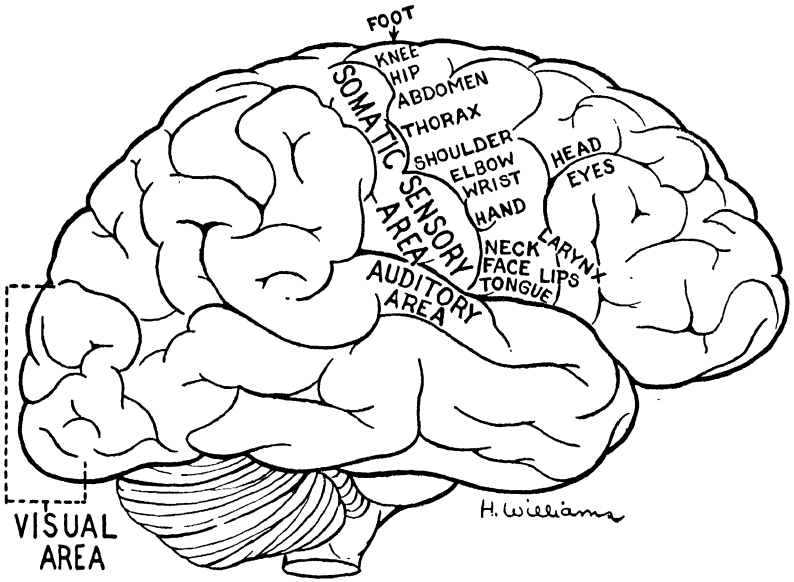


The brain from below. (From Francis: *Fundamentals of Anatomy.*)

Habit.—Energy-saving habits are made possible through the development of what may be considered a series of reflexes. For example, a given series of movements, such as those used in buttoning clothing, develop in response to given situations. These movements almost automatically follow a given situation because a well-established path is developed between the nerve endings receiving stimuli from a particular situation and the nerve endings stimulating the proper muscular movement. The contact of the fingers with the button and the buttonhole initiates a series of impulses resulting in the movements which put the button in place. These movements do not demand conscious attention un-

less some difficulty is encountered. Eating, dressing, and many activities connected with the daily work are relegated to the realm of habit, and thus spare the energy of the nervous system. Energy-saving habits are highly desirable.

Apart from this, psychologists have pointed out a group of so-called indifferent habits, such as the continual use of particular words and phrases, and the lack of reasonable variety in dress and recreation. They have shown that old age reflects a fixity of the nervous system which such long-continued habits have



Tracing of brain showing areas of cerebral localization. (From Francis: *Fundamentals of Anatomy.*)

limited to particular channels of thought and action. If this is true, it is possible to postpone old age by occasionally breaking up these habits in a determined fashion and freeing the mind from ruts.

Concentration.—Perhaps the most important characteristic of the efficient nervous system is the power of concentration upon the task at hand. This is expressed in another way as the power of inhibiting undesirable stimuli. Concentration is equally valuable in work and in recreation.

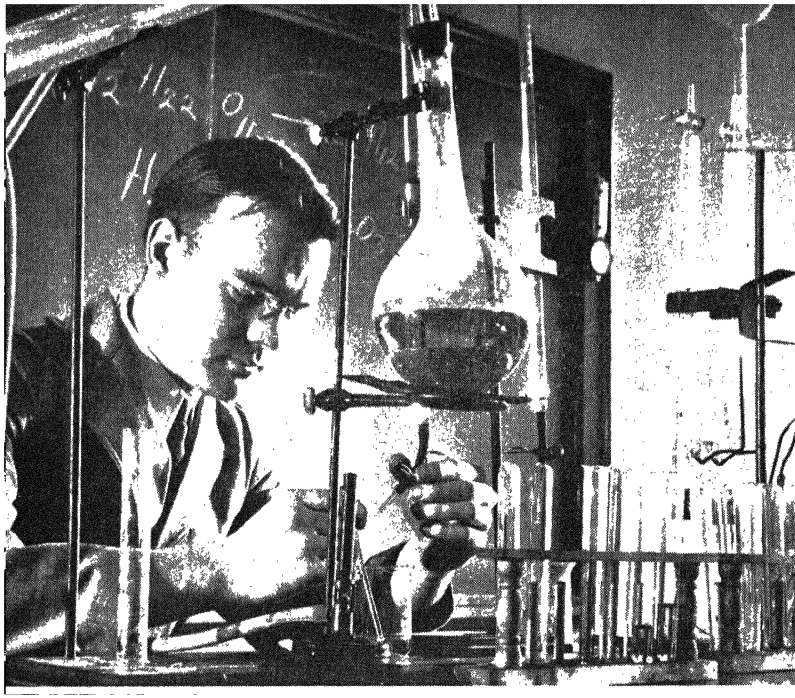
In work the individual inhibits from the center of consciousness those thoughts which are not germane to the subject in hand and also those extraneous stimuli which arise from the surroundings and make their way to the center of consciousness through the portals of sight, hearing, touch, and perhaps taste and smell.

In recreation the reverse process obtains and the individual severely forbids thoughts and worries of his work to crowd in upon the enjoyment of the pleasures he has allowed himself. For those persons who, like great executives, are obliged to shoulder heavy responsibilities and are weighed down with numerous cares, the power of complete relaxation may be a saving grace. The criticism sometimes made of Lincoln and other men of his type for brief periods of light-heartedness in the midst of great problems is entirely unjust and unreasonable.

The power of concentration is so intimately linked with efficiency and personal success that one may well ask how it may be secured or improved. Perhaps the most valuable aid is good health, for with it the body is free from minor pains, irritations, and morbid sensations that constantly break into the train of thought of the physically unfit, opening the way for other distracting influences.

Fondness for one's work is another important factor, since the work itself makes a constant appeal to the mentality and the volition. That is why there is a unity between the things people like to do and the things they do well. The arrangement of one's workshop or desk in such a way that only one thing at a time is before the worker is helpful. Often it is of material assistance to occupy the hands with a pencil in making notes or sketches, or with models, apparatus, or instruments in studying technic. It is well to eliminate such distracting stimuli as glare, uncomfortable chairs, or confusion of material.

Sleep.—No satisfactory substitute for sleep can be found. The unconsciousness of sound sleep carries with it the nearly complete relaxation of the muscles. This is the time for the body tissues to make good their losses. It is largely this relaxation and its accompanying reduction of oxidation that makes a person chilly upon falling asleep in his chair in a room that previously seemed warm. The peripheral circulation and, consequently, the rate of heat loss are also increased during sleep.



(Ewing Galloway)

Efficiency demands concentration.

Factors other than nervous fatigue are important in determining the amount of sleep required. It varies greatly in different persons and is markedly greater in the young than in the old. Heavy eaters are characteristically heavy sleepers, whereas a reduction in the amount of food eaten and more complete mastication reduce the amount of sleep these persons need.

Eight hours of sleep are sufficient for the average normal and healthy adult person; but the thin and nervously exhausted adult may find that an extra hour of sleep or an afternoon rest period is indispensable. Sleep is heaviest during the first two hours, and thereafter the person is awakened more easily. This does not necessarily mean that the later hours of sleep are not equally restful; it merely indicates that the nervous threshold has been lowered by the rest already secured.

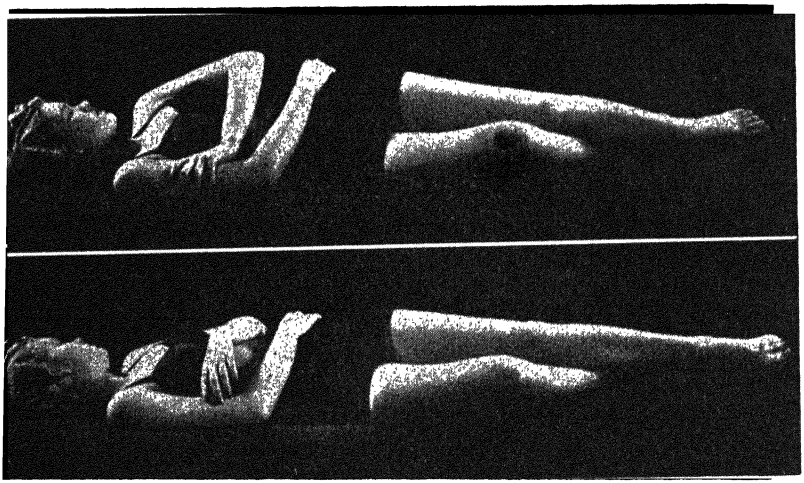
The difficulties in going to sleep promptly and in sleeping soundly do not usually exist for the normal person if he is physically tired. Wakefulness often seems more serious than it really is, for, although the person may hear the clock strike regularly he may still obtain several hours of light and dozing sleep. It is

sometimes possible to avoid sleeplessness by the elimination of disturbing factors. The bed should be comfortable, the room dark and quiet, and the ventilation adequate. The absolute banishment from the mind of excitement and worries, persistent reflection upon inconsequential and humdrum things, and the conscious and complete relaxation of all muscles also aid a person in promptly falling asleep.

The graph on page 177 shows the relationship between the amount of sleep and working efficiency. The data are taken from a study of rest pauses and employee effectiveness made by the Western Electric Company. In this research, with which the author was associated, the output for individual days was compared with the number of hours of sleep obtained the night before. The averages shown in the graph were compiled from data extending over a period of several months and indicate clearly that sleep is a measurable factor in determining a person's productivity. The workers studied were five young women engaged in a light, manual, bench operation requiring dexterity. Some



(Ewing Galloway)



(Gjon Mili)

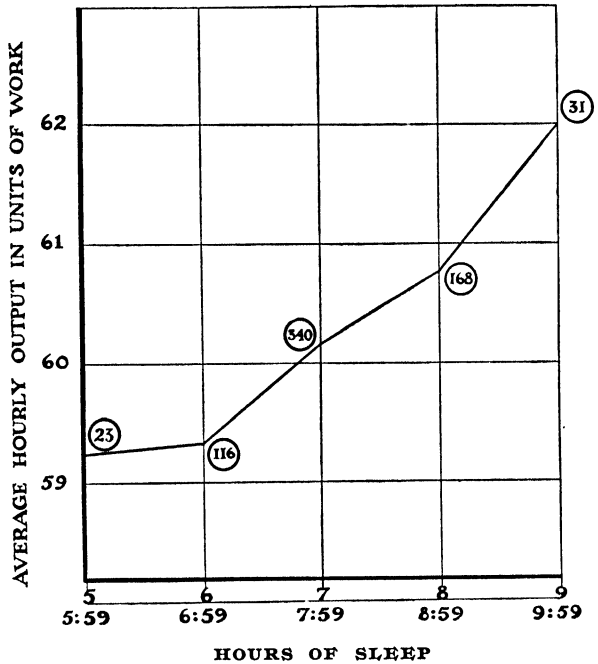
Can you relax completely? Note carefully the upper picture. Muscles may still be tense although one is lying down. Learn to let go completely in each muscle as in the lower picture.

girls were able to withstand loss of sleep much better than others so far as reduced working capacity was concerned.

Dreams.—There are two types of dreams, the remote and the recent. The remote type deals with experiences widely separated from the activities of the day; the recent type deals with the worries and problems of our waking hours. It is the latter, and not the former, which should be a warning to us that our nervous system is not in a rested and normal condition.

Change of Work.—Another method of resting the nervous system is by a change of work which puts into play a wholly different set of nerve structures. The man who has worked over a machine all day and is thoroughly tired may rest his nervous system and refresh his muscular system by playing baseball or tennis. But one must be careful, in this connection, not to commit the fallacy of assuming that nervous excitement, when it involves the nervous structures already tired, is rest. The man who is tired from driving an automobile may forget his weariness by watching a moving picture of an automobile race; but he is not rested thereby, and it is only the strong stimulation of the overtired nervous structures which causes him to forget his fatigue

temporarily. It is probably unfortunate for the nervous system as well as for family life that the habit of quiet home reading has been so widely abandoned for a variety of exciting social amusements.



Graph showing relationship between the number of hours of sleep obtained by factory employees doing light manual work and the output the following day. The number of days included in each average is shown in the circles. (Courtesy Western Electric Co.)

Overwork.—Overworking the mind means putting too great a tax upon its endurance and not too strenuous an endeavor to concentrate the mental faculties. It is a case of too long hours and not of too vigorous mental work. There is a maxim for students in regulating their hours of daily work that "8 plus 2 equals 10 but 10 plus 2 equals 8" when measured by the effective work done. In others words, there is a time limit in taxing the nervous system beyond which accomplishment is reduced.

Bodily Defects.—We remember that pain has the same effect upon many organs of the body as rage, fear, and anxiety; and

it seems reasonable that many mild bodily ills, which are tolerated when they should be corrected, will create continuous and harmful sensations in the central nervous system. Decayed teeth, foot disorders (fallen arches, ill-fitting shoes, corns, and blisters), the wearing of orthodontic appliances by children, nasal obstruction, tonsillar and adenoid trouble, hemorrhoids, and uterine displacement are examples of conditions that should receive prompt attention, not only for their own sake but also for the injury they do to the nervous system.

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CHAPTER XII

MENTAL HYGIENE*

What Is Mental Hygiene?—Mental hygiene, whether it is conceived as a movement in the field of public health, or as an art or a science, concerns itself with the human mind and with ways and means of preserving its integrity, and of preventing its impairment.

From the community point of view, mental hygiene is concerned with problems of the hospital care of the mentally diseased, disordered, and defective. It also deals with the problems of the delinquents, alcoholics, drug addicts, prostitutes, illegitimates, and dependents. All these involve the state, school, church, neighborhood, and industry.

From the individual standpoint, mental hygiene includes the ways and means of obtaining personal enrichment of life and developing to the utmost the capacities and potentialities of the family.

Mental hygiene utilizes the sciences and arts of medicine, psychiatry, psychology, mental testing, sociology and social work, economics, and education. It is dependent upon the contributions of the biologic, medical, psychologic, and social sciences, and it has been influenced considerably by philosophical and speculative considerations (psychoanalysis). In mental hygiene one deals with such psychologic concepts as capacities, tendencies, activities, instincts, desires, wishes, attitudes, emotions, and feelings. The "total situation" in which human beings find themselves in the interplay of everyday relationships forms a major topic in mental hygiene.

Mental hygiene concerns itself chiefly with the understanding and control of environmental and personal factors, and gives sec-

*The author wishes to acknowledge the courtesy of the Massachusetts Society for Mental Hygiene for the privilege of presenting in this chapter a statement of the problem based upon *A Mental Hygiene Primer*, issued by the organization and originally prepared by the following eminent authorities: Henry B. Elkind, M.D.; Donald Greeg, M.D.; Abraham Myerson, M.D.; Harry C. Solomon, M.D.; A. Warren Stearns, M.D.; William H. Burnham, Ph.D.; Douglas A. Thom, M.D.; Walter E. Fernald, M.D.; Ransom A. Greene, M.D.; and William Healy, M.D. Special appreciation is expressed to Dr. Elkind for individual assistance in arranging the material.

ondary consideration to hereditary influences, not because the latter do not play an ever important role in human existence, but because it is impossible to change one's heredity. Only so far as prospective mating and issue are involved does eugenics become the concern of mental hygiene.

Mental hygiene first became the exclusive interest of an organized movement in the field of public health in 1909 when Clifford W. Beers founded the National Committee for Mental Hygiene. Prior to that time and since that date, leadership in the field of mental hygiene has been assumed and maintained by psychiatrists. This has resulted in an undue emphasis on the abnormal aspects of human behavior. Increased consideration is now being given to positive and constructive possibilities in mental hygiene.

We hope that through education a significant amount of mental disease and disorder will be cut down, the mentally defective will be better adjusted to the requirements of the community, and much of the misery of present-day civilization will be ameliorated. Every one should have some insight into the factors contributing to mental difficulty.

There is no question as to the importance of the problems to the community. It has been estimated that one out of every ten to twenty persons born will develop mental disease eventually and will have to enter a mental disease hospital. Over one-half the hospital beds in this country are used for mental disease. The mentally defective make up from 2 to 5 per cent of the general population. The hosts of neurotic persons, the delinquents and criminals, and the socially inadequate, whose number is difficult to ascertain, form a truly staggering figure.

Mild Cases of Mental Disorder.—Incipient and mild cases of mental disorder much more commonly involve the emotions than the intellect. By intellect we mean the portion of our mental processes involving memory, calculations, theories, plans, etc., which usually pertain to the material world surrounding us. By emotions we mean our feelings that result from stimuli that act upon us and produce a reaction. Adding two and two, or remembering who was president of the United States in 1900, is essentially an intellectual activity; jumping when a door slams, or crying over news of the death of a dear one, is essentially an emotional activity.

The emotional activity that is most commonly associated with mild cases of mental disorder is the one activity that results when our big instincts are thwarted, or are in danger of being thwarted —in other words, fear, in all its varying forms, conscious and unconscious. We have an instinct of self-preservation, and we are afraid of illness, or symptoms that we believe indicate illness; we fear financial failure, or difficulties that threaten our social status. We have an instinct to do as others do, and we are distressed if we cannot have a straw hat when every one else is wearing one. We have an instinct to pass on life to another generation, and we are worried if we cannot marry and have a home of our own. Fears of one sort or another produce most cases of mild mental disorder. The problem is, How can we be freed from these fears?

Where do our emotions come from? They arise from our environment as environmental strains, from our bodies as pains, and from our minds as worries. And of these three sources the most common is the *mind.* Hard work alone, or pain alone, seldom, if ever, produces mental disorder; but work plus worry, pain plus worry, or sleeplessness plus worry (not sleeplessness alone) may result at times in mild mental disorder. By cutting out worries, by following a code of behavior which meets our own approval and that of society, by understanding our troubles, and, if we cannot solve them, by gaining a trust in a Higher Power that will bring things out all right in good time, we can avoid mild cases of mental disorder.

Of course, persons vary greatly in the degree to which they react to emotional stimuli, and any one person varies from time to time in his reactions. John may suffer from having a discord struck on a piano, while Charles may not notice the discord at all. When a person is chronically so sensitive as to be incapacitated by stimuli that produce little effect on most persons, he is considered to be in a psychopathic state of mind, and he must learn to control his reactions to these stimuli. This is best done by occupation that diverts his attention from his sensations, or by substitution of other and more important and engrossing stimuli; thus, many a psychopathic person has found health when happily at work, and many a "nervous invalid" in time of crisis has become a successful leader.



(Ewing Galloway)

Health includes mental health.

Perhaps the commonest symptoms of approaching mental breakdown are depression and feelings of inadequacy. Such feelings arise frequently with fatigue, and after or during illness, especially jaundice and influenza. Statistics show that acute recoverable mental cases are more likely to be depressed than severe non-recoverable cases. To be depressed requires brains, and working brains.

There are two excellent rules to follow:

First, when you have worked until you are tired and then are compelled to keep on working, and you begin to feel less and less tired the more work you do, and you seem to require progressively less sleep, be careful! You have tired out your sense of fatigue. Stop work and take a vacation, or you will probably have to take a long one.

Second, when you begin to feel that no one can do your job but yourself, be careful! A fresh assistant can do almost any job better than you can when you are tired. Again it is time for a vacation unless you want to be forced to take a long rest.

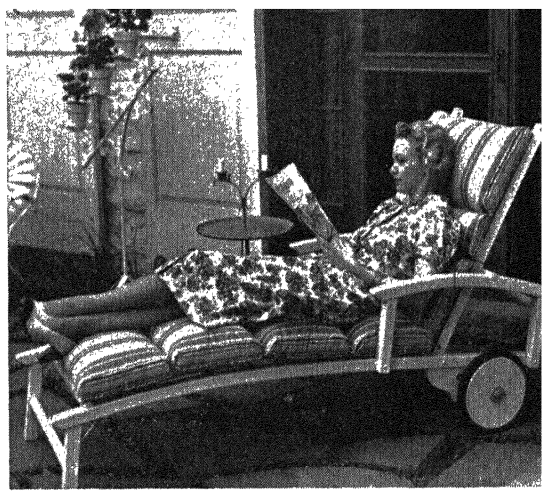
Psychoneuroses.—The term "psychoneurosis" is used to include certain nervous and mental disorders in which no alteration can be found in any part of the nervous system. One might compare the psychoneuroses to a watch that needs oiling or cleaning, or merely winding up, not with one that has a vital part broken.

Psychoneuroses are divided by physicians into three kinds: neurasthenia, psychasthenia, and hysteria. Fundamentally, *neurasthenia* is marked by an increased liability to fatigue. The tired feeling that comes on with a minimum of exertion, that is worse on arising than on going to bed, is its distinguishing mark.

This fatigue enters into all functions of the mind and body. It is often marked by a lack of control over the emotional expression, so that anger blazes forth more easily over trifles, and even slight vexation brings tears.

In addition to this central group of symptoms are varied pains and aches which are really more often disagreeable feelings rather than true pains; changes in the appetite and in the condition of the bowels; and insomnia or disturbed, restless slumber. Worry is a fundamental emotion in the symptoms of neurasthenia. It takes two main forms: first, the worry over the life situation in general; and, second, a special form of worry called hypochondria, which essentially is morbid anxiety about one's own health.

The term *psychasthenia* includes a group of conditions in which the bodily symptoms, such as fatigue, sleeplessness, loss of appetite, etc., either are not so marked as in neurasthenia or are overshadowed by other more distinctly mental symptoms. These mental symptoms are of three main types: First, recurring fears of all kinds and descriptions, fears which have received formidable Greek names, but which are fears of open places, of closed places, of being alone, of dirt, and of disease. Second, obsessive ideas and doubts which persist in coming, against the will of the patient. In extreme psychasthenia the difficulty of making decisions becomes so great that a person may suffer an agony of internal debate about crossing the street, putting on the clothing, eating the meals, in fact, about every detail



A vacation combining recreational reading with a program of activity is one cure for mental fatigue.

(H. Armstrong Roberts)

of action and thought. Third, impulsions and habits. The impulsions are sometimes absurd, as when a person feels compelled to step over every crack, to touch the posts along the journey, or to take three steps at a time. The habits range from the desire to bite one's nails to the quick, which is so common in children and which persists in the psychasthenic adult, to the odd grimaces, facial contortions, blinking of the eyes, and cracking of the joints.

The third great psychoneurosis is *hysteria,* which almost defies a short account. There is a hysteric temperament, an emotional instability, and an egotistic, easily wounded nature, craving sympathy and respect, admiration and achievement, but unable to earn them legitimately. Next is a group of symptoms, the so-called paralyses, which may involve any part of the body and persist in certain cases for years. These paralyses yield remarkably to any energizing influence as good fortune, the compelling personality of a physician, clergyman, or healer (the miracle cure), or a serious danger. Comparable to the paralyses are queer losses in sensation which sometimes take the form of hysterical blindness, or deafness, and which, like the paralyses, yield at times in bizarre manner to unusual influences.

We may discuss the causative factors of these three conditions. Let us start with the statement that mind and body are one, that what happens to one physically may change the whole trend of thinking, feeling, and acting; and what happens to one mentally, either as an idea or as an emotion, may change the workings of the body, disturbing sleep, digestion, and the coordinated action of the great organs of the body. These are psychosomatic relationships. Thus psychoneuroses may follow exhausting illness, surgical operation, difficult childbirth, and any other situation which drains the energy and resources of the organism.

Just as surely as physical situations may cause neurasthenia, psychasthenia, or hysteria, so mental situations may likewise cause them. Fear may arise as a sudden and overpowering emotion on the battlefield, or in the perilous places in industry, or on the streets of the cities, and, occasionally, even in the safest and coziest nook of the home. Fear may act as a most potent drug, and its physical

effects may range from the cold chill, the rapid heartbeat, the sharp, painful respiration, and the all-gone feeling in the abdomen, to the most complete unconsciousness.

Every human being is a pot boiling with desires, passions, lusts, wishes, purposes, ideas, and emotions, some of which he clearly recognizes and clearly admits, and some of which he does not clearly recognize and which he would deny. These desires, passions, and purposes are not in harmony with one another; they are often irreconcilable, and one must often be suppressed for the expression of the other. It is in these conflicts and their results that the major part of neurasthenia, psychasthenia, and hysteria arises.

Serious Cases of Mental Disorder.—The cases of mental disease in which the symptoms become marked are characterized as insanity. It should be thoroughly understood that from the standpoint of medicine insanity is a useless term. However, let us briefly review the types of mental disease with symptoms that frequently make it necessary to secure medical supervision in an institution. The cases may be divided into two major groups: (A) those in which a definite recognizable organic disorder exists, from which disorder the mental symptoms arise; and (B) those in which no such organic disorder has been demonstrated, and which we are prone to consider as a group of functional psychoses, that is, with disorders not of organic origin.

A. The organic group consists of cases in which one of the following occurs:

1. A pathologic process having its primary seat in the central nervous system, as (a) general paresis ("softening of the brain" due to syphilis), (b) brain tumor, (c) cerebral arteriosclerosis ("hardening of arteries of brain"), (d) senile dementia, (e) multiple sclerosis and (f) injury to the brain as from a blow on the head.

2. An injury of the brain secondary to disease in the body, such as (a) fever delirium, (b) uremic "poisoning," (c) injury due to disorders of the endocrine systems, such as exophthalmic goiter and myxedema.

3. An injury of the brain due to poisons taken into the body, as alcohol, drugs, metallic poisons (lead, mercury).

Some of the conditions, such as brain tumor, senile dementia, and the other degenerative lesions, we are helpless to prevent. On the other hand, the prevention or early and adequate treatment of acquired syphilis should prevent general paresis. Abstinence will prevent the diseases arising from alcohol and drugs. Hygiene will eliminate the possibility of metallic poisons, and the reduction of infections will diminish the resultant mental symptoms.

B. The functional psychoses must be considered from the psychologic standpoint. While heredity and constitutional factors have a bearing upon the development of these psychoses, they are so intangible that they cannot be considered of any great practical application. Mental factors, life experiences, are the elements that must be studied.

One group of these cases includes *manic-depressive psychosis* and *involutional melancholia.* While the symptoms may be exceedingly marked and disturbing, the prognosis is, on the whole, good.

The second large group of functional psychoses are those that have a tendency to deterioration and chronicity, and are usually considered under the medical diagnosis of *schizophrenia (dementia praecox).* These cases tend to show disorder of thought (delusions, hallucinations). They begin, on the average, at the adolescent period and have a bad prognosis. They become the most unfortunate and the most important of the mental disorders. They represent a high proportion of the cases admitted to the state hospitals for mental diseases.

Finally, mention should be made of *paranoia,* a condition characterized by the development of delusions. The disease progresses slowly and insidiously and makes the patient unfit for normal life.

Prophylaxis should be directed toward proper training during the early days of childhood. Each case should be considered on its own merits and should be studied from the standpoint of the person himself, his personal endowments, his past experiences and difficulties.

Mental Difficulties of Peculiar Persons.—Conspicuous among eccentric persons are the *paranoid personalities.* These individuals are peculiarly sensitive. Their ego is dominant, and they care

more for its promptings than for the commendation of the other members of their group. These persons frequently head reform movements, but more often they live a thorn in the flesh of their associates, quibbling over the social transgressions of their neighbors, and attempting numerous social measures in an unconscious and blind struggle against the dictates of the larger herd or group of people. Among these will be found sympathizers with the enemy in time of war, certain conscientious objectors, and those who habitually form themselves into "anti" societies. Carried to the extreme degree, these persons are called *paranoiacs*—those who are so far unbalanced as to have delusions of persecution and ideas of grandeur. Mental hygiene does not attempt to remake these individuals, but it asserts that, understood and tolerated, most of them are useful and important members of society.

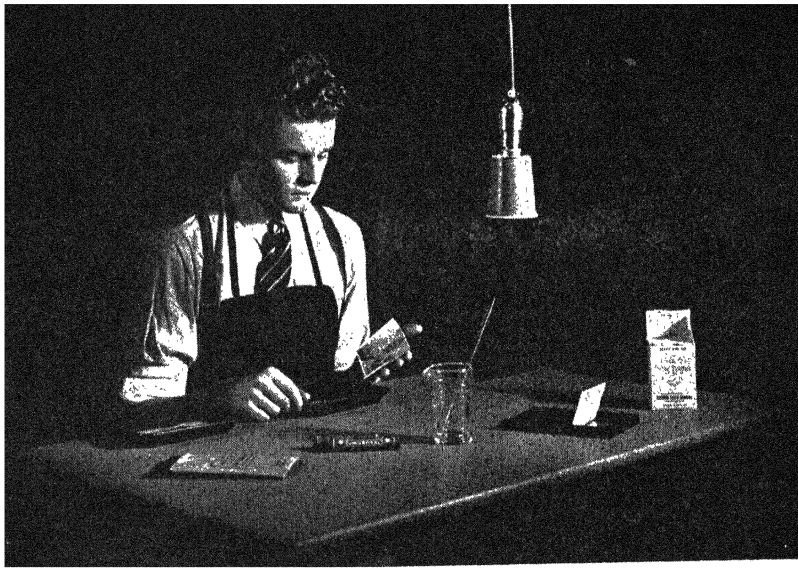
A word of caution is necessary in considering this group, and this is our innate tendency to regard any one who disagrees with us as being of morbid or inferior mind. It must be remembered that every once in a while one of these persons is right, and the world is wrong.

Another type of personality that leads to conduct disorder is that having *unstable* or *untrained emotion.* Such a person reacts excessively to the ordinary emotional irritants of life, and often violently to minor stimuli. To be sure, this emotional instability is almost normal in childhood, and when we deal with it in adult life, we can hardly be sure whether the condition is due to an innate quality or to the lack of opportunity for acquiring normal poise.

Another type frequently mentioned is the *inadequate personality.* With these persons we can never be sure whether they can, but do not want to, or whether they want to, but cannot. The net result, however, is clear; viz., they must be carried along by their stronger, more virile, associates.

Generally speaking, it is wrong to think of these disorders of personality as insanity, and they are better understood if they are conceived as types of mankind.

Mental Health for Normal Children.—Among normal individuals, especially children, we often see reactions suggestive of those which characterize mental illness. Only when they are



A good hobby contributes to mental health.

exaggerated and repeated, becoming consistent behavior patterns, are they cause for alarm. The following table lists some of these reactions:

BEHAVIOR IN CHILDREN WHICH IS SERIOUS ONLY WHEN HABITUAL	MENTAL DISEASES HAVING SIMILAR BUT EXAGGERATED RÉACTIONS
Avoiding unpleasant assignments by having "indigestion" or a "headache" or by being "all tired out"	Neurasthenia
Doing needless things (like stepping over every crack) for fear of ill luck	Psychasthenia
Having a temper tantrum when things do not go his way.	Hysteria
Daydreaming of a life in which all his wishes are met	Schizophrenia
Always getting his feelings hurt, blaming others, and feeling that others do not like him	Paranoia

The simple principles of mental hygiene should be practiced in every home, and should be heeded in all forms of school instruction and discipline. Among the most important are the following, expressed here in terms of child training:

1. Children should be given an opportunity for normal reaction to their natural instincts and impulses—to be active in play and work, to express their emotions; not only to assert themselves, but also to serve others and cooperate with them.

2. Children should be trained to control their activities and impulses. Natural and helpful control does not come from repression and direct inhibition, but rather from indirect control. We control one action by doing something else, one interest by developing other interests; we stop thinking of one subject by thinking of another.

3. Children should be taught to concentrate attention on the one thing in hand. Children naturally do this. Short periods, complete attention, no dawdling, should be the rule. Children should be taught to live one day at a time, to settle their moral accounts every night, never to hold a grudge, never to let the sun go down upon their wrath; to look upon each morning as a new day in which to improve, and not to carry over their troubles from yesterday.

4. Attention to the present situation implies orderly association. Disorderly association is the beginning of mental conflict and worry. Tasks should be simple and definite, instructions clear and concrete, decisions and action straightforward and wholehearted if habits of orderly association are to be developed.

5. The fifth condition of mental health is an active attitude in the face of difficulties. The trying situations of childhood, "when a feller needs a friend," the occasions of worry, of fear, and of rage, represent opportunity for the most important training. The physiology of these emotions indicates the hygienic response. There are increased secretion of adrenalin into the blood, an increase in heart rate, blood pressure, and sugar secreted from the liver, and cessation of digestion. Everything is prepared for action. Vigorous action is normal. The repression of action probably means short-circuiting and nervous strain.

6. The sixth condition of mental hygiene concerns normal social relations. It is better for a child's mental health to eat, play, work, and study with other children than alone or with adults. To act with others as follower or leader, to serve, to cooperate, and on occasion to resent or to fight, represent healthful attitudes and healthful forms of activity; to deceive, to act cruelly, to be suspicious, to hold a grudge, are unhealthful as well as unsocial mental attitudes.

7. The seventh condition of healthful mental activity is a normal sense of dependence. This is perhaps the essential psycho-

logic element in religion—a sense of dependence on a Supreme Being, or on the beneficent laws and forces of nature or on the moral strength of humanity, or the categorical undebatable authority of duty, or one's sense of honor, absolute and worth while for its own sake. If not tampered with, this seems to develop normally in children; first as dependence on one's own parents, later as dependence on something higher.

To state these principles is easy; to practice them, infinitely difficult; and to train children to practice them, a task for the greatest artist.

Mental Conflicts of Children.—The four fundamental characteristics of *plasticity, suggestibility, imitativeness,* and a *love of approbation* are dominant during the first few years of life, and are invaluable assets in our efforts to model and remodel personality.

The home represents the workshop in which these personalities are developed; but the mental atmosphere of the home can be very easily contaminated. The ever-changing moods of the parents, colored by their indifferences, their quarrels, depressions, and resentments, and shown by their manner of speech and action, are decidedly unhealthful; so, too, are the timidity of a mother, the arrogance of a father, the self-consciousness of a younger sister, and the egotism of an older brother. On the other hand, cheerfulness, affection, kindly consideration, cleanliness, and a manner and speech that are not forbidding but show interest in the questions of the child, frankness and honesty in answering his questions, with the idea of developing freedom in speech and action not inhibited by fear of punishment or silent contempt—all these things play an inestimable part in the development of the personality of the child. The environment is mirrored in the character of the child, regardless of what his heredity may be.

Frances, aged 2 years, was brought to a habit clinic by her mother because she was making vicious attacks upon her older sister, Ruth, aged 4 years. The day before her visit to the clinic, she bit her sister on the abdomen and scratched her face rather severely. Investigation of this particular situation revealed the fact that the father had noticed that when Frances was eighteen months old, she showed rather unusual and amusing reactions whenever he petted her older sister. It soon became his pastime, when he came home from work, to make a great deal over Ruth

in order to arouse jealousy in Frances. He did not realize the danger of this. Here is a good example of jealousy developed in pure culture, an emotional reaction that we are all aware frequently leads to serious difficulties.

Paul, aged 4 years, an alert lad of normal intelligence, every now and then caused much concern in the family by losing his voice. The reason for the trouble was obscure until Mrs. N reported at the out-patient clinic at the Psychopathic Hospital with the identical complaint. Investigation revealed the fact that Paul lived in the same house with Mrs. N and that he spent as much time in her home as he did in his own. This symptom was one that had its basis in the imitative tendency, so well marked in children.

The foregoing conditions are "undesirable habits" which might well be considered self-eliminating, yet this in no way justifies our ignoring them.

Feeblemindedness.—Feeblemindedness is not a disease like scarlet fever or pneumonia; it is a condition characterized by a lack of normal development of the *intelligence,* resulting from damage to the structure of the brain by disease or injury sustained before birth, at birth, or during the first six years of life, or from imperfect development of the brain structure.

Feeblemindedness may be due to a great variety of *causes.* Often the cause is not known. A feebleminded child may have perfectly healthy parents. Feeblemindedness may be caused by illness or weakness of the mother during pregnancy, or of the father at the time of conception. Injury of the head at birth or falls or blows in early infancy may be causes, although very severe head injuries at this time often are not followed by mental defect. There is frequently a history of normal, healthy infancy for several months, with a sudden occurrence of symptoms of severe illness, perhaps with vomiting, high fever, stupor, and even convulsions. After a few days the acute illness subsides, but the child is less bright and is never right mentally afterward. In other cases, the mental defect seems to be a sequel of measles, whooping cough, pneumonia, cholera infantum, and so forth, occurring during the first six years.

Syphilis of the parents is responsible for at least 6 per cent of the mental defects found in Massachusetts institutions for feebleminded persons.



An intelligence test. (Courtesy Bates College.)

In *cretinism* the mental defect is caused by imperfect action of the thyroid gland, which prevents the brain from functioning normally. Other forms of mental defect, such as *mongolism*, are probably caused by abnormal conditions of other ductless glands. The structure of the brain is so damaged that normal intellectual development cannot occur as in healthy children.

There is also the *hereditary type of feeblemindedness* which in certain families is transmitted from generation to generation in accordance with certain definite laws of heredity. If both parents possess this type of hereditary defect, all of their children are usually feebleminded. If only one parent is of this type, the children may be normal, but some of their descendants will be feebleminded. The defect may disappear in one generation, only to reappear in the next.

Thus there are two main types of feeblemindedness: the *accidental* and the *hereditary*. The appearance of a feebleminded child of the accidental type does not mean that other cases are likely to occur in that family, and does not, in any sense, imply family

inferiority. The parents should understand that such a child is an invalid just as if he were crippled as a result of any form of bodily disease.

By the use of modern psychometric tests the intelligence of the defective child can be accurately *measured,* and a very close estimate made as to what his mental development will be when he reaches adult life. These tests enable us to state the intelligence of the child at a given time in terms of *mental age.* For instance, a mental age of 6 means a degree of intelligence corresponding to that of a normal child of 6 years, and so forth. A defective child 12 years old may have a mental age of only 9 or 6 or 3, or even less. The ratio between the mental age and the real age is called the intelligence quotient, or the I.Q., and it tells just how backward the child really is compared to a normal child. Thus a normal child 12 years old with a mental age of 6 has an I.Q. of 50.

According to many authorities, an intelligence quotient of less than 70 generally means that the child is feebleminded. However, this is not always true. Defective persons with an I.Q. between 50 and 70 are called *morons;* those with an I.Q. between 25 and 49 are called *imbeciles;* and those with an I.Q. of less than 25 are called *idiots.*

The *mental age* reveals the intelligence of a defective child at the time of examination. The *intelligence quotient* tells how bright he is compared to a normal child and how intelligent he will be when he reaches the age of 15, or the adult level. The mother or the teacher must disregard the child's real age and base his instruction and training on his *mental age.*

It is useless for a defective child with a mental age of less than 5 years to attend school. For the defective child with a mental age of 6 or over, the public schools in most cities and large towns now have special classes where he can receive proper instruction. These children often do well in regular school classes if they are understood by the teacher and the work is suited to their mental age, and if the teacher is satisfied with the best the child can do. The teacher cannot make the child brighter. He has a small mental dipper and he gets that dipper full under very ordinary and common conditions. The teacher's task is largely a matter of social training of the child; that is, training in inhibition, in emotional control, in conforming to the amenities of life, and in teaching

him to do as other children do. There is no special pedagogy for feebleminded children.

The current belief that feebleminded persons usually become idle, vicious, and troublesome when they reach adult life is only partially true. Defective children who are *neglected* and the few who seem to be innately bad from early childhood are much more likely to become vicious and immoral than normal children. They need much more care than do normal children; in fact, they usually need supervision and assistance as long as they live. But defective persons with a mental age of from 6 to 10, who are properly trained and protected during the formative years, as a rule become well-behaved and useful adults.

No two defective persons are exactly alike. What is good for one may be bad for another. A defective individual can be adequately expressed or described only by an equation—his intelligence + his body + his family + his personality traits + his morals, and so forth. No routine procedure will meet the needs of this highly differential group.

We now know that all feebleminded persons cannot be permanently segregated in institutions. We believe that the vast majority will never need such provision; they will adjust themselves at home, as they have always done in the past. They will be recognized during their school life by school and traveling clinics and they will be given better training in special classes or in the regular classes. Much of the present scholastic training will be supplanted by industrial training. The schools are providing special social supervision and will do much more in the future. The bad defective individuals and the neglected ones will be sent to institutions before they come to grief. After the school age the state will provide extramural supervision for all neglected or badly behaved defectives. The price of liberty will be good behavior. Those who can live at home safely and usefully will be allowed to do so. Well-behaved institution patients will be released on permanent supervised parole. It should be a highly selective process.

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CHAPTER XIII

NARCOTICS AND STIMULANTS

ALCOHOL

What are the effects of alcohol on the human body, on society, and on industry? An intelligent decision by the individual as to his own course of action with regard to the use of alcohol must be based on accurate information regarding these points.

Alcohol and Health.—The alcohol used as a beverage is a variable solution of ethyl alcohol, containing aldehydes and ethers which give the different flavors to liquors.

PERCENTAGE OF ALCOHOL IN VARIOUS KINDS OF ALCOHOLIC DRINKS*

Beers	1.0 to 7.5
Ale	3.2 to 5.4
Porter	3.7 to 4.0
Stout	4.7 to 5.3
Wine	4.2 to 23.0
Spirits	43.0 to 54.0
Liquors and Cordials	32.0 to 67.0

*From Emerson: *Alcohol—Its Effects on Men.* Reproduced with permission of D. Appleton-Century Co., Publishers, New York.

Physiologists now agree that alcohol is not a stimulant but a narcotic, capable of producing unconsciousness or of inhibiting activities. The feeling of exhilaration that follows a mild dose of alcohol is due to paralysis of the higher nerve centers that cause inhibition. When these centers are shut out from the rest of the nervous system, the individual no longer feels the restraint of dignity and propriety. He gives free rein to his impulses and thinks he is the soul of wit and the prince of good-fellows even though his activities are most asinine. Alcoholic stimulation is like taking the brakes off an automobile that is traveling downhill.

Alcohol has some fuel value. It can be oxidized immediately, but it cannot be stored nor can it aid in the building of any tissue. It spares to some extent the use of fats, carbohydrates, and proteins as energy-producers and permits their storage. However, it has certain drug and poison effects not present in the other

classes of food. Hence, although in the strictly limited sense alcohol can be called a fuel food, it is neither a necessary nor a desirable one.

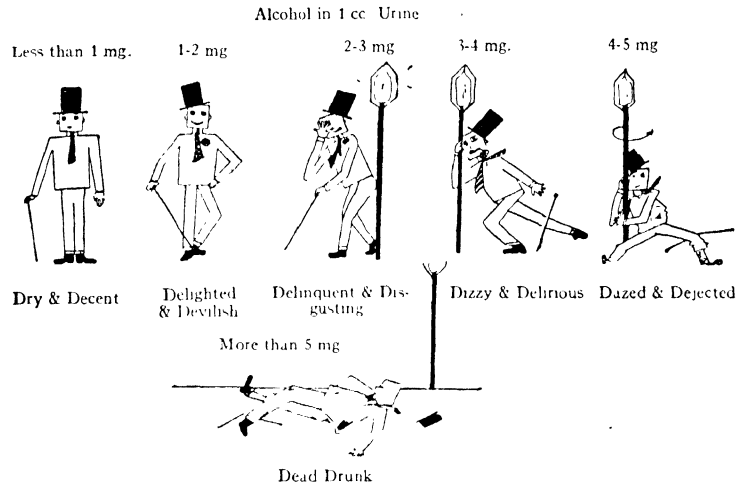
What happens when alcohol is taken into the body? About one-fifth of it passes directly into the circulatory system from the walls of the stomach, and the remainder is absorbed from the small intestine. No digestive changes take place with alcohol. Once in the blood stream, it passes rapidly into other tissues and organs, moving always toward cells with low alcohol concentration. Approximately 2 per cent of the alcohol taken into the body is eliminated through the lungs and the kidneys. The remainder enters the tissues and is completely oxidized to produce carbon dioxide and water. Alcohol can be burned in the body at the rate of about 10 c.c. per hour. Its oxidation rate cannot be increased, and hence the time required for complete elimination is dependent on the amount taken. While alcohol is being transformed into heat or energy, it is exerting characteristic effects upon various organs. What are these effects?

Alcohol Acts as a Narcotic on the Central Nervous System. The extent of this action is dependent upon the quantity of alcohol which reaches the brain and spinal cord. The effect produced varies from a pleasant state of euphoria in which disturbing and unpleasant facts of life fade out of consciousness, to final stupor, coma, and, in some cases, even death. The higher centers of the brain that function in memory, attention, thought, judgment, and self-control are the first affected by the narcotic. The centers that control motor and sensory functions are affected later, altering muscular and sensory reactions.

Alcohol Produces No Direct Effect Upon Muscle Tissue. Alcohol acts upon nerve tissues rather than muscles and effects a reduction in the speed and accuracy of muscular reactions. This has been shown by tests to vary from 5 to 60 per cent. Through acting upon the inhibitory nerves of the heart, which ordinarily prevent its overactivity alcohol increases the rate of contraction and causes rapid heartbeat. Thus alcohol is not a heart stimulant. Its usefulness in rousing an unconscious person to consciousness is due to its irritating effect on the surfaces of the mouth and throat.

Alcohol Produces Changes in the Circulation Due to the Dilatation of the Blood Vessels at the Surface of the Body. This inter-

feres with the maintenance of the body temperature through the heat-regulating mechanism. Congestion of blood in the skin produces a feeling of warmth and leads to excessive heat loss. There is no compensatory increase of heat production in the tissues. The individual feels warm, but his deep body temperature is lowered. No harm results if the person is resting and well protected from cold, but the effect of alcohol during exposure is often serious.



Changes in reaction as the concentration of alcohol in the body increases. (From Emerson: *Alcohol and Man.* Courtesy The Macmillan Co.)

Accuracy in interpreting sensations and speed in responding to these, are lessened by the *narcotic effect of alcohol on nerve tissues in the special sense organs.* Error in interpreting and delay in responding to the danger signals which reach the brain through the eye, the ear, and kinesthetic sense have an important bearing on speed and power in industry and in automobile driving. Because alcohol is eliminated from the body at a constant, but slow, rate its effect upon these sense organs may be present for many hours after the taking of even a moderate drink.

While the most profound changes produced by alcohol are upon nerve tissues, and through these on muscles, sense organs, and the heat-regulating mechanism, it is interesting to note *its effect upon other parts of the body.* Small or moderate amounts of alcohol

cause no appreciable change in *respiration,* but large doses may cause complete paralysis of the center, and death.

Alcohol produces very little effect upon the *digestive processes* when used in moderate amounts. It acts as a depressant on the nerves and lessens peristaltic action. The flow of saliva increases slightly, though this is of slight significance. There is an increase in the flow of gastric juice which is lower in pepsin and higher in hydrochloric acid than normal. This apparently does no particular harm. When alcohol of from 5 to 10 per cent or greater concentration is taken, the chemical changes of digestion are retarded greatly. The flow of gastric juice diminishes and mucus, a symptom of gastritis, appears, due to the irritation of the glandular surfaces.

The removal of inhibitions which ordinarily function leads to undesirable freedom in *sex conduct,* and hence to the danger of infection with gonorrhea or syphilis. There appears to be no actual damage to the reproductive glands themselves from the use of alcohol.

The use of alcohol as a *medicine* depends chiefly on its narcotic effect on the central nervous system, its ability to dilate the blood vessels of the skin, its soothing effect on the muscular action of the alimentary tract, and its ability to be assimilated without requiring digestive change. Its use as a medicine should be under the direction of a physician just as is the use of other prescribed remedies.

Many *patent medicines* have an alcoholic content greater than champagne. It may be appropriate to classify such substances as alcoholic drinks, especially since, in many cases, their real medicinal value is seriously in question. The man who is foolish enough to take such a remedy without the advice of a good physician should know what it is that makes him "feel better" when he takes a patent medicine cocktail.

Acute *alcohol poisoning* may follow continued and excessive use of alcohol. The presence in the body of from 5 to 6 mg. of alcohol per cubic centimeter of blood will cause death. This is due to a paralysis of the respiratory center and is purely functional. Chronic alcoholism develops slowly with continued or intermittent use of beverages of high alcoholic content (40-50 per cent) or the repeated drinking of additional alcohol before the alcohol

already taken has been entirely disposed of by the body. Gradual changes appear that affect not only personality and intelligence but also the physical condition of the organs of digestion, the liver, and other soft tissues of the body, so that disease may develop in these parts. Inflammation of the nerves is commonly found in chronic alcoholics. Alcohol may cause death directly or it may cause it indirectly through accident or disease.

Both acute and chronic alcoholism are accompanied by *lowered resistance* to respiratory and to septic infections, though there seems to be no evidence that the moderate use of alcohol lessens disease resistance appreciably.

The use of alcohol has a marked effect on *longevity*. Statistics from life insurance companies show that, on an average, total abstainers live longer than nonabstainers. There is evidence that alcohol, even when used in moderation, is a factor in shortening the average length of life.

Alcohol and Society.—The social consequences of alcoholic beverages are related to the character, nervous instability, and physical constitution of the persons who use them. The social problems that have followed the use of alcohol in the past include, among others, crimes of violence, neglect of family obligations, poverty, dependency, invalidism, and insanity. It is likely that these will always be associated with the use of alcohol as a beverage, for persons who are lacking in nervous stability and self-control are most addicted to its use.

Experts estimate that the United States has 3,750,000 chronic and excessive drinkers, of whom 750,000 are problem drinkers and that they cost society one billion dollars a year. The problem drinkers are sick persons, needing the consideration and attention of medical science. Arrest and jail sentences are not curative measures.

If social ill-effects were to be avoided, the alcoholic content of beverages would have to be restricted to well below 10 per cent. These would have to be taken slowly, with or soon after meals, but never on an empty stomach. It would require that drinks be taken only after work is over and that, for several hours following, there should be no possible demand for physical or mental activity or for maximum exertion, skill, and judgment. Above

all, it would require that drinks never be taken at a time when the person is responsible for the safety or life of another.

In industry it has been found that alcohol reduces output and lessens caution, skill, endurance, and accuracy. Accordingly, production is lowered and avoidable accidents increase. It has been found also that alcoholism predisposes a person to many industrial poisons.

The effect of alcohol upon the accident rate outside of industry is also apparent when statistics are reviewed. Twenty per cent of all fatal traffic accidents are due to the use of alcohol, according to the National Safety Council.

The attitude of society toward the use of alcohol varies sharply in different communities and among different groups in the same community. Some groups condemn the use of alcohol while other groups seem to expect it. The thoughtful hostess anticipates these differences among her guests. She provides fruit juices at cocktail parties for those who prefer it. Certainly the person who does not care for alcoholic drinks should not hesitate to refuse them any more than he would hesitate to refuse a food he does not like or to which he is allergic.

Summary.—Dr. Emerson summarizes the effects of alcohol, which are supported by a remarkable unanimity of scientific opinion, as follows:*

1. Alcohol is a narcotic which, by depressing the higher centers, removes inhibitions.
2. Outside of the nervous system and the digestive tract, alcohol used as a beverage has little demonstrable effect.
3. It is a food, utilizable as a source of energy and a sparer of protein, but it is such only to a very limited extent.
4. It is improbable that the quality of human stock has been at all injured or adversely modified by the long use of alcohol, although the effects on the individual are often devastating.
5. The therapeutic usefulness and value of alcohol are slight.
6. It may be a comfort and a psychologic aid to the aged.
7. It does not increase, and it sometimes decreases, the body's resistance to infection.
8. By releasing inhibitions, it makes for social ease and pleasure, and herein lies one of its great dangers.
9. Its effects are best studied by changes of conduct.

*Loc. cit.

10. It impairs reason, will, self-control, judgment, physical skill, and endurance.
11. It may produce situations from which crime and social lapses result.
12. It is a frequent destroyer of health, happiness, and mental stability.
13. Its use commonly lowers longevity and increases mortality.
14. It is used primarily for its psychologic effect as a means of escape from unpleasant reality.
15. It constitutes an important community health problem.

NARCOTIC DRUGS

Certain alkaloid drugs that are useful in medical practice to soothe pain and to dull the senses have a tendency to create a craving for repeated and larger doses. These drugs include cocaine, an extract from the leaf of the coca plant, and opium, the juice of a certain poppy. Products of opium include morphine, codeine, heroin, and many other substances.

Various laws have been enacted to control the use of drugs in the United States. The Harrison Narcotic Act of 1914 requires the reporting of all sales of narcotic drugs as well as of all imports and exports of the drug. It makes it illegal for anyone except properly authorized persons to sell or to give away any narcotic drugs. In 1922 the Jones-Miller Bill was passed, prohibiting the importation of any narcotic except crude opium and coca leaves and these only in such amounts as are necessary to provide for medical and legitimate uses.

Narcotic drugs are poisons, but the body has the ability to develop a "tolerance" with repeated doses. As this tolerance grows, larger doses are required to produce the desired effect.

The drug habit may be acquired accidentally through the use of drug-containing medicines. Probably the greatest source of danger lies in the chance taking of drugs by young persons, due to either ignorance or lack of character, when solicited by dealers in their illicit sale. The fact that about one-third of the drug addictions begin before the age of 20 years points to this danger. The large profits accruing in organized drug traffic stimulate the business of securing recruits by offering the seemingly harmless drug to unsuspecting or uninformed young persons.

The Federal Food, Drug, and Narcotic Act of 1938 provides a warning against habit-forming substances by requiring that all drugs offered for sale shall carry a label bearing the name, quan-

tity, and percentage of narcotic or hypnotic substances contained therein. The label must also carry the statement "Warning—May be habit-forming." The substances which must be mentioned in the label are alpha eucaine, barbituric acid, beta eucaine, bromal, cannabis, carbromal, chloral, coca, cocaine, codeine, heroin, marihuana, morphine, opium, paraldehyde, peyote, or sulfonmethane; and any chemical derivative of any of these substances which has been found to be habit-forming.

The repeated taking of a drug for as long as ten to thirty days, depending upon individual susceptibility, places one in danger of becoming an addict. Early stimulation gives no warning of the intense physical suffering the confirmed addict must endure. The drug addict is helpless unless he gets his customary dose, and may suffer virtual insanity during the time he is deprived of it.

One of the serious results of drug addiction is the increase in crime. Authorities state that a large percentage of criminals are heroin addicts.

The drug habit can be cured, but only through long and skillful treatment. Even after cure there is danger that old associations and temptations may lead to recurrence of the habit. The controlled and intelligent use of narcotic drugs brings immeasurable relief to human suffering, but unwise use brings untold misery.

Marihuana cigarettes are sometimes used by young people. These are cigarettes dipped in the fluid extract of a weed, *Cannabis indica.* They produce hallucinations, with or without euphoria, and easily establish a craving for the drug. Their habitual use weakens the person's intellectual capacity and leads to general physical deterioration. Smokers of marihuana nearly always become imbecile in time.

NICOTINE

Tobacco is a narcotic, although its first effect on the nervous system is stimulating. The leaf of the tobacco plant is fermented, dried, and prepared for smoking. Its chief drug constituent is a volatile alkaloid, nicotine, one of the most violent poisons known. The drug is fatal in small doses, the amount varying with the individual and with pre-existing tolerance.

Other harmful substances that occur in tobacco smoke in addition to nicotine are ammonia gas, pyridine derivatives, carbon

monoxide, and traces of hydrocyanic acid, phenols, and aldehydes. It is believed, however, that the chief deleterious effects of tobacco are not due to the local effects of these substances on the mucous membranes, but to the presence of nicotine.

The nicotine content of tobacco varies from 0.6 to 4.8 per cent, the higher concentrations accompanying the presence of moisture. The amount of nicotine present in tobacco smoke also varies, not only with the kind of tobacco and its dryness, but also with the form in which it is burned. Nicotine volatilizes less completely in small burning areas (cigarettes) than in larger areas (cigars). About 14 to 33 per cent of the nicotine in cigarettes appears in the smoke. More nicotine is retained by the body when the smoke is inhaled than when it is not.

The first use of tobacco is usually accompanied by symptoms of poisoning. There is a marked difference in the ability of the body to tolerate nicotine; many persons develop a high degree of tolerance through use while others do so only in part. The adverse effects on nerves and heart are usually more profound in persons with sedentary habits than in those who are more active. In the person who is inclined to nervousness the smoking habit often becomes so fixed that the smoker cannot work for two hours without a cigarette. The most significant effects of the excessive use of tobacco are produced through chronic inflammation of nerve tissues. Among the more common symptoms are headaches, vertigo, and insomnia. The optic nerve is not infreqently affected. A smoker is likely to exhibit irritable traits, requiring continuous use of tobacco to allay these feelings.

The excessive use of tobacco tends to increase the heart rate, and the accompanying shortness of breath may become a definite handicap. Motor disturbances appear as tremor and loss of control of the finer muscles and reduced skill in manipulations. These disturbances in small muscle control may extend to the tiny muscles of the eyes and interfere with sight. The tissues of the gums, sinuses, and pharynx are often injured through the local irritation which accompanies smoking.

While the question of injury from the use of tobacco is largely an individual problem in the case of the adult, there is no question as to its deleterious effect upon youth. Growth is definitely re-

tarded under the influence of tobacco. Until growth is completed, tobacco should not be used.

There is no doubt that nicotine has a harmful influence upon mental efficiency. Laboratory experiments covering a large number of different intellectual processes substantiate this finding.

Earp, in summarizing the result of experimental research at Antioch College[1] states that there is "an undisputable association between the smoking habit and inferior scholarship. Evidence is adduced in favor of the hypothesis that low scholarship is in part at least directly due to the habit of smoking." This may not necessarily mean loss of mental power but rather the formation of habits of inertness and lassitude which do not contribute to the energetic mental effort necessary in intellectual pursuits.

It has been suggested that "smokers who attribute to smoking an increase in their capacity for intellectual and physical work are subjects of auto-suggestion: or the increased cerebral circulation from increased heart frequency may seem to produce an increased mental activity."

The question as to why smoking is so gratifying to the individual has been answered by experimental research. The action of nicotine on the adrenal glands increases temporarily the concentration of blood sugar and raises the rate of sugar combustion. The feeling of temporary refreshment is understood when we realize that it is the presence of hyperglycemia (excess of sugar in the blood) following a meal which relieves the fatigue and irritability occurring soon after blood sugar reaches the "fasting level" (0.08 to 0.10 per cent). The concentration of blood sugar may rise to 0.12 or 0.14 per cent within fifteen minutes following the smoking of a cigarette. During the next thirty minutes it may drop to, or slightly below, its former level. Many chronic smokers suffer some loss of appetite and loss of weight, gaining weight when they stop smoking.

CAFFEINE

Coffee and Tea.—The beverages made from the coffee bean and from tea leaves, as well as some soft drinks, contain an alkaloid, caffeine, which is a nerve and heart stimulant, quickening the heartbeat and relieving feelings of fatigue. Roasted coffee contains from 0.75 to 2.7 per cent of caffeine. Tea is still richer in

caffeine; but the amount present in a cup of tea is usually less than in a cup of coffee owing to the smaller quantity of the leaves used.

Caffeine first increases the rate of heartbeat and then lowers and strengthens it. In persons who are not accustomed to its use the blood pressure rises but later drops. This is due to the action of caffeine on the nervous control of the vasoconstrictor and vasodilator mechanisms. Caffeine also increases the secretory action of the kidneys. It has important medicinal uses as a cerebral stimulant and serves as an antidote for some narcotic drugs.

People usually drink tea and coffee to retard fatigue or to keep awake. They are stimulants, not narcotics. Their effects on the body depend very largely on the individual.

The use of tea and coffee by growing children interferes with normal nutrition. There is no food value in either beverage except the milk or sugar that may be added. Their use tends to satisfy hunger and to crowd out the foods which are needed for growth and energy. In addition, the caffeine tends to overstimulate the sensitive nervous system of the child.

Extremely nervous adults often suffer from nervous fatigue. They tend to be easily irritated and they fail to rest sufficiently. Such persons are most likely to indulge immoderately in the use of tea and coffee. The use of the stimulants aggravates the condition. Rest is the cure. Nutrition experts are agreed that the abuse of these beverages definitely causes considerable damage to the body.

There are times, however, when the use of caffeine as a stimulant may be highly desirable. The busy person frequently finds it necessary to meet unusual demands, when mental clarity is particularly needed. If a tolerance to caffeine has not been developed by constant use, a cup of coffee serves this purpose well and gives a temporary increase in mental alertness. It is well to know how to use such a drug as caffeine wisely. Those persons in whom it produces undesirable effects should avoid its use entirely.

THEOBROMINE

Theobromine, an alkaloid closely related to caffeine, is the active principle in cocoa and in chocolate, both of which are prepared from the seeds of the cacao tree. While its physiologic

properties are like those of caffeine, it has a greater action on the kidneys and a lesser action on the brain and central nervous system. Accordingly, it is less likely to produce nervous stimulation and sleeplessness. Both cocoa and chocolate have food value in addition to their stimulating properties. Chocolate contains about twice as much fat as does cocoa. Proteins, carbohydrates, and small amounts of minerals are also present. Owing to the small quantities used in beverages, their calorie value is not high except when milk and sugar are used in their preparation.

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CHAPTER XIV

THE HYGIENE OF BODY ACTIVITY

Successful living is aided by a good physique, a body which is able to carry one through the daily demands of work and play without undue fatigue. The development of such a physique is partly within one's control. Heredity determines it only in part. Physical activity produces beneficial changes in circulation, heartbeat, digestion, and assimilation. A brief review of the general structure and functioning of the mechanism involved will give a better understanding of the hygienic requirements of exercise.

Bones.—The skeletal structure provides protection and support for the soft portions of the body as well as leverage through which the muscular system can accomplish locomotion and manipulate objects. Contrary to the oft-used simile "dry as a bone," the bony skeleton of the living body is not dry, but made of living cells surrounded by hard, porous lime salts.

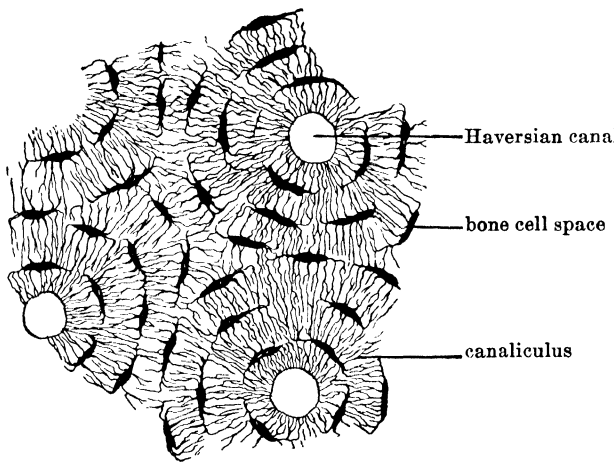
Bones are made up of a dense outer portion beneath which is a more spongy part. In long bones there is a central cavity containing marrow, consisting chiefly of fats and blood. The erythroblasts, from which red blood cells are formed, develop in the marrow at the ends of the long bones and in certain flat bones, including the ribs and sternum. Covering the bone and closely adhering to it is the protective *periosteum,* a layer of connective tissue through which nerves, lymph, and blood vessels enter and leave the bone.

Injuries to bones require immediate surgical attention. Injured bones begin to heal at once and any delay in having them properly adjusted may cause a deformity that is difficult to correct later.

Joints.—Two bones that are joined have, in most cases, special structures to make movement possible. An enlargement of the bones at their joint provides greater strength and permits the attachment of ligaments, which are strong bands of connective tissue that bind the bones securely together. In some joints, as in the vertebral column, the knee joint, and between the ribs and breast bone, pads of cartilage occur; these act as cushions to pre-

vent jar and to ease the motion between the bones. The ends of the bones (the articular surfaces) are cartilaginous. All joints are surrounded by a tough membrane called a capsule; it is lined with a synovial membrane which secretes a viscid fluid that lubricates the articular cartilages.

The Vertebral Column.—The main structures of the skeleton, including the protective cavities of the skull, thorax, and pelvis, and the appendages (arms and legs), are familiar to us. A brief discussion of the nature of the vertebral column, which supports the trunk and head, will help in understanding the hygiene of body activity.



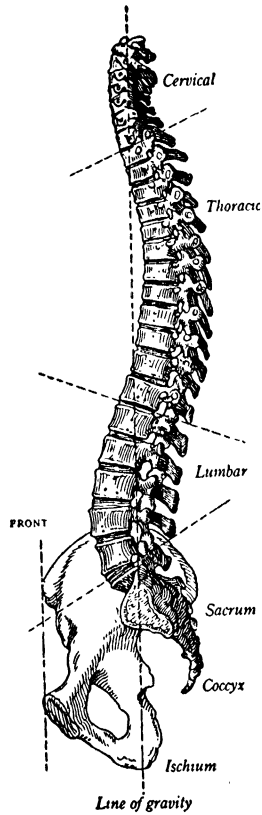
Compact bone (×200). (After Pitzman.)

The vertebral column is composed of separate bones, bound together by ligaments and separated by cushions of cartilage. The base of the column is part of the pelvis *(basin)*. The spine is flexible in every direction and normally shows alternating curves, which compensate when the body is erect, so that the line of gravity for the body weight falls almost wholly within the vertebral column.

Since bones and ligaments are practically insensible to fatigue or strain, the back can support heavy weights or remain erect with minimum effort, provided the spinal column is properly poised. Strain follows when the pelvis is tilted backward, and

the natural curve of the spine is disturbed. Then the body weight, instead of being sustained by the spine, must be supported by the action of muscles.

Muscles.—Closely associated with the skeletal system are the



Spinal column in erect posture, showing its support upon the sacrum and (the right) hip bone. Observe the angle formed by the top of the sacrum; the cervical, thoracic or dorsal, and lumbar curves; and the position of the line of gravity. (From Bennett: *School Posture and Seating.* Courtesy Ginn & Co.)

muscles which move the body in space, aid in holding the parts of the skeleton together, and cover the entire framework, giving form and beauty to the body.

All muscle cells are contractile. They tend to maintain a constant slight contraction (muscle tone) so that heat is always being

produced. Muscles are the chief organs for heat and energy production, for in their cells most of the oxidation occurs. Cold increases the tone of muscles causing greater heat production and producing a bracing effect. If the temperature is low enough, involuntary muscle contraction occurs (shivering, chattering of the teeth, "gooseflesh"). Too high a temperature reduces tone, causing less heat production and lassitude.

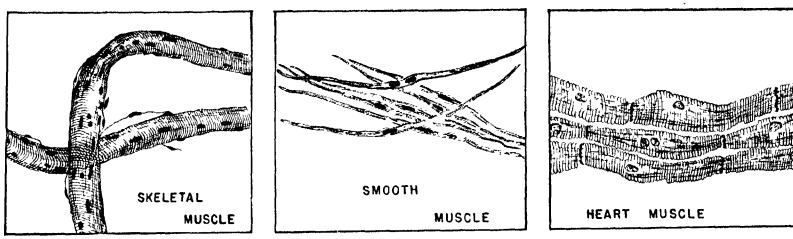
There are three different types of muscles: skeletal, visceral, and cardiac. The skeletal muscles are under the control of the central nervous system and are termed *voluntary muscles.* The cells of these muscles show distinct striations which lead to their designation as striped muscle. The visceral muscles, in the walls of the blood vessels and the viscera, are under the control of the autonomic nervous system and are termed *smooth muscles.* Their cells are slender and tapering in shape and show no striations. They are very important in the control of circulation and in the functioning of the digestive and excretory organs. The *cardiac muscle* is found only in the heart. The individual cells show striations somewhat like those in the striped muscle, but in their performance they resemble the smooth muscle. They function involuntarily. We are interested here in the skeletal or voluntary muscles and their relation to motion.

A typical muscle consists of a thick portion, known as the belly of the muscle, which tapers into the tendons that serve as attachments to the periosteum of the bones. The tendons are continuations of the connective tissue that surrounds the individual muscle fibers.

These fibers of the skeletal muscle are multinuclear, cylindric cells. They vary in length up to three or four centimeters. Each fiber consists of (1) the sarcolemma, an enclosing membrane; (2) the fibrils, longitudinal cylinders of dense protoplasm; and (3) the sarcoplasm, a fluid occuping the space between the fibrils. The sarcolemma is the "harness" or structure by means of which tension developed in the fibril is transmitted and made effective.

Muscles are richly supplied with blood vessels and nerves. The individual cells take up dissolved food substances from the blood and store up glycogen. They also absorb oxygen from the blood. Under proper stimulation from motor nerves various chemical changes, including oxidation, occur in the cells. Energy is liber-

ated and the cell contracts. The exact nature of this process has not been explained. The tension that develops in the cell after momentary stimulation is instantaneous and is followed by immediate relaxation. When nerve stimulations are applied in rapid succession so that relaxation is not possible between contractions, a condition known as physiologic tetanus occurs in which the effect is a sustained contraction.



The three kinds of muscle fibers. (Highly magnified.)

Muscular fatigue is loss of contractile power following continued stimulation. It seems to be due to the accumulation of sodium lactate within the muscle fibers, which interferes with the chemical processes necessary to produce contraction. Muscular fatigue is prevented when waste products are removed regularly and do not accumulate in the muscles. Muscular efficiency may be impaired by the failure of the body to supply sufficient oxygen to the muscles (as in the 100 yard dash) or to supply enough fuel (as in the marathon race).

Muscles are arranged in opposing groups, each producing movement in the opposite direction. Examples of such opposing movements are the flexion and extension of the forearm, and the forward and backward movement of the shoulders or the head.

Physical Activity.—Primitive man was active or he perished. In this day of complex living, the muscular exercise needed by the body must often be obtained by a planned program. It is more essential to the health of the sedentary person than mental exercise is to the health of a man employed in active physical labor. Especially among those who are intellectually inclined there is danger that the desire for good physical condition may stop with the envy of those who possess it or with an attempt to

secure the equivalent of exercise, by massage, alcoholic stimulants, drugs, and patent medicines.

Young persons need a well-planned program of physical exercise if they are to secure an all-around physical development. Exercise planned from the viewpoint of the body mechanics and fundamental skill trains one to use the body efficiently and gracefully in the performance of daily tasks.

The neuromuscular mechanism develops skill only through practice. Careful training in the proper technic in such fundamental movements as standing, walking, running, vaulting, sitting, climbing, hanging, stretching, lifting, and throwing should be given every person during childhood. Awkwardness is undesirable from an aesthetic point of view and as a possible source of danger.

How Exercise Contributes to Health.—Briefly, what are the actual effects of regular physical exercise upon the body? In the first place, it is a most important stimulus to the *circulation* of the blood and the lymph. The movement of the muscles and other organs exerts a massaging action on these two streams in the capillaries and lymph spaces; and the increased respiration exerts a suction upon the venous blood into the great veins near the heart by the same bellows-like action that draws air into the lungs. This increased breathing is also important to the *lungs* themselves in filling air spaces, which under normal conditions may not be used, and particularly in inflating the top or apical regions of the lungs.

The increased bodily activity increases the *oxidation* in the body. The extent of this action is shown by the fact that the output of carbon dioxide is increased from three to ten times by muscular activity. Exercise increases the demand for oxygen in the tissues, and thereby stimulates the formation of *red corpuscles* in red bone marrow and leads to an increase in hemoglobin. The *skin* is cleared by the generous excretion of the sweat glands and the consequent softening of the horny layers.

The most generally obvious aspect of exercise is the building up of the skeletal *muscular system,* which constitutes about one-half of the bulk and weight of the body. Muscle fibrils increase in size when they are used but when unused their size decreases. This is important for the man of sedentary occupation, because for every one there are emergencies which must be met by un-

usual physical energy. The need of reserve strength is especially important in the case of the *heart,* which, like the skeletal muscles, is built up and strengthened by proper physical exercise. In the emergencies that call for sudden unusual exertion and in certain diseases, such as pneumonia, it is primarily important that the heart be sufficiently strong to withstand the strain. In fact, in disease the strength of the heart often determines the question of life or death.

The other internal organs also gain vastly from physical exercise. The viscera are relieved from serious *internal congestion* that is likely to take place in the body of a sedentary person and to interfere with digestion, circulation, and the physical well-being. *Digestion* itself is aided by the increased peristalsis produced by the churning activities of these organs and by the increased use of the abdominal muscles. This favors elimination of waste from the colon.

To any one who has learned to enjoy physical exercise, it is not necessary to say that the foregoing changes produce a beneficial effect on the *mental tone.* Of equal importance is the effect upon the *heat-regulating mechanism.* Muscular activity increases oxidation in the muscle cells. It opens the small blood vessels of the muscles and the region near the skin and contracts the blood vessels of the internal viscera. It is upon our ability to make these changes that we rely, in large part, for our bodily adjustments to changes of temperature.

Summarizing, the beneficial effects of muscular exercises include: (1) an aid to circulation, (2) an increase in red corpuscles and hemoglobin, (3) an aid in the removal of waste from tissues, (4) clearing the skin, (5) strengthening the muscular system, (6) aiding digestion, (7) improving the mental tone, (8) relieving internal congestion, (9) strengthening and enlarging the lungs, (10) strengthening the heart, and (11) improving the heat-regulating mechanism. The end results of exercise are a general improvement in health and an increased ability of the body to resist fatigue and to carry on sustained effort. Play and sports do more than develop physical power. They promote physical alertness, rapid thinking, quick decisions, and sportsmanship.

The Measurement of Physical Condition.—From the standpoint of health we are concerned with a good physical condition or the

ability of the body to respond to the demands for vigorous action we place upon it. Although a person who is unable to sustain physical exercise may be free from disease, we ordinarily think of adequate health as implying the capacity for reasonable muscular effort. Athletic ability involves neuromuscular skills which have been developed by training. These coordinations are valuable to the person in his day-to-day activities.

We know that the physical condition of the body can be improved through military or athletic training. We know that it declines in the presence of disease and gradually returns during the period of convalescence and immediately thereafter. Various tests have been developed to give an index of physical condition. One index is the extent to which the heart rate is increased by some standard activity, and the length of time required for the heart rate to return to normal after the standard exercise has been completed. Vital capacity has also been suggested as an index. It is commonly determined by finding the length of time a person can exhale or blow out the breath at a given rate. Strength tests, power tests, and endurance tests have been developed to enable the individual to observe changes in his physical condition and to compare his physical capacity with that of others.

Choice of Physical Exercise.—The amount of exercise taken should be carefully graded to one's capacity so that undue fatigue will not follow. Unfortunately, bursts of enthusiasm for exercise, untempered with judgment, are not uncommon and often lead to overexertion, lameness, and excessive fatigue. The proper use of hot and cold showers and of massage following exercise may help to reduce stiffness and soreness, caused by delay in the removal of waste products from the tissues. No person need hesitate to participate in physical exercise that is suitable for his age and sex, if a thorough physical examination has shown that he has no organic condition which would be aggravated thereby. Sound programs of physical education are based on careful physical examinations.

Differences in the type of exercise for men and women depend chiefly upon their differences in physical structure. Women are smaller than men and their proportions are different. The arms and legs are proportionately shorter, the trunk longer, and the pelvis much broader. The oblique angle at which the thigh bone

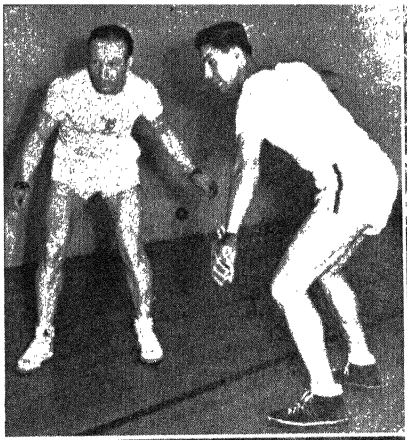
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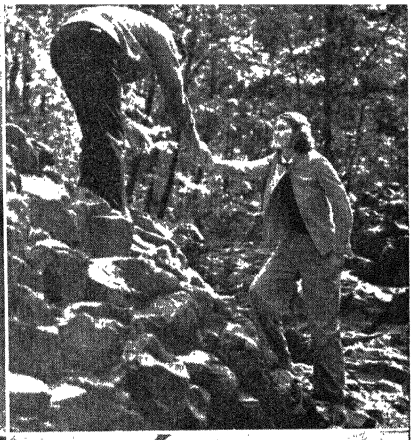
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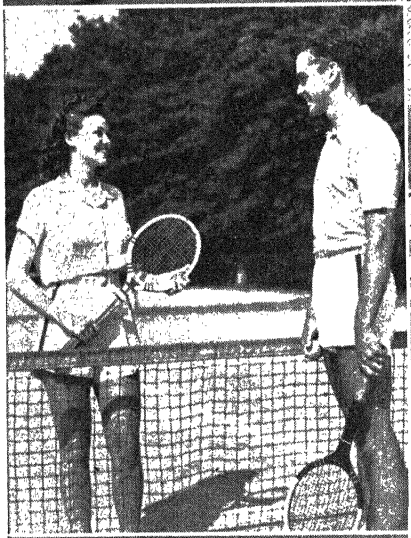
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The Measurement of Physical Condition.—From the standpoint of health we are concerned with a good physical condition or the













it attached to the pelvis interferes with the ability of women to run. Red corpuscles are less numerous in women than in men. Limited physical strength in women is partially due to these physiologic differences.

Persons usually find greatest enjoyment in those activities in which they excel. Women are superior to men in exercises that demand grace of movement and fine coordinations, and men excel in feats of strength and speed. Men and women alike can find pleasure in outdoor recreation, such as golf, tennis, swimming, hiking, canoeing, and archery.

One's general mode of living should be taken into consideration in choosing suitable exercise. A person whose daily routine involves strenuous physical activity needs to exercise muscles which have been less used during the day. His activity should be stimulating to the nervous system. The person who has been sitting at a desk throughout the day is in special need of exercise sufficiently vigorous to react beneficially upon the lungs, the heart, and the skeletal muscles.

Healthful exercise should be regular, enjoyable, and adapted to the needs of the person. It should involve rhythmic, not monotonous, muscular contraction. It should allow free play to the various parts of the body and should call into use a great number of muscles. It should aid in the development of good body mechanics and provide skill in fundamental activities, such as walking, running, handling, and throwing. Activities which are fascinating and absorbing are most refreshing. Above all, the exercise should be reasonably vigorous. It is well to master sports which can be carried into adult life, as tennis, golf, handball, fencing, and squash.

Certain adult activities deserve mention. *Walking* is an excellent exercise that is available to every one. Fast walking in the open is invigorating and should never be confused with loitering or strolling. *Folk dancing* is also an excellent form of exercise which satisfies one's love of rhythm and develops fine cordination. *Social dancing* may be equally effective as a form of exercise if it is done in a suitable physical and social environment. *Swimming* exercises many muscle groups, is not likely to produce strains, and is now available to many people the year round.

Setting-up exercises call into play the muscles of trunk, chest, neck, arms, and legs through rhythmical reaching, stretching, bending, and twisting. For the busy person living a sedentary life with little time for outdoor sports and games, setting-up exercises, taken regularly in the morning before the bath, are a valuable aid in maintaining the health of the internal organs. They cannot, however, entirely take the place of vigorous outdoor exercise.

The Adjustment of Activity to Age Level.—The choice of activity is guided by the individual's age, physical development, and interests. Let us review the general physical and mental characteristics at various age levels and the types of activity which many authorities have indicated as suitable for these groups, in so doing remembering that there are no distinct dividing lines to mark transition from one age level to another.

Infancy (First Year). Rapid growth period. Body weight trebles and brain increases its weight from two to three times. Activities are mouthing, reaching, grasping, kicking, crying, pulling, throwing, lifting, creeping, standing. The child needs objects to handle, bright objects upon which to focus attention, and a safe place in which to play.

Runabout (Two to Five Years). Rapid growth in body and brain and great physical activity. Memory is developing and sensory knowledge increasing. The child likes to imitate; his imagination is very active, and he is inclined to be self-assertive and self-centered. Play includes running, rolling, climbing, digging, tossing, catching, imitative play, and constructive play with blocks. The child enjoys motor activity and is not interested in the results of his play. He requires adequate play space, with a sand pile, slide, swing, blocks, dolls, balls, bean bags.

Primary Grades (Six to Eight Years). Physical development is less rapid, respiration is shallow, circulation slows up, and there is a tendency to heart weakness and fatigue, though muscles crave activity. Disturbances in digestion are frequent as second teeth are developing. The brain reaches nearly its full weight at about eight. Memory is strengthening; imagination is active; sensory interests are strong; attention is weak. Interest in competition awakens and the child begins to play games with other children. The child is more interested in the outcome of his activity. Activities include games of chasing, hunting, throwing, such as tag,

puss in the corner, run sheep run, follow the leader, hide and seek; constructive play, such as making kites, huts, paper dolls, baskets; dramatic and imitative play, such as school, cowboys, fire department; singing games and rhythms. Play space is required, and equipment should include sand pile, seesaw, climbing rope, sleds, balls, and shovels.

Intermediate Grades (Nine to Eleven Years). Physical growth is lessened. Blood vessels increase in size, but the heart remains small and the child should avoid severe physical strain in work or in competitive athletic contests. Girls show more rapid growth than boys. The child shows the greatest physical activity during these years. Memory reaches its height and this is sometimes termed the golden period for memorizing and drill, for developing facility and skill. A tendency to cooperate in games appears for the first time, but the child is still self-assertive and apparently selfish.

More formal games of great physical activity appeal at this age, but the character of play is individualistic rather than cooperative. Appropriate activities include dramatic and imitative play, such as wild-west shows, or Indians; games of chasing, hunting, and throwing, calling for individual speed and skill rather than cooperative action, such as prisoner's base, three deep, or tag games; constructive play through which pride in good work develops, such as making lanterns, toys, bird houses or stilts; and games for physical development, such as wrestling, tumbling, and balancing. Apparatus of greatest interest includes rings, trapeze, circle bars, giant stride, baseball, basketball courts, sleds, and skates.

Junior High School (Twelve to Fourteen Years). Rapid bodily growth. The development of heart and lungs is not yet complete and endurance is small. Rapid development of all organs takes place. The length of legs and arms increases out of proportion to the length of the trunk and awkwardness results. Postural defects become more obvious. Emotions are unstable. There is increasing interest in competitive games and readiness to cooperate with the group. Games desirable in this group include many of those from the preceding age group, baseball, football, hockey, cricket, tennis, handball, and volley ball; games involving trial of strength, quickness and skill, such as dashes, relay races, swimming, rowing, and

bicycling. The apparatus required includes an outdoor gymnasium, track, ball fields, swimming pools, and workshops.

Senior High School (Fifteen to Seventeen Years). Strength increases rapidly in this period, the heart becomes larger, and growth nears completion. The trunk increases in size so that it is proportional to the length of the legs. Boys show keen enjoyment in sports, and girls are more interested in social organizations. Regular physical exercise is more important at this age than at any other period. Suitable activities are baseball, basketball, tennis, golf, volley ball, hiking, camping, swimming, field or track sports.

Young Manhood and Womanhood (Eighteen to Twenty-One Years). Height has practically reached its maximum in most cases and development in breadth is in process. There is rapid growth of the heart and lungs, with no corresponding growth of the arteries. Vigorous exercise is very important because of its effect on the development of the heart and lungs. Games involving running are particularly valuable. Desirable activities include the major and minor college sports and such "carry-over" activities as handball, golf, camping, and hiking.

From this age on exercise is largely an individual matter to be worked out by each in accordance with his preference, his physical capacity, and his leisure. Fortunate is the person who has developed during youth an interest and proficiency in outdoor sports which he can carry over into adult life as a means of exercise and mental relaxation. The following general statements may be made:

Early Maturity (Twenty-One to Thirty Years). Physical development is practically completed during this period. Capacity for skill and speed reach the maximum. All types of outdoor activities, setting-up exercises, or games which appeal to an adult are suitable, provided an examination shows the person is physically fit.

Maturity (Thirty to Fifty Years). Skill and speed are on the decline, while endurance and strength are now greater than at any other period of life. Interest in an active outdoor life is not so great during this period, and business and professional life increasingly interfere with exercise. Such less strenuous games, as golf, walking, tennis, swimming, handball and volley ball, are most suitable for this age group.

Later Maturity (Fifty to Seventy Years). Endurance and skill are maintained to some extent in this age group, but speed and

strength have declined to a minimum. Vigorous exercise presents the danger of bone fractures and dilatation of the heart muscle. Light outdoor exercise, including golf, walking, and swimming, is suitable for this group.

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CHAPTER XV

BODY MECHANICS

The Importance of Posture.—The first impression of a person may be largely determined by the degree to which his posture reflects alertness, grace, good breeding, and strength, or their opposites. Correct posture gives one a feeling of ease and self-confidence. When a young person is being selected for a position by brief interviews in competition with many other applicants, posture may be one of the deciding factors.

The proper mechanical use of the body goes beyond appearance. It affects efficiency. In war it has been found that thousands of soldiers have such poor mechanical use of the body that they cannot stand severe military duty. In some colleges, freshmen with poor body mechanics are not allowed to participate in athletics until this condition has been corrected. In industry, many workers become disqualified because of strain or fatigue resulting from the improper use of the body.

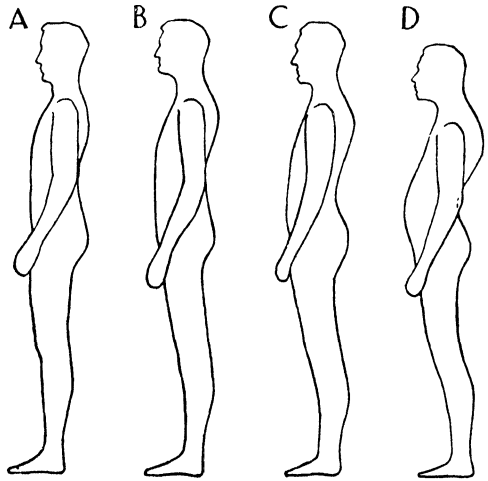
Defects of Posture.—Common defects include curvatures of the spine, flat chest, restricted lower chest, and pouchy abdomen. Deviations from the normal position of body parts which are due to wrong use are termed *functional* defects of posture. These defects may come from carelessness, from muscle weakness following prolonged illness, or from an undeveloped kinesthetic sense. It is possible for the individual to correct them by suitable exercise and training. Functional defects become increasingly difficult to correct as pairs of antagonistic muscles adjust themselves to the new position. One group of muscles shortens and the other stretches.

The *anatomical* or fixed defects result from actual deformity of the skeleton. The more serious defects are those involving abnormal curvatures of the spine. These are made possible because of the yielding nature of the cartilage forming the cushion between the vertebrae.

Three defects involving the anteroposterior curvatures of the spine are common. One is *lordosis,* or hollow back, in which there

is an exaggerated forward curve in the lumbar region. Another is *kyphosis,* or humpback, an exaggerated outward curve of the upper back. The third is *stoop shoulders* in which the head is projected forward, the curve in the neck is increased, and the seventh cervical vertebra at the back of the neck is very prominent. In all these

TRACINGS MADE DURING EXAMINATION OF 700 HARVARD FRESHMEN



Group A—7.5% Group B—12.5% Group C—55% Group D—25%

Posture chart showing the result of the examination of Harvard freshmen.

Group A.—Good mechanical use of the human body. 1. Head straight above chest, hips, and feet. 2. Chest up and forward. 3. Abdomen in or flat. 4. Usual back curves not exaggerated.

Group B.—Fairly good mechanical use of the human body. (Note changes from Group A.) 1. Head too far forward. 2. Chest not so well up or forward. 3. Abdomen very little changed. 4. Back very little changed.

Group C.—Bad mechanical use of the body. (Note changes from Group A.) 1. Head forward of chest. 2. Chest flat. 3. Abdomen relaxed and forward. 4. Back curves are exaggerated.

Group D.—Very bad mechanical use of the body. (Note changes from Group A.) 1. Head still farther forward. 2. Chest still flatter and farther back. 3. Abdomen completely relaxed. "Slouchy." 4. All back curves exaggerated to the extreme. (Lee.)

types of faulty posture we are likely to find the shoulders brought forward, the chest flattened, the shoulder blades protruding, and the abdomen relaxed. The anteroposterior curvatures are very common, although they could be largely prevented by attention to the formation of proper habits of body mechanics.

A lateral curvature of the spine is called *scoliosis.* It may be single or compound. The curve may be in the upper or lower back. One shoulder or one hip may be higher than the other, and one side of the chest may be more prominent. Scolioses are usually acquired and are consequently more numerous in youths and adults than in children. The earlier stages of these curvatures are not easily detected by the casual observer. Their correction may require the aid of an orthopedist.

There are many minor defects of posture, some of which you have probably observed. These include stiff neck and shoulders, head to one side, stiff gait, knees held in too great flexion, ankles rolled inward, knock knees, and head carried forward.

Causes of Poor Posture.—Some postural defects are due to inherited structure, to accidents, or to particular diseases, such as infantile paralysis or tuberculosis of the bones. Rickets or faulty calcium metabolism produces bowlegs, a deformity that results from the bending of softened bone under body weight. Bowlegs do not occur in healthy children as the result of walking too soon, an opinion commonly held. Their presence indicates some degree of rickets.

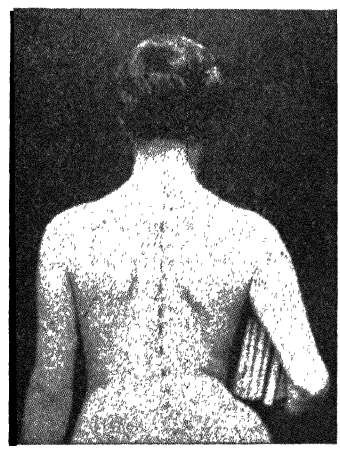
Many defects are produced by faulty habits. Lateral curves of the spine may be produced by carrying weights always on one side, sitting with one leg under the body, habitually standing with the weight on one foot, or using writing desks which are either too high or too low. Poor vision may cause one to throw the body out of proper alignment in an attempt to see more clearly. Poor hearing may cause one to tip the head to one side. Fatigue from poorly developed muscles, unequal to the demands made upon them, may lead to a drooping posture. The wearing of high-heeled shoes tips the pelvis forward and is a common cause of lordosis in young women. Tight clothing may flatten the chest and curve the back by bending in the front edges of the ribs.

Effects of Poor Posture on Health.—Poor posture may produce pain, discomfort, or symptoms of illness, or it may affect health indirectly through the derangement of certain organs of the body. Among the *direct* effects are the increased fatigue and muscular strain that result from holding the body in poor position. Poor

sitting posture with the head lowered forward produces muscular and nervous tension and the feeling of congestion in the back of the neck. Hollow back or lordosis often produces backache because of the pressure of the processes of the spine upon one another. It also puts a strain on the sacroiliac joint (the articulation of the spine with the pelvic basin), which may cause extreme pain. Poor posture in writing contributes to the development of writer's cramp. Pains ascribed to rheumatism and sciatica are sometimes due to faulty posture.

The undesirable *indirect* effects arising from poor posture are primarily concerned with the displacement of the internal organs when the chest is depressed and the abdomen protrudes. The lungs are less completely expanded; some portions become less active and more readily susceptible to tuberculous infection. The diaphragm is pushed down and cannot function properly. The stomach and the transverse section of the large intestine sag (see page 73). X-ray examinations have shown that the stomach may be so displaced that food cannot readily pass through it. The abdominal wall is relaxed and the organs it supports are forced into an unnatural position, contributing to indigestion, fermentation of food in the intestine, and chronic constipation. The stagnation of blood in the liver and other abdominal organs tends to cause despondency and mental confusion as well as physical ailments. Dysmenorrhea or painful menstruation may be due to the tipping forward of the pelvis or to congestion within it.

Correction of Postural Defects.— The correction of severe postural defects should be made under the direction of an expert. Exercises are usually prescribed by the orthopedic surgeon. In some situations remedial corrective surgery or massage instead of corrective gymnastics may be indicated. Food, sleep, sun-



Scoliosis is easily acquired. (From Drew: *Individual Gymnastics,* Courtesy Lea & Febiger.)

shine, rest, or medical attention rather than exercise may be needed. Braces should never be worn without the doctor's advice.

A careful study of one's habits in sitting, standing, and carrying weights should be made, to determine whether there are factors contributing to postural defects that can be removed. The physical examination should reveal vision or auditory defects. Weak muscles should be toned by adequate rest, nutrition, and suitable exercise. Posture often improves automatically with improvement in the musculature. No amount of effort to assume good posture will succeed unless the muscles are strong enough to hold the body parts in proper relation to each other.

What Is Good Posture and How Is It Secured?—We have already implied that the right mechanical use of the body requires the minimum muscular effort. This involves a condition of balance. We should be able to move the body at any time in any direction, easily and without strain. We may think of good posture in standing, sitting, walking, and working as the position that enables the body to act most effectively. Good posture does not require the maintenance of an unvarying position at all times. Temporary twisting, turning, stooping, and bending help to relieve strain. Good posture is habitual carriage in the most effective position.

In good *standing position* the head is well back, the chin in, the abdomen flat, the back straight, the knees slightly flexed, and the toes pointed straight ahead. The chest is the point of the body that is farthest forward. It is raised as though lifted forward and upward. Weight is borne chiefly on the balls of the feet. A line dropped from the base of the ear would pass through the shoulder, the hip joint, the kneecap, and just in front of the ankle. The normal spine curves slightly forward at the neck and at the small of the back and backward at the shoulders and at the hips. There are no lateral curves in the normal spine. A straight back is a strong back.

In *walking* the body is carried easily and gracefully in the position of standing, with the toes always pointing straight ahead. Hands hang loosely and comfortably at the side. Good carriage of neck and head is one of the most important factors in the appearance of good posture.

The development of good standing and walking posture involves getting into the proper position and strengthening the muscles involved in maintaining this position. If through improper use certain muscles become lengthened or shortened, the condition must be corrected. The simplest direction for getting the body into good position is "stand tall." In doing this one may stand a pole beside the body or drop a plumb line to determine whether the ear, shoulder, hip joint, kneecap, and instep are in a straight line. Another recommended procedure is to stand with the heels against a flat wall and with one hand behind the back at the waistline. Contract the gluteal (buttock) muscles. Contract the abdominal muscles by pulling in the abdomen and pushing back against the hand. Raise the chest forward and upward. Draw the chin in and stretch up tall as though balancing a weight on the head. Walk away in this position and make an effort to maintain it.

If opposing muscles are not properly balanced, they become "set" in the wrong position. For example, there are certain chest muscles (pectoral) that move the shoulders forward and certain upper back muscles (rhomboids) that move the shoulders back. If the chest muscles habitually draw the shoulders forward, they overbalance the opposing muscles, which become stretched, and the chest is characteristically held in this cramped position. The only way to correct the difficulty is to strengthen the muscles that pull the shoulders back and to stretch the muscles that pull the shoulders forward.

In erect *sitting posture* the relationships of the body, neck, and head are the same as in standing posture. A straight line would pass

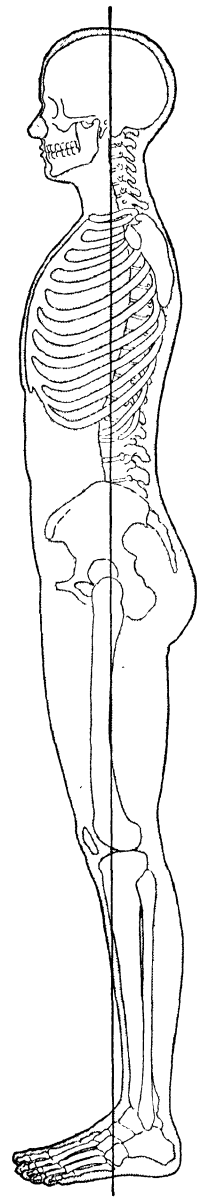


Diagram showing good posture.



(H. Armstrong Roberts)

In walking the body is carried easily and gracefully

through the ear, the shoulder, and the hip joint. The person sits back as far as possible in the chair so that the back is supported at the dorsolumbar junction. When working at a desk, as in writing, the body bends forward from the waist without breaking this straight line.

Proper sitting posture requires a chair so constructed that good posture is possible. The depth of the seat should not be more than 80 to 85 per cent of its height from the floor. The height should be such that the feet can rest squarely on the floor when the thighs are parallel to it and the knees at right angles. There should be support at the junction of the dorsal and lumbar portions of the back.

The chair should be close enough to the desk so that the fleshy inner part of the forearm may rest easily on the surface of the desk without pushing up the shoulders. This allows the right arm freedom of motion in writing. Sitting on one foot is a poor habit, since it tips the base on which the spine rests and throws the spine out of alignment. It also interferes with circulation.

When *stooping* to pick up an object or to lift a weight a person should place one foot slightly in front of the other and bend the body at the hips and at the knees, keeping the back flat.

The height of the workbench, table, desk, or kitchen sink is of considerable importance. It should be planned for use with the worker either standing or sitting, not both, and the height should be adjusted so that the worker can keep a straight back without stooping forward. A woman is often as much fatigued from iron-

CHAPTER XVI

FOOT HYGIENE

The foot is so constructed that it is capable, if used properly, of bearing the body weight untiringly. If its structure is weakened through misuse, aches and pains result. The effects of unhygienic use of the feet extend even farther, because the bodily activity necessary to health depends upon good feet, capable of being used efficiently and without discomfort.

Structure.—The foot is similar in structure to the hand, its chief differences being in the shortened digits and in the enlarged bones of the ankle, developed to bear the necessary weight. Its twenty-six bones are held together by ligaments and muscles in such a way that they give elasticity in movement. Nerves and blood vessels are numerous throughout these structures.

Long tendons connect the bones of the foot with the large muscles in the leg to give the foot its powerful movements. These tendons are bound down at the ankle by bands of ligaments so that, as in a pulley, the direction of force is changed.

The bones of the foot are so arranged as to form two well-defined arches. The *longitudinal* arch or "instep" extends from the heel forward to the ball of the foot. The transverse or *anterior arch* extends across the foot back of the toes and at right angles to the longitudinal arch.

The position of the bones in the arches is dependent upon the support given by the ligaments that bind them together. Small muscles on the soles of the feet also aid in preserving the arches. If these muscles are so weakened through lack of use that they become relaxed, the weight placed on the arches is greater than the ligaments can support and they stretch, allowing the bones to fall. The maintenance of the arches is of prime importance in foot hygiene and depends not only upon keeping the muscles in proper tone but also upon the proper mechanical use of the feet.

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The normal shape of the foot is triangular, with the apex at the heel and the broad portion at the toes. Its relation to the bones of

the leg is such that a plane passed through the center of the kneecap would pass through the center of the ankle and between the first and second toes. A low-arched foot is normal in some persons and appears without adverse symptoms just as do high arches in other persons.

Function.—In the normal foot the weight of the body is distributed upon the heel, the ball, and the outer edge of the foot. The strongest position of the foot is with the toes pointed straight ahead so that the weight falls along the length of the longitudinal arch, with the great toe and transverse arch giving additional support. If the toes are pointed outward, the weight falls on a point at about the middle of the longitudinal arch on its inner edge. The arch is highest here, less well supported by ligaments, and unsuited to bear the heavy weight. The additional support of the transverse arch and great toe is lost in this position.

When walking with the feet unhampered by shoes, the forepart of the foot grips the ground at each step, and the great toe serves as a lever and gives the body a strong push forward. When shoes are worn which do not permit this use of the foot, much of its efficiency is lost, and it eventually becomes incapable of functioning properly.

Foot Defects.—The wearing of poorly fitted or high-heeled shoes, faulty habits in the use of the foot, and weakened muscles, due either to lack of use or to illness, may all contribute to foot defects. Foot strain from overuse occurs in persons who stand for hours at their work. It is also likely to follow prolonged or violent foot exercise, especially when the person has been inactive for a time.

One of the commonest foot defects is *pronation,* a condition in which the ankle rolls toward the inner border of the foot, the weight falls on the inner side of the longitudinal arch, which tends to flatten out, and the great toe loses its leverage capacity. Pronated feet can easily be identified by standing directly in front of a low mirror and noting the position of the ankle with relation to the foot and the kneecap. Pronation often starts from a slight weakness in the muscles of the ankles, or from wearing improper shoes. More frequently it comes from toeing out. It is usually

progressive if not corrected early, and eventually results in "flatfoot."

Flatfoot is usually acquired but it may be congenital. In acquired *flatfoot* the weakened muscles have permitted the ligaments to stretch so that the bones of the longitudinal arch have dropped. The foot loses its resiliency and symptoms of fatigue accompanied by pain commonly appear. The flattened arch can be identified by the imprint left by a wet foot placed on a dry floor. In the "normal" foot the inner edge leaves no mark at the center, but in flatfoot the print is as wide at the center as at the heel.

Pronation is prevented by placing the toes straight ahead and putting the weight on the outer edge of the foot. This distributes the body weight throughout the length of the foot and draws the ankle into a proper position. It is usually difficult at first to maintain this position, and the muscles need to be strengthened by suitable exercises for the feet. Orthopedists sometimes prescribe a special shoe in which the inner edge of the sole or heel, or both, is raised so that the weight is thrown in the right direction. The use of arch supports should not be relied upon permanently. They should serve only as crutches to aid the muscles and ligaments until they can be strengthened to perform their proper function. In a normally functioning foot there should be a degree of flexibility ordinarily impossible when arch supports are used.

A *fallen transverse arch* is due to a letdown of the ligaments and muscles which join the metatarsal bones.

This was once common in women and was usually caused by wearing high heels and pointed toes. Too much weight was thus thrown forward onto the transverse arch. The muscles were weakened because the narrow shoe prevented their use in gripping the ground when walking. A corn or callus is often formed on the sole of the foot under the fallen transverse arch due to the pressure of the bones. Exercises that strengthen the gripping muscles of the toes are useful in keeping the transverse arch in normal position.

A *shortened tendon of Achilles* arises from the constant wearing of high-heeled shoes. This tendon, which connects the large calf muscle to the heel, gradually shortens to accommodate itself. The foot loses its flexibility and becomes more immobile. Its use is so restricted that a stiff, awkward gait results. The foot muscles be-

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ency to force the nail into the surrounding soft tissues, forming *ingrowing nails.* These are painful and frequently cause the toe to become infected. Wearing well-fitting shoes and keeping the nails cut straight across are important in preventing this condition.



Pronated feet. (From Key and Conwell.)



Clavus or corn on the third, fourth, and fifth toes. (From Dickson and Diveley: *Functional Disorders of the Foot.* Courtesy J. B. Lippincott Co.)

A *sprain* is an injury to a joint, usually temporary. It is caused by a sudden wrench for which the muscles have not had time to prepare and is accompanied by stretching or tearing of the ligaments. A physician should be consulted to determine the extent of the injury. An x-ray may be necessary to detect a possible fracture which cannot be felt. Until a physician can be secured, the sprained foot should be elevated above the horizontal. Cold compresses, or hot and cold compresses used alternately, may be applied for an hour or two.

Hygiene of the Foot.—Proper care of the feet requires strengthening of general muscle tone, using the foot in a proper mechani-

cal way, and wearing properly fitted and correctly shaped shoes and stockings. Defects that develop should be corrected by an orthopedist or a competent physician.

A good shoe should conform to the shape of the foot, permitting free use of the bones, muscles, and ligaments without pressure. At the same time it should give support in the place where it is needed, that is, around the bones of the instep. A straight inner edge which permits the use of the great toe as a lever, and a sole broad enough to permit proper toe spread and "grip" are desirable. Heels of the work shoe should be low and broad enough to provide a solid foundation.



What do high heels do to the feet?

Much of the harm that comes from ill-fitted shoes results from failure to differentiate in the choice of shoes for utility and for dress. The wearing of a suitable work shoe most of the time will keep the foot in good condition and will permit the occasional wearing of a more ornamental shoe. Hosiery that is too short in the foot likewise interferes with the proper foot movement.

Cleanliness of the feet is essential to their hygiene. Leather footwear interferes with the evaporation of moisture from the numerous sweat glands of the feet and provides a favorable site for fungus infection if the feet are not bathed daily and dried thoroughly.

Exercises for the Feet.—Authorities recommend exercises for strengthening the three groups of muscles that are used in flexing

the foot and the ankle and in turning the foot inward. The following exercises are commonly suggested:

1. Sit with one knee crossed over the other so that the leg hangs free. Extend the ankle, pushing down with toes, then turn foot inward and upward, in a circular motion, flexing the ankle strongly.
2. Sit or stand with feet parallel on the floor. Raise the arch by drawing the toes toward the heel, and turn the toes inward with strong inversion as if gripping the ground.
3. While standing, rise on tiptoes, then slowly lower the heels with weight on outer sides of the feet.
4. Stand with the arches drawn up and the weight on the outer borders of the feet.
5. Walk with the feet slightly turned inward and with toes pointing straight forward.
6. Stand on low stool or book with the toes protruding over and grasping the edge.
7. Practice picking up a marble or pencil with the toes.
8. Walk on a straight line, with heel of forward foot touching toe of rear foot at each step, keeping weight on outer borders of the feet.

To be effective, exercises must be followed persistently several times a day, but not continued to the point of fatigue. Only two or three exercises should be practiced at any one time.

Walking properly without shoes or in suitable footwear is good exercise for the feet. They should be kept straight and the heel should be brought down without banging. The weight should be transferred toward the ball of the foot and the toes used as in a gripping action. Attention to walking properly will do much to improve muscle tone and to develop the right mechanical use of the feet.

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CHAPTER XVII

HEREDITY AND HEALTH

The amount of space that can be devoted to the relationship between heredity and health must necessarily be limited in a textbook of this type. Only the basic principles of heredity and those facts that are important in guarding against the perpetuation of undesirable traits and physical conditions in offspring merit discussion here. Our knowledge of the subject has come from the researches on human heredity (eugenics) begun by Galton, and researches in plant and animal breeding (genetics) initiated by Mendel.

Mendelian Inheritance.—Mendel's law enunciates the principle that opposing unit factor characteristics in the male and female parents do not blend in the offspring, but the units of heredity, or *genes,* remain distinct in the germ cells of the offspring, recombining in future generations according to probability and chance.

This law may be illustrated from animal heredity. Among guinea pigs the crossing of a black strain with a white (albino) strain produces in the first generation only black offspring; but if these pigs are bred among themselves, the resulting offspring are in the ratio of approximately three black pigs to one white. Black coat is a dominant characteristic and white coat a recessive characteristic. We can understand these results if we assume that the black guinea pig possesses a factor in the germ cell for black color and that the color factor is lacking in the white pig.

Black coat and white coat are alternative characteristics. If a black-pigment-producing substance is present in either of the two germ cells that go to make up a new individual, that animal will be black, i.e., black is dominant. If none of the genes of the reproductive cells contain such a substance, no black pigment can develop and the animal is white.

It may help us to understand the law better if we consider the explanation afforded by the belief that the chromosomes are

bearers of the hereditary characteristics. The reader who has studied elementary biology will recall that the chromatin, or deeply staining substance of the cell nucleus, arranges itself into short threads called chromosomes whenever there is a cell division. Each chromosome splits lengthwise (except in the production of sex cells when they do not split, but half of the chromosomes go to each new cell). The number of these chromosomes is thus constant for any species of animal. The number in each of the *body* cells is twice that in the mature *sex* cell. In other words,

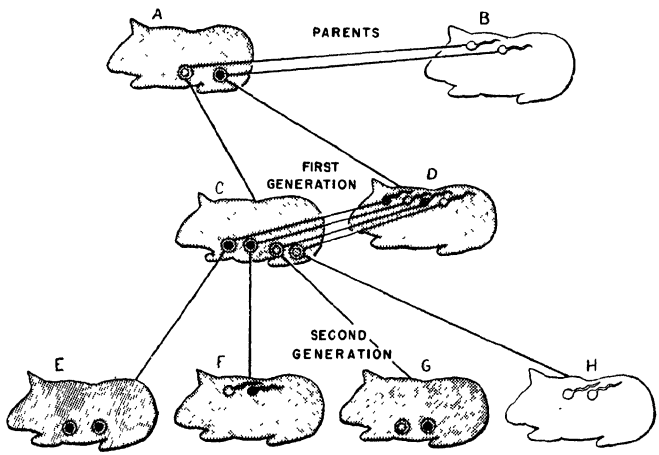


Diagram illustrating the mechanism by which the unit factor, color, is inherited in guinea pigs. Animal *A* is a black, female of pure stock. Such an animal is called homozygous, and all of its sex cells are alike in carrying the unit character in question. Animal *B* is a homozygous white male; none of the sex cells have the characteristic for blackness. Animals *C* (female), and *D* (male), are hybrids. In each case half of the sex cells carry the characteristic for blackness and half of them lack this characteristic. When *C* and *D* are crossed, the offspring of the second generation are in the approximate ratio of three black to one white. The diagram illustrates each possible chance combination of sperm and egg, and it will be seen that, of the second generation animals, *E* is a homozygous black. *F* and *G* are heterozygous like *C* and *D*, and *H* is a homozygous white.

the final maturation processes of sex-cell development allow a separation of the chromosomes into two sets or groups, so that there *may be* two kinds of sperms and two kinds of ova so far as the inheritance or noninheritance of a characteristic is concerned. A careful study of the accompanying diagram should make clear the way in which a unit factor is inherited.

We can only marvel at the miracle Nature displays in heredity. From each mating of sex cells, all of which look alike when viewed with the microscope, Nature produces an individual different in characteristics from any other of the millions of people who inhabit the earth. It is difficult to explain how so many characteristics can be arranged spatially in the tiny germ cell unless we can assume that these characteristics are produced by the infinite varieties in molecular pattern which are possible in the highly complex chromatin substances.* The mechanism of

TABLE SHOWING MENDELIAN INHERITANCE IN MAN

(Teratologic and Pathologic Characters)

Dominant	Recessive
Achondroplasia (dwarfs with short stout limbs but with bodies and heads of normal size)	Normal
Hereditary fragility of bones	Normal
Brachydactylia (short fingers and toes)	Normal
Syndactylia (webbed fingers and toes)	Normal
Polydactylia (supernumerary digits)	Normal
Symphalangism (fused joints of digits, stiff digits)	Normal
Epidermolysis (excessive formation of blisters)	
Blonde or brunette	Albino
Spotted with white	Uniformly colored
Diabetes insipidus (excessive production of urine)	Normal
Huntington's chorea	Normal
Front of iris pigmented (eye brown, black, etc.)	Only back of iris pigmented (eye blue)
Normal	Pigmentary degeneration of retina
Glaucoma (internal pressure and swelling of eyeball)	Normal
Hereditary cataract	Normal

(Sex-Linked Characters)

Recessive characters, appearing in male when *simplex*, in female only when *duplex*.

Normal	Gower's muscular atrophy
Normal	Hemophilia (slow clotting of blood) †
Normal	Color blindness (Daltonism; inability to distinguish red from green)

*Miescher has shown that a molecule of albumin with forty carbon atoms may have as many as one billion stereoisomers; in protoplasm there are many kinds of albumin and other proteins, some with probably more than 700 carbon atoms.—*Conklin.*

†Studies suggest the existence of another type of hemophilia which is dominant and not sex-linked. The condition is due to weakness in the capillary walls. Levit and Malkova: A New Mutation in Man, J. Heredity 21: 73-78.



(H. Armstrong Roberts)

person is his heredity plus his human experience.

inheritance is in no way better illustrated than in the complete similarity of identical twins, who result from the separation of the embryo into two equal halves at an early stage, and therefore receive identical hereditary factors.*

Inherited Diseases and Abnormalities.—There are several unit characters which have already been discovered in human heredity. Some of these are diseases but, fortunately for the race, these diseases are usually recessive. (See table on page 239.) If recessive (and not sex linked) they are not passed on to children unless both parents carry the defect.

Germ diseases are not inherited, although the embryo may become infected through the placenta, as in the case of congenital syphilis. In other cases, as in tuberculosis, a predisposition toward a disease in the form of constitutional weakness may be passed from one generation to another. Many other physical and mental qualities, special abilities, some forms of epilepsy and feeblemindedness, and special traits, such as left-handedness and a tendency to produce twins, appear to be inherited, but they do not behave as simple Mendelian characters.

It is difficult to secure evidence in human heredity, and the mechanism of inheritance of many of these characteristics is still in doubt. Marriage between near relatives is usually not advisable because some hidden hereditary family weakness in both persons may appear in the offspring. If both parties are free from hereditary defects, such a union is not to be feared.

How Sex in the Offspring Is Determined.—There has always been considerable speculation as to the determination of sex in

*Fraternal or unlike twins are produced from separate eggs, each of which is fertilized by a separate sperm cell.

the offspring, because the question is of vital interest to parents who have a preference for either a son or a daughter. It is interesting to find that the explanation offered by Mendelian studies in heredity and the microscopic studies of cell structure indicate that sex in the offspring cannot be controlled.



(Black Box)

Identical twins illustrate the importance heredity.

All pairs of chromosomes in the body cells of animals, with the exception of one pair, are similar in appearance. These are the so-called sex chromosomes, the X-chromosome and the Y-chromosome. The accompanying diagram shows the chromosome structure in the body cells of the fruit fly, *Drosophila.* The body cells of the female contain two X-chromosomes, and the body cells of the male contain one X-chromosome and one Y-chromosome. Each germ cell contains one chromosome from each pair. Obviously the ova will all be alike. The sperms, on the other hand, will be of two types. Half of them will contain the X-chromosome and half of them will contain the Y-chromosome. The sex of the offspring depends upon whether the sperm cell which fertilizes the egg contains the X-chromosome or the Y-chromosome.

Sex-Linked Characters.—Apparently, the causative factors of certain other characteristics are located in the pair of chromosomes which determine sex or, more exactly, in the tip of chromatin carried by the X-chromosome but lacking in the Y-chromosome. Such unit characters are sex-linked. Remembering the nature of the sperm cells previously described, we see that a dominant sex-linked character in a man may be transmitted to his daughter but not to his son. If it were a recessive character, it could not appear in any of the children, provided the mother was normal in this respect. Recessive sex-linked characteristics, when transmitted by the mother, would be apparent only in the sons. A recessive characteristic appears in the male when the X-chromosome carries the recessive character; it appears in the female only when both X-chromosomes carry the recessive character.

Color blindness is an example of this kind of inheritance. Its transmission is explained in the accompanying diagram.

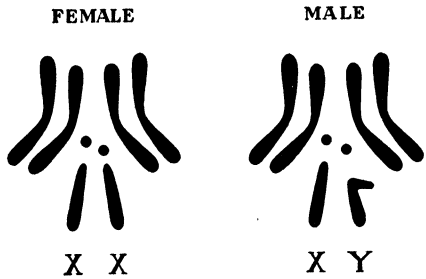
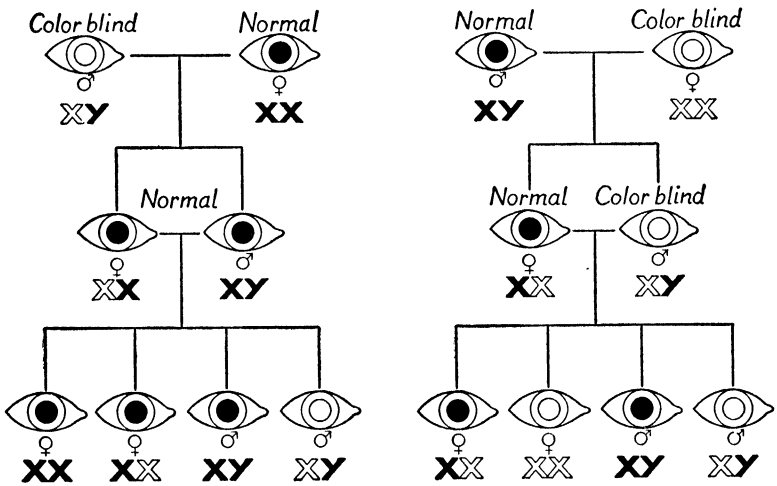


Diagram showing the four pairs of chromosomes in the fruit fly, *Drosophila*. X and Y indicate the sex chromosomes. (After Bridges.)



The inheritance of color blindness. The chart on the left shows the inheritance when a color-blind man is married to a normal woman. None of the children are color-blind, but the defect is transmitted through the daughters to half of their sons. Color-blind persons and chromosomes carrying the gene for this character are shown in white. The chart on the right shows the inheritance pattern when a color-blind woman is married to a normal man. All the sons are color-blind. In the second generation (from the type of mating shown in the diagram) half of the daughters and half of the sons will be color-blind.

Mentality and Heredity.—Mental ability is without doubt inherited, since there is a high correlation between the mentality of fathers and sons, and between the mentality of brothers. There

is also a high correlation between the mental abilities of husbands and wives. (In contradiction to a popular belief, most persons marry "likes," not opposites.) This helps to raise the father and son correlation. The question of environment enters here, since children of the most brilliant parents usually have the best surroundings.

In mentality, physical stature, size, and some other characteristics the offspring of widely different parents appear to be intermediate between the two. It would seem that there is either a blending of characteristics or the quality in question is produced by many or "multiple" unit factors. In the latter case, if the father possessed twenty factors for mental ability and the mother ten, the offspring would be most likely to receive about fifteen and would, therefore, be intermediate in condition, thus giving the appearance of "blending inheritance."

Apparently there are "good strains" of human stock. Dr. Woods has shown that the first thirty persons selected for the Hall of Fame averaged one near relative of distinction apiece. One out of four of the persons listed in standard biographical dictionaries has a near relative of distinction. In the great group of Americans who are not listed in a biographical dictionary, only one person in five hundred is closely related to a man of distinction.

Statistics in *The Builders of America* by Ellsworth Huntington, Yale social scientist, and Leon F. Whiting, eugenist, show that for every twenty clergymen one clergyman's son is listed in *Who's Who,* whereas the proportion for other professions is 46 to 1; for skilled labor, 1,600 to 1; for unskilled labor, 48,000 to one. The children of clergymen have the advantage, of course, of growing up in homes where the standards of education and morals are high.

We have the story of the family of the illustrious Jonathan Edwards which shows innumerable examples of the highest intellectual and moral worth among its descendants. On the other hand, there is the story of the Jukes family, investigated by Dugdale, and concerning which we find the following statistics: In five generations of the descendants of a worthless fisherman there were 1,200 persons; the history of 1,040 of these persons is partly known or well known. About 300 died in infancy; of those re-

maining 7 were murderers, 60 were habitual thieves, 130 were convicted criminals, 140 were physically wrecked by their own diseases and wickedness, more than half of the women were prostitutes, and 310 were professional paupers living in almshouses a total of 2,300 years. Not one of these persons had a common school education and only 20 learned a trade, 10 of whom learned it in a state prison. Here it is not easy to separate heredity and environment or to estimate the cost of this family to society.

Feeblemindedness.—Four measures have been proposed for controlling the propagation of defectives: (1) education, (2) legislation, (3) segregation, and (4) surgery. No one of these measures is fully satisfactory. *Education* of the general public may make society more alert to the problem. *Laws* limiting the marriage of feebleminded persons have been enacted in many states. *Segregation* is an ideal procedure whenever it can be applied, but it is hopeless to attempt to secure all the afflicted and to place them in segregation hospitals. *Surgery* has been performed to sever the vas deferens in the male or the Fallopian tube in the female. It produces no change whatever in the physiology of the individual but it does prevent procreation.

Twenty-nine states already have carefully written eugenic sterilization laws. The principle of compulsory sterilization was approved by the Supreme Court of the United States in 1927 by a decision in which Justice Oliver Wendell Holmes remarked, "Three generations of imbeciles are enough." These laws provide for expert unbiased medical investigation, usually with the written consent of the nearest relatives, to make sure that sterilization is applied only to cases of *hereditary* feeblemindedness or mental disease. About 40,000 sterilizations have been performed in this country. Relatives of patients, physicians, and social workers approve the plan because they have observed that sterilization is a protection, not a punishment, and that it enables many patients to return to their homes and live normal lives.

The long-range importance of sterilization is readily seen. Evidence indicates that families furnishing children to state homes for the feebleminded multiply about twice as fast as the rest of the population. Experts estimate that it would be possible to decrease feeblemindedness 36 per cent in one generation by means of sterilization. One state reports that sterilization is already

providing an estimated annual saving of $2,000,000 in the cost of caring for its feebleminded and insane in institutions.

Heredity and Conduct.—What effect will one's habits, virtues, and vices have upon the offspring? The present theory regarding the inheritance of acquired characteristics is indicated in the surgical experiment of Dr. W. E. Castle in which the ovaries from a small black guinea pig were transplanted into an albino (pure white) guinea pig, which was later mated with another albino. The offspring produced were black. This experiment shows that the hereditary qualities lay in the germ cells and not in the body as a whole. Mutilation experiments, such as the amputation of tails of mice for several generations, have failed to produce mice with shorter tails.

One may say that, from the standpoint of the race, the germ cell is of greater importance than the individual. A person is like the father because he is descended from the same line of similar germ cells. The children of soldiers who are mutilated in war will be normal in every respect; the physical condition of the parent will not be transmitted to the child. An injury to the germ cells is much more serious than an injury to the body tissues of the individual.

The number of cells of the body which, through one's descendants, may outlive the span of his own life is the same as the number of his children. We cannot change the hereditary characteristics embodied in these cells, but we should remember that these cells are a living part of the body and that they are subject to some of the same influences that injure other tissues. We would expect to find the greatest vitality in those cells of a normal and healthy body.

Certain poisons, which are distributed through the circulation, can reach these cells, and a poison that is capable of serious injury to the growing or adult organism may thus be expected to extend in its influences to the sex cell. Lead is such a poison. When there is serious lead poisoning in either the father or the mother, many of the babies are stillborn, and those who do live often have inferior vitality. Syphilis produces a poison that has most harmful effects, especially upon the nervous system of children.

One may ask, however, whether all this does not end the parental obligation to exercise proper control over the temper and

the nervous system generally. The answer is that faulty hygiene in these respects will injuriously affect the environment of the children. If the parent is a confirmed neurasthenic, he is almost sure to impair the mental health of his children.

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CHAPTER XVIII

THE HYGIENE OF REPRODUCTION

The Problem Defined.—The hygiene of reproduction in its broadest sense involves the replacing of one generation by another in the best possible manner. There are two phases to this problem. One is selective mating in order to guarantee sound heredity; the other is hygienic living, with particular reference to sex hygiene, the hygiene of pregnancy, and the hygiene of infancy.

Structure of the Genital Organs.—The primary sex differences begin relatively early in the life of the embryo with the development of sex glands (ovaries and testes) which arise from the germinal epithelium near the developing kidney.

In the male the two testes develop in the embryo, move downward to the brim of the pelvis, and pass through the anterior abdominal wall to take their final position in the scrotum, a pouch of skin suspended from the lower part of the male pelvis. The pair of ducts or tubes which carry the sperm to the exterior begin with a set of *sperm tubules* in each testis. These unite to form the coiled tube of the *epididymis,* lying along side the testis. This tube becomes the *vas deferens,* or spermatic duct, which passes upward from the scrotum, in front of the pelvic bone of the groin, through the inguinal canal in the abdominal wall and into the abdominal cavity. After crossing the ureter, it descends back of the urinary bladder to the bottom of the pelvic cavity.

The lower portions of these ducts receive the contents of the *seminal vesicles,* pass through the prostate gland, and empty into the urethra. The secretions of the seminal vesicles, the prostate, and the bulbourethral glands plus the sperm (for which they serve as a vehicle) constitute the *semen.* The *urethra* begins at the neck of the bladder and passes downward through a portion of the prostate gland and through the *penis,* the external male organ, to the outside.

In the female the two ovaries develop in the embryo and each is suspended in the abdominal cavity by a broad ligament. The *Fallopian tube* (oviduct) of the female genital apparatus is not

attached to the ovary, but its open end is close to the area of the ovary from which egg cells are discharged, and the movement of its cilia insures the entrance of the ovum into the oviduct. The right and left oviducts open into the *uterus,* or womb. This is a pear-shaped, muscular-walled organ, about two inches wide and three inches long. The neck of the uterus projects into the thin-walled musculomembranous canal, the *vagina,* which opens to the exterior of the body.

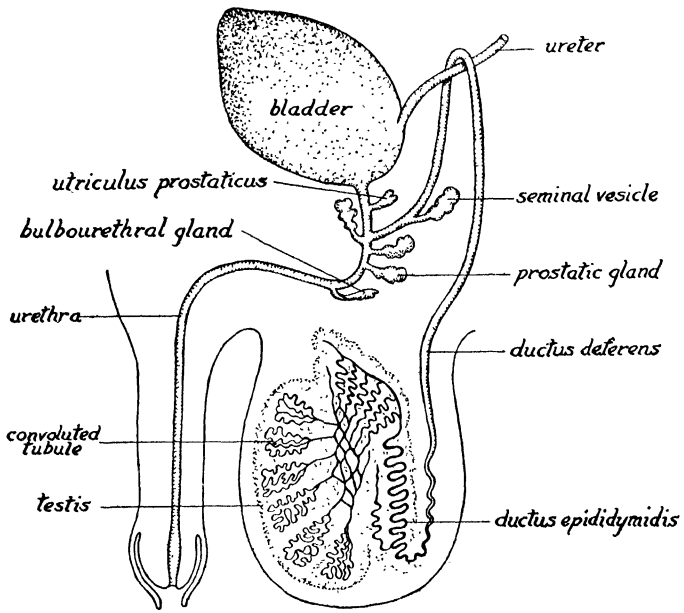


Diagram of the male genital organs. (After Lewis and Stöhr: *Textbook of Histology.* Courtesy The Blakiston Co.)

The urethra does not open into the vagina but through a separate external orifice. Two folds of tissues called *labia* constitute the external genitals or vulva. The *clitoris* is a particularly sensitive structure, located where the labia unite above. In the virgin the outer opening of the vagina is partially closed by a thin membrane called the *hymen.* This membrane may be ruptured by chance during childhood or, if it remains intact, during the first sexual intercourse.

The Reproductive Process.—The ova develop in vesicle-like structures in the ovary. These are called *Graafian follicles.* As the follicle enlarges, it approaches the surface of the ovary and forms an elevation nearly one-half inch in diameter. The ovum itself is only about $\frac{1}{125}$ inch, or 0.2 mm. in diameter. The follicle finally ruptures, liberating its single ovum into the pelvic cavity, from whence it passes directly into the opening of one of the Fallopian tubes. This process of liberating the ovum is called *ovulation.*

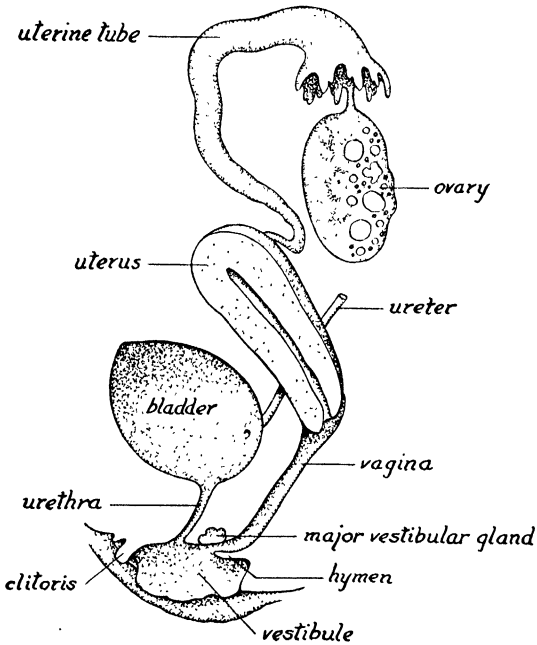
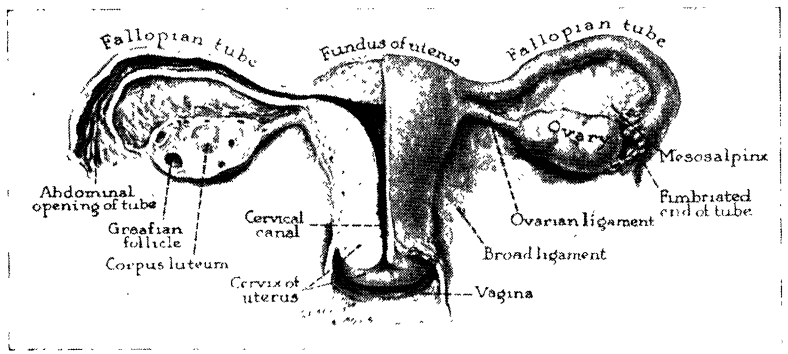


Diagram of the female genital organs. (After Lewis and Stöhr: *Textbook of Histology.* Courtesy The Blakiston Co.)

The empty follicle fills with blood and forms a structure which is gradually changed into the yellow body, or *corpus luteum.* This produces a hormone that prepares the uterus for the reception of the ovum. If fertilization takes place, the corpus luteum persists for some time, and ovulation does not again occur until after the pregnancy is completed.

The *spermatozoa* arise from cells that line the tubules of the testes. A maturing process changes these cells into the tadpole-

shaped spermatozoa, each consisting of a head, a middle, and a long tail piece. These minute motile cells are only about 0.055 mm. in length, and it has been estimated that more than 200 millions are discharged in one emission. They are capable of living for several days after they have been deposited in the genital tract of the female. They move about ⅛ inch per minute and travel up through the uterus to the oviducts. If an ovum is present, a sperm cell penetrates its outer membrane and unites with it. This process is called *fertilization* or conception. Once it has taken place, other sperm cells are repelled from the now fertilized egg, and they soon die.

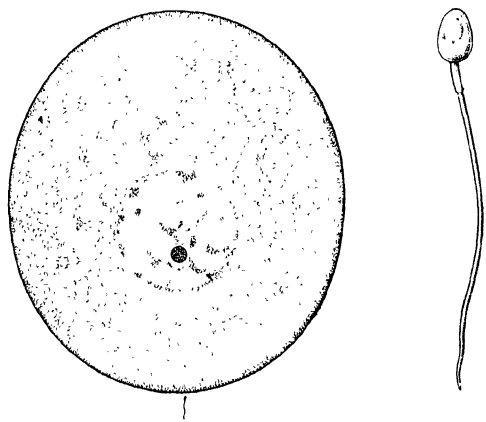


Uterus and associated organs, at left with anterior one-half removed. (From Camp: *Anatomical Studies.*)

The fertilized egg descends into the uterus and becomes implanted in the now highly vascular mucous membrane. It is the beginning of a new individual in the single-cell stage and it starts its growth by dividing into two parts. This process of cell division continues rapidly. It is not possible to make a positive diagnosis of pregnancy by ordinary examination until about four months after conception takes place. However, a highly reliable hormone test may be used a month or more after conception when the gonadotropic hormones of the pituitary (see Chapter IX) appear in high concentration in the urine. Injection of such hormone-containing urine into immature mice or rabbits produces characteristic changes in their ovaries which are diagnostic of pregnancy.

The *embryo* begins its development and at the same time a surrounding membrane, the *amniotic sac,* forms. The embryo is suspended from the wall of this sac and floats in a fluid which fills the sac and acts as a protective cushion for the growing fetus.

At the point where the sac touches the mucous membrane, projecting growths develop in the soft lining of the uterus, forming an attachment between the uterus and the embryo. This area of attachment becomes larger as the fetus grows and is called the *placenta.*

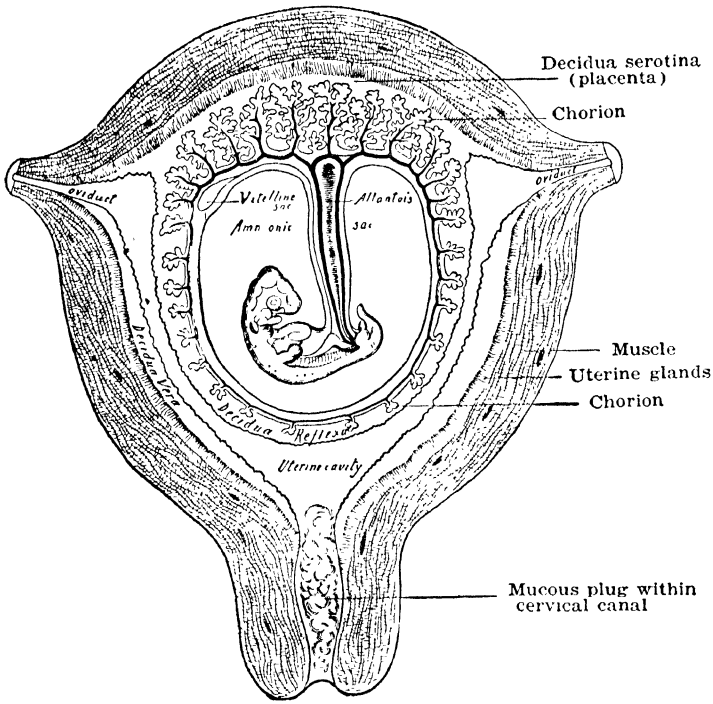


Ovum and sperm. To show the marked difference in size a sperm is shown beneath the ovum in about the same magnification. At the right the sperm, much enlarged, is shown in detail.

The placenta is a highly vascular organ. It connects the fetus with the mother by means of the umbilical cord, which contains two arteries and a vein. The embryo produces its own blood supply, and the blood of the mother never enters it. The circulatory system of the embryo begins to function by the end of the third week. The fetal and maternal capillary systems within the placenta are so close to each other that an exchange of food and waste can take place. The nourishment of the fetus is thus seen to be dependent upon the quality of the nutrition of the mother. Poisons may pass from the blood of the mother to that of the fetus.

The uterus increases tremendously in size and in contracting power during pregnancy. About nine months after conception the fetus is mature, the neck of the uterus softens and dilates, and the

body of the uterus begins a series of automatic contractions. Eventually the membranes rupture and the amniotic fluid escapes. Aided by the contractions of the uterus and by the voluntary contractions of the abdominal muscles, the child passes through the vagina.



Human uterus at seventh week of pregnancy. (After Allen Thompson.)

As soon as the child is born, it gasps, or cries, fills its lungs with air, and begins to breathe. The umbilical cord is cut. A short time later the uterus expels the membranes to which this cord was attached. The birth process is thus completed.

The Sex Hormones.—Sex function follows adolescence, but during the early childhood period the sex glands, ovaries and testes, liberate certain hormones into the blood. These develop the physical differences that characterize the two sexes, including the maturation and development of the sex organs themselves.

The relationship of the sex glands to the secondary sex characteristics is easily studied in domestic animals. For example, experiments with the domestic fowl have shown that the removal of the sex glands from the male prevents the development of the comb and wattles. The effect of castration may also be seen in the ox. His build, vigor, and disposition are essentially different from those of the bull.

The Male.—Beginning with puberty (between 12 and 17 years of age) spermatozoa are formed continually in the tubes of the testes. They make their way to the epididymis, an oblong body attached to the upper part of each testis, and are stored there until ejaculation takes place. Failing this, they die and are absorbed. It was formerly thought that sperms were stored in the seminal vesicles. Many authorities now maintain that these structures are purely secretory. The prostate and bulbo-urethral glands also contribute to the fluid content of the seminal discharge.

The ejaculation of spermatic fluid is believed to be due to an accumulation of secretion. Night emissions occur naturally at intervals of from one to five or six weeks and are not a sign of abnormality or disease. They occur less frequently when the individual has sufficient physical activity and normal wholesome mental occupations. Their frequency is increased by erotic thoughts or situations and by the local congestion or irritation which may result from drinking too much liquid immediately before retiring, from constipation, or from lying flat on the back during sleep.

If night emissions occur as frequently as several times a week, it is usually desirable to consult a physician. After marriage, night emissions ordinarily cease because the seminal fluid is discharged during normal sexual intercourse.

The ejaculation of seminal fluid may be produced by masturbation, or the voluntary excitation of the genital organs. This is not a natural procedure, but its harmfulness has often been exaggerated. The study of individual cases suggests that probably the majority of boys have masturbated to some extent prior to puberty. It is not true that masturbation is bound to produce mental disease. Ordinarily the individual discontinues the practice as he grows older.

The Female.—In the female, as in the male, the arrival of puberty brings bodily changes and the maturation and discharge

of sex cells. The ovaries contain from 30,000 to 40,000 immature sex cells when the individual is born. These cells mature and are expelled from the ovary only between puberty (at about age 14 years) and the menopause (at about age 45 years). This process, called ovulation, occurs normally every twenty-eight days within these periods. We have already described the sequence of events when fertilization takes place. Usually there is no fertilization, and menstruation follows ovulation.

The menstrual function is a normal and natural process that renews the mucous lining of the uterus. In the normal menstrual cycle there is a pregravid period of approximately four days during which the mucous membrane lining the uterus becomes congested with blood. There follows a period of discharge of about five days when this disintegrated lining is carried away with blood and mucus; then a period of restoration and repair of about seven days, followed by a period of rest of about twelve days. Ovulation usually takes place about two weeks after the beginning of the last menstruation, although women vary in this time relation. The internal secretions of the Graffian follicle and corpus luteum are causative factors in these uterine changes.

The twenty-eight-day interval between menstrual periods is far from universal. Many women have a menstrual cycle which is either shorter or longer. Normal menstruation should not be associated with pain. Dysmenorrhea or painful menstruation is often due to such functional causes as poor posture, constipation, insufficient exercise, fatigue, and chilling of the body. Occasionally an organic condition such as a displacement of the uterus, an infantile uterus, or an ovarian cyst may be the cause. When menstruation causes intense pain, when the periods are irregular, or when the flow is excessive, medical advice should be sought.

During menstruation the less strenuous activities of the person need not be restricted but such vigorous or jarring exercise as horseback riding or basketball should be avoided. Swimming is not advised. Care should be taken to avoid chilling the body through prolonged exposure, since it tends to produce congestion of the pelvic organs. Daily baths without subsequent chilling during this period are desirable.

Masturbation or self-stimulation of the genital organs has already been discussed. This habit is found among both sexes,

although girls are less likely than boys to discover the practice. As indicated, no dire consequences inevitably follow. The girl, more than the boy, is liable to nervousness, headache, and backache, following prolonged periods of sex excitement, such as result from too great intimacies between boys and girls. This is due to the congestion in the genital organs.

Diseases.—Communicable diseases of the sex organs have an important place in any consideration of sex hygiene. These diseases constitute a public health problem and are considered in Chapter XXIII and Appendix A.

Sex Education.—In the rearing of children adequate sex instruction is obviously desirable. When the child of 3 or 4 years begins to ask questions, to inquire from whence he came, he should be given a truthful answer to his questions, but no more. Old stories about the stork should not be used; but, on the other hand, this is not the time to teach the details of sex hygiene.

Before puberty the child should be informed about the changes he is soon to undergo. The instruction should be brief, personal, and individual—a task for the parents, doctor, friend, or perhaps the exceptional teacher. All schools can do much to lay a good foundation for sex education through nature study and the development of correct social attitudes. The home, the school, and the church have a joint responsibility in the rearing of the child. Any unusual health problem of the adolescent should receive medical attention.

The third stage of instruction is to be given to young men and women between ages 16 and 18 years, and concerns chiefly information regarding the venereal peril. Fear alone is not a deterrent; but a consideration of each person's obligation to his future mate and a clear understanding of the dangers of infection will go far to pave the way for proper living.

It is not necessary that youth should concern itself with deviations from normal physiology, but it is important to understand that there are wide physiological differences in both males and females. Some women may show traits of masculinity and some men may exhibit femininity. Although normality is the rule, some persons are oversexed, and others reflect a high degree of frigidity. One has a more sympathetic understanding of personality when he realizes that other persons may not be like himself.

Homosexuality is a condition that exists when the mature sex instinct seeks an outlet through a member of the same sex. An intense affection of a member of one sex for another of the same sex is normal and wholesome in children, but it is not to be expected in adults.

Marriage.—Mating and reproduction are the agencies through which nature perpetuates a species. A strong sex impulse guarantees the fulfillment of these functions throughout the animal world. Man finds that many of the richest experiences of life are related to this biologic urge which normally results in parenthood and the rearing of children. The home is society's basic, central, stabilizing institution. Society revolves about the home. Sociologists believe that the rising divorce rate (up sevenfold since 1887 and now one-third the marriage rate) and the loss of family-mindedness are important factors not only in the rearing of children and in juvenile delinquency, but also in the increase of crime and inhumanity. Happy homes are the greatest factor in personal happiness and in national strength and integrity.

The experience of mankind has indicated that monogamous marriage is the best basis for family life. Physically, emotionally, and psychologically, man is adapted to monogamy. In "falling in love" the individual idealizes the prospective mate, and the desire to insure permanent happiness subordinates the selfish desire for sexual gratification. In some cases, to be sure, physical attractiveness is the chief factor in mating, but in most cases mutual respect, common interests, similar tastes, and mutual admiration for qualities of mind and spirit are the more important factors. This leads toward the mating of superior persons with others of their own kind.

The need for advice in marital relations has resulted in the establishment of marriage counsel services in several large cities. Marriage counsel obviously involves ethical, social, economic, and hygienic factors. The experience of marriage counselors shows that a large percentage of marital problems have a basis in some form of sexual incompatability which can often be removed by a better understanding of sex hygiene. One of these problems is sterility in either the male or the female, which may be caused by one of several correctable pathological conditions. Problems also arise concerning the spacing of children in the family, which

is frequently desirable from the standpoint of the mother's health, the care of the children, or the economic limitations under which the family is living. Both the church and the medical profession have been concerned with the difficult problems here involved.

Continence before marriage is contributory to the success of the mating in making the love element more idealistic and in bringing men and women to this important relationship with the highest degree of self-respect. Promiscuity cannot claim the excuse of physical necessity, since a person suffers no physical or mental injury from the postponement of sex life. Laxity in morals produces prostitution with its serious social problems, as well as an unfortunate group of women and illegitimate children. It is responsible for a large amount of venereal disease. There are no sure ways to avoid disease or pregnancy in sexual intercourse. Society frowns upon those persons who do not conform to the usual standards of sex behavior, and such persons are likely to suffer acutely from remorse.

Most persons who do not marry find it readily possible to fill life with wholesome interests, activities, and useful service. Some of the best services to society have come from single persons whose dominating interest has been a worth-while cause. Celibacy is entirely compatible with health.

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CHAPTER XIX

ADULT HYGIENE

The adult faces various responsibilities for health maintenance in keeping up his own efficiency, in protecting the health of his family, and in meeting his health responsibilities as a citizen. New health problems arise with advancing years. Many of these have been considered already. Others will be discussed in this chapter and in the chapters on community health.

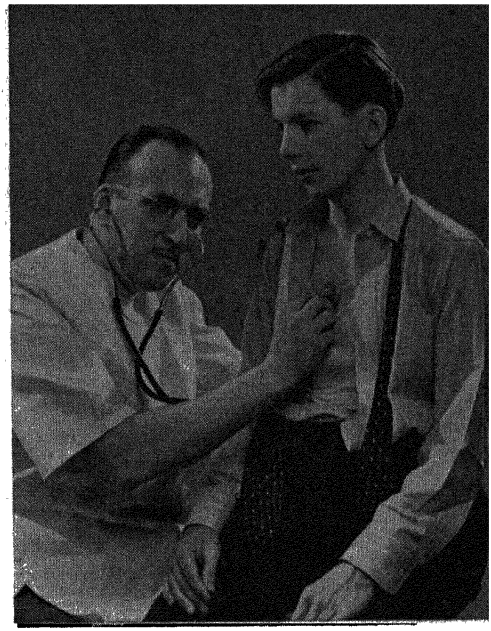
Medical Care.—No hard and fast rules of living can be made that will apply equally to all persons. It is very important, therefore, that each person through his own experience and through medical advice understand his own particular limitations and live within them. The old-fashioned idea that medical services exist only for those who are physically disabled is gradually being replaced by the more modern point of view that such services should also be used to prevent disease.

Unfortunately, many persons treat themselves until they become seriously ill; then they call the physician and demand that he perform a miracle in short order. A person of this type usually follows the doctor's orders only so long as he is sick in bed and returns to his old habits the moment he is able to be on his feet again, disregarding repeated warnings from the physician. He expects too much and cooperates too little.

The physician should be given an opportunity to advise during health and to detect the first signs of deviation from normal. At that time correction may be made with the greatest assurance of success and with the least pain and inconvenience to the patient. The annual health examination for a thorough check-up by the physician is now a recognized procedure in the maintenance of health. The physician has certain tools of science such as blood pressure, microscopic examination of the blood, urinalysis and x-ray examinations, which are very helpful in revealing obscure signs significant in the diagnosis of disease.

The physician should also be consulted when any symptoms appear which seem to suggest a deviation from normal, as for example the appearance of a lump anywhere in the body, undue

fatigue, chronic pain, discomfort, or a persistent cough. Medical supervision is needed for the expectant mother, infant, and runabout child. While these are normal situations in life, there are many dangers attendant upon them that can be avoided by expert supervision. Immunization against the diseases for which it is possible and needed is a most important health service.



(Harold M. Lambert)

The health examination is an important part of your health program.

Choosing One's Physician.—The choice of one's physician merits careful thought. Beyond preferences as to personality, there is the more important consideration as to the quality of training he has received. If the physician is a graduate of a recognized medical school and has had training or experience in a first-class hospital, his background may be considered adequate. In addition to this qualification a good physician must keep up with progress in scientific discoveries and in medical and surgical practice. He probably belongs to local and national medical associations. It is always well to choose a physician who is liked and employed by worthy people in the community. In a new or strange community, ask the advice of a hospital.

In the medical profession as elsewhere there are variations in ethics and in competency. Reputable physicians follow a high code of ethics and are actuated by the spirit of service to humanity. They do not advertise.

There are no secrets regarding cures that a reputable physician will withhold from other physicians. Authentic discoveries are freely discussed in medical journals. New theories are given very careful scrutiny before they are accepted and endorsed by the medical profession. One should beware of those who advertise special or secret methods of cure or who claim ability to cure

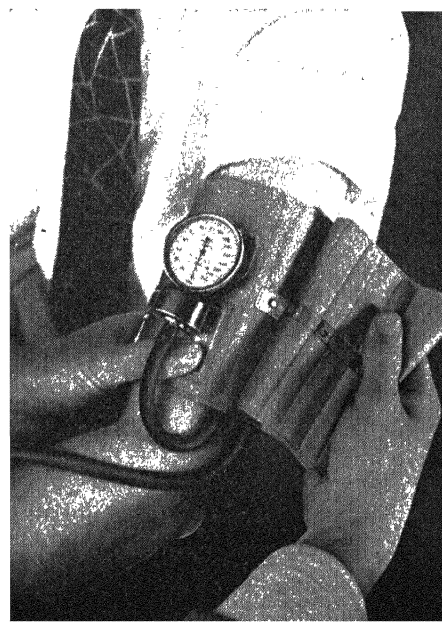
serious ailments easily and quickly. These are the methods of the "quack." A person should not trust his well-being and safety to one who resorts to these methods. One should also avoid itinerant healers who do not remain long enough in one place to assume full responsibility for results of treatments given.

Health Insurance, State Medicine, Socialized Medicine.—A study of medical service available to the majority of the world's population both in the past and today will show how fortunate the American citizen is in being able to employ the quality of medical and surgical skill available. There is much to be said for the ideal relationship between the patient and his private physician who advises him in health and treats him in disease. Nevertheless, European countries have developed various forms of organized or socialized medicine and similar proposals have been advanced in this country. We can do little more here than state the nature of this important problem. Interested students are urged to look up the literature and to write to the American Medical Association, Chicago, Illinois, for additional material.

Those who advocate some change in the nature of medical practice point out certain difficulties, problems, and needs in our present system. These may be briefly enumerated: (1) More medical service is needed than is now being received, particularly in the form of early treatment and convalescent care. (2) More preventive services are needed, particularly immunization and advice in dietetics. (3) Medical costs are uneven. There may be many months without medical cost to the family and then costs over the following few months may be financially crippling. (4) Medicine is complex. The patient often needs the services of specialists and of laboratories as well as those of the general practitioner. (5) The geographic distribution of physicians is poor. (6) The cost of medical education and of getting established in medical practice is high. (7) The quality of some medical service is low. Various cults thrive because uninformed people are willing to purchase such services. In some areas specialists in the various phases of medicine are absent. Many physicians cannot obtain the graduate training they would like. (8) Disease rather than health is profitable, inasmuch as the physician is paid only when sickness occurs.

It is easy to see the difficulties that arise in the present situation, but it is not so easy to find ways to eliminate them. In general, it is true that adequate medical service has been available to people with means, who can afford the best medical service, and to the very poor, who are served gratuitously by physicians and in many localities by social agencies. The chief concern has been the provision of medical service for the middle classes. Various attempts have been made to meet some of the above-mentioned problems through middle-rate hospitals, pay clinics, better medical care for the indigent, the establishment of private office practice in hospitals, public health nursing, trained midwives, and nursing attendants. More pretentious plans for organizing medical service and spreading the cost of medical care fall under three headings: health insurance, state medicine, and socialized medicine.

Health insurance may be of three types. (1) Direct money payment is sometimes provided through the insurance principle by insurance companies or by fraternal or insurance societies. (2) Medical and surgical care is sometimes provided on the insurance principle by employers, by associations of workers, by joint payment from employers and workers, by colleges through the college health service, by hospital insurance sold to groups of individuals, and by prepayment medical care. Many plans for voluntary health insurance or prepayment medical care have developed in various states and cities in recent years. Hospital insurance is at present more widespread than complete medical coverage. (3) Both money payment and



Taking the blood pressure. (Courtesy Taylor Instrument Companies.)

care are provided to special groups under workmen's compensation in this country and in the various health insurance plans of other countries.

State medicine, the second type of approach to this problem, is seen in Russia, where free medical service is provided for the people at government expense in the same way that free public education is provided in the United States. Free medical schools are provided much as our free normal schools are provided for teachers. There is the fear in this country that professional advancement in the practice of medicine under such a system would be by political preference rather than by professional ability.

The third possibility is *socialized medicine.* In this plan medical service, equipment, and professional education are furnished by the state as in state medicine, but the program is operated and regulated by professional groups rather than by government. Under this system the medical profession, the medical and dental colleges, and the public health agencies would control medical practice and medical care.

Health Problems of the Adult.—There are more adults, proportionately, in the population than there were a few decades ago. In 1900 less than 20 per cent of the population was 45 years or more of age. By 1940 the group was over 25 per cent of the total; and it is estimated that by 1960 it will be 33 per cent.

This change has come about through a sharp reduction in the number of infant deaths and deaths from those communicable diseases which formerly carried away great numbers of children and of young people. As late as 1900, tuberculosis and pneumonia were the two leading causes of death, with approximately 190 and 160 annual deaths, respectively, per hundred thousand population. Heart disease was third, with a rate of 125, and diarrhea and enteritis in children under 2 years was fourth, with the rate of 120.

Contrast these figures with those compiled by the National Office of Vital Statistics giving the number of deaths and the death rate per one hundred thousand population for the twelve leading causes in the 1,401,719 deaths for the year 1945.

A glance at the present leading causes of death reflects the change in the age distribution of the population. They are mainly diseases of adult life. The startling jump in the death rates from

TWELVE LEADING CAUSES OF DEATH IN 1945

CAUSE OF DEATH	NUMBER	RATE
1. Heart disease	424,328	326
2. Cancer	177,464	135
3. Hemorrhage of brain	129,144	98
4. Accidents	95,918	73
5. Kidney disease (nephritis)	88,078	67
6. Pneumonia and influenza	68,386	52
7. Tuberculosis	52,916	40
8. Diabetes	35,160	27
9. Premature births	31,614	24
10. Deformities present at birth	16,187	12
11. Suicide	14,782	11
12. Syphilis	14,062	11

diseases of the heart and blood vessels and from cancer come chiefly from having more people in these older ages where those diseases occur most frequently.

The two leading causes of death not considered elsewhere, cancer and accidents, will be briefly discussed in this chapter. To these we would like to add some comment upon rheumatism, which, although not an important cause of death, is a widespread and serious disease.

Cancer.—In the normal development of the body the production of new cells takes place in accordance with a definite pattern during the years of growth. Then cell growth ceases, except in certain generative tissues located at specific points, or in regenerative tissues occurring at the site of an injury. An uncontrolled new growth of cells anywhere in the body is an abnormal condition. The enlargement which follows such growth is called a *tumor*. Tumors are classified as benign or malignant.

A *benign tumor* is essentially harmless, though it may produce injury or even death if it presses upon an important organ so as to interfere with its functioning. Examples of such interference may occur in brain tumors; in tumors which hinder the circulation of blood; or in tumors which invade the tissue of the ovary, preventing ovulation. A benign tumor may, if irritated, become malignant, or it may soften and degenerate until it menaces health. Benign tumors should be examined by a physician. They are usually removed because it is difficult to be absolutely certain of the benign nature of a tumor. Once removed, they do not recur.

Malignant tumors grow steadily, and tend to invade and destroy surrounding tissues and to transplant themselves through the lym-

phatic system or blood stream to other parts of the body (metastasis). They threaten life unless removed early, and they may recur after surgical removal if any portion of the tumor remains.

Malignant tumors are named by the pathologist in accordance with the type of tissue in which they originate. Carcinomas are malignant tumors originating in the epithelial tissue (skin, glands, and mucous membranes of alimentary canal, respiratory tract, or genitourinary system), and sarcomas are those originating in connective tissue (bones, tendons, fat, and fibers). The term "cancer" is commonly used by lay persons to designate any form of malignant tumor. Cancer may affect any part of the body, but the stomach, breast, rectum, esophagus, liver, mouth, skin, and female genital organs are the most common sites affected.

The *cause* of cancer is not known. It reflects a disturbance in normal cell mechanics, and we do not yet understand the latter. It is known, however, that chronic irritation may be an exciting cause. A pigmented mole that is constantly rubbed by clothing may develop into a cancer. Cancer of the lip occurs frequently in persons who smoke cigars or short clay pipes. Workers in certain trades who are exposed to irritants often develop cancer on the parts thus irritated.

It has often been observed that cancer seems to "run in families," and the question arises as to whether or not a predisposition to develop cancer is hereditary. In certain strains of mice the tendency to cancer is a persistent characteristic and is, therefore, regarded as hereditary; in other strains cancer almost never occurs. Other laboratory experimentation has demonstrated that cancer can be induced by chronic irritation. A report has been made of a study in which an irritant was applied to contrasting strains of mice, with the result that while cancer was produced in both, it occurred four times as often in the mice that were naturally susceptible to cancer as in those that were not. This suggests that in cancer formation in man both heredity and environment (irritants) may be concerned. The degree of constitutional susceptibility may vary greatly in persons. Likewise, the external conditions to which different persons are subjected may vary. All sorts of combinations of these factors might occur, varying from the individual with low susceptibility who does not come into contact with irritants to the highly susceptible person who is

constantly under adverse environmental influences. This may account for the great variability in the appearance of cancer and the difficulty in making generalizations regarding it.

There is no evidence that diet has any relation with the occurrence of cancer. While chronic irritation may induce cancer, there is no evidence that a sudden blow or injury is sufficient to do so. Cancer is not contagious nor is it hereditary in the sense that it can be transmitted directly from parent to offspring through the germ cells.

Cancer is increasing according to statistical reports. It now ranks second as a cause of death in the United States Registration Area. In general, cancer is a disease of late maturity rather than of youth, since relatively few cases occur in persons under 40 years of age. The increasing percentage of the population above this age naturally increases the cancer death rate. The fact that more than 189,000 persons die of cancer yearly deserves attention, especially since a considerable percentage of these deaths could be prevented by early recognition and proper treatment.

The two most important steps in *the control of cancer* are (1) early discovery of the disease before it has had time to spread from the point of origin and scatter into parts of the body where it cannot be reached, (2) complete removal of the growth by surgery or its complete destruction by radiation.

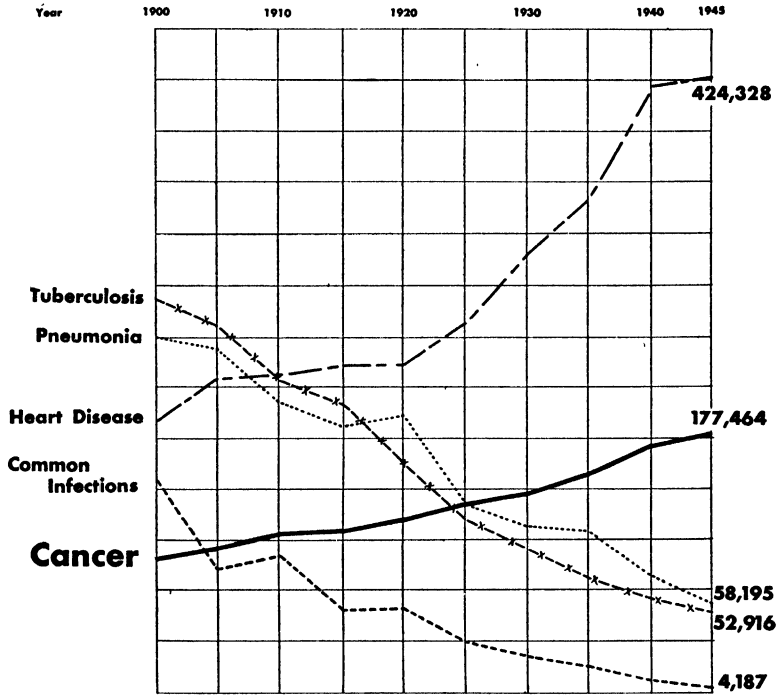
The early discovery of cancer is not easy because it is almost always painless. The earliest sign is usually a lump. If it occurs on the skin, the lip, or the breast, it can be detected easily and is most readily curable. It has been estimated that from 95 to 99 per cent of the cases of skin cancer can be cured if properly treated.

If cancer occurs in one of the body cavities, the uterus, the bladder, or the rectum, it may not be detected in its early stage, but its first symptom will appear in bleeding or other abnormal discharge. The next largest number of cures are in this group.

If the lump is located inside the body—in the stomach, the liver, kidneys, or pancreas, it cannot be seen or felt and no visible discharge can be detected. The patient does not become aware of it until it has developed to the point of causing pain by nerve involvement or of obstructing the stomach, the bile duct, or the intestines. By this time it has usually become so thoroughly dis-

seminated throughout the body that its removal is impossible. This group is the least curable.

The responsibility for discovering the first signs of cancer and bringing these to the attention of the physician rests largely with the individual. When, through proper educational work, everyone understands this and assumes his responsibility, the cancer problem will be much better controlled.



Cancer ranks second among all causes of death. (Courtesy American Cancer Society.)

When a patient has any one of the following symptoms he should regard it with suspicion and promptly consult a physician for diagnosis and treatment:

1. Any sore which is slow in healing. (An open sore that resists treatment for three weeks is a dangerous one.)

2. Any lump in the breast. (Three out of four breast lumps are harmless, but an examination by a physician is necessary to identify these.)

3. Any wart, wen, or mole which shows sudden or unusual growth.

4. Any unusual or irregular bleeding or discharge from any body opening. (While in many instances this may be harmless, a physician should be consulted.)

5. Persistent indigestion or difficulty in swallowing.

6. Persistent hoarseness or cough.

7. Any change in normal bowel habits.

The important thing for the person to remember is that early cancer is curable but there is no known cure except by complete removal or complete destruction of the abnormal tissue before portions have spread to other parts of the body and formed new growths. Due to this danger no cure is recognized as such until five years have passed without recurrence of growth.

Many cancer "cures" have been flooding the world in recent years. These advertised cures invariably catch the public eye, and the uninformed person who is ignorant of the true nature of cancer is easily misled by their unscientific claims. Thousands of cancer patients and thousands of those who think they have cancer are victims of "special discoveries" and of fads and nostrums every year. No authentic cures of cancer have as yet been demonstrated by the use of drugs of any kind. No success has followed attempts to cure cancer by modifications of the diet. No scientific evidence exists of electrical vibrations in human tissues which can be used in the diagnosis and treatment of cancer. In a disease in which every day of delay in proper treatment lessens the chances of recovery, such attempted "cures" increase the mortality. The following precautionary procedures are offered by the American Cancer Society to guide the public:

"1. Avoid every advertised cancer cure.

"2. Be sure that the treatment advocated rests on a firm foundation of scientific experimentation with animals.

"3. Be sure that the method of treatment is not the personal monopoly of the person offering it. In other words, be sure that no secret formula or method is used."

General recognition of the importance of early discovery and treatment will do more than anything else to curb the rapidly increasing cancer fatality.

Accidents.—The National Safety Council gives the following figures which indicate in round numbers the accident experience of the United States in 1946, involving an estimated cost of $6,400,000,000.

CLASSIFICATION	PERSONS INJURED	PERSONS KILLED
Home	5,100,000	33,000
Motor vehicles	1,150,000	33,500
Public (not motor) vehicles	2,100,000	17,000
Occupational	2,050,000	16,500
Total	10,400,000	100,000

Most accidents are among the adult population, 70 per cent of them occurring in persons over 24 and 85 per cent in persons over 15 years of age. Nevertheless, from 2 to 27 years of age accidents of all types cause more deaths than any single disease. Naturally the age incidence varies with the type of accident. In motor vehicle accidents, teen-age drivers have the highest accident rate. This rate decreases to about 60 years of age, when it rises rapidly.

The largest group of accidents, *home accidents,* are caused by falls, burns, explosions, poisonings, poisonous gas, mechanical suffocation, and firearms. *Motor vehicle accidents* (both collision and noncollision), although less numerous, cause about twice as many deaths as *other public accidents* (including transportation accidents and nontransportation accidents like drowning, falls, firearms, and burns) and about twice as many as *industrial accidents.* Industrial accidents are further discussed in Chapter XXXI).

Important as this problem is we cannot here consider the innumerable precautions against countless possible accidents, much less discuss first aid, which is a skill and must be learned in a practice situation. We do recognize safety as a life and death matter and although we may prefer "choose your adventure" to "safety first" as a slogan, we know that, desirable as is adventure, needless risk is stupid. We can check the safety of environment and equipment and use skill and science in accident prevention.

Rheumatism.—The term rheumatism is applied to several diseases involving inflammation in muscles or joints. These include muscular rheumatism and several catagories of arthritis. Among the latter are specific infectious arthritis (gonorrheal, pneumococcal, or tuberculous), rheumatic fever (an acute fever

beginning with sore throat and associated with the presence of hemolytic streptococci), rheumatoid arthritis (with slowly progressive swelling and stiffening of joints and low ascorbic acid in the blood plasma), and gout (with high uric acid in the blood and chalky deposits of urates in the cartilages and the joints). This group of diseases appears to be increasing and surveys indicate that one person in thirty suffers from some form of rheumatism.

We do not know the cause of these diseases. Related factors are exposure to extreme and sudden changes of temperature and moisture, family predisposition to rheumatoid diseases, dietary deficiency (especially vitamin C), repeated attacks of low-grade infection, glandular disturbances, and injury to joint tissue. The extent of the damage done to the individual depends to a large extent upon his general health and upon his resistance to disease.

Medical attention is obviously needed in order that an early and exact diagnosis may be made and in order that immediate measures for the control of the disease may be instituted. The complications which follow rheumatic fever are serious. It has been estimated that more than 80 per cent of the heart disease found in young adults is due to rheumatic fever.

Gerontology.—As old age approaches, the efficiency of the various body mechanisms naturally declines. Many so-called degenerative diseases appear, such as high blood pressure and hardening of the arteries (see chapter on Circulation). Obesity may add to the burden of the circulatory system. The hardening of the arteries of the pancreas contributes to the development of diabetes in middle age. Similarly, less efficient functioning may occur in kidney, glands, or central nervous system. Our knowledge of the conditions and problems of old age constitutes the science of gerontology and the medical specialty serving the aged is geriatrics.

With ideal heredity and perfect hygiene old age would bring a gradual lessening of mental and physical vigor and the person's exit from this world would be as natural and painless as was his entrance into it. Such an end is described in Dr. Oliver Wendell Holmes' classic poem "The One-Hoss Shay" which went to pieces

> "All at once, and nothing first—
> "Just as bubbles do when they burst."

Unfortunately, as the good physician pointed out, it is rare that all parts of the body are equally strong. Through a degenerative disease some part fails. As he expressed it:

> "Now in building of chasses I tell you what,
> "There is always *somewhere* a weakest spot . . .
> "And that's the reason beyond a doubt
> "A chaise *breaks down,* but doesn't *wear out.*"

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Part II
Community Health

CHAPTER XX
THE SCIENCE OF DISEASE PREVENTION

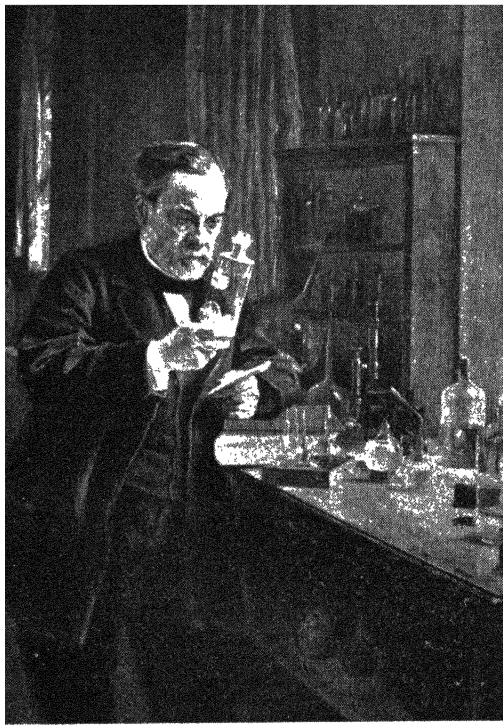
Thus far the discussion in the text has been concerned with three primary topics: the normal functioning of the body, the hygienic conduct of daily life, and the avoidance of diseases which arise from some derangement of the body mechanism from within—the so-called *constitutional* diseases.

There is another group of diseases which we may call *environmental* or *communicable* because they arise outside the body. Such diseases are comparable to the troubles with a machine that arise from the entrance of foreign bodies. Through preventive medicine, sanitation, and hygiene the number of deaths from this group of diseases is being rapidly reduced. In the body, as in the machine, it is possible to prevent these injuries arising from without while the results of wear and tear will eventually make themselves felt.

Early Theories of Disease.—It is difficult to realize that our knowledge of the cause of communicable disease does not date back of our own Civil War and that some persons now living can distinctly remember the days when germs were unknown. Previous to this time the world had entertained vague notions as to the nature of these maladies, including the early conceptions of primitive man, the doctrines of Hippocrates, and later the doctrines of Sydenham.

The *demonic theory* of primitive man held that pain, disease, and death were caused by evil spirits. Under such a theory "curative medicine" consisted of sacrifice or some other method of placating the evil spirits, and "preventive medicine" was the use of charms or magic substances to keep the demons away.

From Hippocrates (460-359 B.C.) came the *theory of the four humors* which held the essential elements of the body to be phlegm,



(Ewing Galloway)

Louis Pasteur (1822-1895).

blood, yellow bile, and black bile, and disease to result from the improper balance between these substances. Our vocabulary still bears testimony to this belief when we speak of persons of a sanguine, phlegmatic, or melancholic (black bile) temperament. The theories of Hippocrates and his follower Galen dominated medical thought until the sixteenth century.

We cannot be detained with a discussion of the various advances in thought between this period and the establishing of our present knowledge except to mention the work of Thomas Sydenham (1644-1689), who asserted that "a disease is nothing more than an effort of nature to restore the health of the patient by the elimination of the morbific matter." Through his belief in a definite substance, the *materies morbi,* as the cause of the disease, the "English Hippocrates," as Sydenham has been called, foreshadowed the scientific recognition of infective organisms in the classical researches of Pasteur.

Foreshadowings of the Present Theory.—Certain other scientific developments preceded the work of Pasteur. The compound microscope was developed about 1835. This was a necessary prerequisite to the study of infectious disease, as well as to the development of cytologic and histologic knowledge. In 1837 the Italian investigator, Bassi, discovered that a contagious disease of silkworms, known as *muscardine,* was caused by a parasitic fungus, and only two years later (1839) Schönlein showed that another moldlike plant was the cause of *favus,* or honeycomb of the human

scalp. This was our first definite information of a parasitic plant as the cause of a human disease.

Fermentation and Disease.—It was in 1838 that Cagniard de Latour and Schwann, in studying yeast, showed that alcoholic fermentation is caused by a living plant. Their theory that this plant was the real cause of the fermentation process was at first disputed and it was only thoroughly and finally established by Louis Pasteur (in 1857-1863) who went still further and showed that the "diseases" of beer and wine (abnormal sour and bitter tastes) were produced by micro-organisms other than ordinary yeast. These had invaded the liquid and disturbed the usual alcoholic fermentation by producing undesirable fermentations of their own.

It could hardly fail to occur to any thoughtful person that if this were true for certain diseases of wine and beer, it might well be true also for certain diseases of animals, for if we consider step by step the course of any familiar fermentation and then do the same for any familiar infectious disease, we shall discover between them a remarkable similarity. For this purpose we may take the fermentation of apple juice, or cider, and smallpox. . . .*

FERMENTATION (Apple juice)	AN INFECTIOUS DISEASE (Smallpox)
1. Exposure of the juice to air, dust, etc.	1. Exposure of the patient to infection.
2. Repose and then slow change. (Growth of the ferment.)	2. Incubation. (Slow and insidious progress of the disease.)
3. Active fermentation or "working." Evolution of gas bubbles, change of sugar to alcohol. Rise of temperature.	3. Active disease. Eruption, disturbance of the usual functions. Rise of temperature or fever.
4. Gradual cessation of fermentation.	4. Slow convalescence (or death).
5. No further liability to alcoholic fermentation.	5. Immunity to smallpox.

Pasteur.—After Pasteur had finished his important studies on the nature of fermentation in wine and beer, thereby opening for himself a broad and alluring field for further research, the French government urged him to undertake the study of a disease of silkworms. This disease not only was causing an annual loss of 100,000,000 francs in France but also was spreading rapidly to other countries, so that it threatened the existence of the silk

*From Sedgwick: *Principles of Sanitary Science and Public Health.*

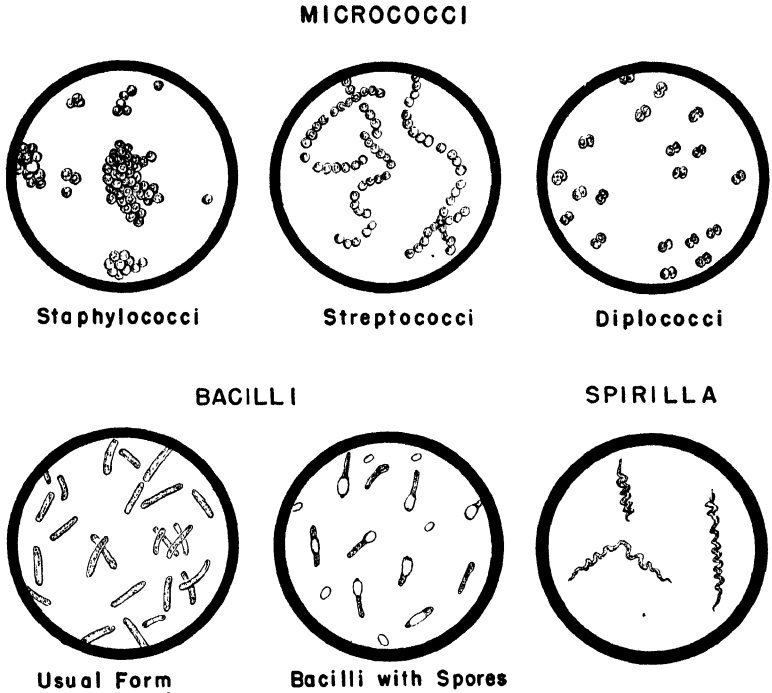
industry in all parts of the world. During the years 1865-1868 Pasteur proved this disease (pébrine) to be caused by a particular germ which could be grown by itself in suitable liquid. He also devised a method by which the eggs could be hatched and the silkworms could be raised without becoming infected with this disease. The foundations for the science of bacteriology and the germ theory of disease were thus securely laid. Pasteur extended his studies to diseases of the domestic animals and of man.

Lister.—Development from this point was rapid. Sir Joseph Lister, reflecting upon the significance of the investigations of Pasteur, concluded that many wound diseases were probably infectious and set to work to establish his thesis by the use of antiseptic sprays and dressings. Lister's use of antiseptic substances paved the way for the modern practice of sanitary, or aseptic, surgery.

Koch and the Development of Bacteriology.—Then came the startling work of Robert Koch. It was he who firmly established the science of bacteriology by his researches on anthrax and other diseases and by the adaptation of solid culture media, prepared from gelatin substances, on which bacteria could be readily grown and isolated. In his work with anthrax, or splenic fever, a disease then very common among cattle and sheep, and occasionally attacking human beings, he found, as others had already observed, that there were minute or microscopic rods in the blood of animals which had died from this disease. He removed these minute plants from the tissues and planted them in the clear liquid which constituted the aqueous humor of the ox's eye. The organisms grew in this liquid from which minute quantities were introduced into fresh aqueous humor several times in succession until only the remote descendants of the plants first used were left. When these were introduced into healthy animals, they produced typical anthrax. In other words, the chain of proof had been made complete. A specific germ had been found in animals having a particular disease, it had been isolated and grown by itself in pure cultures, it had been introduced into healthy animals where it produced disease and the death of the animal, after which it had been recovered from the tissues. These

four steps are known as Koch's rules for identifying the cause of a disease.

From such beginnings has developed the science of bacteriology. It has many applications today in industry (dairying, farming, and food preservation), in public health, and in medical practice.



Common types of bacteria.

Characteristics of Bacteria. Bacteria are microscopic single-celled organisms, comprising one of the lowest forms of vegetable life. In shape most species are spherical (coccus), cylindric (bacillus), or spiral (spirillum). They are so small that their size is expressed in microns (thousandths of a millimeter). They vary greatly in size, some forms being 0.5 micron in length, others being 40 microns.

Bacteria are widely distributed over the earth's surface where they play an important role. The chemical changes known as

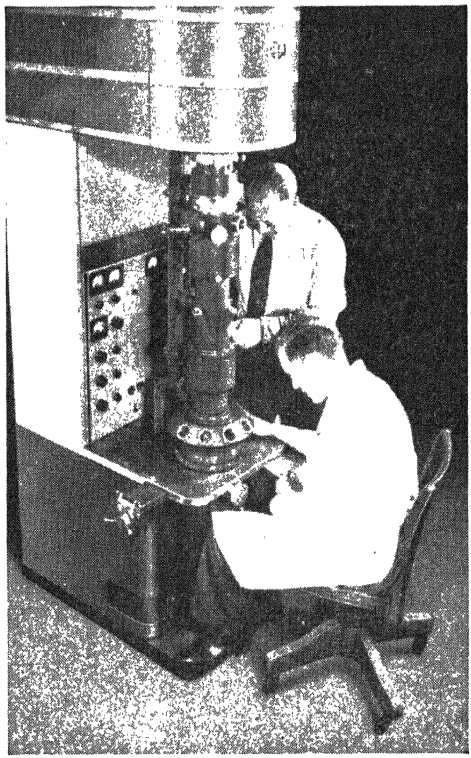
putrefaction (in which proteins are split into simpler substances) and fermentations (in which carbon compounds are broken up) are due to the action of bacteria. These processes are useful in nature in preventing the accumulation of useless organic material.

While bacteria are widely scattered, they are not capable of growing everywhere. Proper nourishment, moisture, oxygen, temperature, and the absence of direct sunlight and retarding chemicals are essential to their growth. With few exceptions, they must have food in the form of complex organic compounds. Some bacteria are saprophytic, living on lifeless organic matter; others are parasitic, thriving in the living tissues of plants or animals. The latter are the pathogenic bacteria that produce disease.

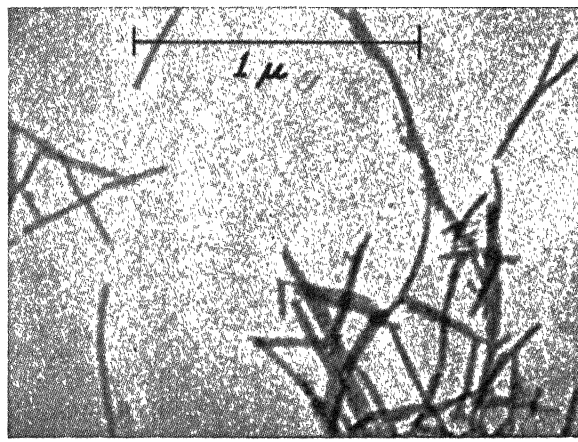
Water is essential to the growth of bacteria. This fact is the basis for the preservation of foods by drying. Oxygen is also essential to bacterial life, though some bacteria (aerobic) must secure it directly as oxygen while others (anaerobic) obtain their supply from some compound, such as sugar, which is rich in oxygen.

With each species of bacteria there is one temperature, the optimum, that is most favorable to growth. Within a varying range above and below are found the maximum and minimum temperatures at which growth can continue. For the majority of bacteria the optimum temperature lies between 25° and 30° C. (75° to 85° F.), although pathogenic bacteria thrive best at body temperature, 37° C. (98.6° F.). The thermal death point of bacteria which do not produce spores is usually between 65° and 70° C. (148° to 158° F.). This has important applications in the process of disinfecting. Low temperatures do not kill bacteria so easily. They are usually fairly resistant to freezing.

Bacteria thrive best in the dark or in diffused daylight. When conditions are favorable for growth, they multiply rapidly by a process of simple cell division. Under some conditions this may occur as often as once every twenty minutes. The process of division is not unlimited, however, because the accumulation of waste substances from the bacteria and the disintegration products of the food in surrounding media eventually act as inhibitory factors.



The electron microscope. (Courtesy RCA Manufacturing Co.)



Filtrable tobacco mosaic virus, photographed through the electron microscope (x 39,000). (From Stanley and Anderson: J. Biol. Chem. 139: 325, 1941.)

Some bacteria have the ability to form spores when the environment becomes unfavorable. These spores are resistant to heat, to drying, and to chemicals. Although spore formation is not very common among bacteria, it is a factor which must be taken into account in sterilizing substances.



Transferring a pure culture of bacteria from a culture plate.

How Bacteria Are Studied. As has been stated, the construction of the microscope was the first step in making the recognition of bacteria possible. The development of a special technic for the detailed study of these colorless, almost transparent, cells was essential before progress could be made. This technic includes the use of stains to render the bacteria more readily visible, and the use of suitable culture media in which organisms can be isolated and grown in the laboratory. As we have seen, Robert Koch was responsible for overcoming most of the difficulties involved. The method he developed for killing, fixing, and staining bacteria is still in use today.

One of the greatest contributions Koch made in the study of bacteria was his method of preparing pure cultures. It requires the preparation of a liquid food medium to which a solidifying agent, such as gelatin or agar-agar, is added. This is sterilized

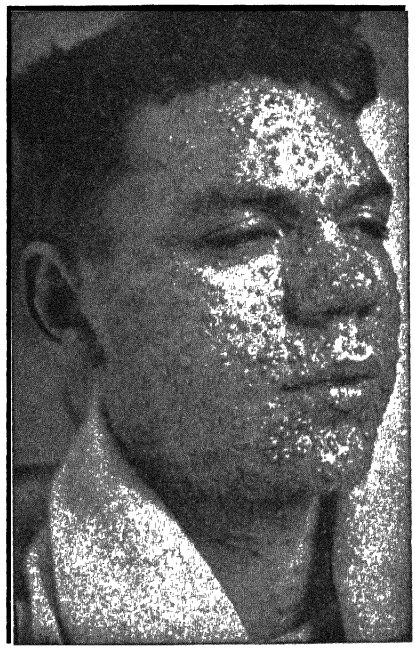
by heat, cooled to a considerable degree, and inoculated with a small quantity of the material to be studied. After thorough mixing, the liquid is poured in a thin layer into a sterilized glass plate and covered. The bacteria are thus distributed over a relatively large area, and as the liquid solidifies each bacterium is fixed in place and is unable to move throughout the medium. As each bacterium multiplies it produces a visible mass of cells, known as a colony, composed of only one kind of bacteria. By means of a sterile needle a portion of the colony can be transferred to a sterile tube of culture media. This tube develops a pure culture of bacteria.

Progress Due to Bacteriology.—The adoption of the foregoing methods of laboratory study and the use of Koch's four rules for identifying the cause of a disease were followed by the discovery of the bacillus of tuberculosis in 1882, the discovery of cholera vibrio in 1883, the bacilli of diphtheria and of tetanus (lockjaw) in 1884. Within fifteen years after Koch's technic had been perfected, the causative organisms of most diseases which are now known to be of bacterial origin were discovered. It should be remembered that diseases are caused by a variety of microscopic organisms, including not only bacteria and filtrable viruses, but also fungi or moldlike plants, and animal parasites, such as those causing malaria, amebic dysentery, and trichinosis.

The contribution of bacteriology to the control of disease, however, does not stop with the identification of the causative organisms. Careful study and experimentation with these causative agents reveal facts that are useful in preventing the dissemination of disease germs and their entrance into the body. Bacteriologic research also has aided in the development of methods of producing artificial immunity for certain diseases.

Viruses.—In the 1890's it was discovered that the mosaic disease of tobacco and the foot and mouth disease of cattle were due to agents apparently living but too small to be seen under the microscope and small enough to pass through porcelain filters which hold back bacteria. Since 1900 many diseases of man and other animals have been shown to be due to filtrable viruses, including smallpox, common cold, influenza, poliomyelitis, measles,

mumps, chicken pox, shingles, psittacosis, rabies, yellow fever, and dengue fever. In 1915 a similar agent was discovered which destroys bacterial cells. It was called bacteriophage and may be regarded as a virus disease of bacteria. No virus has as yet been cultivated in the absence of living cells.



Smallpox on seventh day of eruption. (After Sutton and Sutton.)

PREVENTING DISEASE

From our growing knowledge of disease-producing organisms there arose three phases of the science of disease prevention: namely, preventive medicine, preventive sanitation, and preventive hygiene. Let us examine the origin and nature of each.

Preventive Medicine

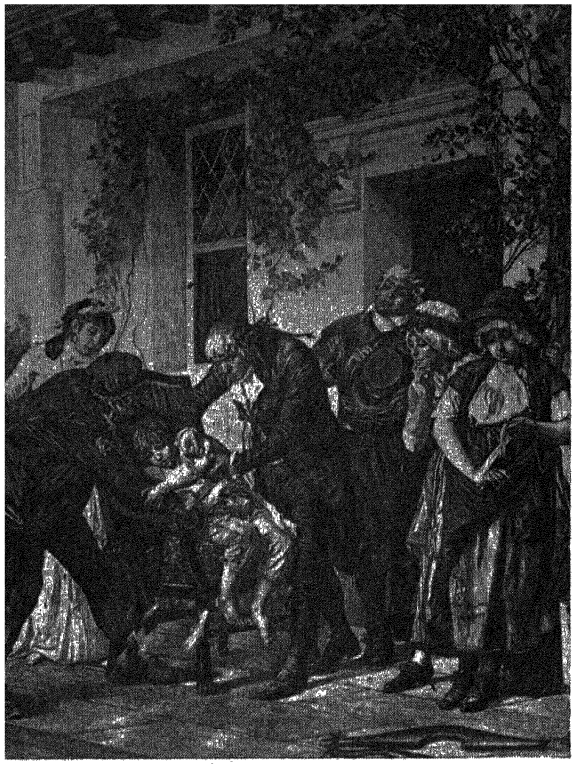
The term "preventive medicine" is sometimes used to include all public health activities. More specifically, it may be properly limited to those processes by which the individual is so treated

as to become immune to particular diseases, in other words, the treatment of the individual to prevent disease. We look upon Pasteur as the founder of this science. In beginning his studies on immunity Pasteur had before him the example of smallpox vaccination which had been developed and successfully applied without knowledge of the germ theory of disease. Let us briefly review this story.

Smallpox and Vaccination.—As early as 1717 Lady Mary Wortley Montagu, the wife of the British ambassador at Constantinople, wrote to friends at home of the Turkish custom of "inoculating" against smallpox. In this inoculation some "matter" obtained from the pustule of a smallpox patient was introduced under the skin of a healthy person. Such an individual, by choosing inoculation when he was in good physical health, and by taking good care of himself from the onset of the disease usually had a mild attack and was immune thereafter. The general adoption throughout Europe of this strenuous method of securing immunity speaks for the horror with which the disease was regarded. Previous to that time smallpox was the great scourge and destroyer of mankind, hardly one person in a thousand escaped it, and so common was it that nearly everyone contracted the disease during childhood, so that it was regarded as a children's disease.

Then came the wonderful discovery of vaccine by Edward Jenner in 1796. Jenner had been impressed as a medical student by the remark of a patient, a dairymaid, who said, "I cannot take smallpox because I have had cowpox." Testing this belief in his classical experiments, Jenner transferred the vaccine virus from the eruption upon the hand of Sarah Nelms, a dairymaid who had contracted cowpox from her master's cow by infection through a scratch in the hand, to the arm of James Phipps, a boy about 8 years old. This successful vaccination was followed by exposures which showed James to be immune to smallpox.

By vaccination this great scourge has been practically eliminated. Indeed, so rare has it become, that even sensible, though unthinking, persons forget the horror of the disease and give ear to those who oppose vaccination, in spite of the fact that vaccination is now under almost perfect control and is the only sure



(Keystone)

Edward Jenner (1749-1823). An old print showing enner performing the first vaccination upon James 'hipps.

preventive against smallpox.

Immunity in Anthrax and Rabies. — It remained for Pasteur to develop the principle of immunity and to apply it to other diseases. Applying the principle of germ disease to this phenomenon, Pasteur reasoned that if the infectious disease is a struggle between a man and a microbe, it is probable that in vaccination for smallpox the struggle is less severe for the patient, because the germs have been weakened through residence in the body of the cow. This suggested that disease germs might be weakened by heat, cold, dilution, or starvation. Pasteur actually produced less virulent or "attenuated" cultures of anthrax and chicken cholera by these means.

The story of Pasteur's dramatic public demonstration of the practicability of vaccinating animals against anthrax, or splenic fever, is one of the most interesting in the history of science. Here he showed that animals which had been vaccinated with attenuated cultures of the bacillus were not subject to the disease after inoculation with virulent germs, while animals which had not previously received such a vaccination and had been inoculated with the same virulent germs died as a result of the disease.

The experiments began on May 5, 1881, at four kilometers' distance from Melun, on a farm of the commune of Pouilly-le-Fort, belonging to a veterinary doctor, M. Rossignol, Secretary-General of the Society of Melun. At the desire of the Society of Agriculture, a goat had been substituted for one of

the twenty-five sheep of each lot. On the 5th of May they inoculated, by means of the little syringe of Pravaz—that which is used in all hypodermic injections—twenty-four sheep, the goat and six cows, with five drops of an attenuated splenic virus.

On May 31 very virulent inoculation was effected. Veterinary doctors, inquisitive people, and agriculturists formed a crowd around this little flock. The thirty-one vaccinated subjects awaiting the terrible trial stood side by side with the twenty-four sheep, the goat, and the four cows, which awaited also their turn of virulent inoculation. Upon the proposal of a veterinary doctor, which disguised his scepticism under the expressed desire to render the trial more comparative, they inoculated alternately a vaccinated and a nonvaccinated animal. A meeting was then arranged by Pasteur and all other persons present for Thursday, June 2, thus allowing an interval of forty-eight hours after the virulent inoculation.

More than two hundred persons met that day at Melun. The Prefect of Seine-et-Marne, M. Patinot, senators, general counsellors, journalists, a great number of doctors, of veterinary surgeons and farmers, those who believed and those who doubted came, impatient for the result. On their arrival at the farm of Pouilly-le-Fort, they could not repress a shout of admiration. Out of the twenty-four sheep which had not been vaccinated, twenty-one were dead; the nonvaccinated goat was also dead; two other sheep were dying, and the last was certain to die that very evening. The nonvaccinated cows all had voluminous swellings at the point of inoculation, behind the shoulder. The fever was intense, and they had no longer strength to eat. The vaccinated sheep were in full health and gayety. The vaccinated cows showed no tumor; they had not even suffered an elevation of temperature, and they continued to eat quietly.—*Radot.**

Later Pasteur evolved a preventive treatment for rabies, a disease in which the causative germ (a filtrable virus) was not known. In the "Pasteur treatment" for rabies spinal cords which were known to contain the germs of the disease were removed from infected rabbits and the strength of the virus was reduced by extended periods of drying. Then the treatment was begun by introducing into a patient, who had been bitten by a rabid dog, an emulsion made from spinal cord which had been drying for two weeks. On the following days the emulsion was made up from fresher and fresher spinal cord until that which had been dried only two days was administered. If administered first this would have produced rabies and death. The story of the first application of this treatment to a human subject in the successful treatment which Pasteur gave to the Alsatian boy, Joseph Meister, is of absorbing interest. (See *Life of Pasteur*

**Louis Pasteur: His Life and Labors.* By his son-in-law. From the French by Lady Claud Hamilton, New York, 1885, D. Appleton & Co.

previously quoted.) Now treatment is made by the Semple method, using a carbolized fixed virus, administered in fourteen divided doses, one treatment being given daily.

Diphtheria and Antitoxin.—Diphtheria is a disease of special historic interest. Its conquest well illustrates the principles of preventive medicine, and our mastery of it is so complete that it is nearly eliminated.

A definite poison (toxin) is secreted by the germ just as alcohol is secreted as a metabolic product of the yeast cell. This toxin is extremely poisonous to the cells of the body.

In 1892 Berhing and Kitasato discovered that the blood of an animal that had been made immune to the toxin of diphtheria was able to neutralize or to render harmless the toxin of the disease, while the serum of a nonimmunized animal could not. It was found possible to secure antitoxin from the blood of horses which had been immunized by injecting small and increasingly larger doses of toxin. When introduced into the body of the patient, antitoxin neutralizes the toxins produced by the diphtheria bacillus; and, if given early enough, it is a sure cure for the disease.

In 1913 Béla Schick devised a test by which it is possible to discover whether or not a person has diphtheria antitoxin in his blood. A small amount of diluted toxin is injected into the outer skin. If the individual's blood contains antitoxin, the toxin is neutralized, and the test is negative. If the blood contains no antitoxin, which means that the person is susceptible to the disease, the small amount of toxin sets up a slight local irritation, and the appearance of a small red spot constitutes a positive test. Although persons vary markedly in susceptibility, the great majority of adults have been found to be immune. They have manufactured their own diphtheria antitoxin.

Mothers transmit some antitoxin from their own blood to infants, through the placental circulation before birth and through mothers' milk after birth. This antitoxin is soon thrown off in the discharges from the body of the infant. A similar situation occurs when antitoxin is injected into the body of an older person to prevent diphtheria. The person is made immune for a time, but the immunity does not last long.

It is now possible to produce a somewhat lasting immunity against diphtheria by injecting toxoid (toxin modified by the addi-

tion of formalin) which acts upon the cells of the body and causes them to produce their own antitoxin.

Use of Specific Chemical Substances in Fighting Germ Diseases.—We have seen that it is possible for the body of man and other animals to produce antibodies, such as antitoxin, which can kill the germs of disease, but which are harmless to the tissues of the human body. To some extent we have discovered chemical substances produced outside the body that possess similar abilities. Quinine is such a substance. It kills the malarial parasite in the blood of the patient and helps to prevent persons who are constantly exposed to the infection from contracting the disease.

The more recent discovery of the effective bactericidal action of various sulfa drugs, including sulfanilamide, sulfadiazine, sulfapyridine, and sulfathiazole, in the human body has enabled physicians to reduce the number of deaths from meningococcus meningitis and from certain streptococcus infections to a fraction of the former figure. These drugs have been used with highly successful results in the treatment of many different communicable diseases, including such serious maladies as pneumonia and gonorrhea. Sulfa drugs are used in treatment rather than in prevention, although experiments in the disease prevention possibilities of the drugs are under way. The exact behavior of these drugs is not yet clear.

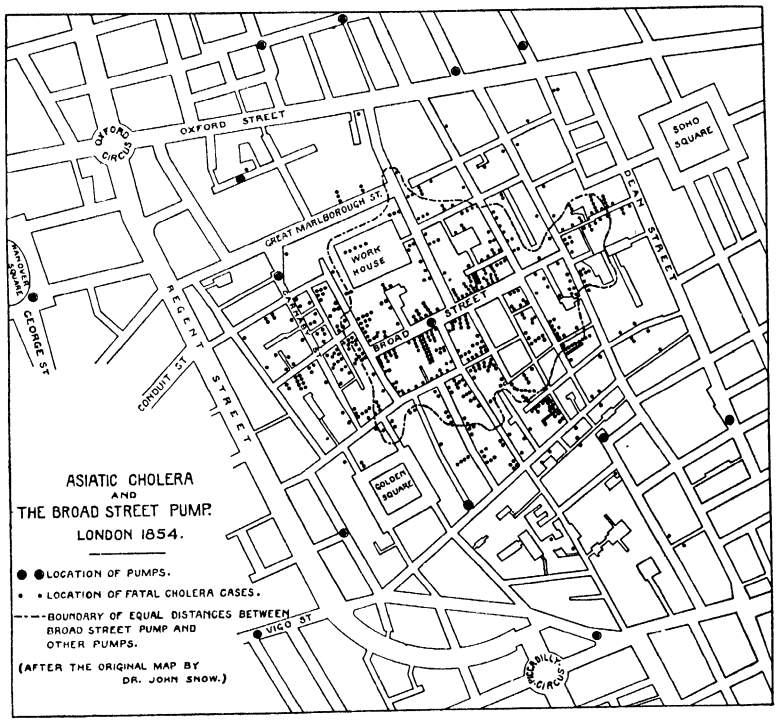
Other new antibacterial chemical substances, the *antibiotics,* are of biologic origin. The best known is penicillin, discovered by Alexander Fleming, in 1929. He observed that substances produced by a mold *(Penicillium notatum)* checked the growth of a culture of staphylococci. The therapeutic possibilities of penicillin were not appreciated until the work of the Oxford chemists in 1940. It is used extensively in the treatment of pneumonia, meningitis, scarlet fever, Vincent's angina, and the venereal diseases. Gramicidin (from the soil bacillus, *Bacillus brevis*) and streptomycin (from *Actinomyces griseus*) are other well-known substances in the group of antibiotics. These substances, like the sulphur drugs, should be used only on physician's prescription, not in self-medication.

We may anticipate the future development or discovery of an increasing number of substances that will be tolerated by the body tissues but which will be so toxic to particular microorganisms as to aid materially in curing or preventing diseases.

Further consideration of the subject of immunity is presented in Chapter XXI.

Preventive Sanitation

The knowledge that diseases are produced by germs and that the spread of disease is due to the infection of the healthy individual with these living germs makes it clear that for self-protection society must prevent the voiding of germs by diseased per-



Cholera deaths in the epidemic of the Broad Street Well.

sons where they will be picked up by others. Even before the germ theory of disease was established, there was a belief among experts that specific poisons capable of producing cholera and typhoid fever are contained in the discharges from the bowels of persons suffering from the disease.

The Epidemic of the Broad Street Well.—One of the foundation stones for this belief was laid in 1854 by the excellent work of Dr. John Snow, of London. Dr. Snow investigated an epidemic

of Asiatic cholera, which was traced to the water of the Broad Street Well. Inasmuch as this study was the beginning of the science of epidemiology it is discussed briefly.

During the epidemic the death rate in St. James Parish was far higher than that for any other district. Moreover, the deaths were unequally distributed and had nearly all taken place in the vicinity of Broad Street. It appeared, therefore, that there must be involved a factor other than the usually accredited causes of epidemics, such as meteorologic conditions, the general impurity of the air, the nature of the soil, and the density of the population. From the beginning of the outbreak Dr. Snow had recorded the number and location of fatal cases. He found that eighty-three deaths took place during three days, beginning with August 31. To quote from his report:

On proceeding to the spot I found that nearly all the deaths had taken place within a short distance of the pump in Broad Street. There were only ten (10) deaths in houses situated directly nearer to another street pump. In five (5) of these cases the families of deceased persons told me they always sent to the pump in Broad Street, as they preferred the water to that of the pump which was nearer. In three other cases the deceased were children who went to school near the pump in Broad Street. Two of them were known to have drunk the water, and the parents of the third think it probable that it did so. The other two deaths beyond the district which the pump supplies represent only the amount of mortality from cholera that was occurring before the eruption took place.

With regard to the 73 deaths occurring in the locality belonging, as it were, to the pump, there were 61 instances in which I was informed that the deceased persons used to drink water from the pump in Broad Street, either constantly or occasionally. In six (6) instances I could get no information, owing to the death or the departure of every one connected with the deceased individuals; and in six (6) cases I was informed that the deceased persons did not drink the pump water before their illness.

The result of the inquiry consequently was that there had been no particular outbreak or increase of cholera in this part of London, except among the persons who were in the habit of drinking the water of the above-mentioned pump well.

I had an interview with the Board of Guardians of St. James Parish on the evening of Thursday, 7th of September, and represented the above circumstances to them. In consequence of what I said the handle of the pump was removed on the following day.

Among the unusual cases that added confirmation to this belief, Dr. Snow describes two, as follows:

A gentleman in delicate health was sent for from Brighton to see his brother at No. 6 Poland Street, who was attacked with cholera and died in twelve hours, on the first of September. The gentleman arrived after his brother's

death and did not see the body. He only stayed about twenty minutes in the house, where he took a hasty and scanty luncheon of rump steak, taking with it a small tumbler of cold brandy-and-water, the water being from the Broad Street pump. He went to Pentonville and was attacked with cholera on the evening of the following day, September the 2nd, and died the next evening.

The deaths of Mrs. E— and her niece, who drank the water from Broad Street at the West End, Hampstead, deserve especially to be noticed. I was informed by Mrs. E—'s son that his mother had not been in the neighborhood of Broad Street for many months. A cart went from Broad Street to West End every day, and it was the custom to take out a large bottle of the water from the pump in Broad Street, as she preferred it. The water was taken out on Thursday, the 31st of August, and she drank of it in the evening and also on Friday. She was seized with cholera on the evening of the latter day, and died on Saturday. A niece who was on a visit to this lady also drank of the water; she returned to her residence, a high and healthy part of Islington, was attacked with cholera, and died also. There was no cholera at this time, either at East End or in the neighborhood where the niece died. Besides these two persons only one servant partook of the water at West End, Hampstead, and she did not suffer, or, at least, not severely. She had diarrhea.

The investigation was further continued by the Rev. H. Whitehead, who studied the cause of the sudden pollution of the Broad Street Well which he believed must have been the cause of the epidemic discussed. He found that in house No. 40 Broad Street there had been not only four fatal cholera cases at the time of the epidemic but also earlier cases of an obscure nature which were probably cholera, and that the dejecta from these had been thrown into a cesspool near the well. The walls of the cesspool were in a leaky condition, and the removal of the soil showed that there had been a direct drainage from the cesspool into the well. Apparently the water had been long polluted, but it required a specific infection from a person discharging cholera germs from his digestive tract to produce the outbreak of Asiatic cholera.

Thus water-borne disease was known to exist before it was known that the disease was produced by germs. It was believed that *filth* caused certain diseases because it produced, harbored, and developed poisons instead of furnishing, as we now know to be the case, a temporary abode for the germs which had been thrown off from the body of a person infected with the disease.

We might describe other epidemics of intestinal disease that have been traced to polluted water before and after the discovery of the germs of these diseases. To this we could add the story of scores of epidemics of typhoid fever, scarlet fever, and diphtheria,

which have been traced to unpasteurized milk, and the various other methods of infection by means of food or some other intermediate substance.

The knowledge of germs as the cause of disease, their viability in water, milk, infected oysters, and other foods, and the methods by which they may be destroyed, has made it possible to develop scientific means of sewage disposal, water purification, and the protection of food materials. The practical details of preventive sanitation in these various fields will be later considered.

Preventive Hygiene

Preventive hygiene or the conduct of persons in such a way as to avoid infection and communicable disease is based upon our knowledge of both preventive medicine and preventive sanitation. Our habits are now influenced by our knowledge of the germs of particular diseases, their mode of life, and the manner in which they may be transferred, so that in our daily activities we avoid opportunities for infection. Promiscuous kissing, the use of common drinking cups, and the eating of food prepared and served by persons with unclean habits whose freedom from infectious disease cannot be vouched for, and many other unhygienic habits are automatically condemned by our knowledge of germ diseases.

We must also consider resistance. Pasteur demonstrated that the outcome of the battle between man and the microbe may be determined by weakening or attenuating the latter or by building up a specific resistance of the human body. Dr. Theobald Smith has spoken of disease in terms of the formula $D = \frac{NV}{R}$; when D = the disease; N = the number of organisms in the initial infection; V = the virulence of the germs; and R = the resistance of the individual.

This resistance in many diseases depends upon a specific immune substance, but in other diseases, like tuberculosis, the resistance may be related to the bodily vigor and the general health of the person. Thus personal hygiene, which assists in building up a strong and healthy body, is also important in preventing or minimizing certain diseases.

Because preventive hygiene for the prevention of disease and personal hygiene for the promotion of positive health are both based upon the application of health knowledge by the individual,

organized *health education* in the school and in the community has now become an important factor in the promotion of public health. The first health education fellowship in a school of education was awarded in 1920 for study at Teachers College, Columbia University. The first program of graduate training in health education to be established in a school of public health was offered in 1921 in the school conducted jointly by Harvard University and the Massachusetts Institute of Technology. Several accredited programs for the professional education of health educators have now been set up; techniques and skills have been highly developed; and health departments, school systems, and private health agencies have added health educators to their staffs.

Summary.—We have seen the origin of three united sciences in our study of disease prevention.

Preventive medicine goes back to the experiments of Pasteur in producing immunity to a specific disease. It includes all the more recent developments of this science by the use of specific vaccines, antitoxins, viruses, and drugs to assist the person to ward off or withstand infectious diseases. *Preventive sanitation* uses our knowledge of disease causation and prevents the spread of infection from the sick to the healthy through quarantine, the supervision of water, milk, and other food supplies, the purification of sewage, and the prevention of other conditions which would make it possible for live germs to reach and infect healthy persons. *Preventive hygiene* recognizes the infectious agents of disease and prescribes such courses of individual conduct as are best calculated to avoid personal infection. Health education is concerned with preventive hygiene as well as with the broader problems of positive health. These sciences, together with the art and science of curative medicine serve mankind.

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CHAPTER XXI

ESSENTIAL FACTS OF IMMUNITY

Why can certain bacteria grow in the human body but not in the bodies of lower animals? Why do the lower animals have certain diseases to which man is immune? Why do the parasites of certain diseases attack particular parts of the body? Why does one who has had certain diseases become immune to them thereafter? How does nature fight the disease? What is the explanation of the protection furnished by vaccination? How is immunity explained?

It is easier to understand the presence of an immunity than the process by which it is secured. The science of immunology is the foundation of the art of preventive medicine, and a brief statement of the essential facts of this rapidly developing science has a place in any extended discussion of hygiene.

Immunity Defined.—Immunity is the power of the organism to resist infection. It is opposite in meaning to the word susceptibility and both these words are relative terms. Immunity may be complete, or it may be so weak as to be hardly appreciable. In many instances we use the term resistance as equivalent to immunity.

Another variable quantity, that is always related to the immunity of the patient, is the virulence of the disease-producing organism. Virulent means poisonous or deadly. The different strains of germs vary in their virulence or ability to injure the body just as persons vary in their powers of resistance.

We may illustrate immunity with an analogy from international experience. It is not very difficult for us to conceive of a nation thirsting for world power and opposed to the welfare of the great body of humanity outside it. The people of such a country may represent the germs of a disease and the great body of humanity, the person subject to the disease. The inhabitants of such a nation usually appear innocent enough and, like the germs of disease, quite similar to their harmless neighbors. There finally arises an opportunity for the invasion of other lands, and these people make war upon the rest of the world just as the

germs enter into a struggle with the human body. If they are successful, the life of the invaded nations comes to an end; if they are not successful, they are eliminated from the territory they have overrun and their armies are reduced in strength.

The other peoples of the world, if they are wise enough to realize the danger of this lust for world conquest, will set up barriers against the return of a world war; and if these barriers are strong enough, future recurrences may be avoided. These barriers, like the factors of immunity, are varied, numerous, and complex. They may consist of a new army to combat the destructive forces of the enemy, of military barriers set up against the entrance of the foe, or a general readiness of the peoples to respond immediately to a threat of a new attack. Likewise, the human body when attacked by the germs of disease may create new defensive substances which remain in the blood, the tissues subject to microbial invasion may become more resistant to the particular organism, or the whole bodily reaction may be more prompt and effective at a second attack.

Our knowledge of immunity comes from the observation of diseases, from experimental biology, and from certain fields of chemistry. We are not yet able to state the exact chemical reactions in immunity and disease, and we must expand the science by a study of the reactions of experimental animals.

RESISTANCE

The important factors in breaking down general resistance or general vitality are the following:

1. Fatigue.—It has been found that white rats are more susceptible to anthrax after being worked in a revolving cage; and it has also been found that the defensive powers of dogs, rabbits, and guinea pigs against typhoid are reduced by excessive exercise. Studies indicate that a person may be made transiently susceptible to common cold by fatigue. It is hard to explain how fatigue produces these results.

2. Exposure to Wet and Cold.—Exposure to wet and cold reduces the power of resistance to disease, as has been demonstrated in the case of fowls which are naturally immune to anthrax but contract the disease after standing for some time in cold water.

We know that such exposure cools the blood and must, therefore, reduce the activity of the leucocytes. It may also reduce the production of defensive substances in the body. This relationship to temperature explains how muscular exercise reduces the danger of diseases under exposure to cold and wet by keeping up the body temperature. Sudden exposure to dampness and cold, especially if the individual has reduced the efficiency of the heat-regulating system of the body produces a lowered resistance.

3. Alcohol.—The use of alcohol is known to increase susceptibility to tuberculosis and to reduce the chances of recovery from some of the other communicable diseases. The factors involved may be the lowering of temperature, the destruction of delicate defensive substances in the body, and the inhibition of leucocyte activity.

4. Malnutrition.—Insufficient or unsuitable food accelerates tuberculosis. We have seen that lack of sufficient vitamin A in the diet lowers the health of the mucous membranes and renders them more susceptible to infection. Diets inadequate in protein interfere with antibody formation and may predispose to bacterial infection. Our growing knowledge of nutrition indicates a greater relationship between malnutrition and resistance than has hitherto been realized.

5. Focal Infections.—Bacteria growing at the roots of teeth or in chronically inflamed tonsils are producing poisons which continually tax the protective powers of the body and may make it easier for other infective organisms to enter and produce disease.

6. Physical Defects.—Enlarged tonsils and adenoids reduce the body vigor by their injurious effect upon breathing and nutrition.

IMMUNITY

Immunity exists when certain substances (immune bodies or antibodies) are present in the blood to prevent or retard the development of the disease in question. It may be innate or acquired. Acquired immunity may be active or passive. Immunity is sometimes divided into two further categories: general and local. There is not a great deal of evidence for the existence of local or tissue immunity. In addition to the presence of antibodies, some alteration in tissues may be involved in immunity.

Natural Immunity.—Natural immunity is the power to resist infection under normal conditions. Such resistance to a specific disease may be *racial, species,* or *individual.* Little is known of the mechanisms involved.

Some species of animals are immune to many communicable diseases of man, such as cholera, typhoid fever, mumps, measles, scarlet fever, yellow fever, malaria, and leprosy. Man is immune to many diseases that attack lower animals. This is species immunity. Certain germs, however, attack several, though not all, species of widely different genera. These germs include the organisms of tetanus, malignant edema, anthrax, pus formation, glanders, plague, rabies, Malta fever, foot-and-mouth disease, ringworm, and paratyphoid fever. Races and individuals also differ widely in susceptibility to individual diseases.

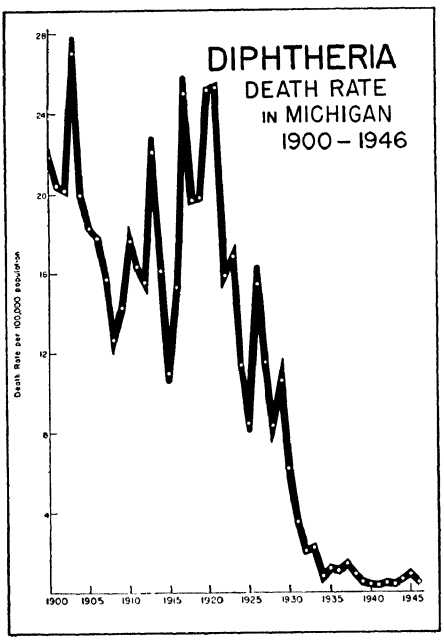
Acquired Immunity.—Immunity which is acquired may be either active or passive. *Active immunity* is resistance to disease produced as the result of the body's own efforts. Substances called *antigens* stimulate the body to produce protective substances, called *antibodies.* A person may develop active immunity by having the disease or by the injection of an antigen, of which there are three types. In smallpox vaccination the antigen is the *living attenuated organism.* In typhoid immunization the antigen is a vaccine made of the *killed organisms* of the disease. In diphtheria immunization a modified *toxin* is used to stimulate the production of antibodies.

Sometimes *sensitized vaccines* are produced by mixing the bacteria with the specific antibodies from the blood serum of an animal that has been made immune. *Polyvalent vaccines* are made up from several strains of the same organism. *Mixed vaccines,* containing the dead bacilli of two or more diseases, like typhoid, paratyphoid, and cholera, are sometimes used.

In *passive immunity* the protective substance (antibodies) is artificially transmitted to the person by injection or is transferred from mother to offspring through the placenta. The production of immunity to diphtheria by means of antitoxin is an example. The horse from which antitoxin is secured is rendered immune to the disease by the injection of increasing doses of diphtheria toxin, and its immunity is active. The patient may be made temporarily immune by the injection of immune substances

from the blood serum of the horse. This immunity is passive or transferred and is of brief duration. (Diphtheria antitoxin is ordinarily used in the treatment of the disease, but it is sometimes used to confer a temporary, passive immunity upon a susceptible person who is known to have been infected with the diphtheria bacillus.)

The infant at birth usually has a passive immunity to diphtheria, because antitoxin from the blood of the mother has passed through the placental membrane into the blood of the fetus. This immunity lasts only a few months.



(Michigan Department of Health)

Carriers.—Usually after a disease the body rids itself entirely of the germs. Occasionally, however, this does not happen and a condition of mutual tolerance is set up. This "immunity without disinfection" is a condition in which the patient continues to be a *carrier* of the germs without showing evidence of disease. The patient and the infective organism have acquired the ability to tolerate each other, and the reaction of each has apparently be-

come milder. Carriers of diphtheria, typhoid, cholera, meningococcus meningitis, malaria, amebic dysentery, and poliomyelitis are known to exist. Many epidemics have been traced to such carriers. In some instances, a lowered vitality of the carrier may result in a recurrence of active disease in the individual himself.

Disease Reactions.—Just as different plants grow best in different soils, select somewhat different foods, and produce different products, so the germs of disease vary in the part of the body they attack and differ in their life processes as well as in the effects they produce upon the individual. The actions and reactions between the various microbes and man are numerous and complex. They have such an important bearing upon our comprehension of disease and the terms are so rapidly finding a place in our everyday vocabulary that a brief description of the terminology and phenomena may be useful.

Toxins.—There are two types of bacterial poisons or toxins, exotoxins and endotoxins.

Exotoxins.—The true toxins, exotoxins, are poisonous substances of bacterial origin. They are apparently proteins, and are usually thermolabile and unstable. Exotoxins are antigenic, i.e., they stimulate the production of antibodies. Since these antibodies neutralize toxins, they are called antitoxins. Causative organisms that produce exotoxins include those of diphtheria, tetanus, scarlet fever, and botulism. Certain plant poisons, such as ricin from the castor bean and abrin from the jequirity bean, and animal poisons, such as the venoms produced by wasps, scorpions, spiders, and snakes, are usually included in the study of toxins because their behavior resembles that of bacterial toxins.

Endotoxins.—Certain bacteria contain poisons called endotoxins which remain in the bacterial cells but may be liberated when the cells die. It is possible to obtain endotoxins by grinding the cells of the dysentery bacillus or the cholera vibrio. Endotoxins in general are less toxic and weaker antigens than exotoxins.

Reactive Phenomena.—The body has been found to react in definite ways to particular diseases, and our knowledge of the basis of immunity rests upon the study of these phenomena which include (1) phagocytosis, (2) allergy, and (3) the production of specific substances for combating the infection.

1. *Phagocytosis.*—The important work of Metchnikoff in the study of immunity showed that certain bacteria are devoured and digested in great numbers by the cells of the body. These cells are of two types: the motile cells (certain white blood cells) and the fixed cells of the connective tissue and endothelium.

The phagocytic blood cells are susceptible to chemotactic influences, i.e., they are attracted to bacteria and certain inert materials, and it is conceivable that the attack of a disease might so accelerate their activity that at the inception of a second infection the invading bacteria might be devoured before the disease could be produced. Phagocytosis, however, is not a complete and adequate explanation for immunity.



Leucocytes contacting and engulfing bacteria. (From Sharp: *Microbiology and Public Health*, The C. V. Mosby Co.)

Phagocytosis is facilitated by the presence of certain substances which prepare the bacteria for phagocytic action. These substances called *opsonins,* are normally present in the body but are found in greater concentration in immune serum.

2. *Allergy.*—Allergy (altered reaction or hypersusceptibility) is a condition of the body in which it gives an exaggerated reaction to foreign proteins, many of which are harmless to the normal person. It is a specific reaction that develops against infectious organisms or other protein substances, such as certain foods. It may be congenital or acquired, local or general.

In many people fish, tomatoes, and cheese are likely to produce an urticarial rash; eggs may produce asthmatic symptoms; and

cereals, pork, and milk may produce erythemas. These cases and many cases of eczema may be due to allergic reactions to specific proteins.

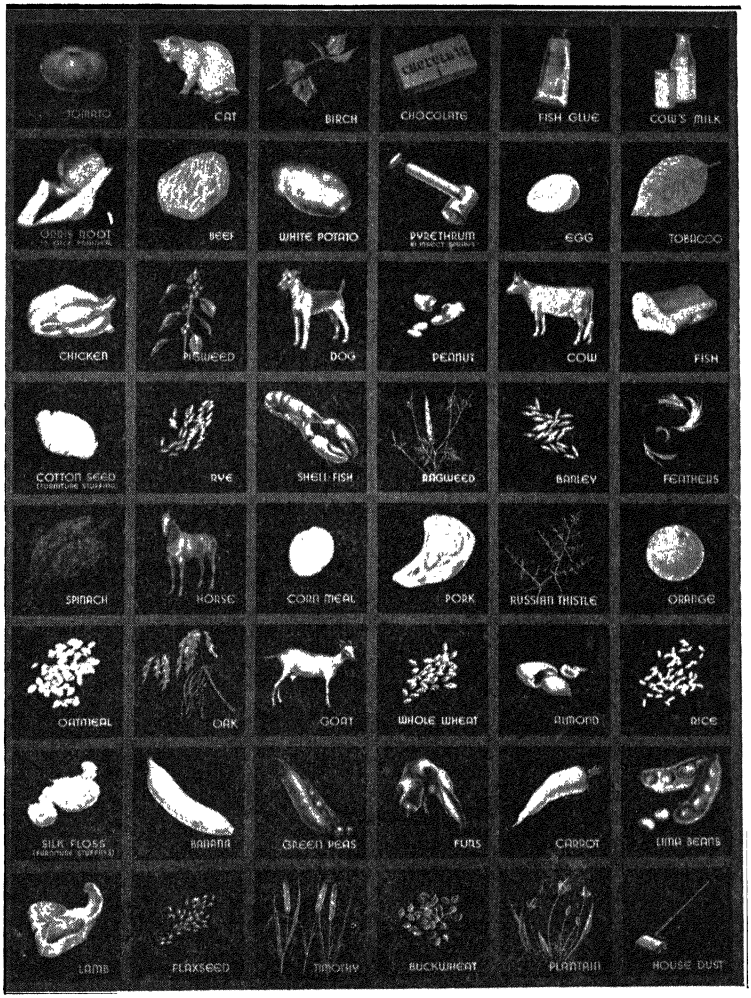
Allergy in hay fever is the hypersusceptibility of the mucous membrane of the respiratory tract to the pollen of ragweed, goldenrod, or other plants. Dandruff from horses or other animals may produce similar conditions.

Another reaction that resembles the hypersensitivities just described is anaphylactic shock. It has certain distinctive differences, however, and some authorities feel that it should not be classified as an allergy.

An example of anaphylaxis produced by a harmless substance is secured by the injection of horse serum into a guinea pig. If the second injection of serum is separated from the first by an interval of from eight to fourteen days, it produces what is known as acute anaphylactic shock. The guinea pig becomes restless, manifests difficulty in breathing, is generally agitated, and discharges both urine and feces. Complete paralysis, the arrest of breathing, and death may follow. The guinea pig is apparently much more susceptible to this reaction than any other animal. The explanation of this fact and the phenomenon itself is furnished by Schultz, who showed that serum anaphylaxis produces the hypersensitization of smooth muscle tissue which contracts during shock. In the case of the guinea pig, the result is often fatal because the mucosal layer of its secondary bronchi is thrown into folds and breathing is inhibited. This reaction is strictly specific.

The serum sickness, which often takes place after the injection of antitoxic sera and shows symptoms of fever, itching and pain at the point of injection, and a general urticarial rash, may be an allergic reaction. When the symptoms are very severe, the condition resembles anaphylaxis and is known as serum shock.

3. *Specific Substances.*—In reacting to the presence of bacteria or their products, the animal body produces various substances. One antitoxin—that of diphtheria—has already been mentioned. *Antitoxins* are produced by the body through the stimulation of specific toxins. They are capable of neutralizing the corresponding toxins.



Forty-eight causes of allergic reactions. (Courtesy Lederle Laboratories.)

Widal showed that very dilute mixtures of the blood serum of a typhoid patient causes the typhoid bacilli to agglutinate, that is, to lose their motility and gather in small clumps. It was later found that agglutinating substances or *agglutinins* may be produced in the blood by injecting dead bacteria into the body, as in typhoid vaccination. Agglutinins may also be produced for red

blood corpuscles and protozoa. The part these substances play in immunity is not yet clear.

Agglutination is an important factor to consider in blood transfusion. In 1900 Landsteiner discovered that the blood serum of certain individuals would clump down or agglutinate the red blood cells of others. In blood transfusion it is necessary to select a donor whose cells will not be clumped by the recipient's serum. There are four main blood groups: O, AB, A, and B. A donor must belong to the same group as the recipient or to group O, the universal donor group.

Substances known as *precipitins* are produced in the blood by the injection of soluble antigens such as proteins. When clear serum from the immunized animal is added to the clear antigen, a precipitate forms at the bottom of the test tube. The relationship of these substances to immunity is not clear, but we can see how it may be possible for them to throw down poisons from solution and make them inert.

In 1896 Pfeiffer observed that when living cholera vibriones were injected into the peritoneal cavity of a guinea pig, previously immunized against cholera, they lost their power of motion, became grouped together in clumps, and were finally completely dissolved. Antibodies which bring about dissolution or lysis of bacterial or other cells are called *lysins*. Those that disintegrate bacteria are called bacteriolysins, those that dissolve the red blood corpuscles of other animals are called hemolysins, and those that dissolve the cells of glandular tissues are called cytolysins.

Immunization in Specific Diseases.—It seems worth while to review the different immune processes with reference to particular diseases. (See also Appendix A.)

Active immunity may be produced in various ways, as we have seen. An *attenuated organism* may be introduced as in the case of smallpox, rabies, influenza, and yellow fever. In smallpox it is the cowpox virus which is used. In rabies the virus (in the spinal cord from an infected rabbit) is weakened by carbolic acid. In influenza the virus of types A and B is used and rendered noninfectious by treatment with formaldehyde. The yellow fever virus is attenuated by repeated transfer in tissue culture. *Suspensions of dead bacteria* (bacterins) are injected in producing immunity

against typhoid fever, cholera, bacillary dysentery, Malta fever, paratyphoid fever, and whooping cough. *Modified toxins* are used to produce active immunity in diphtheria, scarlet fever, and tetanus.

Passive immunity is available through the use of *antitoxins* for diphtheria, scarlet fever, tetanus, and botulism. Following exposure to measles, *adult immune serum* or placental extract may be injected to prevent the disease.

Tests of Immunity and Sensitivity.—By the Schick test, we can determine a person's immunity or susceptibility to diphtheria. A small amount of modified toxin is introduced into the skin. If no appreciable local reaction appears, antitoxin is present in the blood, and the patient is immune. The Dick test is a similar test for use in scarlet fever.

In the tuberculin tests for tuberculosis the protein introduced into the skin is derived from tubercle bacilli. If the individual has had an appreciable amount of infection with the bacillus of tuberculosis, he will have become particularly sensitive and a local (positive) reaction will develop.

Skin tests are also available for aid in the early diagnosis of undulant fever, trichinosis, and tularemia.

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CHAPTER XXII

ALIMENTARY AND RESPIRATORY INFECTIONS

How can we *miss* communicable diseases instead of *catching* them? What kinds of organisms cause them? How can they be carried from the sick to the well? Can they be classified into groups of similar diseases?

The public health aspects of communicable diseases are presented in Appendix A. We shall consider here the nature and grouping of these diseases and discuss a few of the typical and most important ones in some detail.

The Interrelationship of Plants and Animals.—Depending upon the method of securing food, all living things are divided into two groups, the independent and the dependent. The green plants are said to be independent, or autotrophic, because with the aid of sunlight they are capable of manufacturing their own food from the inorganic substances of soil, water, and air. Animals, on the other hand, are dependent, for they must have their food already manufactured. They feed upon the fruit or tissues of plants, upon the flesh of other animals, or upon the fluids or organic products of these plants or animals. Many plants are also dependent. The fungi (molds and bacteria) are characteristically dependent upon organic rather than inorganic substances for their food supply.

Almost every living thing, including man, is sought as a source of food by some plants or animals. Three different groups of organisms seek human beings as a source of food.

First, there are such insects as the mosquito and the bedbug, and such larger animals as the wolves or tigers which occasionally attack man as prey. There is no continual relationship between man and such animal enemies.

The second group includes organisms known as *saprophytes* which secure their food from nonliving substances. The common intestinal bacteria present a good example of this relationship. If we conceive of the body as made up of one tube inside another we think of these intestinal bacteria as not being in the body proper, but as being in contact with the "inner skin." Within

the intestines are always millions of bacteria, of which the most common is the colon bacillus. Such bacteria live in the intestines under normal conditions without producing harmful results. Experiments indicate that animals can live without any bacteria in the intestines. Chicks very carefully hatched under aseptic conditions were kept for many days upon sterile food, and it was found that the contents of the intestines were sterile. Under normal conditions, however, the intestines of all animals contain great numbers of ordinarily harmless saprophytic organisms which live upon the partly digested food without injuring the animal.

The third group of organisms are the *parasites.* The word "parasite" literally means "to sit at the table beside another," and among the Greeks it had much the same usage as our present term "social parasite." In biology a parasite is defined as an organism living in or upon the body of another (called the host) to the disadvantage of the latter. The bacillus of typhoid fever, like the colon bacillus, grows in the human intestine, but it is definitely disadvantageous to the host. It produces substances injurious to the body and destroys the body tissue with which it comes in contact. The typhoid bacillus is a disease producer, a parasite; the colon bacillus is a harmless saprophyte.

In most communicable diseases of man a parasitic organism makes its way inside the body and is called an *internal parasite.* In a few diseases, however, the plant or animal lives on the outside of the body, i.e., it is an *external parasite.* The mold, Trichophyton, which causes ringworm of the scalp, body, feet ("athlete's foot"), and groin, and the louse, Pediculus, which causes pediculosis, are external parasites.

Types of Communicable Disease.—Many different parasites produce disease in or upon the body. They include single-cell animals, worms, insects, molds, bacteria and viruses. Every parasite differs in its life processes, its attack upon the body, and in the effect it produces. There is also a difference in the manner in which the various parasites are transmitted from the body of the infected person to the body of the well person. We might indeed classify the communicable diseases according to the kind of parasite that causes the disease, placing the bacterial diseases in one group, the worm diseases in another, and so forth. We might, on the other hand, classify these diseases according to the part of the

body infected, separating them into diseases of the blood, diseases of the digestive tract, diseases of the lungs, and so forth. For purposes of public health, it seems most logical to classify them according to their mode of entering the body. This puts communicable diseases into four groups, with somewhat similar methods of control for the diseases in each group:

1. The *Alimentary* group in which the infective agent leaves the body in the urine, feces, and other discharges, and produces disease through the alimentary tract.

2. The *Respiratory* group in which the infective agent is carried in the discharges of the nose and throat and may reach the respiratory tract of the susceptible person through the air.

3. The *Contact* group in which the infective agent is spread through touching an infected person or animal or infected material.

4. The *Inoculation* group in which the infective agent is conveyed by the bites of insects.

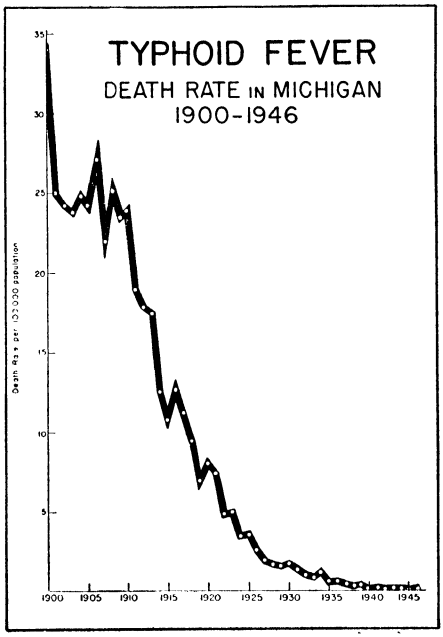
This classification is not perfectly sharp and clear cut. There would probably be differences of opinion as to the group in which certain diseases shouuld be placed. This is because many diseases are transmitted in more than one way. In some diseases the germ may be in both the alimentary and respiratory tracts. In others it may sometimes be air borne and sometimes picked up by direct contact.

It is often difficult to determine the ways in which a disease is transmitted. In poliomyelitis, for example, it was originally thought that the virus entered the brain by way of the nose and of the olfactory nerves. Now we know that the virus is more abundant in the digestive tract than it is in the respiratory passages. There is some evidence that the disease may be transmitted by flies as well as by direct contact. The method of transmission is one of the subjects being studied by the National Foundation of Infantile Paralysis in its all-out battle against the disease.

THE ALIMENTARY DISEASES

Some of the diseases of the alimentary tract are produced by bacteria, others are produced by parasitic worms, and at least one (amebic dysentery) is produced by a protozoan or single-cell animal. In any case the infecting organism finds its way into the body through the digestive tract.

Among the *bacterial diseases* we find such important infections as cholera, typhoid fever, and bacillary dysentery. The organisms producing these diseases take up their abode in the intestines and are present there in enormous numbers throughout the course of the disease. Consequently, they are present in the excreta and may be carried to healthy persons by contaminated water or food. The spread of these diseases is also extended because of the presence of "carriers,"—apparently healthy persons who either have recovered from the disease without having eliminated all the or-



(Michigan Department of Health)

ganisms or have become infected with the disease and, although they harbor the germ, are not made clinically ill by it. From these persons, as well as from the more seriously ill, the organisms from the discharges find their way to food or drink and thus to the intestine of a well person. They may be transmitted to the hands and then to the mouths of well persons by direct contact and by the handling of articles soiled by the discharges of patients, or they may be carried to food on the feet of flies.

Among the *worm diseases* are trichinosis, hookworm (ancylostomiasis), and tapeworm disease. The mode of transmission of each parasite causing the disease is dependent upon that part of its life history which takes place outside the human body.

Most of the worm parasites that infect man also infect some other animal. The roundworm, which produces trichinosis, and the various tapeworms come to man encysted in the muscles of animals used as food. (See chapter on Food Control.) Sanitary measures in these cases prohibit the use of infected animals as food and demand the thorough cooking of meat to kill any parasites that may be present.

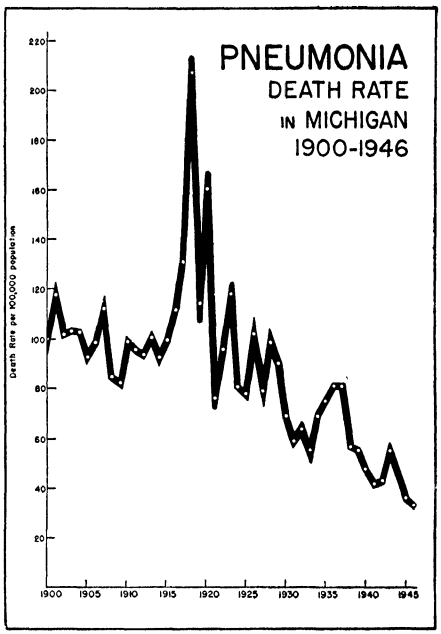
In hookworm disease the bowel discharges of the patient contain great numbers of eggs. These eggs develop into larvae which infest the ground. They may enter the mouth in drinking water or solid food, but usually they pierce the skin of the hands or feet, pass through the lymphatics to the blood stream, and thence to the lungs. Here they pierce the walls of the air sacs, pass up the breathing tubes to the throat, from whence they are swallowed and lodge in the small intestines to grow and reproduce. We check this disease by preventing the spread of the infective organism from the body discharges. We provide sanitary privies for the prevention of soil infection, and safeguard our water supplies from picking up and conveying these parasites.

RESPIRATORY DISEASES

There is a large group of diseases in which the germ is transmitted through the secretions of the mouth and nose. The breath, if it is not forcibly exhaled, is sterile, but in the transmission of these diseases *coughing* or *sneezing* sprays into the air a large number of small droplets of water which contain the infective organism. The organisms remain in the air for a time and may be carried over a distance of several feet and inhaled by another person.

Some of the virus diseases like influenza, psitticosis, common cold, measles, German measles, chicken pox, smallpox, and mumps are air borne to a greater degree than are bacterial diseases like pneumonia, tuberculosis, meningococcus meningitis (cerebral spinal

fever), and the respiratory streptococcal infections (scarlet fever and streptococcal sore throat). The fresh discharges from the mouth and nose may also be transmitted by direct contact and by the handling of common objects, eventually reaching the mouth or nasal passages of a well person. In the case of smallpox and chicken pox the discharges from the body or the skin may also transmit the disease. In most of the children's diseases mentioned the first symptoms are like those of common cold.



(Michigan Department of Health)

Many of these diseases merit individual consideration and may be studied in connection with the presentation of their public health aspects in Appendix A. Two of them, common cold and tuberculosis, will be considered further at this point.

Common Cold*

The common cold is the most widespread of the communicable diseases. It is *continuously pandemic.* Always and everywhere in large population groups common cold is present to some extent.

*See also Common Cold in Appendix A.

In the United States more than one-half of all the people have two colds a year, and one-quarter of them have three or more colds a year. The cases are most numerous in October and in March.

Colds cost the country hundreds of millions of dollars annually. The wage loss in industry is greater than that for any other disease; it is estimated at a billion dollars a year. From a poll taken among industrial workers, Dr. George Gallup concluded that 59,000,000 days are lost annually in industry, because of colds and influenza. To this the loss due to interference with school programs and the cost of drugs and medical care must be added. School children yearly lose an average of two days each from colds, those in the lower grades having the more frequent and more severe infections. The effect of the cold upon the health of the nation is serious because of the frequency with which it is followed by such complications as sinus infection, laryngitis, bronchitis, mastoid infection, middle ear infection, pneumonia, arthritis, or tuberculosis.

Nature and Transmission.—The common cold is an acute infection of the upper respiratory tract. It begins with a feeling of dryness and discomfort in the nasopharynx. This is followed by sneezing, watery discharge and indisposition. In the sub-acute stage the discharge becomes thick and the swelling of the lining of the nasal passages gradually subsides.

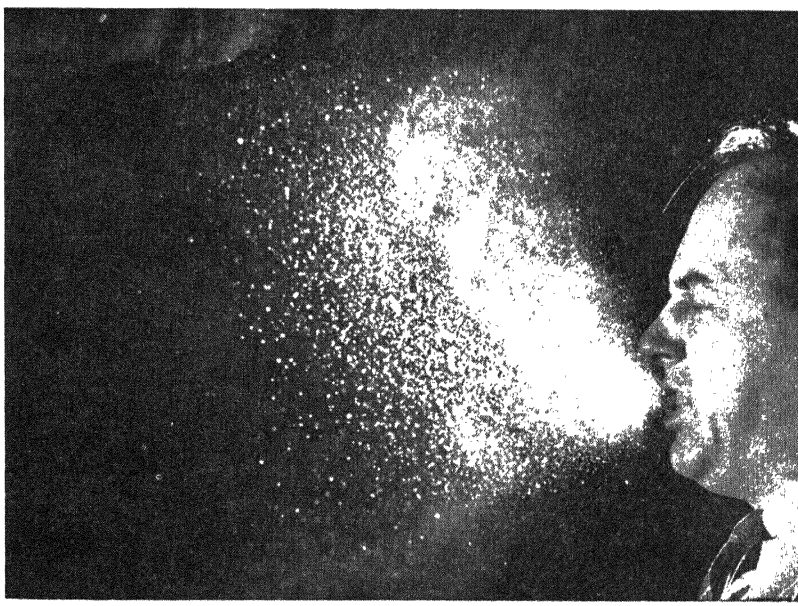
A filtrable virus has been shown to produce this disease. Some authorities believe it is the only cause. Other workers believe that infections of the upper respiratory tract, having the appearance of the common cold, are produced by various other microorganisms. In any case we are sure that various microorganisms act as secondary invaders and prolong the infection and irritation of the breathing passages.

The cold is spread by infected saliva through coughing, sneezing, or freshly contaminated materials, particularly during the first twenty-four hours of the disease. It appears not to be infectious after three or four days even if a cough persists. The incubation period is most commonly from twenty-four to forty-eight hours, usually thirty-six.

City dwellers cannot hope to escape the infection. On the other hand, the completely isolated individual or a small isolated com-

munity may be free from infection until such time as it is brought in by some outside contact. Apparently the virus dies out after a while. This is readily explained by the fact that carriers are extremely rare or nonexistent. Those who catch a cold establish a temporary immunity. Since the disease is readily communicable, it quickly exhausts all available material and disappears for lack of carriers and susceptible persons. In Spitzbergen, miners living in poorly ventilated barracks are free from colds all winter, but following the arrival of the first ship in the spring there is regularly an epidemic of colds.

Studies in the tropics, where colds are usually less severe and uncomplicated, indicate that the disease lasts less than a week. In temperate climates, however, the various organisms which act as secondary invaders continue and modify the symptoms of the original cold. These secondary invaders include such organisms as the influenza bacillus, the pneumococcus, certain staphylococci, streptococci, and Micrococcus catarrhalis. Some of these organisms are always in the throat or nose, and they increase in number during the third or fourth day of the disease. Chilling or unusual



Photograph of a sneeze taken with an exposure of 1/30,000 second. (Courtesy M. W. Jennison.)

fatigue at that time may bring on pneumonia, probably because of extension of the pneumococcus infection from the upper respiratory tract to the lungs.

Control.—Some fortunate persons have a natural resistance to colds. Others are unusually susceptible. The mucous blanket and the ciliary movement on the nasal membranes are believed to be important defense mechanisms in preventing the virus from establishing itself. The relative immunity which follows an attack of the disease lasts for only a month or so.

One cannot usually separate the symptoms of the cold itself from those of the secondary invaders. There are various practices which are helpful in avoiding both the cold and the secondary infection, but a specific practice may relate more to one condition than to the other.

The use of cold vaccine is an attempt to combat the secondary invaders. These vaccines seem beneficial to some and relatively ineffective for others. Autogenous vaccines are made up from organisms secured from the patient; stock vaccines are made from a group of organisms that most commonly cause the infection.

There is evidence that persons whose diet is deficient in vitamin A are likely to have more severe colds than persons on an adequate diet. Sleeping out of doors does not reduce the number of colds.

Although we still need further information on the hygiene of cold prevention, there are certain facts upon which there is general agreement. Chilling is an important factor, especially in persons who do not make rapid adjustments to weather changes. It is, therefore, helpful to avoid rapid changes in temperature such as occur when one sits in a draft or when one goes out of doors without adequate wraps after having worked in a hot, stuffy room. Humidifying indoor air and holding a handkerchief over the nose for a few moments upon going out on a very cold day may be helpful. Dress for the weather. A diet rich in fruits, vegetables, milk, and meat is preferable to one that contains an excess of pastries and sweets. Excessive fatigue, lack of sleep, worry, and anxiety increase susceptibility.

Prompt action at the first sign of a cold (dryness and burning in the nasopharynx) may give some hope of avoiding the disease and the dangerous secondary infections. Protection against chilling and fatigue should be instituted at once. A warm room

(about 70 degrees) with relatively high humidity is desirable. The best way to get both rest and warmth is to go to bed. This also avoids contact with other people at the time when the cold is most infectious. If fever develops, rest in bed until twenty-four hours after it abates should be considered imperative.

Studies have failed to disclose any effectiveness of cathartics, gargles, counterirritants, sodium bicarbonates and other antiacids, or the many commercially advertised "cold remedies" investigated. Self medication with sulfa drugs or antibiotics cannot be recommended. The sufferer from a cold should have a simple diet with plenty of liquid. Orange juice is good.

The nose should be blown with both nostrils wide open. Use disposable paper tissues, and do not kiss anyone during the acute stages of a cold—unless it is someone you dislike!

The person who is seriously ill with a cold or who has persistent or frequent colds needs medical advice, not a cupboard full of cold remedies.

Tuberculosis*

Prevalence.—Descriptions of tuberculosis may be found in the earliest medical writings. It has been one of the great scourges of mankind, but it is rapidly coming under control. Some experts believe that it may be virtually eliminated as a cause of death in the United States within a generation. In 1900 the tuberculosis death rate for the United States was 194 per 100,000. Now it is about 37; and in a few states it is below 15. Even so, it still takes more than 50,000 lives a year.

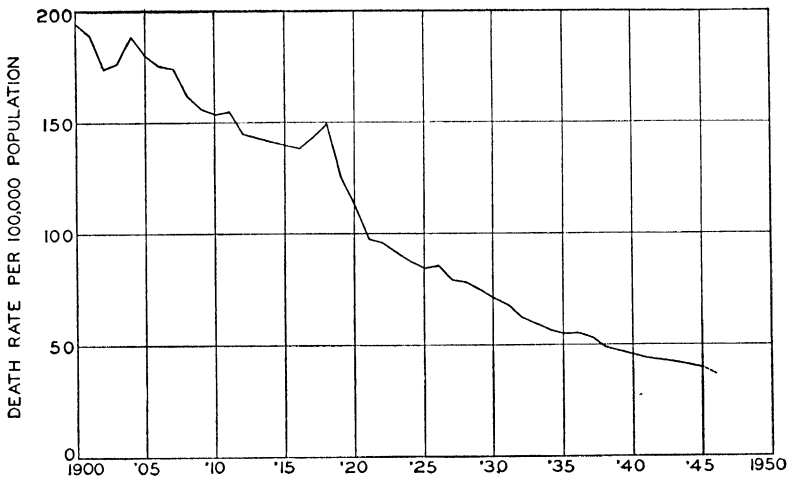
The disease is concentrated in specific groups. These include Negroes, older men, industrial workers in certain occupations (such as that of metal mining), and young mothers. The death rate from tuberculosis among unskilled workers is three times as high as that of skilled workers and seven times as high as that of professional men. It is among such highly infected groups that measures for tuberculosis control need to be centered.

The age distribution of tuberculosis deaths may be seen from the accompanying chart. Infants are very susceptible to tuberculosis but you will note a low death rate at 3 to 12 years of age. A serious infection rarely develops during these ages, al-

*See also "Tuberculosis, Pulmonary" and "Tuberculosis, Other Than Pulmonary" in Appendix A.

though an infection at this time may develop an active disease during adolescence. Note the rising death rate during adolescence and youth, and the continual increase in the rate for men as age advances.

Death rates for Negroes are about three and one-half times that for whites in the country as a whole. Yet mass surveys of large population groups have shown fewer cases of tuberculosis in Negroes than in whites. The explanation of this seeming contradiction lies in the fact that Negroes who do develop pulmonary tuberculosis survive a much shorter time than do the whites.



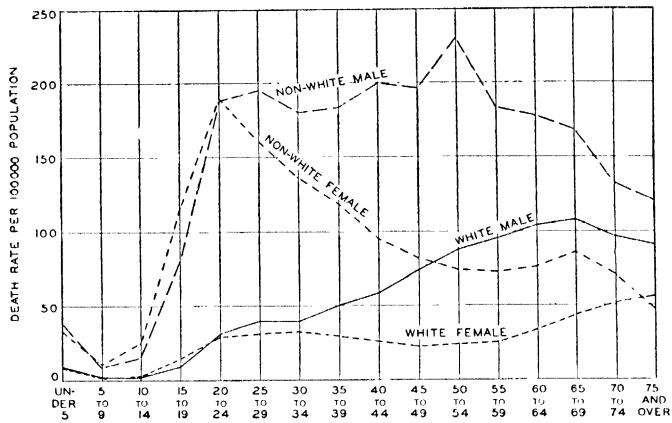
Tuberculosis death rate in the United States, 1900-1946. (Courtesy National Tuberculosis Association.)

Negroes do not acquire tuberculosis more readily than white men, but they develop the disease at an earlier age and resistance seems much lower. Among other racial groups we find high death rates among the Indians, and Spanish-speaking people but low death rates among the Jewish people.

Apart from differences of age and race, tuberculosis is always higher where poverty, malnutrition, cumulative fatigue, exposure to free silica dusts, poor housing, overcrowding, ignorance, and lack of healthful recreation exist. The level of body resistance and the amount of infection are the factors which determine whether any person develops tuberculosis.

Nature of the Disease.—The tubercle bacillus is capable of attacking many parts of the body, but the most common form of the disease is tuberculosis of the lungs, or *pulmonary tuberculosis,* which is of two types or phases.

The *primary or first infection type* is usually caused by inhaling the tubercle bacilli, with the production of a focus of infection in the lung. Usually it is a single, minute spot of infection. Body cells surround the tubercle bacilli, aiding in the formation of a soft mass which is later encapsulated by fibrous tissue and calcium, to form a tiny tuberlike lump or tubercle. During this early stage bacilli are commonly carried along the lymph channels



Tuberculosis death rates among white and nonwhite males and females by age; United States, 1944. (Courtesy National Tuberculosis Association.)

to the lymph nodes of the chest. These lymph glands of the hilum (area between the two lungs near where the bronchi enter) screen out the bacilli and prevent them from passing into the general circulation. They become enlarged. This primary infection is more common in children than in adults and was formerly called childhood tuberculosis. Usually no clinical symptoms are produced.

In the majority of instances healing occurs, but there are two evidences in the body to indicate what has taken place: (1) calcified foci have been formed in the lung and in the lymph nodes (hilum glands) which may contain living tubercle bacilli, and (2)

the body has become allergic or hypersensitive to the infectious organism. The presence of the calcified areas may be indicated by an x-ray examination and the allergy may be detected by the tuberculin skin reaction.

The *reinfection or adult type* of tuberculosis is the more serious, advanced, and widely known phase of the disease, usually accompanied by fatigue, loss of weight, indigestion, and a persistent cough. The infection usually appears in the upper third of the lung and may be caused by bacilli which enter the body from outside or by bacilli which have been liberated by the breaking down or rupturing of a lesion of earlier primary tuberculosis. Thus the reinfection stage may arise from fresh contact with a person having tuberculosis or from a weakening of the individual's vitality through overwork, strain, dissipation, mental depression, or such infections as a cold or influenza. This new lesion or "infiltration" may progress rapidly, distributing germs to other parts of the lungs. If complete rest can be obtained, the lesions will heal. Obviously, the treatment (rest) should be instituted at the earliest possible moment since the chances of cure will then be best and treatment will be completed in the shortest time.

Tuberculosis other than pulmonary is relatively rare. The infection comes from human beings with the disease and from tuberculous cows. Many years ago bovine tuberculosis was common and caused many cases of tuberculosis of the bones (including tuberculosis of the spine with hunchback) and infection of the lymphatic glands of the neck. With the elimination of infected cattle and the general pasteurization of milk, bovine tuberculosis has almost disappeared in the United States. Tuberculosis of the skin, kidneys, intestines, or other organs of the body sometimes occurs.

Prevention and Control.—Tuberculosis is not subject to control by either sanitation or vaccination. Vaccines made with killed organisms and with nonvirulent organisms (BCG or Bacillus Calmette Guérin vaccine) have been tried and large-scale experiments with them are still under way. To date they have not been strikingly successful. The possibility that streptomycin or one of the other antibiotics may inhibit the growth of *Mycobacterium tuberculosis* is also being investigated.

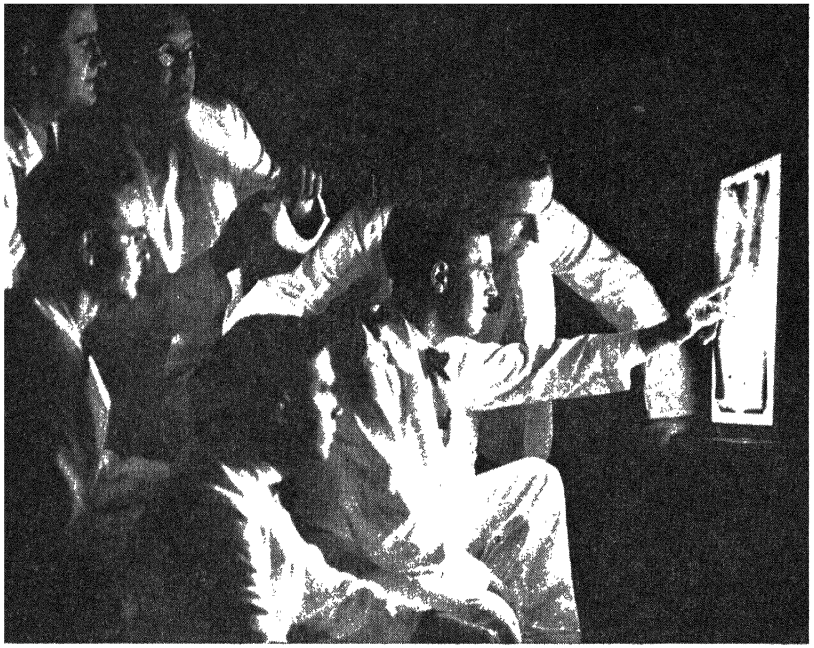
Our progress against the disease has come mainly (1) from educating the public toward better personal hygiene, better ventilation, better diet, and the avoidance of unpasteurized milk, common drinking cups, severe and protracted fatigue, the ingestion of alcohol and intimate associations with persons who have tuberculosis, (2) from finding cases early and obtaining prompt treatment, and (3) from a general improvement in the standard of living. Health departments have had most valuable assistance from the National Tuberculosis Association and its state and local societies.

One of the difficulties in *early case finding* lies in the fact that the disease does not give readily discernible signs until it is relatively far advanced. It is therefore necessary to seek the disease among supposedly well people. In doing this, wide use has been made of tuberculin skin tests. In the *Mantoux diagnostic skin test* a small amount of tuberculin extracted from the tubercle bacillus is injected into the skin. If previous infection has made the person sensitive or allergic to the germ, a red or mildly inflamed spot appears within forty-eight hours. If the test is positive, it indicates that there has been a previous invasion of the organism but it does not necessarily show how far tuberculosis has progressed.

The *patch test* is simpler to use and is nearly as reliable. A patch of adhesive tape holds against the skin a square of filter paper saturated with tuberculin. It is removed after forty-eight hours and read at ninety-six hours.

In the past most children over 10 years of age gave a positive tuberculin test, but recent surveys in colleges show that less than 20 per cent of the entering students react.

It has been the practice to give tuberculin tests to large groups of people and to x-ray and examine medically those who gave a positive reaction. The x-ray is the most exact means of diagnosing tuberculosis, and recently improved techniques have made it possible to employ it as the primary diagnostic or screening device. Small cellulose films, 4 by 5 cm. or 35 mm., are used instead of the standard 14 by 17 inch cellulose films. Chest x-rays are now given routinely in many parts of the country to college students, high school students, expectant mothers, and all patients entering



(Ewing Galloway)

The reading of an x-ray plate requires medical skill and experience.

general hospitals. In addition, community campaigns using portable x-ray equipment promote the taking of x-ray pictures of all the persons in industries and in whole communities.

Probably many cases of advanced tuberculosis could be prevented if every one between the ages of 10 and 20 years could receive one or more x-ray examinations. It is particularly important to have regular x-ray examinations for persons who, like teachers or domestic servants, are in intimate contact with children.

The laboratory examination of *sputum* reveals the presence of the bacteria in active disease. Sputum examination is not as good a means of early diagnosis as the x-ray, although the bacteria often appear in the sputum and in stomach washings before clinical signs of the disease appear.

Early treatment is important in reducing the recovery time and in avoiding the danger of infecting others. Rest is the one cure for tuberculosis and it should be taken at the earliest possible moment. No medicine will cure the disease. Patent medicines may quiet a cough or stimulate a patient temporarily, but they are

dangerous because they postpone the one real cure—complete bed rest. The sanatorium is the ideal place for such treatment. The sanatorium patient is free from anxiety that he may be exposing a well person to the disease. He lives in cheerful surroundings and follows a medically planned regimen, which includes good food, fresh air, and *rest.* The sanatorium also trains the patient to keep well after the disease has been arrested.

Medical science makes wide use of another device for resting a lung. It is called *pneumothorax* and is a device for collapsing the diseased lung by injecting air into the pleural sac between the lung and the chest wall. It can collapse one lung so that it does not breathe. The healthy lung does all of the work. Sometimes the lung is kept collapsed for years by putting a "refill" of air into the chest from time to time.

Some tuberculous patients are treated at home. When this is done, it is most important to follow the doctor's directions with the utmost care in obtaining a good diet, in disposing of sputum, in the sanitation of dishes used by the patient, and in the day-to-day schedule of rest. Sanatorium care is greatly preferred.

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CHAPTER XXIII

CONTACT AND INOCULATION DISEASES

The number of contact diseases and inoculation diseases is not great, but some of them are very important.

CONTACT DISEASES

This group of diseases includes maladies which vary widely in nature, but have a point of similarity, in that they are spread by direct contact (touching) between the well person and the infected human being or animal, as the case may be; or they are spread by a direct contact with infected material, such as clothing or bedding.

Anthrax, glanders and *foot-and-mouth disease* and perhaps *actinomycosis* are transmitted to man from other animals or from animal products, such as the hair, hides, or flesh. Contact with the infected material allows the disease to enter through a break in the skin or mucous membrane or through the alimentary or respiratory tract. In such a group of diseases control of the disease in animals is the fundamental sanitary procedure.

Other diseases in the contact group are transmitted directly by the contact of the sick with the well, or they are transferred by indirect contact when the well person touches, handles or uses materials or articles recently in the possession of the infected individual. In this group are the *venereal diseases* and *trachoma,* a disease of the eyes or conjunctiva in which the infection is often transmitted by use of the common towel. Included also are *erysipelas,* a streptococcus infection of the skin which enters the victim through a break in the skin; and *scabies* (itch) which passes from person to person when sufficiently close contact allows the itch mite to get upon the body of the new host.

In some diseases of this group the infection is introduced into the body through actual rupture of the outer skin. *Tetanus,* or lockjaw, is produced by a bacillus which, although it causes serious disease or death in man, normally lives in the intestinal tract of animals without producing disease. This organism lives not

only in the intestinal tracts of animals, but also in the soil, and its mode of entrance into the body is with dirt which enters a wound. This disease, even in time of war, is almost completely controlled by prompt attention to the cleanliness of wounds and the use of a specific, antitetanic serum which prevents the disease from developing. It is also possible to immunize against tetanus with toxoid. This immunization is commonly given in infancy or early childhood and renewed at intervals.

Rabies is likewise a wound disease. The organism of the disease is present in the saliva of the infected or rabid dog, and when the dog bites a person, the virus is introduced directly into the wound. The control of the disease is obviously limited to the control of dogs or other animals which are subject to the infection.

The venereal diseases (syphilis, gonorrhea, soft chancre, lymphogranuloma venereum, and granuloma inguinale) are of such importance (especially syphilis) that they deserve some discussion beyond that presented in Appendix A.

Syphilis*

The disease seems to have appeared in the civilized world about 1493. There is one theory that it was carried to Europe by the crew of Columbus on the return of his first voyage. By those members of the crew who joined the army of Charles VIII of France, it is thought to have been carried into Italy with the invasion of that country for the conquest of Naples in 1494. The epidemic which began there rapidly spread over all Europe, with the most serious consequences, for the disease was then new and its course was extremely rapid and severe. Although syphilis has been recognized for centuries, it was not until 1905 that the causative organism, the *treponema pallidum,* was discovered.

Syphilis has long been one of our most important public health problems, but only within the last decade or two has a really vigorous attack been made upon it in this country. Widespread publicity during the thirties focussed attention upon the problem, and in 1938 Congress enacted a Venereal Disease Control Act, by unanimous vote in both Houses, providing aid to states for "the prevention, treatment and control of the venereal diseases."

*See discussion of Syphilis in Appendix A for statement on control of the disease.

We do not know the exact prevalence of syphilis. The number of reported cases in the United States during the last few years is shown in the following table.

DIAGNOSED CASES OF SYPHILIS AND GONORRHEA REPORTED FOR THE FIRST TIME IN THE UNITED STATES AND TERRITORIES (1941-1947*)

YR.	SYPHILIS	GONORRHEA
1941	489,184	201,225
1942	550,767	252,481
1943	521,632	296,190
1944	409,891	294,785
1945	359,211	318,585
1946	393,571	422,833
1947*	377,000	383,000

*Estimated on the basis of figures for January through June.

Surveys have been made in individual communities by sending several public health workers into the community to record the number of cases under treatment on a single day in clinics and by private physicians. There are also data from serologic blood tests for large groups of persons. All of these surveys show sharp differences in the infection rate in different groups of persons. These differences are shown in the following table.

POSITIVE WASSERMANN TESTS ENCOUNTERED IN MASS SURVEYS OF VARIOUS SOCIAL GROUPS

(From Smillie, W. G.: Preventive Medicine and Public Health, New York, 1947, The Macmillan Co.)

SOCIAL GROUP	NUMBER PER 1,000
American university students, unselected series	1
Large industrial plants employing skilled labor	6
Prospective blood donors, 2,044 examined	8
Premarital examinations, all persons	12
White rural unskilled day laborers, all ages	23
Street beggars	110
Railroad employees, large series	117
Negroes, all ages, southern United States	190
Convicts, large series	240
Prostitutes, large series	300-700

Such a study shows the association of syphilis with crime, social maladjustment, ignorance, poverty, carelessness, and negligence.

Some of our most exact data on the prevalence of syphilis come from the serologic blood tests given to selectees for army service. Of all selectees examined for syphilis in World War II, 4.5 per cent

showed positive serologic tests. The following table is prepared from reports on the first two million selectees examined during 1940 to 1942.

PERCENTAGE OF POSITIVE SEROLOGIC TESTS FOR SYPHILIS

AGE GROUP	WHITE MEN (%)	NEGRO MEN (%)
21-25	1.0	19.0
26-30	2.1	29.4
31-35	3.9	35.7
Total for all ages	1.7	25.2

This table shows, as might be expected, an increasing number of positive reactions in the higher age groups. Much more startling is the contrast in infection rate between white men and Negroes. The infection rate varies in different parts of the country, but the rate among Negro men is consistently more than eight times that among white men. This is shown in the following table in which we have included, from among the states with considerable Negro population, three of the states with the highest rates and three with the lowest rates.

SYPHILIS PREVALENCE IN THREE STATES WITH HIGH RATES AND IN THREE STATES WITH LOW RATES

STATE	WHITE MEN (%)	NEGRO MEN (%)
Florida	5.3	40.6
Texas	5.3	34.3
Georgia	3.9	32.8
Wisconsin	0.6	15.7
Minnesota	0.8	14.2
Massachusetts	0.9	11.6

It would appear that the disease can be controlled in both groups because of the sharp difference in the rates between the different states listed. However, the consistently sharp difference between the incidence in the two races shows that statistics for any state as a whole are relatively meaningless until the data are broken down so that the rates in these two races can be seen separately.

It is estimated that 10 per cent of all insanity, 15 per cent of all blindness, and 18 per cent of deaths from organic heart disease, are due to syphilis. If an expectant mother has syphilis and is not adequately treated, the infection is often transferred to the

unborn infant. The disease transmitted in this way is called *congenital syphilis.* It is estimated that 2 per cent of children are born with congenital syphilis. A large proportion of these infants are born dead, and the others are likely to be sickly, deformed, blind, or feebleminded unless adequately treated.

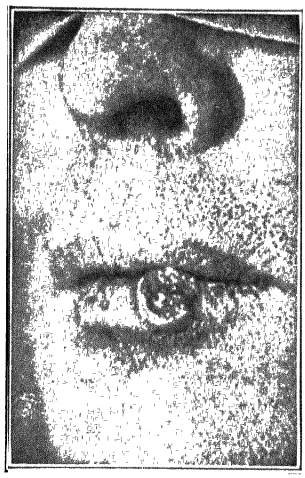
It is estimated that syphilis costs the nation more than three hundred million dollars annually for treatment, in lost time from work, and in reduced efficiency of employees. This is more than the total amount spent for all our departments of health. The cost of syphilitic blindness alone is estimated at forty-one million dollars a year.

The fact that syphilis is sometimes transmitted outside of venery makes it a menace to everyone. Continent, moral and hygienic conduct is the best protection against it, but that protection cannot be complete. Even a slight scratch in the skin is sufficient to permit the introduction of the germ as has often been demonstrated by infections upon the hands of surgeons, nurses, and midwives. It is possible for the disease to be transmitted by the kiss of an infected person. Innocent infections occur in the wife of the syphilitic husband and, as we have indicated, in the fetus of the infected mother.

Nature of the Disease.—When syphilis is untreated, it usually but not always follows a characteristic course. There *first* occurs a hard indurated ulcer, or chancre, in the skin or mucous membrane at the site of the original infection. The chancre appears from ten days to ten weeks (usually three weeks) after exposure. It is usually painless and disappears in a few weeks even without treatment. The disease is highly contagious during this chancre stage. The germ can be detected in the fluid from the chancre by means of the dark-field microscope, although the blood may not yet show a positive reaction to the blood test for syphilis. Cure is practically certain if treatment is commenced during this early stage of the disease.

In untreated syphilis during the sixth to the twelfth week after infection, the *second stage* of the disease appears. Its symptoms usually include a skin rash, fever, headache, mouth sores, a sore throat, and a general run-down feeling. The mouth sores are highly contagious. The blood test for syphilis is usually positive at this time.

The disease subsequently passes into a *later stage* in which there are no obvious symptoms, but in which the vital structures and organs are undermined. In this third stage of syphilis the untreated patient develops serious damage to the heart and blood vessels. Further common developments are deafness, blindness, ulcers, mental derangement, convulsions, and paralysis. The largest number of deaths are from cardiovascular syphilis. General paralysis of the insane (paresis) and progressive loss of muscular control (tabes dorsalis) are among complications that result from untreated syphilis.



Chancre of lip. (After Sutton and Sutton.)

Reducing or Eliminating the Disease.—There is no doubt that we shall be able to reduce the amount of syphilis tremendously. Before World War II Denmark, Norway, and Sweden had made syphilis a rare disease. If we compare their syphilis rates with our own, we find that New York State, with one of the best control programs in this country and approximately the same population as these three countries, had 25 times as many cases of syphilis.

Prewar figures from Sweden show a total of only about 400 new cases of syphilis in a year among the population of 6,260,000, a rate of $\frac{1}{150}$ of 1 per cent (0.0066 per cent). This remarkable rate was achieved largely as the result of a law passed in 1918 re-

quiring all persons suffering from venereal disease to submit to treatment. If a person refuses, he may be required to enter a hospital. All infected persons in Sweden have the right to free treatment at the expense of the State. Doctors are required to report every case by number but not by name unless the patient fails to comply with the regulations. Every effort is made to discover the source of the infection and to place that person under treatment. Prostitution is suppressed. There is a good program of popular education. Wholesome recreation is encouraged. Freedom from venereal disease is a prerequisite to marriage.

This type of program can reduce the disease to the vanishing point if it is vigorously applied; and we can expect a reasonably rapid reduction in this country with the realistic approach which the people now demand. We are making progress in research on the disease. We have a large and increasing group of medical and public health specialists. We have organized effort in voluntary agencies (American Social Hygiene Association) and health departments. We have methods of early diagnosis and effective methods of treatment, and there is no reason why we should not give young people such an intelligent understanding of the facts that they will avoid infection.

Do you agree that the general public should know the following facts?—Syphilis is catching and dangerous. It is transmitted by sexual contact, by kissing, and by an infected mother congenitally. It is different from gonorrhea, but it is possible for one to have both diseases at the same time. A normal, moral life is the best protection. The prostitute is a major carrier of the organism since the majority of them are infected. Prostitutes are a biologically inferior group, approximately one-third of whom have been shown to be feebleminded. Prophylaxis with calomel ointment within a few hours after exposure is generally successful, but is not an infallible prevention against the disease. The Wassermann test, Kahn test, or similar serological or blood tests are valuable aids in detecting syphilis. We have excellent methods for treating syphilis, and a cure is practically certain if treatment is started early and continued regularly under competent medical skill. Improved methods of treatment are being developed and tested; but whatever treatment is used, the patient must continue under medical care until the cure is complete. Most states require syphilis to be re-

ported by number and not by name unless the patient discontinues treatment. Records concerning syphilis are held strictly confidential by the private physician, by clinics, and by the health officer. Health departments provide free blood tests for syphilis, and generally provide free drugs for the treatment of patients. Blood tests early in pregnancy are important. Valuable progress is being made in the discovery and eradication of this disease by premarital blood testing of couples before the marriage license is issued and by routine blood tests of pregnant women. The promptness with which a person becomes noninfectious when placed under proper treatment makes it unnecessary and unreasonable to discharge from ordinary factory occupations those persons who have a positive blood test for syphilis. Self-treatment with drugstore remedies is unwise and dangerous. The life expectancy for untreated syphilis is 20 per cent lower than normal. An adequate program in the community under the leadership of a trained public health staff includes the follow-up of all cases, available treatment for those who cannot afford to pay, free diagnostic laboratory service, free antisyphilitic drugs, a blood test for every expectant mother, premarital blood tests, blood tests with routine health examinations, and an educational program aimed at the age groups most frequently acquiring syphilis.

Other Venereal Diseases

The most important of the other venereal diseases is gonorrhea. The initial infection of the gonococcus *(Neisseria gonorrhoeae)* is ordinarily along the lining of the genital tract. However, the complications of the disease resulting from the spread of the infection along the genital tract are most serious. The germ may enter the small glands, producing an infection that is difficult to cure. It may close the ducts from the testes or ovaries, making parenthood impossible. It may reach and infect the bladder or it may enter the blood. This germ may cause rheumatism. It may infect the eyes and cause blindness in newborn infants.

Studies on the prevalence of gonorrhea indicate that at least 1,000,000 persons acquire gonorrhea every year in the United States. The age distribution is similar to that of syphilis. The tendency to hide the presence of the disease and to resort to dangerous self-treatment is even greater than in syphilis. The sulfa

drugs were found helpful in the treatment of gonorrhea, and penicillin has been found to be even better; but neither of them can be used effectively and safely in self-treatment.

Chancroid, or soft chancre, is a localized disease which is limited usually to a deep painful ulcer at the point of infection and in which serious sequelae from this infection occur occasionally. Chancroid, lymphogranuloma venereum, and granuloma inguinale are much less common in the United States than are syphilis and gonorrhea but are widely prevalent in tropical and subtropical areas of the world.

INOCULATION DISEASES

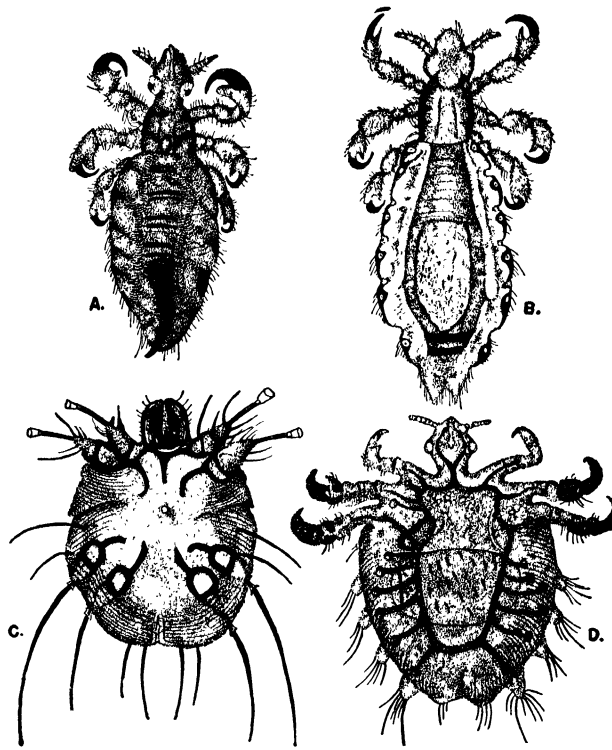
The transfer of disease by inoculation is by the entrance of the germ through the skin or flesh. Man has long recognized the hostility of a variety of biting insects that are always ready to disturb his comfort. The mosquito is eager to draw its food from man's blood supply. If human habitations are unsanitary, the bedbug makes its abode in the house, with its program of watchful waiting and sudden action. If man's habits of personal cleanliness are sufficiently poor, the louse lives upon his body. The itch mite burrows into the skin of man, producing redness, itching, and irritation. But not until 1879 was it suggested that any insect could transmit disease-producing germs.

The studies of Sir Patrick Manson showed that the blood of patients suffering from a disease known as *filariasis* contained in great numbers the young of a specific worm. He suggested, and later was able to prove, that this worm is drawn from the blood when a mosquito bites an infected person, passes part of its life in the body of the mosquito, and reaches a new human victim when the latter is bitten by the mosquito.

General attention was centered on insects as possible carriers of diseases in 1893 by the conclusive studies of Dr. Theobald Smith on *Texas fever,* a disease of cattle. He showed that the blood parasite (*Babesia bovis*) lives in the body of the infected tick and is transferred to cattle by the bite of the insect.

From these investigations we recognized a new means of disease transmission—namely, the *biologic.* By this we mean that the parasite passes part of its life history in the body of some other

animal which acts as a temporary host. In many cases, the temporary existence in the body of this other host is necessary for the complete development of the parasite, and it cannot be transferred back to man until it has passed through certain stages of development in the body of the temporary host. Insects responsible for the biologic transmission of an infection are known as



External animal parasites which infest human beings. *A*, Head louse; *B*, body louse; *C*, itch mite; and *D*, pubic, or crab louse. (After Sutton and Sutton.)

vectors of disease. This must be clearly distinguished from the mechanical transmission of disease. Houseflies or other insects may collect the germs of typhoid, cholera, dysentery, or some other disease on their feet and legs and carry them to a healthy individual or to food about to be eaten, thereby transporting the causative agent of the disease by mechanical means.

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The studies of Sir Patrick Manson showed that the blood of patients suffering from a disease known as *filariasis* contained in great numbers the young of a specific worm. He suggested, and later was able to prove, that this worm is drawn from the blood when a mosquito bites an infected person, passes part of its life in the body of the mosquito, and reaches a new human victim when the latter is bitten by the mosquito.

General attention was centered on insects as possible carriers of diseases in 1893 by the conclusive studies of Dr. Theobald Smith on *Texas fever,* a disease of cattle. He showed that the blood parasite (*Babesia bovis*) lives in the body of the infected tick and is transferred to cattle by the bite of the insect.

From these investigations we recognized a new means of disease transmission—namely, the *biologic.* By this we mean that the parasite passes part of its life history in the body of some other

Further research has taught us that malaria, yellow fever, filariasis, dengue, plague, African sleeping sickness, and Rocky Mountain spotted fever, together with a few less important maladies, are conveyed to man by biting insects. Usually the germ of the disease is capable of living in the body of the particular insect without injuring it. When transferred to man, the germ attacks a particular part of the body, or by its presence produces fever and tissue destruction.

There are several possible points of attack in the elimination of such diseases. We may undertake measures to kill the insect that carries the infection, we may keep the insect away from the sick to prevent their becoming infected, we may use precautions of screening and the eradication of vermin to keep man protected from attack and the bite of the insect, or in some cases we may attack the germ itself—as in the case of malaria by the use of a specific substance, like quinine, chloroquin, Atabrine, or Plasmochin, which kills the organism in the blood of the human patient. The entomologist and the sanitarian, from a knowledge of the life history and habits of the insect, suggest the methods by which the disease can best be attacked. Our general program includes all these means of restricting the disease: prompt diagnosis and treatment of the patient under suitable isolation, a campaign against the insects themselves, and the protection of the healthy population by education and cleanliness.

Mosquito-Borne Diseases

Dengue fever and filariasis are mosquito-borne diseases, but the two diseases which have been most important as causes of disability and death are malaria and yellow fever.

Malaria throughout the ages has been one of the world's greatest scourges. It has been suggested that this disease contributed more than any other factor to the downfall of the Greek Empire. In Italy certain valleys, like the Campania, were filled with infection, and the name malaria, meaning "bad air," reflects the early erroneous belief that the humid swamp air produced the disease.

Although Laveran, the French scientist, found in the blood of malaria patients the single-cell animal, Plasmodium, which causes the disease, it was Ross (1895) who first discovered its transmis-

sion by the mosquito. Later studies showed that the mosquito was the only agency of transmission.

Since then the complete life history of the parasite has been worked out. It has been learned that certain stages of its life history must be passed in the body of the mosquito. Moreover, it is a specific mosquito, the Anopheles, which harbors and transmits the malaria germ. More than this, it is only the female of the species which is the dangerous agent. The male mosquitoes are not blood sucking but feed upon vegetable juices. The females *must* feed upon blood to complete their development so that reproduction is possible. Thus the desire for blood sucking is linked with ordinary hunger and with the sex instinct. (See Appendix A for the facts regarding its control.)

Yellow fever was added to the list of insect-borne diseases in 1900 by the distinguished work of the American Yellow Fever Commission, composed of Reed, Carroll, Lazear, and Agramonte. This disease also is conveyed by a single species of mosquito, Aedes, formerly called Stegomyia. World-wide campaigns against this disease have gone far toward its elimination. North America has been free from this disease for many years.

In 1902 *dengue* was found to be transmitted by the mosquito, and, as we have seen, *filariasis* has been known to be transmitted by various species of mosquitoes for a much longer period.

Mosquito Control.—It has been demonstrated in many communities that systematic and scientific programs of mosquito control, if sufficiently broad in scope and carried over a reasonable period, may nearly or completely rid an area of mosquito-borne disease.

The best method of attack upon the mosquito is the destruction of its larvae. The mosquito lays its eggs in the water. After one and a half days the eggs hatch into the larvae or "wigglers." During the larval period the insect eats almost continuously. Although it lives in the water, it is an air-breathing organism. A breathing tube extends through a long projection at the posterior end of the body, and when air is taken in, this projection is thrust through the surface film of water. After six or seven days the pupa stage develops. During this period the insect eats nothing, and it breaths through two tubes situated in the upper part of the thorax. This stage undergoes transformation during a period of about two days and the mature insect is formed. The pupa

case is broken open along the back, the mosquito crawls out upon this floating skin and flies away.

Different varieties of mosquitoes are found as vectors of disease in different parts of the world. Their breeding, feeding, and other life habits vary. Consequently the methods of their control must vary.

An anti-mosquito campaign involves first an attack upon the breeding places. These may be eliminated by developing systems of drainage, and by cleaning the shores of streams and lakes, thus eliminating the grass growing in the water near the shore in which the insects can hide from fish and other natural enemies. In water that cannot be drained, the larvae may be killed by a poison (larvicide) or by the use of crude oil. The oil is spread over the surface and forms a film through which the breathing tubes of the developing insect cannot penetrate, and the insect dies from want of air. DDT (5 per cent in kerosene or a 10 per cent powder) and other larvicides are used as a means of poisoning and killing the larval forms. Proper screening prevents mosquitoes from entering dwellings and protects well persons, and proper screening of the sick prevents the infection of mosquitoes. Various substances have been discovered which can be released into the air or spread upon the hands and face to kill or drive off the adult mosquito. Dimethylphthalate is a very efficient insect repellent.

Diseases Carried by Other Insects

Another disease usually transmitted by an insect is *plague.* It is primarily a disease of rodents, but it is communicable to man. Plague swept over Europe about the middle of the fourteenth century, and from available records it apparently killed about twenty-five million people or one-fourth of the entire population. It is known in history as "The Black Death." The disease is spread (except in the pneumonic form) by the bite of the *rat flea.* The flea picks up the bacillus from an infected rat and carries it to other rodents or to man.

In a campaign against plague, therefore, isolation and specific treatment of infected patients are not sufficient. The rat must be trapped and killed, and prevented from being carried to countries or cities by ships. Rat-proof construction in the building of houses and commercial buildings, the use of cats and other

natural enemies, and the covering of garbage in an attempt to eliminate the natural food supply all aid in exterminating the rat. The disease is present in ground squirrels and other rodents west of the Mississippi. There is an occasional case in this country from that source.

It has been proved that the body *louse* transmits *typhus fever* and *relapsing fever* (see Appendix A). Ridding infected persons of lice and maintaining clean habits of living to prevent the spread of lice among the population are fundamental procedures in eliminating the diseases. *Ticks* also convey these diseases as well as *Rocky Mountain spotted fever* and *Texas fever* (in cattle). The *Tsetse fly* conveys *African sleeping sickness.* In all these diseases a scientific sanitary program of prevention calls for an attack upon the specific insect.

DDT (Dichlorodiphenyltrichloroethane)

DDT—dichlorodiphenyltrichloroethane—came into widespread use during World War II. It is so much more effective than earlier insecticides that it has revolutionized the control of insect-borne diseases. It is widely used as a general insecticide in the household and in agriculture.

DDT is a contact poison for most insects. It is slowly absorbed from any portion of the insect body contaminated with it and after some hours produces what seems to be paralysis of the nervous system. It is a stable compound and remains on a surface for three to six months, killing insects that tread upon it. It is prepared in a variety of forms—as a dust (usually 5 to 10 per cent mixed with talc), as an oil solution (usually 5 per cent in kerosene or diesel oil), as an emulsion (usually with xylene), as a suspension of the powder in water, or as an aerosol (with pyrethrum and a solvent to be used in "bombs" as a space sprayer for killing adult insects in enclosed areas or for keeping small outdoor areas free from insects for a period of two hours or so).

It is used as a residual spray for killing flies, mosquitoes, bedbugs, ants, clothes moths, and other insects. In the powder form it is widely used against cockroaches, fleas, body lice, head lice, and crab lice. Sprinkled on the clothing it remains effective against body lice for three weeks or more and has proved invaluable in the

control of typhus fever. It is used as a powder dusted into the hair in the control of head lice.

DDT is toxic to man and to other animals, although individuals and species vary widely in their susceptibility. The danger lies in ingesting the substance or in its absorption through the skin when in oily solution. It does not irritate the skin so there is nothing to signal that it is being absorbed.

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CHAPTER XXIV

FOOD CONTROL

We have considered food from the standpoint of diet. Under food control we shall consider the adulteration and sanitation of foods.

The prevention of food adulteration protects both the pocketbook and the health. The pure food laws are believed to save the consumers of the country more than fifty million dollars a year. The fraud practiced in food adulteration may sometimes be harmless; but if the adulteration reduces the nutritive quality of a food or adds some poisonous or infected substance, it injures health.

FOOD ADULTERATION

Nature and Cause of Adulteration.—Food adulteration has now become a highly specialized art. The man who adulterates food employs the skill of the chemist and an ingenuity equal to that of the theater "make-up man" in preparing his products. Coffee has been found which consisted of molasses and flour molded into the shape of coffee berries. American cottonseed and peanut oil from the southern states have been sent abroad and refined, then returned to us as pure Mediterranean Olive Oil. It is only by combating the craft of the manufacturer with the skill of the trained analyst that this type of food adulteration can be detected.

Pure Food Laws.—It is not the purpose of a pure food law to prohibit the making of cheap foods or even of second quality foods, but it does insist that these foods be sold for what they really are and not passed off to the public for first quality materials. It is good to have second quality foods in the market if they are clean and wholesome, because they are inexpensive. For example, catsup made largely from tomato skins may be nearly as good as that made from the fleshy part or inside of the tomato, provided that the material is properly washed and sterilized, for the difference in food value in a condiment is not important. What is important to prevent is the use of dirty tomato skins pre-

pared in an unsanitary manner or the sale of second-grade catsup under misleading labels. The public is entitled to know what it is buying. Often the difference between grades of canned and other foods is merely a difference in the size of the fruit or the appearance of the product, and not a difference in the food value.

The most important law dealing with food control is the Federal Food, Drug, and Cosmetic Act of 1938, which prohibits the adulteration and misbranding of these consumer goods. It considers a food as adulterated:

1. If it contains any poisonous or deleterious substance which may render it injurious to health. (Formaldehyde, arsenic, lead, salicylic acid, boric acid, benzoate, or other substances which might be present in dangerous amounts.)
2. If it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food. (Oysters contaminated with sewage, wormy figs.)
3. If it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health.
4. If it is, in whole or in part, a product of a diseased animal or of an animal which has died otherwise than by slaughter.
5. If its container is composed, in whole or in part, of any poisonous or deleterious substance which may render the contents injurious to health.
6. If any valuable constituent has been in whole or in part omitted or abstracted therefrom. (Skimmed milk.)
7. If any substance has been substituted wholly or in part therefor. (Cottonseed oil for olive oil, cane sugar for maple sugar.)
8. If damage or inferiority has been concealed in any manner. (Lemon extract colored with a yellow dye, bleached flour.)
9. If any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or make it appear better or of greater value than it is. (Cocoa shells mixed with cocoa or chocolate, watered milk.)
10. If it bears or contains a coal-tar color other than one from a batch that has been certified under regulations promulgated by the Secretary of Agriculture. (This paragraph does not apply to the coloring of citrus fruits, if such color was commonly used prior to the enactment of this law.)
11. If it is confectionery, and it contains any alcohol or nonnutritive article or substance. (Candy containing metallic trinkets and other inedible substances.) (Harmless coloring, flavoring, and resinous glaze not in excess of 0.4 per cent, natural gum, pectin, and 0.5 per cent by volume of alcohol derived solely from flavoring extract and harmless nonnutritive masticatory substances in chewing gum are allowed.)

According to the act, a food is misbranded:

a. If the labeling is false or misleading in any particular.
b. If it is offered for sale under the name of another food.
c. If it is an imitation of another food, unless it bears the word "imitation."
d. If its container is so made, formed, or filled as to be misleading.
e. If in package form unless it bears a label containing the name and place of business of the manufacturer, packer, or distributor, and an accurate statement of the quantity of the contents.
f. If any word, statement, or other information required by, or under authority of, this Act to appear on the label or labeling is not prominently placed thereon with such conspicuousness and in such terms as to render it likely to be read and understood by the ordinary individual under customary conditions of purchase and use.
g. If it purports to be a food for which a definition and standard of identity has been prescribed by the Secretary of Agriculture, unless (1) it conforms to such definition and standard and unless (2) it bears the name of the food specified in the definition and standard.
h. If it purports to be or is represented as
   (1) a food for which a standard of quality has been prescribed, and its quality falls below such standard unless the label so indicates;
   (2) a food for which standards of fill of container have been prescribed and it falls below this standard unless the label so indicates.
i. If (not subject to Paragraph g above) label fails to bear (1) the common or usual name of the food, if there be any, and (2) in case it is fabricated from two or more ingredients, the common or usual name of each such ingredient. (Spices, flavorings, and colorings may be designated as such without naming each.)
j. If it purports to be or is represented for special dietary uses, unless its label bears such information concerning its vitamin, mineral, and other dietary properties as the Secretary determines to be, and by regulations prescribes as, necessary in order fully to inform purchasers as to its value for such uses.
k. If it bears or contains any artificial flavoring, artificial coloring, or chemical preservative, unless it bears labeling stating that fact. (The provisions of Paragraphs g, i, and k with respect to artificial coloring shall not apply in the case of butter, cheese, or ice cream.)

The Act also defines and prohibits the adulteration and the misbranding of drugs and devices. It requires that the label of drugs used by man shall indicate the presence of certain narcotic or hypnotic substances and carry the statement "Warning—May be habit-forming." Labels must also indicate the presence and the amount of alcohol, bromide, acetanilid, atropine, arsenic, thyroid, and certain other substances. This act also brings all cosmetics,

except toilet soap, under control. It prohibits the false or misleading labeling of cosmetics.

Law Enforcement.—The Federal law applies only to products imported or for interstate shipment. For such products, inspections are made, and enforcement is secured by the United States Department of Agriculture. Additional powers are given to the Secretary of Agriculture for the control of food in interstate commerce, which may be injurious to health by reason of contamination with microorganisms. In such an emergency, the Secretary is allowed, temporarily, to restrict the manufacture, processing, or packing of such products to firms complying with his regulations and receiving permits from his department.

The purity of foods produced and sold within the state is controlled by special state laws, and these laws are enforced by state officials. Individual states usually maintain a Division of Food and Drugs under the State Department of Health. The samples are collected in various parts of the state and analyzed.

The state laws are usually similar to the Federal Food and Drug Act but frequently include additional regulations regarding such locally-produced foods as milk, butter, or sausages.

Special standards for foods like milk, butter, and vinegar are often set up by municipal ordinance, and such foods may be examined in the city public health laboratory. The most common local ordinance is that governing the sale of milk, the skimming or watering of which is determined by a variation from the normal proportion of the constituents. In normal milk the various laboratory determinations give approximately the following figures: sugar 4.7% fat 3.8%, total solids 12.8%, refractive index 37.5, solids not fat 9%, specific gravity 1.032, protein 3.6%, ash 0.7%.

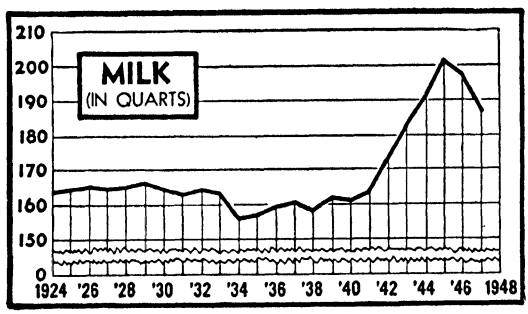
False Advertising.—A federal law in 1938 made it unlawful to disseminate any false advertisement by the United States mails relating to the purchase of food, drugs, devices, or cosmetics. The law is administered by the Federal Trade Commission. It prohibits any advertisement, other than labeling, which is misleading in a material respect.

FOOD SANITATION

The three most important problems in securing clean food involve the sanitation of milk, meat, and prepared food supplies.

Milk.—This country produces more than 57 billion quarts of milk a year, enough to fill a river 3,000 miles long, 40 feet wide, and 3 feet deep. If it were put into quart bottles side by side, the bottles would extend 140 times around the earth. The average American citizen consumes about 190 quarts of milk a year or over a pint a day, as fluid milk.

It is difficult to keep milk in a sanitary condition because it is not a clear fluid but a suspension which hides dirt readily. It is a good medium for the growth of bacteria and they increase rapidly unless the milk is kept at a low temperature. In many cases, milk must be produced at a considerable distance from the point where it is finally used. Some of our large cities obtain milk from farms 300 miles distant. It is particularly important that milk should be kept clean, for it is the one animal food that is consumed uncooked in great quantities.



United States per capita fluid milk consumption. The figures cover the rural and urban population and include cream in terms of milk equivalent. (Courtesy Milk Industry Foundation.)

Bacteria which are not disease-producing cause two kinds of changes in milk, putrefaction and fermentation. *Fermentation* usually results from the growth of lactic acid bacilli which sour milk by breaking down the milk sugar into lactic acid. Sour milk is not injurious to the health. Indeed, specially fermented milk has been recommended as healthful. When milk undergoes *putrefaction,* the proteins are attacked by bacteria. Such milk is alkaline in reaction and bitter to the taste. It may cause a disturbance in digestion.

Milk always contains many harmless bacteria but sometimes it becomes contaminated with the germs of communicable diseases. Everyone has heard of milk-borne epidemics. *Animal diseases* which may be transmitted through milk include bovine tuberculosis, undulant fever, hoof and mouth disease, and various types of streptococcus infection. The diseases of *man* which are transmitted through milk include tuberculosis, typhoid fever, diphtheria, scarlet fever, septic sore throat, and bacillary dysentery.

Milk must be produced from healthy cows, in clean stables, and by sanitary methods to meet health department standards. It must be kept cool and clean from the time it leaves the farm until it reaches the consumer.

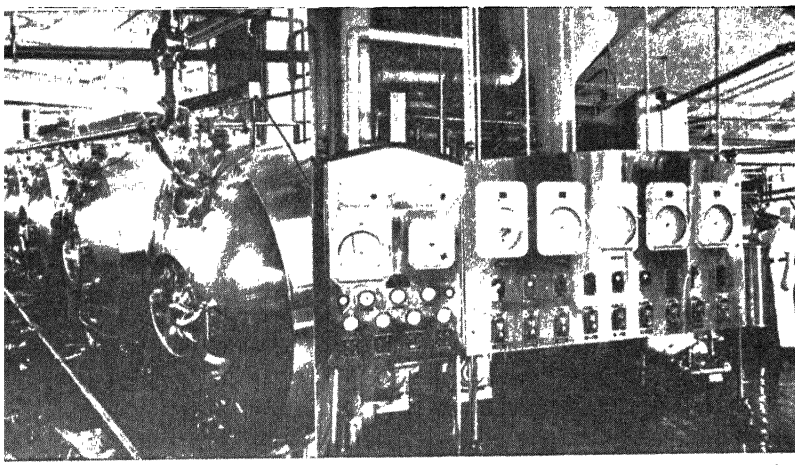
Pasteurization is the great safeguard against milk-borne diseases. It should be required for every public milk supply. The *holding* method consists of heating the milk to a temperature of 143° F. for thirty minutes to kill most nonspore-bearing organisms. It is most valuable when the milk is pasteurized in its final container. In the *flash* method, the milk flows continuously and is heated to 160° F. for fifteen seconds, after which it is cooled rapidly. Pasteurization does not change the composition and taste of the milk, as indicated in the accompanying chart.

It is easy to test the efficiency of pasteurization by a quantitative *phosphatase test.* This enzyme, which is present in milk, is destroyed at pasteurization temperatures. The health department laboratory can also test milk for its bacterial content and its chemical and physical properties.

Boiling makes milk safe but it does change the taste and, to some extent, the quality.

The United States Public Health Service has issued a standard milk ordinance that has been widely adopted. This ordinance places the burden of safe milk on the local health officer and assures sanitary standards of milk production, accurate labeling, and careful supervision. Copies of this ordinance may be obtained from the United States Public Health Service, Washington, D. C.

Remade Milk.—Remade milk is a product that is being used by hospitals and other institutions with good results. It is made by mixing dehydrated skimmed milk (milk powder) and unsalted



(*Acme Newspicture*)

Modern pasteurization machinery.

butter or milk fat with water in a homogenizer. By this process milk may be dehydrated in dairy regions far from the cities and remade in the large centers of population, producing a clean and inexpensive product. Remade milk has a low bacterial count and a good cream line. It is not easily distinguishable from fresh milk.

Condensed, Evaporated, and Dried Milks.—Many advantages are derived from the partial or complete desiccation of milk. It improves the keeping qualities by reducing the water content below the point necessary for bacterial growth. The bulk is reduced and consequently the transportation charges. In this way it is possible to preserve the seasonal surplus of milk or milk produced in remote sections. Sanitary control and honest labeling are, of course, important.

Condensed milk is partially dried, pasteurized, but not sterilized, and then preserved with 40 per cent sugar. It is an altered milk product and cannot be made into a milk of normal proportions. Sugar in this form is expensive.

Evaporated milk is unsweetened. It is heated to such a high temperature that it becomes sterile or nearly so. Two processes are used in the preparation of *dried milk* or milk powder. One method requires the drying of milk in a partial vacuum at a comparatively low temperature. In the other process the milk is first

concentrated in a vacuum and then sprayed into a hot chamber. The product keeps well and has practically all the nutritive value of fresh milk except that the ascorbic acid is reduced.

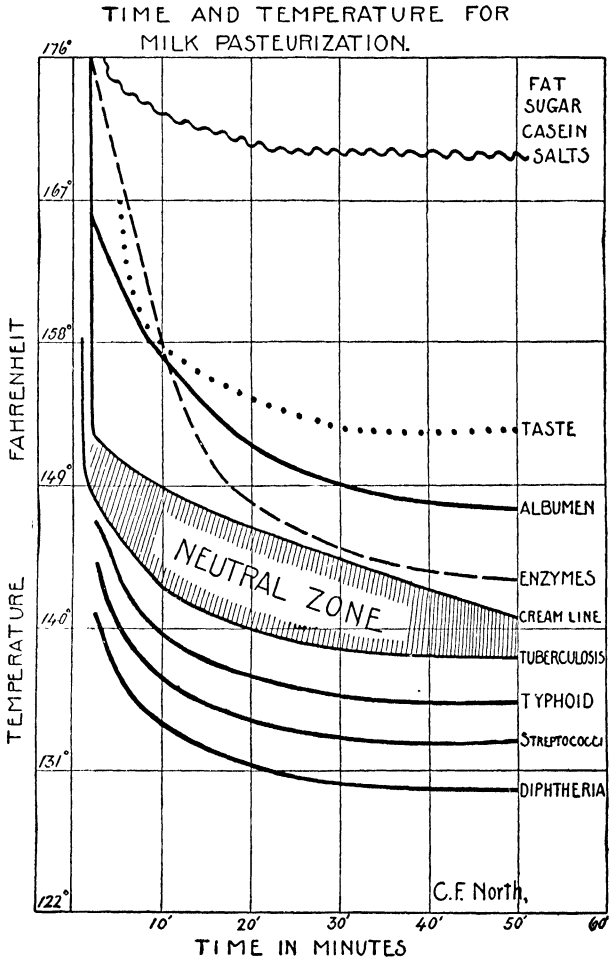
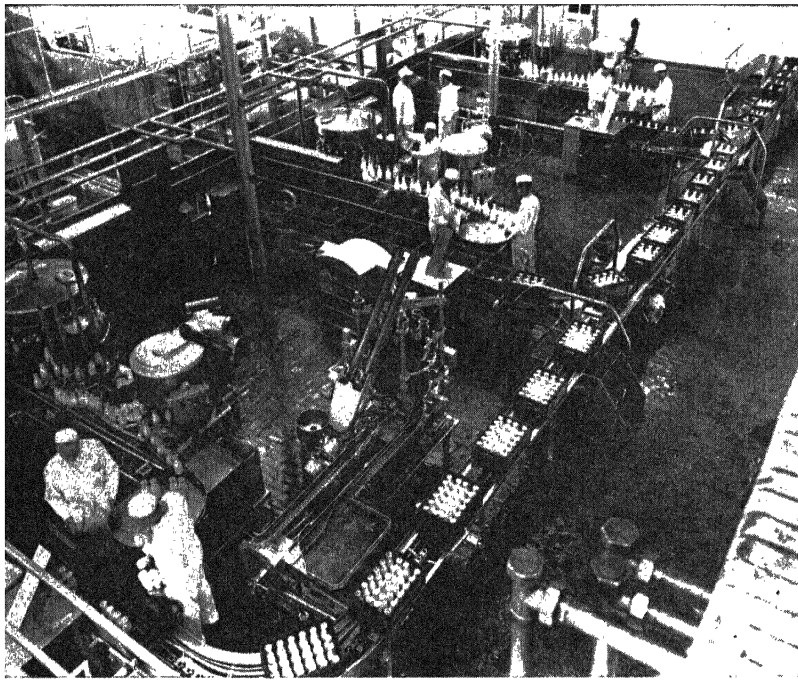


Chart showing the time and temperatures at which bacteria are killed and at which the quality of the milk is changed.

Meat.—Meat is inspected by federal, state and local health agents, and in large abattoirs an inspection is made both before and after killing. One reason for the inspection is to see that the



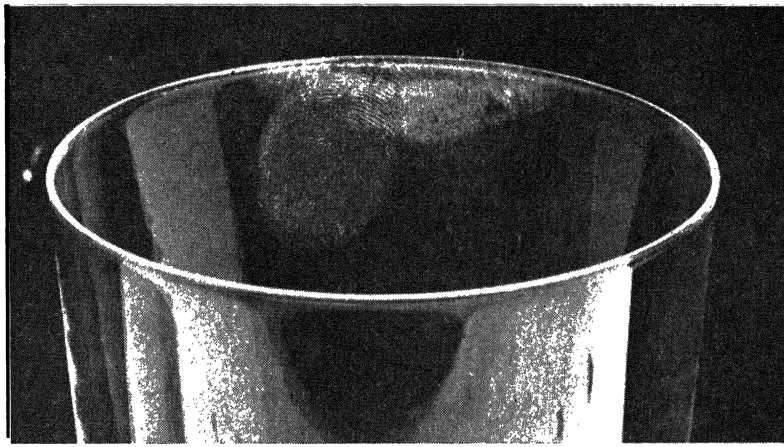
(Keystone)

Bottling pasteurized milk.

animal is free from such diseases as tuberculosis, anthrax, trichinosis, actinomycosis, tapeworm, and septic and pyemic conditions. Later inspections of meat are to make sure that the meat has not become decomposed or infected. Supervision of the processes of slaughter is also made to see that the death of the animal is immediate and painless, that there is an immediate withdrawal of blood, that the intestines, hide, and hair are promptly removed, and that there is immediate cooling.

Dangers in Meat.—The important health dangers from meat are due to the following causes:

1. *Trichinella spiralis,* a small roundworm, infects man, hogs, rats, and other animals. The larvae encyst in muscle tissue. When infected pork is eaten raw or is not thoroughly cooked, trichinosis develops in man. The larvae mature in the intestine and produce young which, in turn, infest the muscles. Microscopic examination of meat is fairly successful in detecting the larvae. Trichinosis may be prevented by the thorough cooking of pork and pork products.



Photograph of a thumb print and lipstick smear on an otherwise clean glass shows the need for sterilizing glassware or using paper cups at soda fountains or public eating places.

2. Tapeworms found usually in hogs (*Taenia solium*), beef (*Taenia saginata*), and fish (*Diphyllobothrium latum*) may infect man. The pork, beef, and fish tapeworms infest the intestinal tract of man when he eats food products that are infected with larvae and are inadequately cooked. The personal prophylaxis against infestation by these parasites consist of thorough cooking of the food products.

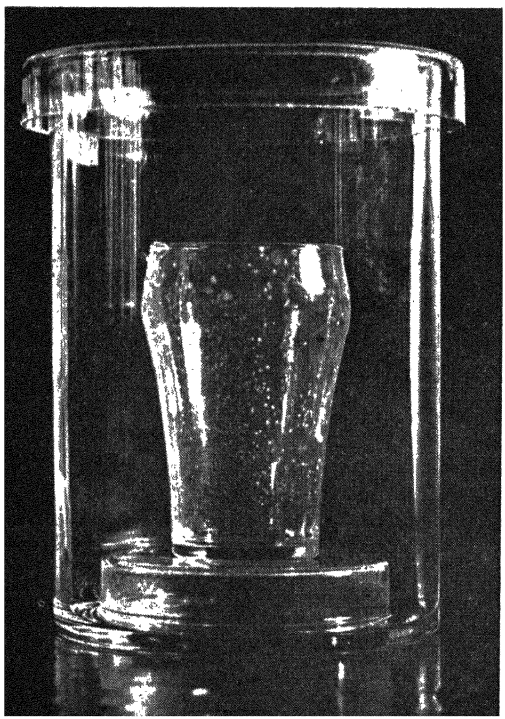
Food Infection and Poisoning.—Food poisoning (sometimes improperly called ptomaine poisoning) may be caused by a poisonous substance in food or by staphylococci, paratyphoid bacilli (Salmonella), or the Clostridia of botulism which have grown on the protein constituent of the food. (See Food Poisonings and Food Infections in Appendix A.) Cream fillings in pastries and other protein-containing foods which have been kept for some time, especially in warm weather, are common sources of food poisonings from bacterial growth.

Oysters and other shellfish are a potential source of infection of intestinal diseases. However, through a cooperative arrangement between state health departments and the United States Public Health Service strict regulations to prevent the pollution of oyster beds and to safeguard the sanitary packing and the shipping of oysters and other shellfish are enforced.

We sometimes hear of people being poisoned by eating poisonous mushrooms instead of the edible variety. Other plants that have been implicated as causing human poisoning are sorrel, rhubarb leaves, locoweed and sunburned, diseased, or unripe potatoes.

The spraying of fruits and vegetables with lead or arsenic-containing insecticides results in at least the potential danger of lead or arsenic poisoning. A wise precaution against such poisoning is the thorough washing or removal of the skins of fruits or vegetables which have been sprayed. Poisoning has been caused by the use of silver polish containing sodium cyanide and by the accidental mixing of a poison with food during its preparation.

Food and Restaurant Sanitation.—We have mentioned milk-borne epidemics. The germs of a variety of diseases may find their way to meat and other foods through unsanitary food handling. Such diseases include tuberculosis, common cold, influenza, septic sore throat, scarlet fever, pneumonia, whooping



A test for the efficiency of dish washing. Colonies of bacteria grow on surface of a drinking glass which has been coated with sterile agar. The agar is prevented from drying by putting the glass in a battery jar. (Courtesy of Milan Novak and American Journal of Hygiene.)

cough, trench mouth, dysentary, typhoid fever, mumps, and measles. Food infections may be caused by contamination of edibles or dishes with the body wastes of rats or mice containing the colon-typhoid group of bacteria or the causal organisms of choriomeningitis or infectious jaundice.

An infected waiter or food handler may infect food prepared in the cleanest kitchen. The healthy carrier of a communicable disease is especially dangerous. The case of one such carrier, "Typhoid Mary," has become famous. This woman who was employed at various places as a cook infected more than a score of persons with typhoid fever before it was learned that she was a carrier.

Some health departments have required an annual health examination and certification of food handlers. This is not universally regarded as desirable, since it is not easy to make sure whether an infection exists. It does, however, provide an opportunity for the education of food handlers which, either in connection with certification or elsewhere, is most desirable. Education is needed both in personal hygiene and in the methods of handling food.

The sanitation of eating and drinking utensils is also important. Individual paper containers solve the problem where they can be used. To kill bacteria, dishes must be immersed in water at 180° F. for at least two minutes. Many state health departments set sanitary standards for dishwashing in restaurants.

Restaurant sanitation is a matter of considerable importance to most of us. Nearly 25 per cent of all the food produced in the United States is eaten in restaurants. Sixty-five million Americans eat at least one meal a day in public places. In a recent twelve-month period 23,765 cases of food-borne disease were reported, representing 389 separate outbreaks or epidemics. And health officials estimate that only about 5 per cent of diseases caused by food filth are reported.

In the study of 298 food-borne outbreaks, the diseases involved were botulism, 9; chemical food poisoning, 8; dysentery, 7; food poisoning, 157; gastroenteritis, 94; trichinosis, 7; typhoid fever, 10; others, 6. Information on the type of establishment involved was available for 264 outbreaks and showed the following distribution: public restaurants, 49 outbreaks; schools and colleges, 38; food shops, 31; hospitals and institutions, 29; industrial cafeterias, 19; labor camps, 16; railroad train, 1; private homes, 50; private parties, 14; picnics, 9; church suppers, 8. The likelihood of a food-

borne outbreak being reported is, of course, much greater in a school or industry than in a public restaurant.

An adequate restaurant code, like that available from the United States Public Health Service in Washington, and constant restaurant supervision with respect to sanitary facilities, food storage, and food handling is desirable in every community.

Food Preservation and Refrigeration.—The prevention of bacterial growth by drying or by the use of sugar, salt, or vinegar in high concentration has long been used as a means of food preservation. The commercial canning of food is now done on such a scientific scale that spoilage is very rare. When it does occur, a bulging of the can from gas formation indicates its presence. Home canning is not carried out so scientifically and home-canned foods, especially canned beans, spinach, and corn, should be reheated before consumption because of the danger of botulism.

Progress in the art of refrigeration during recent years has made a great contribution to the variety of the year-around American diet. Refrigeration plants and the transportation of food at low temperatures on trains and airplanes have made perishable foods, like fruit, meat, and fish more widely available. Quick freezing, with temperatures at –25 to –35° F. and holding temperatures at 0 to –10° F., is now carried out commercially and in individual homes. This process of freezing produces small crystals in the cells of the plant or animal tissues so that the cell walls are not ruptured. The result is that these foods appear firmer when thawed out than do foods preserved under slow freezing. Little nutritive value is lost in the cold storage of foods, but they do decompose rapidly when removed from refrigeration and they should therefore be consumed immediately.

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CHAPTER XXV

WATER SUPPLY

The average American city requires about 100 gallons of water a day per inhabitant for domestic and other uses. Water has the property of picking up dirt, and there are many dangers of pollution with human or animal waste.

Water-borne epidemics of typhoid fever, cholera, and diarrhea have been so numerous in the past that people have a very keen appreciation of the danger from polluted water. Although freedom from disease germs is the most important characteristic of good water, there are many uses of water outside the diet and many factors to consider in planning a public water supply.

What Is Good Water?—The characteristics of a good water supply may be enumerated as follows:

1. *It should be free from the germs of infectious disease.*

2. *It should be free from poisonous metals, particularly lead.* It is well known that lead is a cumulative poison which is readily taken up by the body in small quantities, producing serious effects, particularly upon the stomach and the nervous system. "Painter's colic" and "wrist-drop" are typical symptoms of this type of poisoning. The solvent power of water upon lead pipe depends upon its acidity. Swampy or peaty waters are the worst offenders. The use of lead pipe is dangerous.

3. *The water should be of suitable temperature,* certainly less than 80° F. If the water is too warm, it will not be used in sufficient quantity for drinking purposes.

4. *The water should be low in color* to be acceptable. Color is harmless, but a highly colored water will not be generously used. Filtration through sand reduces color.

5. *It should be clear,* i.e., free from suspended matter, like sand or clay. Sedimentation and the use of a coagulant reduces turbidity.

6. *It should be odorless.* The odor of water most frequently comes from small or microscopic plants which grow in the lake or reservoir and are entirely harmless. The odors they produce,



(Ewing Galloway)

The sanitary drinking fountain throws the water at an angle which does not allow it to fall back upon the bubbler.

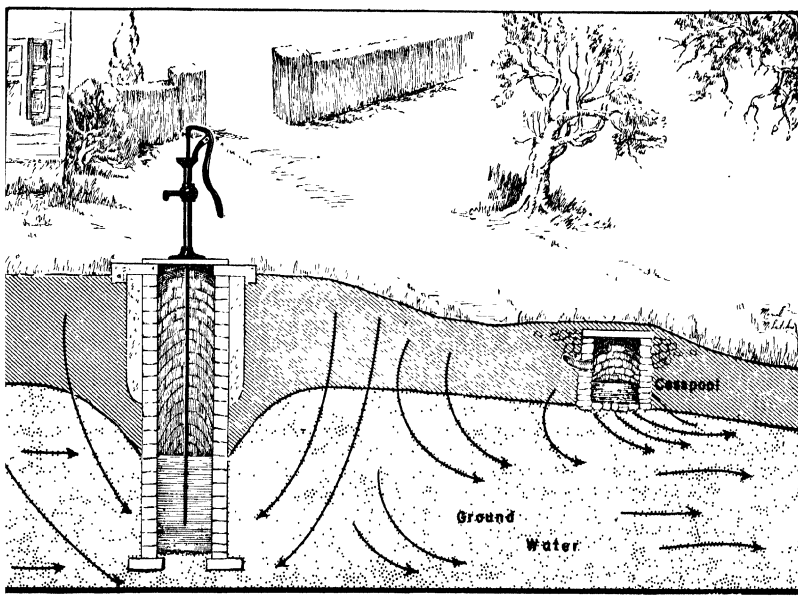
however, are distinctly disagreeable and may make the water offensive. Aeration removes odors.

7. *The water should not be too hard,* since hard water makes laundering particularly difficult. This difficulty is caused by the reaction of the calcium or magnesium salts of hard water in displacing the sodium of soap. Such a reaction forms a precipitate of the salts and enough soap must be added to use up all the calcium and magnesium in the water before any lather is produced. Hard water is, therefore, unpleasant to use on the flesh and is costly for laundering purposes. Added chemicals (lime and sodium carbonate) will precipitate the calcium and magnesium salts and reduce the hardness of water.

8. *It should be practically free from iron.* Iron salts will stain or rust clothes in the laundering process.

Sources of Water Supply.—There are two kinds of water supplies, surface waters and ground waters. We can better appreciate their differences if we follow the history of water after it has fallen as rain. Rain may fall directly into rivers or lakes, or it may reach them by running over the surface of the ground. More often it reaches them by soaking through the soil just beneath the surface, for ground water is always in motion, moving from 0.2 foot to 20 feet per day, toward visible or underground rivers or in the direction of their flow. Water taken directly from rivers and lakes or temporarily stored in reservoirs constitutes a surface water supply.

Surface Water that has washed over the ground and harbors innumerable plants and animals, naturally contains many things besides hydrogen and oxygen; in fact, chemically pure water is difficult to secure even in the laboratory. In nature water that appears very clear to the eye may reveal many things upon chemical and microscopic examination. Water contains dissolved oxygen, used by the fish and other animals in respiration, nitrates and other salts used by plants, carbon dioxide and perhaps ammonia,



Underground water moves slowly toward streams or lakes. Cesspools should be so located that wells will not be contaminated by their drainage. The danger of pollution is less in sand and gravel soil, but these may finally become saturated and permit infection.

marsh gas, and other chemical substances. Microscopic examination reveals particles of dirt, bacteria, minute plants and animals, bits of wood, and fibers of many kinds. If this water passes over polluted ground, filth and disease germs are also collected.

Ground Water is obtained from wells of various depths and may be free from many of these substances, which are caught and held back as the water strains through the soil. Sand or gravel is the

best filter for water, and in passing through 100 feet of sandy soil, water will be purified for a considerable period. However, even this soil will become polluted, and a well 100 feet from a privy or other source of pollution will be endangered. When in place of sand we have a broken formation, as is the case with limestone or some types of ledge, there may be a break having a rivulet by which pollution may reach the well directly.

The difference between surface wells and deep wells is one of character and not one of depth. A *surface well* is one that does not reach through the first impenetrable layer of soil; a *deep well* goes through the impervious layer and furnishes its water from the water table. A deep well may be a quiet well from which the water is pumped, or it may be an artesian well from which the water flows freely. The artesian well is produced by a water pressure beneath the impervious layer of soil which is sufficient to throw water to the surface.

Well water has been used for generations. It is usually clear, cold, and sparkling, and most people share the opinion that well waters are almost always safe. The contrary, however, is frequently the case, especially where polluted surface water can wash in around an imperfect covering to the well or where the soil is heavily polluted. In fact, a clear and sparkling water *may* be more dangerous than the yellow and foul-smelling water of a stagnant pond, for, as we shall see later, water purifies itself by storage. Any student of bacteriology knows that a glass of water may contain thousands of typhoid bacilli without showing the slightest trace of sediment. In China practically all wells are polluted and the people escape intestinal diseases by their tea-drinking habit, that is, they avoid the drinking of water that is not boiled. The water from deep wells is usually more reliable than that from shallow wells, because it has been in the ground longer and has worked its way through the soil for a long distance.

TESTING A WATER SUPPLY

A careful examination is necessary to determine the quality of a water supply. Such an examination includes four factors: (1) a study of the environment, (2) a bacteriologic examination, (3) a microscopic examination, and (4) a chemical examination.

1. **Environment.**—In order to estimate the value of water, the sanitarian must know the nature of the water shed from which it comes; that is, the number of inhabitants in the drainage area, and the nature of the soil and slope of the drainage basin. A laboratory examination of the water at some particular time might be satisfactory; and yet if the water came from a populous district with a clay soil and steep slopes, a heavy rain might wash great quantities of pollution into the stream or lake.

2. **Bacteriologic Study.**—The second step is the bacteriologic examination of a properly secured sample of the water. By plating out the water in gelatin or agar the total number of bacteria may be determined, and by using different temperatures for incubating the Petri dish plates the number of water bacteria can be contrasted with the number that grow well at body temperature.

Tests* are also made to determine the number of colon bacilli in the water. It is not easy to detect typhoid bacilli or other disease germs when they are present, but the colon bacillus, which is a normal inhabitant of the intestines, is easy to discover, and its presence gives a good indication of the pollution or purity of the water in question. Of the various bacteriologic tests that are made, the total bacteria count and the presumptive test for colon bacilli are the most important.

3. **Physical Tests.**—The physical tests made on water include an examination for odor, temperature, color, and turbidity.

The *color* is expressed in parts per million and is determined by comparing the water with a platinum-cobalt standard. True color is produced by substances in solution, many of which come from vegetable tissues soaking in the water.

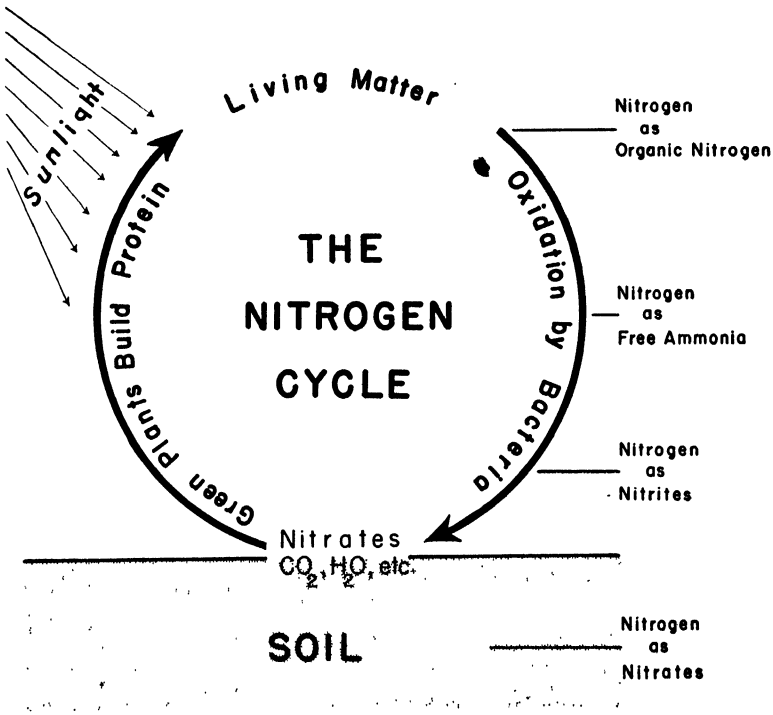
The *turbidity* is likewise expressed in parts per million and is usually determined by comparing the water with a standard suspension of silica. It is produced by finely divided suspended matter like clay, silt, and microscopic organisms.

The *odors* are described as fishy, vegetable, aromatic, grassy, earthy, moldy, musty, disagreeable, peaty, or sweetish. They are caused by decomposing organisms, fermenting material, or such gases as hydrogen-sulfide and methane. Many tiny green plants, particularly the diatoms, have very distinctive odors.

*Laboratory directions for making a complete water analysis may be found in *Standard Methods of Water Analysis*, published by the American Public Health Association.

It will be seen from the foregoing discussion that the physical examination of water tells much about its condition but little about its sanitary quality.

4. **Chemical Tests.**—The most important chemical tests from the point of view of sanitation are the tests for nitrogen in its various forms and the test for chlorine. The nitrogen tests give us an index of the quantity, the nature, and the freshness of pollution



The nitrogen cycle.

by nitrogenous waste material. The test for chlorine is a valuable indicator of pollution, for in soils free from salt deposits the only source of chlorine, except for salt mists brought in from the ocean, is the sodium chloride waste of the body.

Nitrogen and the Nitrogen Cycle.—To understand the meaning of the nitrogen tests we must recall for a moment the story of the nitrogen cycle. We find this important element going through an

endless chain of changes. Inorganic nitrogen is taken up by plants in its simple inorganic condition and transformed into plant protein from which, in turn, it is transformed into animal protein by herbivorous animals. When these complex proteins from living animals are left exposed in the air or in water, they return to their simple condition by a series of definite oxidation processes. In this series of changes the nitrogen is found consecutively in complex proteins, albuminoid substances, ammonium salts, nitrites, and nitrates. A species of bacterium carries out each of the last two steps. Ammonium compounds are acted upon by Nitrosomonas and oxidized to nitrites. Nitrites are oxidized by Nitrobacter to nitrates. In a chemical analysis of water we can determine the amount of nitrogen in these various compounds.

The test for *nitrites* is particularly valuable because the test itself is sensitive and because nitrogen passes through the nitrite stage quickly. The analysis will readily determine the presence of 0.01 part of nitrites per million. Even this small quantity shows clearly that organic substances are being broken up in the water. This is an indication of fresh pollution, for if the pollution were remote, the nitrogen would be found in some of its more stable compounds.

The test for *free ammonia* determines the amount of nitrogen present in the water as ammonium salts that are readily driven off on the direct distillation of slightly alkaline water. A large amount of free ammonia also indicates pollution, although it may be remote.

The test for *albuminoid ammonia* measures the amount of ammonia set free from nitrogenous organic matter by the action of boiling alkaline potassium permanganate. This is a good index of the amount of easily decomposable organic matter in the water. It may come from plant substances or from animal wastes, but when it is from a vegetable source, the water is usually colored and the nitrogenous material is more stable. It follows, therefore, that a colorless water should contain less albuminoid ammonia than the yellow waters of natural storage reservoirs.

Nitrogen in the form of *nitrates* is the final product of the process of oxidation or mineralization. Nitrates are the stable compounds used as food by plants in building up the nitrogen to the organic form. A high concentration of nitrates indicates that

a great quantity of nitrogen has gone through the mineralizing process; a high figure thus indicates pollution even though it be remote. Good ground water may contain more nitrates than surface water because the nitrates of ground water are not used by growing plants.

By a continued study of water supplies of various sorts a set of *standards* or limits can be set as to the amount of these various substances a good water may contain, although in every case, the final interpretation of the chemical analysis should be made by an expert. In general, safe water should not contain more of these substances than is indicated in the following table:

NITROGEN LIMITS IN A SAFE WATER SUPPLY

Expressed in Parts Per Million

Nitrogen as albuminoid ammonia, colorless water, 0.15; colored water, 0.4
Nitrogen as free ammonia 0.15
Nitrogen as nitrites 0.01
Nitrogen as nitrates, surface water, 1.0; ground water, 2.0

Chlorine.—Chlorides occur mostly as the sodium salt, and its concentration is usually expressed in terms of chlorine. As previously stated, waters coming from soils free from salt deposits receive chlorine from only two sources: salt mists blown in from the ocean and animal wastes, principally urine. (Human urine contains about 1 per cent sodium chloride.) It therefore follows that unpolluted waters near the ocean contain more chlorine than waters some distance from the coast. By analyzing many samples of waters of known purity in various parts of a coast state, the normal amount of chlorine for each particular district can be determined, and if a suspected water contains more than the "normal" amount of chlorine, it may be justly concluded that the excess amount has been derived from pollution. It will be seen that it is not the number of parts per million of chlorine but the relationship of the amount of chlorine to the "normal" which is taken into consideration in interpreting this chemical test. (This discussion of chlorine from chlorides bears no relationship to the use of chlorine gas to kill bacteria in water.)

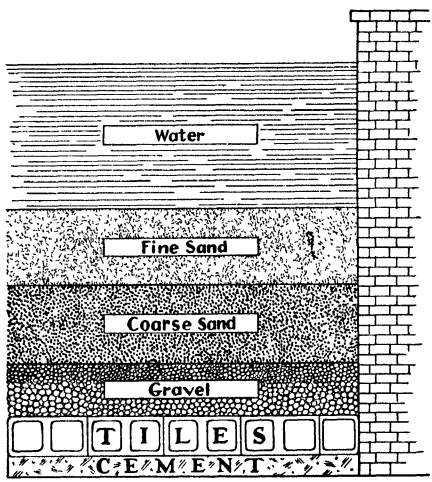
5. Microscopic Analysis.—We have seen that disagreeable tastes and odors commonly arise from the presence of microscopic plants in water. Their presence can be detected by straining some of

the water through sand and then washing the microscopic organisms from the sand and examining the wash water under the microscope. Treating the water supply with copper sulfate kills the objectionable plants and prevents the disagreeable tastes and odors.

By the above-mentioned tests the sanitary and aesthetic quality of a drinking water supply can be accurately determined, and by special tests for hardness and iron, its fitness for industrial purposes can be estimated. It is hardly necessary to repeat that the quality of a drinking water cannot be determined by its appearance to the naked eye.

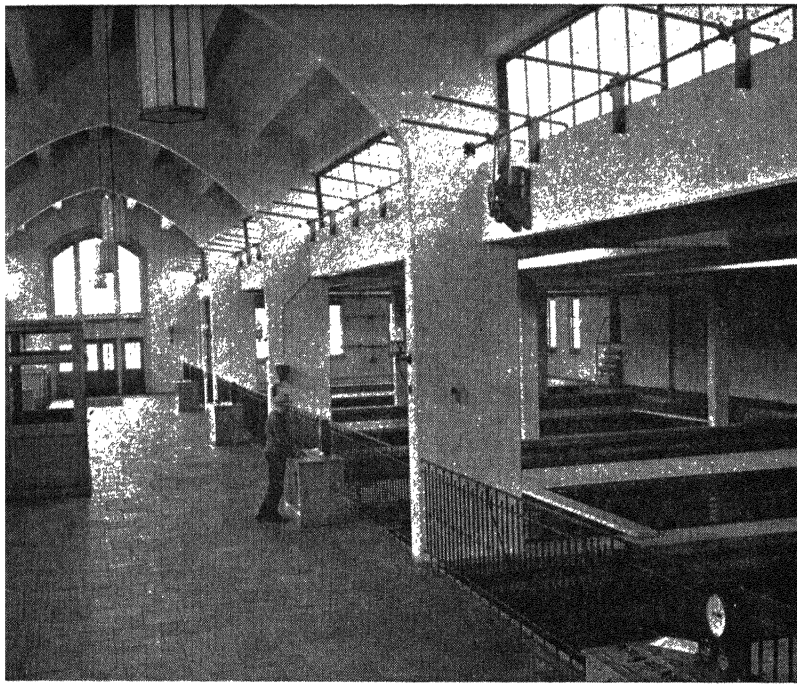
WATER PURIFICATION

It frequently happens that safe water supplies are not available and some method of purifying the water must be adopted. There are three important methods in general use: (1) Storage, (2) Filtration, and (3) Chlorination.



Section through a slow sand filter. The water soaks through the fine sand, the coarse sand, and the gravel, entering the open tiles which carry it to a collecting basin.

Storage.—Storage is the natural way of purifying water. It is the method utilized by man in securing water from lakes and reservoirs. Bacteria and other particles settle to the bottom of



Interior of rapid sand filter. You will see water standing in the filter at the right.

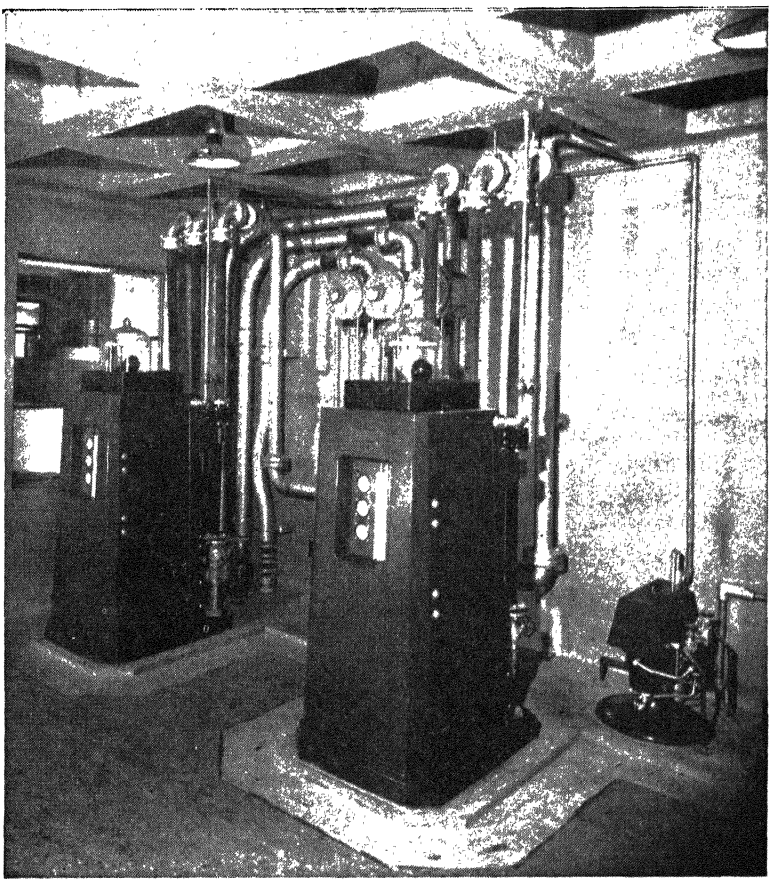
standing water and the bacteria themselves die of starvation or are devoured by other organisms.

The self-purification of rivers and lakes is largely a biologic process. Bacteria break down the organic substances of pollution, and are themselves used as food by protozoa. The protozoans in turn are devoured by small crustacea and other higher animals, which are suitable food for fish. Microscopic green plants use nitrates and, in daylight, take carbon dioxide and throw off oxygen. Still water purifies itself much more rapidly than running water, because in the latter case the plants and animals which assist in purification processes are swept away while in still water they accumulate in enormous numbers.

The storage of water is inexpensive except where there may be a high cost for reservoir construction. Experiments indicate that

all the disease germs usually die in water that has been stored for a month at summer temperatures. The germs live longer in water at low temperatures and may remain alive frozen in ice for many weeks.

Filtration.—There are two types of filtration for drinking water, slow sand filtration and rapid sand filtration. In the construction of a *slow sand filter* a concrete floor is first laid down and drains with open joints are laid upon it, the joints being covered with small rocks. Then the whole filter bottom is covered with gravel



Two master automatic chlorinators. (Courtesy Wallace & Tiernan Co., Inc.)

to a depth of several inches and on top of the gravel is placed a layer of sand about 3 feet in depth. In cold climates the whole structure is placed low in the ground and roofed over with a concrete roof that is covered with soil. This precaution is necessary to prevent the surface from freezing during the winter months.

A filter such as the one at Washington, D. C., consists of large units of about one acre each in area. The water is run onto the sand to a depth of 3 or 4 feet, filtering rapidly. One acre of filter surface is capable of filtering from 3 to 5 million gallons of water per day. This process removes 99 per cent of the bacteria and suspended particles and reduces the color 30 per cent. A description of the biologic principles of the slow sand filtration is included in the chapter on Waste Disposal.

The *rapid sand filter* or "mechanical filter," or "American filter" as it is sometimes called, is designed to accomplish the purification process with much less sand area. In this process a coagulant is first added to the water to produce a chemical precipitate. The substances commonly used are lime and alum which react to produce aluminum hydroxide. These chemicals are thoroughly mixed with the water and then sent to a storage tank, where the precipitate settles to the bottom carrying down most of the bacteria and dirt suspended in the water.

From the top of this tank the water is drawn off to the filter, which in principle of construction is similar to the slow sand filter except that it is much smaller in area and is enclosed in a concrete bin. This filter is also supplied with devices which make it possible to wash the surface of the sand by forcing water back up through the filter. This washing process must be carried out frequently, since the coagulant collects on the top of the sand and clogs the filter. The bacterial efficiency is about 98 or 99 per cent, and it operates at the rate of 125 million gallons of water per acre per day.

Household filters (Berkefeld and others) are purchasable; but they are slow and require careful operation, as well as frequent cleaning. They are not highly recommended.

Chlorination.—This is the third important method of purifying water. Chlorine is added in the form of gas liberated from tubes of liquid chlorine. Various chlorinating devices are on the market. Sufficient chlorine must be added to kill the nonspore-bearing

bacteria, and care must be taken to avoid adding so much as to give a disagreeable taste to the water. The amount necessary to disinfect a water depends upon the amount of organic matter present.

Emergency Treatment of Drinking Water.—Occasionally the traveler or camper must use drinking water of doubtful purity. The simplest and safest expedient for killing infectious bacteria is to boil the water for five minutes. Many people dislike the taste of boiled water, especially if it cannot be made cold after boiling. The flat taste is mainly due to the expulsion of the dissolved gases. Shaking the water to get some air into it will improve the taste. The boiled water may be used in making tea or some other hot beverage with a distinctive flavor.

Sometimes the traveler, hunter, or soldier must partake of water that is likely to be impure where there is no opportunity to boil it. There are special chlorine-containing tablets on the market for use in disinfecting small quantities of water. The same disinfection may be obtained by using two drops of tincture of iodine to a quart of water. Mix well and allow the water to stand for thirty minutes before using.

There is no method for disinfecting small quantities of water which is as simple, safe, and sure an expedient as boiling.

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CHAPTER XXVI

WASTE DISPOSAL

Fundamental facts and important principles involved in the disposal of sewage and garbage will be discussed in this chapter. No attempt is made to present the engineering aspects of the subject. Rural and residential problems are discussed, for those who are not sanitary engineers may need to know the methods applicable at a camp, a cottage, or an institution in which they may be interested.

SEWAGE DISPOSAL

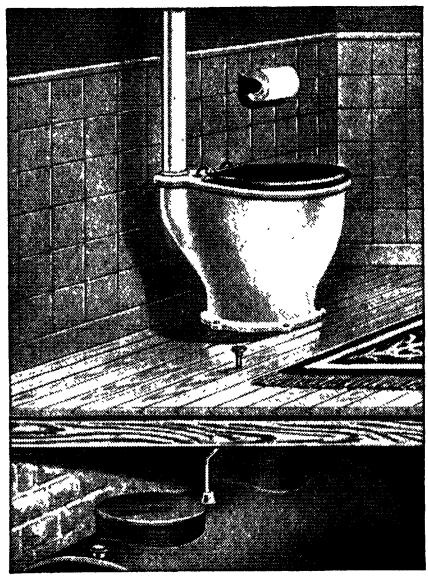
Sewage is the material discharged into the sewers of a city or community and should not be confused with the word sewerage which pertains to the sewer pipes. Sewage is the waste material and sewerage the piping system which carries the sewage.

Efficient design and installation of the sewerage system and efficient plumbing in buildings are both important. Many epidemics have been traced to "cross connections." In some cases faulty plumbing has resulted in back pressure, or back siphonage, within a building and has forced sewerage or waste water into the water supply. In other cases water from an auxiliary emergency supply of polluted water intended for use only in fighting fire has leaked into the water supply through a faulty cross-connection valve.

Our consideration will be directed mainly to domestic or household sewage, which consists chiefly of excreta mixed with the sink wastes, and other waste waters leaving the house. It has a high content of waste protein, with some carbohydrate and a small amount of fat. In city sewage there are also street washings and industrial wastes.

In a previous chapter we have seen that lack of care in disposing of sewage from houses where there are cases of intestinal disease may result in serious epidemics. Innumerable organisms of such intestinal diseases as typhoid, cholera, dysentery, and

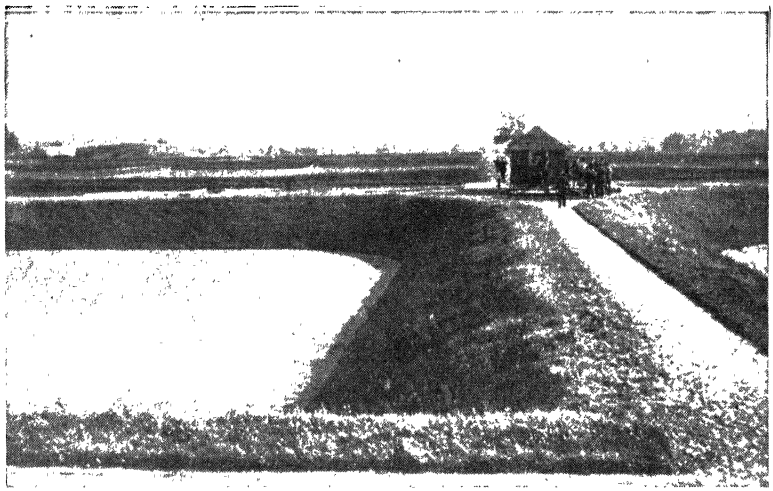
paratyphoid are discharged in the feces of the patient and may remain alive for many days, and even weeks. Whenever drinking water, milk, or food becomes contaminated by the discharges from these patients, there is a possibility of spreading the disease. Thus the first and most important problem in sewage disposal is to take such care of excreta that there will be no opportunity for spreading infection. We must also take care of sewage in such a way that it will not produce a nuisance in the community.



Chemical closet. (Courtesy Dail Steel Products Company.)

Direct Disposal.—Sewage may be disposed of either directly or by purification. In cities located on the seashore or on great rivers and lakes, disposal by dilution or the direct discharge of sewage into a large body of water is possible. A stream can purify about one-fiftieth of its own volume of raw sewage. In the woods or on farms excreta may be covered with soil; but in very large cities and in areas where all the streams are used as drinking water supplies, some other method of purification must be employed.

Chemical Purification.—Artificial methods of sewage disposal involve either chemical or bacteriologic purification. In chemical



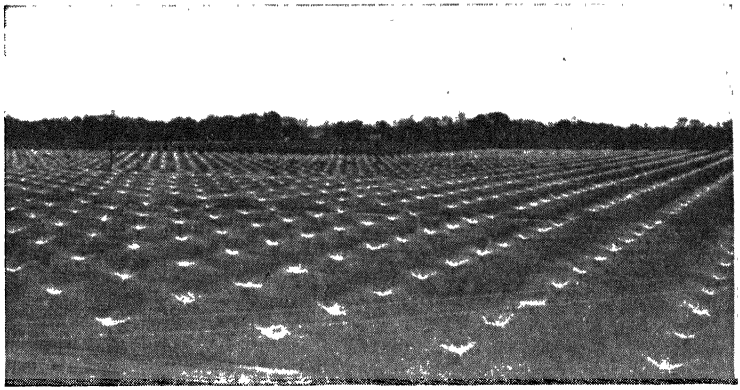
Gate house and intermittent sand filter for sewage filtration. (Courtesy R. S. Weston.)

purification some chemical like chlorine or a strong alkali or acid is added to the sewage to disinfect it. The only process of chemical purification of importance to the readers of a general text is the use of the chemical closet in isolated homes or in camps.

The chemical closet may be located inside the house or in a separate building. It consists of a jar or an iron tank placed under a toilet seat and containing a strong solution of caustic soda which disinfects and partly dissolves the excreta that reach the liquid. These closets are practically free from odor. They are made extensively in this country and may be obtained either as a single unit, consisting of a single seat, or as a large unit with several seats over the tank. Such installations are now used in many boys' camps and in hunting camps.

Bacteriologic Purification.—There are two widely different processes for the bacteriologic purification of sewage, the aerobic and the anaerobic. It is the presence or absence of free oxygen that determines which of these processes will take place.

Aerobic Processes.—Mention has been made of the biologic principles of aerobic purification in reference to the nitrogen cycle and the discussion of the chemical water analysis. When



Sprinkling or trickling filter. (Courtesy R. S. Weston.)

enough oxygen is supplied to sewage, as it is being broken down by the bacteria contained within it, much of the nitrogen is converted into nitrates through the various descending steps of the nitrogen cycle. Carbon dioxide is also produced in large quantities. When the process is completed, the solid residue of the sewage (sludge) has somewhat the consistency of humus soil. Practical applications of this principle are found in intermittent sand filtration, rock filters, and aeration.

1. *Intermittent Sand Filtration.*—Sand beds as they are now constructed are usually about one acre in area and from 4 to 5 feet deep. In making such a bed, underdrains of tile with open joints are first laid. The joints are protected with rocks and gravel to prevent the drain from becoming clogged. Then coarse sand is placed over the drain to a depth of 2 or 3 feet and fine sand is used for making the top of the filter. The bed is flooded with sewage to a depth of a few inches and then permitted to dry. A "breathing space" of several hours is allowed before the next dose of sewage is put on the bed.

The reason for this intermittent method of dosing the sand bed becomes apparent upon a consideration of the biologic principles involved. It is found that, as the bed is used, the sand grains near the surface become coated with a gelatinous growth of the oxidizing bacteria which purify the sewage. This gelatinous coating of the sand grains makes the filter more tight, and as the coating

becomes heavier with increased numbers of bacteria, the efficiency of the filter rapidly increases. These are aerobic or oxygen-breathing bacteria, and it is therefore necessary to let the filter rest or "breathe" long enough for oxygen to penetrate into the bed between intervals when it is flooded with sewage.

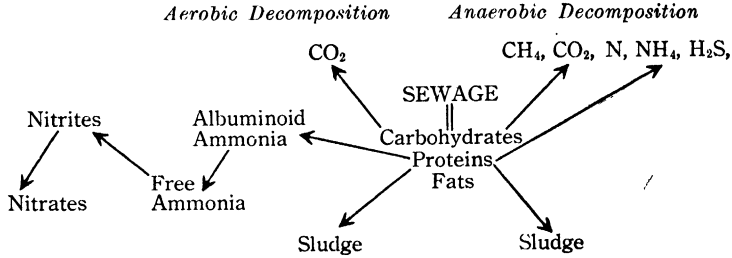
A good intermittent sand filter will remove 99 per cent of the bacteria of sewage and effect a very high degree of purification. In fact, the effluent from such a filter is almost a "drinking water" effluent. A filter bed one acre in area will treat from fifty thousand to one hundred thousand gallons of sewage per day. In other words, one acre of filter will provide sewage treatment facilities for about six hundred people.

2. *Sprinkling Filters.*—Sprinkling or percolating filters treat sewage much more rapidly than intermittent sand filters. They make use of the same biologic principle of aerobic bacterial action, but the purification which such filters effect is not as complete as that in the sand filter. They are from 6 to 8 feet deep and are composed of broken stone, coal or coke, with an effective size of from 1 to 3 inches. This broken stone is placed upon a concrete floor that is properly drained. The sewage is forced onto the bed through sprinkler nozzles that spray the sewage into the air in much the same way that water is thrown into the air by a lawn sprayer. This allows the sewage to accumulate oxygen from the air and remain continuously in contact with the air as it trickles over the rocks of the porous filter.

Sprinkling filters if properly constructed and operated may be depended upon to remove from 70 to 90 per cent of the bacteria and to produce a nonputrescible liquid effluent. This effluent, however, contains suspended solids which easily settle out. The average rate of filtration in American filters of this type is about two million gallons per acre per day.

3. *Aeration.*—A more recent development in the treatment of sewage by the aerobic process involves bubbling air through the sewage as it passes through a deep tank. A few inches above the real bottom of such a tank there is a false bottom, which contains many square plates of porous tile. Air is pumped into the space between the two floors and is forced through the porous plates in fine bubbles which make their way through the sewage

BACTERIAL ACTION IN THE AEROBIC AND ANAEROBIC PROCESSES



to the top of the tank. By continually forcing air through the sewage, the small particles of sludge soon become "activated" by the accumulation of mineralizing bacteria so that the rate of nitrate formation becomes exceedingly rapid. The process removes from 80 to 90 per cent of the bacteria, forms an effluent of high quality, and leaves a nonputrescible sludge of good fertilizer value.

Anaerobic Processes.—The anaerobic decomposition of sewage, which takes place whenever sewage is stored in large tanks, is a very different process. Under these conditions the available oxygen is soon used up by the aerobic or free-oxygen-breathing bacteria. Such bacteria soon die for want of oxygen, and there remain only the anaerobic bacteria: those which are able to wrest their oxygen from the organic compounds undergoing septic action. Nitrogen gas, ammonia, hydrogen sulfide, carbon dioxide and marsh gas are produced. This process results in the reduction of the quantity of solids but leaves a residue or sludge which is tarry in consistency and appearance and is further putrescible. The accompanying diagram contrasts the anaerobic and aerobic processes.

1. *The Cesspool.*—A familiar example of the anaerobic purification of sewage is the leaching cesspool which is usually built like a well with sides of large stones between which the water may pass into the surrounding soil. The sewage solids accumulate at the bottom of this tank and are greatly reduced in volume by the septic action of bacteria.

2. *The Septic Tank.*—Sometimes a tank with tight cement walls is used instead of the leaching cesspool, and there is an even better opportunity for anaerobic action to take place. Here as in the old style cesspool, the quantity of solids is greatly reduced, but residue must be occasionally removed. The liquid is drawn off

from near the top of the tank to be further purified or discharged into a body of water.

3. *The Two-Story Tank.*—The most important type of two-story tank is the Imhoff tank. The sewage flows slowly through the upper chamber, and the solids settle to the bottom, passing through the narrow slot into the lower or sludge digestion chamber. It is in the lower chamber that the septic process takes place, and there

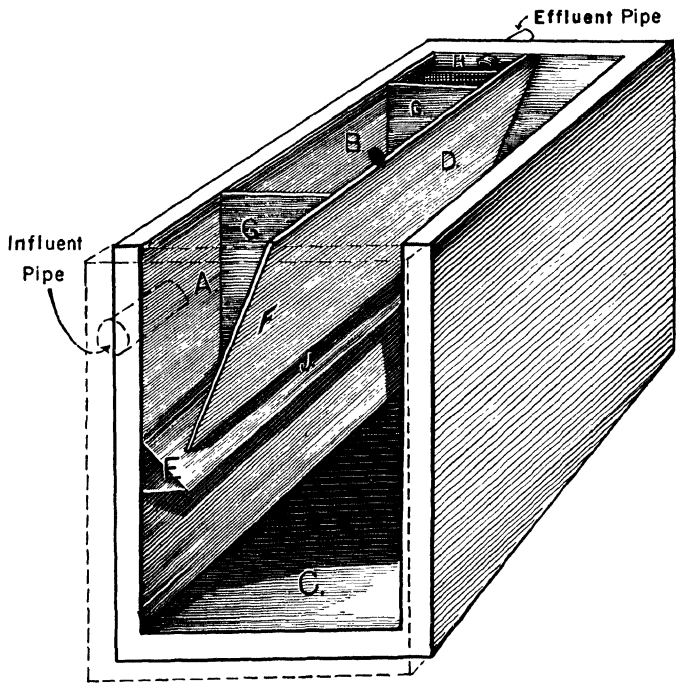
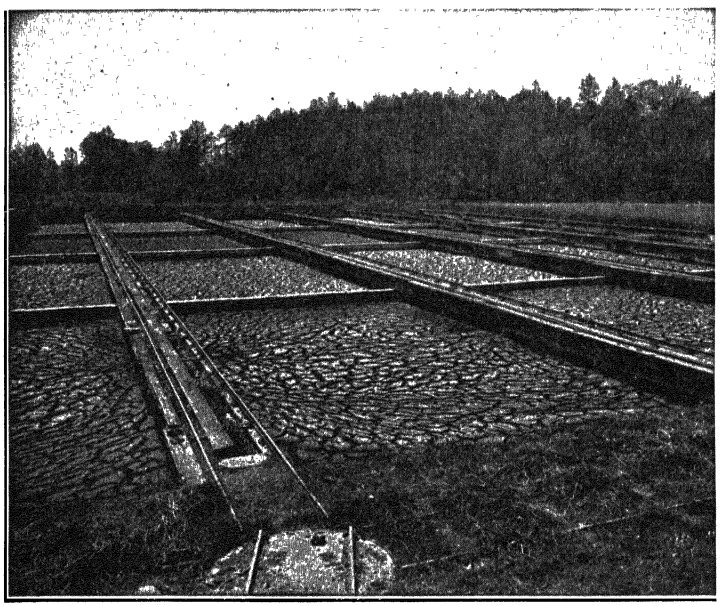


Diagram illustrating the principle of the Imhoff tank. The water flows through the upper chambers of the tank, *A* and *B*, the flow being reduced by the baffles, *G;* the upper chamber is separated from the lower or sludge digestion chamber, *C*, by the partition, *F.;* the solids settle out through the slot, *J*, and the gases escape to the right, *D*, being separated from the fresh sewage. *E* is a baffle, *H* is a screen.

is an advantage over the single-story tank in that the gases produced are prevented from passing through the fresh sewage. The result is that the effluent of such a tank has been freed from solids without losing its dissolved oxygen, and it is therefore more easily purified further by filtration or dilution. The sludge digests for

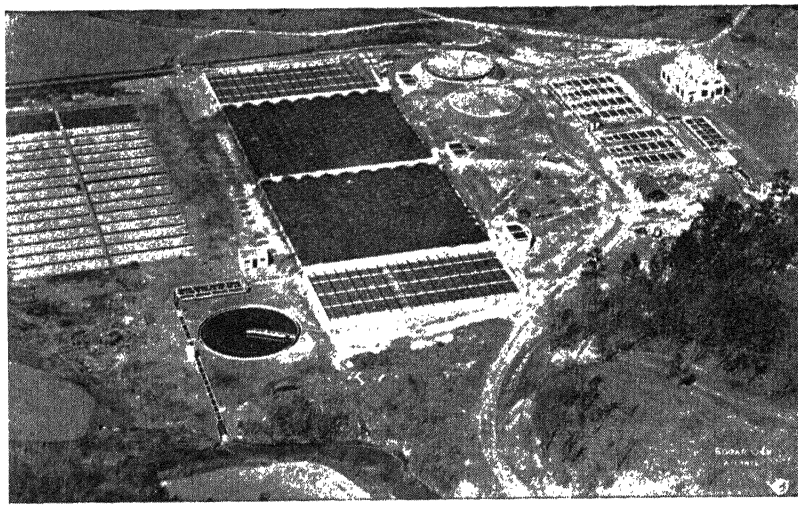
several weeks in the lower chamber and is finally pumped out and allowed to dry, after which it is disposed of on waste or agricultural land.

Final Disinfection.—Chlorine disinfection is frequently used in municipal plants, discharging the effluent into a running stream. The reason for this is that there can be no absolute certainty that the various processes of sewage disposal will eliminate all disease bacteria. In some cases calcium hyperchloride is used as a disinfectant. Where there is a separate sewage disposal installation for institutions, such as hospitals, continuous disinfection of the effluent is commonly recommended by sanitary engineers.



Dried Imhoff tank sludge, Atlanta, Ga. (From Fitzgerald: *Practice of Preventive Medicine*, The C. V. Mosby Co.)

Possibilities and Limitations of Sewage Purification.—In actual practice two or more purification processes may be used jointly, and other devices, like grit chambers to remove the sand, and fine or coarse screens to remove part of the solids, may be added. The sewage of a city might pass successively through screens, septic tanks, and a trickling filter, after which the effluent might be dis-



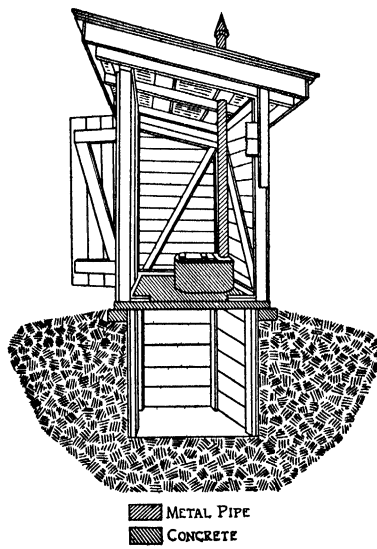
Intrenchment Creek sewage disposal plant, Atlanta, Ga. The sewage enters at the extreme right of the picture passing through a mechanically cleaned screen and then through a grit chamber where gravel and sand settle out. The sewage then goes to the aerator where its oxygen content is increased, after which it goes to a clarifier. In the clarifier the solids settle out from the liquid to form a sludge which is sent to the sludge digestor, thence to the drying bed (left center) from which it is removed by truck. The liquids from the clarifier go to dosing tanks from which they are sent to the fixed nozzle sprinkler filter beds in the middle of the picture. From the sprinkling filters the liquids go to an aerator and then to a secondary clarifier from which they go to the stream in the foreground. The sludge from the secondary clarifier is pumped back into the primary aerator. (Courtesy Department of Construction, City of Atlanta. Photo by Edgar Orr, Atlanta.)

infected with chlorine before being allowed to flow into a lake or stream. The sanitary engineer must propose a treatment in each case which is adapted to the sewage itself and to the condition and location of the city.

A good example of purification may be found in the city of Brockton, Mass. Brockton is an inland city of approximately 65,000 population. It is not located on or near any large lake or river. The sewage is purified by sprinkling filters and then by slow sand filtration, after which the effluent is carried into a small brook. The average daily flow of this brook in summer is only a half million gallons a day, but so completely is the sewage purified that two million gallons of sewage effluent are received daily by the little brook without producing a nuisance. Moreover,

studies upon the self-purification of this stream show that the final processes of purification are carried out so swiftly that two miles below the point where the sewage effluent enters, the stream has regained its normal appearance.

It is possible to purify sewage and discharge the effluent into a stream that is to be used again soon as a city water supply, provided the second city adopts proper methods of purification for its drinking water. If such a process of purification is necessary, it is better to have sand filters between the sewage and the water supply than to rely upon other methods of purification or disinfection.



Pit toilet. (Designed by the Texas State Department of Health.)

Rural Sanitation.—The city has a municipal water supply and a sewage disposal system, both of which are under the supervision of expert sanitary engineers. In the country each family has its own source of water and its own method of waste disposal.

The disposal of human excreta must be so safeguarded that water and ice supplies will be protected from pollution. Milk, small fruits, and vegetables must be protected from contamination. Flies, vermin, and domestic animals are capable of spreading infectious material, and must be kept away from all excrement.

The three most practicable methods of *dry* disposal are the pit privy, the receptacle privy, and the chemical closet. *Wet* disposal methods include the cesspool, the septic tank, the Imhoff tank, and subsurface irrigation.

The pit privy is the simplest arrangement that meets the requirements of sanitation and privacy. It may be used on farms, at camps or hunting lodges, or on engineering construction jobs if they are remote from the water supply sources. Particular care must be taken to prevent the access of flies, rodents, hens, and pigs.

The essential elements of a proper pit privy include a pit of proper depth and capacity and a tight superstructure so designed as to prevent the passage of flies to or from the pit. The privy house should have a floor above the ground level, a door, lids that close automatically when not in use, and durable screens over all openings. Waste, other than excreta, should be excluded from the pit or vault.

The shallow temporary pit latrine may be used by troops on the march or by temporary construction gangs where there is not ample time to build a privy house over the pit. It is kept dry with dry earth or is sprayed with a coal-tar preparation to keep away flies and rodents, and once a day crude oil and straw are burned in it. When no longer used, it is filled in with earth.

The bored-hole latrine is used in many tropical countries. It is a deep hole about 16 inches in diameter and about 20 feet deep. It is made with a posthole auger and reaches down to the groundwater level.

The receptacle privy has a can, pail, box, or tray substituted for the pit or vault. The receptacle usually has a capacity of about two cubic feet. It must be removed frequently and replaced by a clean receptacle having an inch or more of sawdust or dry earth on the bottom. It should be kept dry by the daily addition of dry earth or sawdust. It may be handled from inside or from the rear of the privy house. The privy should be fly-tight.

The chemical closet has already been discussed.

The cesspool, which has already been described, is probably the most common device for wet disposal. The *septic tank* is simple to use and is always preferred where there is any danger of infecting a water supply, as by seepage from a leaky cesspool. The

more elaborate construction of the *Imhoff tank* is sometimes found in larger institutions, such as schools, hospitals, or hotels, which are not accessible to a sewerage system. The use of specially designed septic tanks or Imhoff tanks of suitable size for a single dwelling is being urged by many state departments of health. *Trickling filters* or *sand filters* are sometimes installed for large houses or institutions, but they require the services of an expert in design and regular supervision in operation.

Subsurface irrigation is also employed in sewage disposal. The effluent from a septic tank flows into lines of open-jointed tiles laid from 8 to 15 inches below the surface of the soil. This is a good method to employ, provided the soil is relatively dry sand or gravel. The sewage has an appreciable storage time in the tank, then the liquid passes over into the dosing chamber from which it is discharged into the tile, soaking into the ground through the open joints. It is delivered intermittently from three to six times a day by a siphon. The tile is usually 3 or 4 inches in diameter. It is laid with a gradient of from 2 to 6 inches per hundred feet, and its open joints are covered with tarred paper. During times of storm the soil is so completely saturated with water that ready disposal is difficult.

Excellent pamphlets dealing with rural sanitation may be secured from state health departments.

Disposal of Garbage.—Kitchen waste should be collected in metal cans having tight covers, and should be kept free from ashes and other material. The can should be emptied often and scrubbed with hot water and soap. Its care will be greatly facilitated if it is kept lined with several thicknesses of old newspapers. While small amounts of garbage may be easily burned in the kitchen range, there is risk of odor. Electrically operated garbage disposal units are now installed in the modern sink to chop or grind the garbage and flush it into the waste pipe. Garbage may be buried in the soil.

An economical method for the disposal of garbage by the farmer or in small towns is to feed it to hogs. Before it is fed, however, the garbage should be cooked to prevent the spread of trichinosis and hog cholera.



(Keystone)

Modern sanitary truck of New York City Sanitation Department.

Some large cities incinerate garbage along with rubbish. Another process involves the cooking of garbage with a grease solvent. The cooking process separates an appreciable amount of grease which is later recovered by evaporation of the solvent. The grease is sold as a basis for the manufacture of low-grade soap. The tankage or material left in the tank at the end of the cooking process has value as a fertilizer base. The proceeds from these products return an appreciable part of the cost of operating the disposal plant.

Disposal of Manure.—The chief sanitary difficulty involved in maintaining a barn or stable is that cow and horse manures offer favorite breeding places for the common housefly. It takes about ten days for the larvae to develop. The manure must be disposed of within that period or definite steps must be taken to destroy the larvae.

Fly breeding may be prevented by the application of about one pound of borax to 16 cu. ft. of manure. This is the best larvicide to use if the manure is to be used later for fertilizer. Very satisfactory results may be obtained by sprinkling the manure with a solution of two pounds of copperas to a gallon of water, or with a solution of hellebore mixed in the proportion of one pound to twenty gallons of water and applied at the rate of a gallon of the solution to each cubic foot of manure. Fly breeding may be prevented to a considerable extent by battening down the exposed surface of the manure with a spade. Many larvae are then destroyed by the heat generated below the surface during the process of decomposition.

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CHAPTER XXVII

VENTILATION, HEATING, AND LIGHTING

The ventilation, heating, and lighting of a man's place of work and his home directly affect his health and the health and comfort of his family. Everyone at some time or other has felt the oppressiveness of the air upon entering a poorly ventilated room. We are sensitive to certain changes of temperature and barometric conditions. We notice the unusually fatiguing effect of a day's work in a room where the ventilation is poor, and we have high regard for the stimulating effect of outdoor air at the seaside or in the mountains during the summer. Everyone knows that there is a difference between good air and bad, but too few people know what constitutes that difference and still fewer people have the energy and courage to insist upon suitable ventilation in office, home, or public buildings.

GOOD AIR DEFINED

Physiologic experiments have shown that, contrary to the former belief, it is the physical and not the chemical character of the air which determines its quality. A comparison of the oxygen and carbon dioxide contents of outdoor air, exhaled air, and the air of poorly ventilated rooms shows the reasonableness of the discovery.

OXYGEN AND CARBON DIOXIDE CONTENT OF DIFFERENT KINDS OF AIR

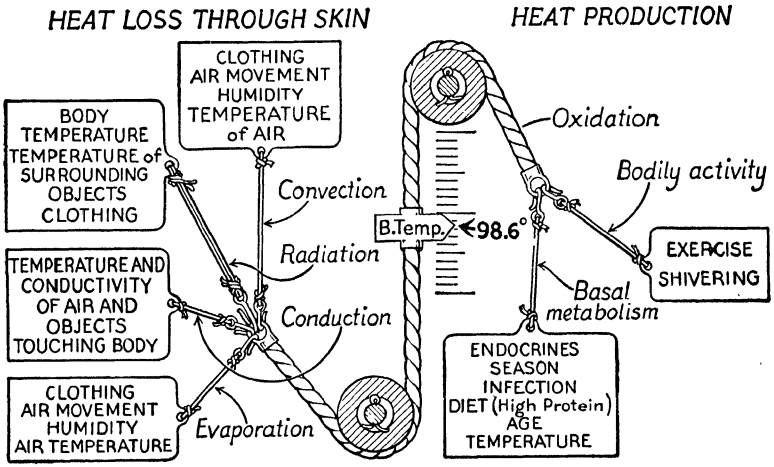
Expressed in Per Cent

	OXYGEN	CARBON DIOXIDE
Composition of pure air	21	0.04
Air in the lungs	16	5.00
Air in the worst ventilated rooms	19	0.40
Composition of air that chemically produces physiologic injury	14	3.00

We decide the quality of ventilation chiefly by the physical effect of the air upon the skin in raising or lowering body temperature. It is easy to forget that the skin is a sense organ, for

unless we are either chilled or perspiring other more important stimuli crowd out these minor sensations.

The movement of air against the body produces definite sensations, as it is easy to demonstrate. Step from the breezy porch of a summer cottage into a room with the doors and windows closed so that there is no movement of the air. Sit for a few minutes quietly and then return to the porch and see whether the breezes do not have a pleasing and stimulating effect. The deadening effect inside the room was due to the fact that the air immediately surrounding the body, *the aerial blanket,* was not being rapidly changed. There was very slight movement of air in the room, and the clothes held the air blanket closely around the body.



Body temperature is kept constant through a balance between heat production and heat loss. This diagram shows the changing factors in heat production and in heat loss through the skin. Body heat is also lost, to a slight extent, through the breath, the excreta, and the warming of cold foods and beverages taken into the stomach.

If we go out from a warm room in winter weather, we notice a definite and marked reaction of the skin. Similar but lesser reactions are continually taking place in adjusting the body to the changing condition of air, and no doubt the body receives an important stimulation from this gentle playing upon the nervous system by the changing air.

These considerations are in harmony with the results of experiments conducted by the New York Ventilating Commission and by other investigators. For example, a man is put in a closed box where the air is hot and moist. A feeling of discomfort soon develops which cannot be relieved by feeding the man air from the outside by means of a tube passed through the wall of the box. Discomfort is relieved by turning on an electric fan inside the box, even when the subject breathes the air from within which has been vitiated by continuous breathing. On the other hand, a man sitting outside the box in air of proper temperature and humidity is not injuriously affected by breathing through a tube which supplies him with air from within, even though it is vitiated, hot, and moist. The effect is on the skin, not on the lungs.

Temperature.—The living body is constantly producing heat through the oxidation of digested food. There is a continual loss of heat. Some heat is lost with the breath. A little is lost in warming cold beverages and foods that are taken into the body. A small amount is lost in the discharge of excreta, but most of the heat is lost through the skin.

At ordinary room temperatures heat loss from the skin takes place largely through *radiation,* i.e., the heat radiates from the warm body to the walls, furniture, and other cool objects. The skin loses some heat through *convection* (the warmed layer of air rises and is replaced by cooler air next to the body). We lose some heat directly by *conduction* to the cold objects we touch. The air takes heat from the body by conduction. When one is too warm, there is a great loss of heat by the *evaporation* of moisture from the surface of the body.

At a room temperature of approximately 68° F. the loss of heat by an inactive person balances the normal production of heat without much tax upon the heat-regulating mechanism. Should the temperature of the room rise above this point, the body must lose heat extensively by the evaporation of perspiration if the balance between heat production and heat loss is to be maintained. If the temperature falls below 60°, such a chilliness is felt that the person begins to move about, if he is free to do so, thereby increasing the amount of heat produced through the increased oxidation resulting from muscular exercise. If the individual is

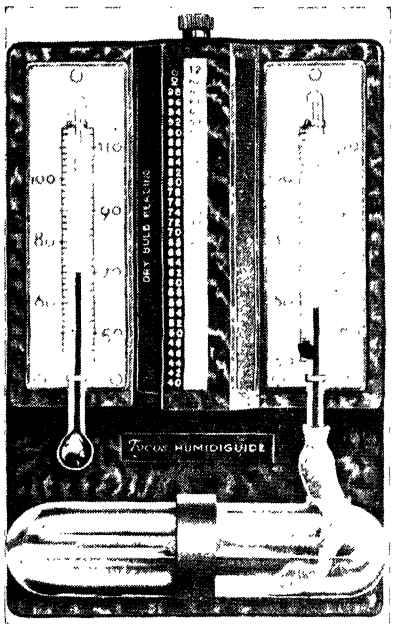
not free to move about, he shivers and the muscles of the skin contract, producing "goose flesh." This is merely nature's way of increasing muscular activity. The superficial arteries constrict, and the heat loss from the surface of the body is reduced to a minimum. However, we must still give the body further protection by wearing heavier clothing. The best room temperature is between 65° and 70°, depending upon the dryness and rate of the air.

Moisture and Air Movement.—What effect does the varying moisture content of the air have upon the body? We know that water is a good conductor of heat and, therefore, if the air is moist and cold it will seem very chilly because the heat is conducted away from the body rapidly, even though the skin has reacted to the low temperature and reduced the evaporation of moisture to a minimum. On the other hand, if the day is very hot and the air is moist, the evaporation of perspiration will be less rapid because the air is already loaded with moisture. This prevents the body from cooling itself by the process of evaporation. It thus appears that a moist air seems colder at 35° and warmer at 95° than dry air at the same temperatures. In any case an increase in the *movement* of the air would make it seem colder or cooler because moving air continually changes the aerial blanket and increases heat transfer and evaporation.

Odors.—Disagreeable odors have a definite effect upon the appetite. The nose can always detect a new odor or a stronger odor and, for this reason, the odor of the air is a good index of its freshness or staleness when one *first enters* the room. One soon ceases to be aware of the unpleasant odor of stale air because the olfactory nerve registers only changes in odor concentration.

Odors arise from foul breath, an unclean mouth, decayed teeth, catarrh, the sudoriferous glands of the feet and axillae, and from the decomposition of organic matter on the skin and clothes. Moisture is always necessary for the detection of odors, and they therefore become more objectionable as the air becomes more humid. Heat or a draft of compressed air may remove odors from solid surfaces when ventilation alone will not.

Testing Air.—When the air in living rooms is not changed with sufficient frequency, it is likely to become *odorous*. The test for



Can you explain these satisfactory but different readings on the dry bulb thermometer and the wet bulb thermometer? (Courtesy Taylor Instrument Companies.)

the amount of *carbon dioxide* in the air also indicates whether or not the air is fresh.

The *temperature* may be read directly from a thermometer. *Relative humidity* is expressed in terms of per cent saturation. When the air is completely saturated with moisture (100 per cent relative humidity), we have a mist or fog. At 68° F. the optimum humidity is about 50 per cent.

The drier the air, the more rapid is the evaporation of moisture. It is this principle that is used in determining relative humidity. If the bulb of an ordinary thermometer is wrapped in a moist cloth, evaporation will take place from the cloth and the thermometer will be cooled, registering a lower temperature than a dry thermometer in the same room. The drier the air and the greater the rate of evaporation, the greater will be the difference between the dry bulb and wet bulb readings.

The movement of air also affects the rate of evaporation. Evaporation approaches its maximum rate when the air is moving at about four miles per hour. If, therefore, the wet bulb thermometer is swung in the air at this rate of speed, the minimum reading can be obtained in a few moments. The relative humidity is obtained by comparing the difference in temperatures of the dry bulb thermometer and the wet bulb thermometer with a set of standard tables. In addition to the relative humidity, the number of grams of moisture in the air and the dew point (temperature at which dew would fall) of the air can be determined from these tables.

The Polymeter. Various instruments have been devised which indicate roughly the relative humidity by showing the effect of moisture in contracting or expanding some substance like horsehairs. The horsehair is usually run from the top of the instrument to a shaft connecting with a dial at the base. If these instruments are kept in proper condition, the dial will indicate the amount of moisture in the air with an inaccuracy of about 1 to 5 per cent. To keep them in good condition, they should be dipped in water every few days.

VENTILATING AND HEATING

The problem of ventilation is to supply clean air, free from bacteria and dust, at the proper temperature, relative humidity, and rate of movement. To ventilate we must renew the air in a room, but to secure air which is properly conditioned we must in addition often heat or cool, and moisten or dry the air. The air should be maintained at the optimum temperature without uncomfortable drafts or any draft lower than 60° F.

The air should be free from unpleasant odors and reasonably free from dust, which is irritating and is usually germ laden. Mechanical exhaust systems are needed in many workrooms to keep the air free from dust. Air washing is necessary in some localities to secure a satisfactory supply of clean air.

Natural Ventilation.—Ventilation may be either natural or artificial. In natural ventilation air inside a building is replaced by the outside air which works its way through the wall and through openings to the outside. Even solid walls allow for the passage of a good deal of air, and much more enters through open windows, ventilating flues or chimneys, cracks or crevices in the walls, under doors and around windows. There are numerous mechanical appliances that permit openings through walls or windows and assist in the interchanging of inside and outside air. Sometimes this exchange of air is assisted by aspirating or withdrawing the air from within by means of the natural draft of a flue or chimney augmented by a heater.

The amount of leakage of air in a building depends on the ratio of the cubic contents of the building to the exposed surface, the tightness of doors and windows, and the condition of the walls.

In general, it is assumed that the leakage amounts to one change of air per hour in a frame building; that is, an amount of air equal to the cubical contents of the building will pass through the walls each hour and an equal volume of air must be heated to replace the loss. In some buildings the air will be changed two times per hour by spontaneous ventilation. The number of changes of air that take place under direct heating in buildings is given below:

	Air Changes Per Hour
Residences	Halls 3; sitting rooms 2
Stores	First story 2 to 3; 2nd story 1½ to 2
Offices	First story 2 to 2½; 2nd story 1½ to 2
Churches and halls	¾ to 2
Large rooms with small exposure	½ to 1

An easily remembered and widely accepted standard for satisfactory natural ventilation is the "five hundred, fifty, five" standard, or 500 cu. ft. of air space per person, 50 sq. ft. of floor area per person, and openings in windows and sky lights equal to 5 per cent of the floor area. Under these conditions radiators under windows, using window boards wherever necessary to avoid drafts, provide a satisfactory and inexpensive heating and ventilating equipment.

Artificial or Mechanical Ventilation.—For halls, churches, business establishments, and factories, and other large buildings the change of air through natural processes is not sufficient, and a mechanical system of ventilation must be adopted. This may be one of three types: (1) the exhaust or *vacuum system* by which air is withdrawn from the room by suction fans; (2) the *plenum system* by which air is forced into the room by fans; or (3) the *combined method* which forcibly brings air into the room and forcibly exhausts it, a combination of both systems.

There are various ways of introducing and removing air from a room, but, in general, it may be said that in buildings of moderate size, such as residences, office buildings, schoolrooms, and factories, where the building is cut up into rooms not over 50 feet square, the intake ducts should be in the side walls near the top of the room from 8 to 10 feet above the floor and should discharge the air with a velocity not exceeding 6 feet per second so that the

drafts will not be felt. Exit ducts should be in the side walls near the floor.

Relative Humidity.—It may be demonstrated that the air in a room at 65° F. and 60 per cent relative humidity actually feels warmer than does the air of a room maintained at 72° F. and 20 per cent relative humidity. This is due to the fact that the sensation of heat or cold as felt by the body (the "sensible temperature") is not indicated by the temperature of the dry bulb thermometer, but more closely corresponds to the temperature indicated by the wet bulb thermometer. It is evident that a higher temperature must be maintained in buildings, if the air is dry, than would be required if the proper relative humidity were provided. If a room feels cold at 68° F. it is because the humidity is too low.

The amount of moisture a cubic foot of air will hold depends entirely upon the temperature. The lower the temperature of the air, the less moisture it is capable of holding. Air at 70° F. will, if saturated, hold 8 grains of moisture per cubic foot. Air at 0° F. will hold about 0.48 grain per cubic foot at saturation. The average relative humidity during winter is about 70 per cent; hence air at 0° F. and 70 per cent relative humidity contains 0.34 grain of moisture per cubic foot. If this air is drawn from outdoors into a building and heated to 70° F., the absolute humidity or the weight of moisture per cubic foot will remain the same as before, but the relative humidity will be reduced to about 4 per cent. Such air is drier than that of the most arid region.

Dry furnace air is likely to cause excessive evaporation and give one a chilly feeling. The humidity of living rooms and offices may be increased by plants, or by porous dishes, like flowerpots, containing water, or by a dish of water or a wet towel placed on or near the radiator. It is evident that fuel can be saved by maintaining air at a reasonably high humidity.

A wet bulb temperature of 56° F. is a better standard for proper air condition than a dry bulb temperature of 65° to 70°.

Air Washing and Humidifying.—Although the humidity may be secured by simple devices in small rooms, more intensive methods must be used for large buildings. Water is forced through small openings in pipes so that a sheet of water is formed, through which the air must pass.

In the general method of washing and conditioning, air is first drawn through the washer by a fan. The water carried mechanically by the air is separated by eliminator plates; then the saturated air is heated by heater coils to the desired temperature. By regulating the temperature of the saturated air entering the heater, the humidity of the heated air may be made any desired amount. Tempering coils are important where the incoming air is likely to go below 32° F., especially where all the air handled is taken from outdoors.

The washing of air is often almost as important as the humidifying. It is necessary to use the outside air for ventilation, and this air is taken from the lower levels where the dust, bacteria, and noxious gases are most concentrated. When street air is passed through a washer, it requires only a few hours for the water to become like sewage in appearance and analysis. Air may be drawn from the rooms, purified, and reheated, and the cost of fuel necessary to heat such air is considerably reduced.

Cooling Air.—To cool air, and at the same time to reduce the amount of moisture, it becomes necessary to work with water at a temperature lower than can ordinarily be obtained from either driven wells or from city mains. Air cooled by ice is unsatisfactory, since it is difficult to cool it sufficiently to deposit the excess moisture, and the slightly cooled air is likely to have a high relative humidity.

The only satisfactory method of air cooling is by the use of refrigerating machines, such as ammonia compression or absorption machines, by which the temperature may be reduced enough to cause a precipitation of the excess of moisture contained in the air.

Air taken in from the room may be cooled, dehumidified, and sent back, or some of the outside air of higher temperature and humidity may be mixed with cooled air in proper proportion to give the final temperature and humidity desired. In general, it is necessary to cool air to 45° to 50° to eliminate the excess moisture, and it is then necessary to heat this air again to 70°. The hot moist air on passing from the room to the cooler may be made to transfer some of its heat to the cold, dehumidified air on its way back to the room.

An increasing number of houses and public buildings are installing equipment for drying and cooling the air in summer. The air-conditioning equipment blows cool, dry air into the rooms, and the

windows are kept closed. Air conditioning equipment is now available for single rooms or large buildings which will supply warm, moist air to the rooms in winter and cool, dry air in summer. It has been found most practical to reduce the indoor temperature only 10° to 15° F. below the outside temperature, even in the hottest weather, in order to avoid too great differences for the person going in or out of the building. Benefits to health other than improvement in comfort and efficiency have not been shown to result from air-conditioned buildings as compared with buildings without air-conditioning equipment, but otherwise properly heated and ventilated.

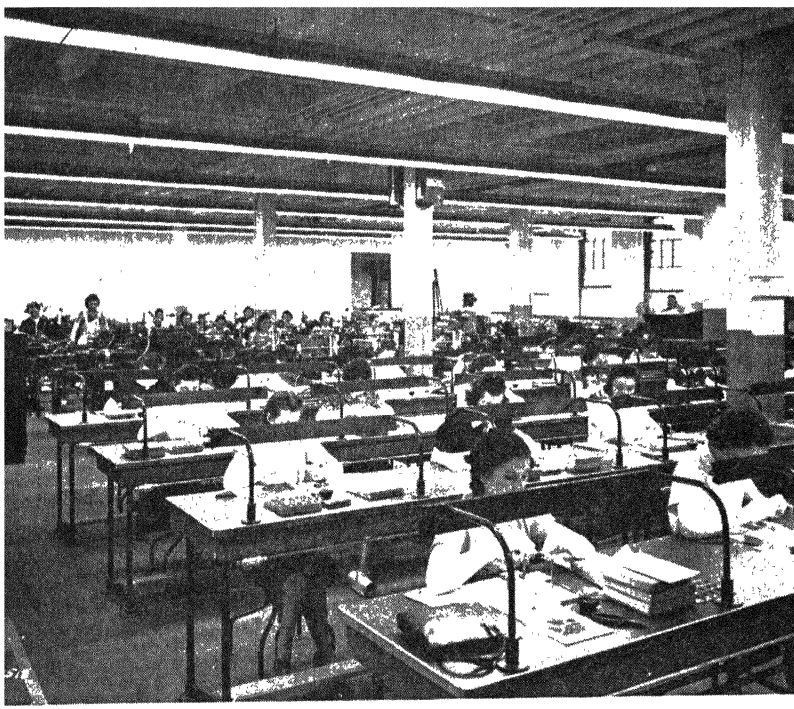
Infection and Sterilization of Air.—The transfer of respiratory disease through droplet infection has long been recognized. Droplets containing bacteria or filtrable viruses are sprayed into the air in coughing or sneezing and contaminate the air, at least temporarily, in the vicinity of the infected person. Dust also furnishes a myriad of vehicles that support or transmit microorganisms in the atmosphere. Investigations have indicated also that the smaller microorganisms, especially the filtrable viruses, may infect the air for several hours. The moisture of the sneeze droplet largely evaporates on the way to the floor, leaving a particle small enough to remain suspended in the air. Many hospitals have installed special lamps that establish a sheet of ultraviolet light to sterilize the air as it moves from one area to the other. The use of ultraviolet light for sterilizing the air in school rooms has been recommended. Triethylene glycol has been used as a spray (1 part in 400,000,000) to kill pathogenic bacteria and viruses in air. It is not toxic or noticeable to persons in the room.

The Economic Value of Good Ventilation.—Industries have found that it is particularly important to remove dust, gases, and fumes that irritate the breathing passages of the worker and cause congestion or predispose the individual to infectious diseases. But even where dusts are not present, the proper regulation of temperature and humidity has an important bearing upon health and efficiency. Dr. Winslow has shown that, all working conditions being equal, 6 per cent more typewriting is performed at 68° than at 75°. In more vigorous physical work, such as ordinary industrial activities, the amount accomplished at 68° is 15 per cent greater than that accomplished at 75°.

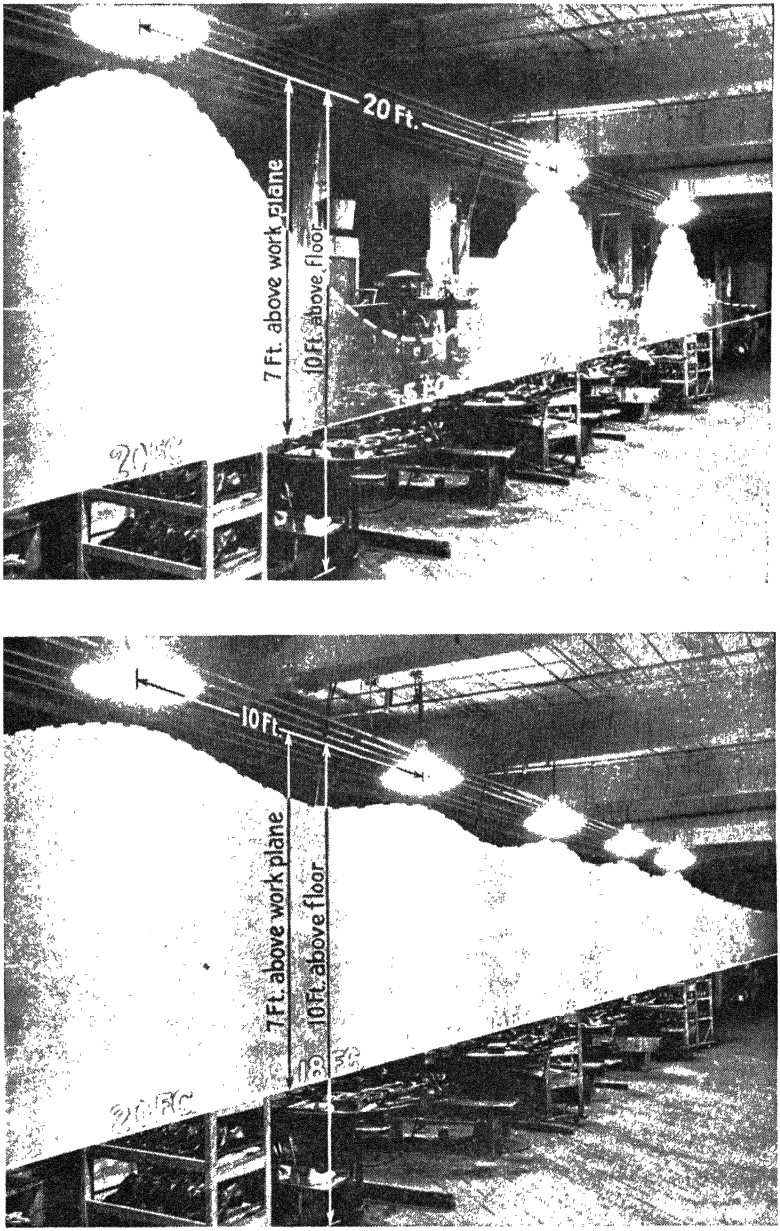
Physicians feel that outdoor air is better than inside air for invalids and consumptives, even though the inside air is properly conditioned. The benefit from being out of doors may be due to sunlight or it may be due to the constantly varying temperature of the outdoor air which doubtless serves as a stimulus and tonic to the system.

LIGHTING

Good lighting is important in many ways. Direct sunlight is a disinfectant, and it has been found to increase the number of white blood cells in the surface blood vessels. Its value in treating tuberculosis of the skin, for example, has been well demonstrated. It should be allowed to enter the home and the work place as much as possible, but it should be prevented from shining directly in the face of the worker.



A well-lighted factory with both overhead and desk lighting. (Courtesy General Electric Co.)



These picture-diagrams show the difference in the evenness of illumination between an inadequate (above) and a proper (below) spacing of factory lights. (Courtesy General Electric Co.)

Outdoor life has always been the normal condition for man throughout the process of evolution. Outdoors the light comes from a luminous body above and very little of it is reflected from the green or brown of the earth, so that the upper part of the retina is not accustomed to a strong stimulation. If the person looks up at the sun directly, the stimulation is excessive and painful. This suggests that, in ideal conditions for artificial lighting, strong light should not be thrown directly into the eyes from below.

Man has acquired great power in adjusting the eyes to the effects of bright daylight and darkness. The varying size of his pupil through the muscular contraction of the iris enables him to make this adjustment. Flickering light causes the eye to attempt a rapid series of these adjustments; continual contraction and relaxation of this muscle result in eyestrain, nervousness, and fatigue. Glare, or sharp contrast in the intensity of lighting within a room, requires similar prolonged adjustment.

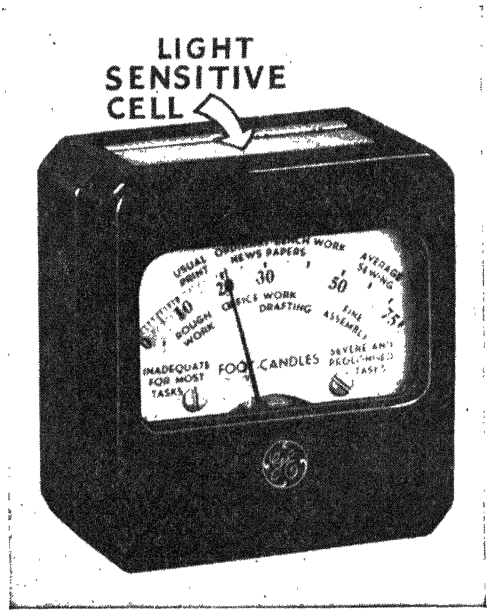
Artificial Illumination.—Ideal lighting provides sufficient and steady illumination in a work area. Lighting should be judged not by the brightness of the lamps but by the illumination at the point where the work is done. Dark objects require more illumination than light objects.

With reference to the position of the source of light artificial illumination may be general, localized, or localized general. In *general* lighting there are a few strong lights at a considerable distance from each other and so placed as to illuminate wide areas. *Localized* illumination is provided by desk lamps or, in the factory, by small lamps illuminating a part of the machine or a limited work area. *Localized-general* lighting is intermediate between these conditions and consists of lamps of intermediate candle power spaced from six to twenty feet apart. The intensity of illumination decreases as the square of the distance from the source of light increases.

The nature of the lighting may be direct, semidirect, or indirect. In *direct lighting* the source of light is directly exposed to view, as in the unfrosted electric light bulb. *Semi-direct lighting* partially protects the source of light from direct view and usually increases the amount that is reflected into the room from the ceiling. In *indirect lighting* the source of light is not visible to the eye at all.

The light is reflected from the ceiling or walls. It is a very desirable type of lighting, since it avoids shadows and sharp contrasts, but it is costly. The amount of illumination is rapidly cut down if the lamp and reflectors are not kept scrupulously clean.

Standards for Lighting.—In this country the "foot candle" is the unit of intensity of illumination commonly used. The term is used to indicate the degree of illumination at a point one foot from a standard candle. One candle power is about equal to one watt consumption in a tungsten lamp.



Light meter for measuring the intensity of light in foot candles. (Courtesy General Electric Co.)

The amount of illumination upon a working surface is measured by some type of simple and inexpensive foot candlemeter. Such a device for measuring illumination is illustrated in the accompanying figure. The required amount of light varies with the type of work or activity. A minimum standard of illumination for reading or office work of 15 foot candles has been recommended by lighting experts.

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CHAPTER XXVIII

PUBLIC HEALTH ADMINISTRATION

The health of the individual is protected, first, by proper personal hygiene, and second, by the activities of organized government in disease prevention. In this chapter we shall consider the health administration of the Federal, State and local governments.

Public Health Authority.—The division of the responsibilities for administering public health among National, State, and Municipal governments is dependent upon the relationship which these bodies bear to each other under the Constitution of the United States and the various state constitutions. Ours is a Federal Government and each state has supreme power in those questions which affect that state alone. In such matters it may, if it chooses, direct the individual community and it may not be interfered with by the Federal Government. In considering the activities of the public health officials we shall first investigate their powers under the law and then discuss their activities.

FEDERAL PUBLIC HEALTH FUNCTIONS

The National Government has only such powers as are granted to it by the Constitution. In these matters state law must give way, but where power is not specifically given to the National Government, it is assumed that the power lies with the states.

Federal Authority.—There is no specific mention of any power over the public health in our Federal Constitution, but power to regulate commerce, to provide for the common defense, and to carry out treaty agreements are specifically granted to the national government. The Federal government is also given direct jurisdiction over territories, national parks and other Federal domains, and power to "promote the general welfare." Certain public health activities are very properly carried on under these broad powers.

Under the *power to regulate commerce* the government has the authority to prohibit, under criminal penalty, the interstate transportation of persons or articles. This includes the power of quarantine against persons or things to prevent their entrance from one

state to another where such an entrance may be judged to endanger the public health or safety. The power of the government to restrict the transportation of an article includes the power to determine whether the article transported falls within the prohibited class, and thus provision is made for requiring the labeling of articles and the inspection at the place of manufacture, as well as for the licensing of persons engaged in the manufacture of articles for interstate commerce.

An important use of this power was the enactment of the Food and Drug Law, which forbids the transportation from one state to another of adulterated food products and drugs. The law was upheld by the Supreme Court as constitutional. On the other hand, the Child Labor Law, which forbade the transportation of goods made in factories where children were employed, was declared unconstitutional because it was regarded as an attempt to regulate the methods of manufacture within a state and not interstate commerce.

The authority which Congress possesses to exercise legislative powers in the carrying out of the provisions of *treaties* has never been widely used.

The *defense power* of the Federal Government to raise and support armies and to provide a navy carries with it the power to do whatever is necessary to protect the health of soldiers and sailors, even within state lines. In the District of Columbia, territories, and reservations, the Federal Government has complete health powers at all times through its *direct jurisdiction.*

Under the power to "*promote the general welfare,*" the United States government has established a national Public Health Service and other agencies authorized to assist state health authorities and to cooperate with them. Thus, although the United States Government may not interfere with the sanitary work of the states, it may have a far-reaching influence on state health administration through its power of appropriating money for health work in the form of grants-in-aid to states for various public health activities.

The United States Public Health Service.—On July 16, 1798, President John Adams signed a federal act creating a Marine Hospital Service to provide medical care and hospitalization to merchant seamen. A small monthly tax was collected by the Collector of Customs from each sailor for his medical care. The

Collector of Customs was under the Treasury Department and so the Marine Hospital Service was also placed under the Secretary of the Treasury.

The public health functions of the service grew slowly, but by 1893 the responsibility for preventing the introduction of cholera, yellow fever, smallpox, plague, and other diseases had been placed in its hands. In 1902 the name was changed to the United States Public Health and Marine Hospital Service. By 1912 public health had become its dominating activity, and it assumed its present name of the United States Public Health Service. After remaining in the Department of the Treasury for one hundred forty-one years, it was transferred, on July 1, 1939, to the Federal Security Agency, which had just been created to consolidate the health, education, and welfare activities of the Federal Government.

The Surgeon General, who is the head of the Public Health Service, is appointed by the President for a period of four years. His staff is made up of both commissioned and civil service personnel, including physicians, engineers, dentists, nurses, and various scientific and technical specialists. He has the advisory services of a National Health Advisory Council and the services of other special advisory councils in such fields as cancer, biological products, and hospitalization.

The functions of the Public Health Service have been described, in reports upon its activities, as four: *police duties, investigation, demonstration,* and *coordination.*

It has been accredited with all the powers that Congress can give it for doing health work. The nature of its activities is limited by the Constitution, and the extent of its activities is limited by the size of its appropriations.

There are four major divisions in the Public Health Service:

1. The *Office of the Surgeon General* contains the Division of Public Health Methods, the Division of Nurse Education, a Dental Division, and the Division of Sanitary Engineering, in which its major public health activities are to be found.

2. The *National Institute of Health* contains (1) the Division of Infectious Diseases, (2) the National Cancer Institute, (3) the Division of Physiology, (4) the Division for the Control of Biological Products, (5) the Chemical Laboratory, (6) the Pathology Laboratory, (7) the Zoology Laboratory, and (8) the Division of Industrial Research.

3. The *Bureau of Medical Services* has charge of the marine hospitals and other direct medical services.

4. The *Bureau of State Services* has (1) a Division of Venereal Disease, (2) a Division of Industrial Hygiene, (3) a Division of Tuberculosis Control, and (4) a division of State Relations, through which grants-in-aid to individual states are operated.

Other Federal Health Agencies.—There are other departments in the Federal Government that are carrying on public health work. The Children's Bureau, now in the Social Security Agency, was established in 1912. It is empowered by Congress to promote the protection of maternity and infancy and to cooperate with state and municipal agencies in protecting the welfare of the growing child. In 1943 it was empowered to develop a nation-wide plan for medical, nursing, and hospital care for the pregnant wives of military personnel in the arm and navy of World War II. The funds were administered through state bureaus of child hygiene. The Office of Education in the Social Security Agency deals with the physical and mental development of school children. The Home Economics Division of the Department of Agriculture is promoting better nutrition of children by educational literature and by practical demonstrations of food values. The National Department of Agriculture also administers the Federal laws dealing with the sanitation of food and drug production, the sanitary supervision of milk production, and the sanitation of milk and milk products. The Bureau of Census in the Department of Commerce takes the national census every ten years and compiles vital statistics on a nation-wide basis. Many departments of the government are doing lesser amounts of health work.

STATE HEALTH FUNCTIONS

Under our form of government each state bears the responsibility for its health conditions, and upon the state legislature, as the supreme power of the state, this responsibility rests primarily. The legislators, limited only by the state constitution and responsible only to the electorate, have supreme power to determine what health regulations shall be made and what official organization shall be provided by municipalities and by the state at large to administer public health. Since public health administration within the state is directly dependent upon the law, it may be profitable to consider the principles of health legislation.

Public Health Laws.—Public health laws may be divided into two groups: laws creating the public health *organization,* and laws governing public health *administration.*

The first law providing for health organization was the Massachusetts law of 1797 establishing boards of health for towns and giving each board power to "make such regulations as it judges necessary for the public health and safety." The other states have made similar laws, and many large cities have had special sanitary provisions incorporated in their charters. The type of local organization has varied in different states, depending upon whether the administrative unit of government was the township or the county. The local authorities are required to keep the state authorities informed as to the sanitary conditions of their districts, and in all cases local health ordinances must not contravene the laws of the state. Since 1855 each state has enacted a law creating a state board of health or its equivalent.

On the legal side of public health administration, common and constitutional, as well as statutory, laws are involved. The *common law,* or lex non scripta, consists of the court decisions made in the course of administering justice. The decision of a lower court or the opinion of an attorney has little value as a precedent, but the decision of the Supreme Court is binding upon subordinate courts until overruled. *Constitutional law* has to do with the interpretation of federal and state constitutions. *Statutory laws* are enacted by legislatures.

All authority for the protective operations of government, including the preservation of public health, is derived from the

police power, an inherent function of government. It is the right of government to protect the health, morals, and safety of the public. In its exercise we find sanction for otherwise illegal acts, such, for example, as the violation of personal or property rights to protect the safety of the people in great epidemics. It is a fundamental social principle that *personal liberty ends when individual action menaces public safety.* Upon this principle are based many public health procedures, such as the prevention of nuisances and the control of communicable diseases.

The use of *license* is essentially police in nature. A license may be issued upon payment of a slight fee, as in licensing milk dealers, where it is the license rather than the fee that restricts or regulates the business. On the other hand, the issuance of licenses at a prohibitive cost has been a reasonable use of police power in restraining the liquor traffic.

In enforcing the public health law the health officer is given considerable *power of discretion* as to what shall be done. He is entitled to do any act within that discretion, and all that he does will be held to have been done with the express authorization of law. Should the health officer abuse his power of discretion, however, he is amenable to prosecution, but the act to be criminal must be willful and corrupt, and proof of this rests upon the camplainant.

If discretion is left entirely to the administrative officer, there is no way he can be forced to act. An officer cannot be sued personally for neglect of an exclusively public duty even to a person specially injured thereby. If a law prescribes specific duties for a health officer (if it is mandatory), he must perform those duties. Some laws, such as quarantine laws, are mandatory as to action, but discretionary as to method. In court proceedings if the law be specific, the only questions which may arise are those of fact; if discretionary, questions of fact, reasonableness, and extent of discretion may be presented.

Injunction (a restraining order issued by the court) can be used to prevent executive action, the taking or impairment of property or the creation of nuisances. It is not used to direct or to restrain the exercise of discretionary authority.

A public health *nuisance* is a state of affairs that is dangerous to public health. Obviously, a thing may be a nuisance under

either common or statutory law. In a case of exigency the health authorities may summarily abate the nuisance, but if the owner of the property cannot get a formal trial before the abatement, he is entitled to a hearing afterward. The burden then falls upon the authorities to justify their action.

State Health Administration.—The oldest and most common type of organization places the administration of public health in the hands of a secretary of the state board of health. He is the executive officer, or state health officer, and his activities are guided by the policy and wishes of the board. Many states have changed their type of organization from a state board of health to a state department of health under the direction of a commissioner with an advisory council.

The work to be done is practically the same regardless of the type of organization, although naturally the extensiveness of the work done by each state varies with the size of its health appropriation, the efficiency and number of its personnel, and the extent to which the state supervises local health administration. The state health officer should be a physician with special graduate training in public health.

Legislatures have delegated a limited amount of "law-making power" to state departments of health. This delegation of power is judicious and progressive, for only a body of experts is qualified to work out the details of public health regulations. Under this power a *Sanitary Code,* consisting of rules and regulations affecting the security of life or health, is enacted. The provisions of this code have the force and effect of law in all parts of the state. In enforcement they supersede any local ordinances which may be inconsistent with them.

Administrative Functions.—Let us consider briefly the activities of the more important divisions of a typical state department of health.

The Division of Administration, which is presided over by the health commissioner, provides the general administration of the department and includes a supervision over the work of the staff, accounts, salaries, and expenditures.

The work of the *Division of Vital Statistics* includes the recording and analyzing of data concerning deaths, births, marriages, population, and diseases. If disease is to be prevented and lives

are to be saved, careful records must be kept to show where, when, and how diseases and deaths occur. The recording and interpretation of vital statistics require skill, and highly trained vital statisticians are employed for this work. The layman may not be particularly interested in the methods of interpreting statistics, but he will at least want to know what is meant by the most commonly computed rates.

The *birth rate* is the number of births annually per thousand population. The *crude death rate* is the number of deaths annually per thousand population. *Specific death rates* state the number of deaths per 100,000 population for specific diseases. The *morbidity rate* is the number of cases of a specific disease per thousand population (sometimes expressed as the number per 100,000 population). The *fatality rate* is the number of deaths from a specific disease per 100 cases (the per cent fatality).

When we realize that such rates show whether we live in a safe and healthful community or a dangerous and unhealthful one, the statistics of our state and local health departments become most interesting reading. The registration of births, marriages, and deaths is also important for legal, social, and property rights.

The *Division of Public Health Education* embraces the publicity work of the State Department of Health through reports, newspapers, health exhibits, pamphlets, lectures, moving pictures, and all the numerous and valuable activities through which the state health department places before the people the important principles of hygiene. Public education in nutrition is especially important and nearly all state departments of health employ nutritionists in either the health education or the maternal and child health division. Some state health departments have developed programs of safety education.

The functions of the *Division of Sanitation* are to safeguard the water supplies and to insure proper waste disposal throughout the state. Such a department maintains facilities for water and sewage analysis and is able to furnish the advice of an expert sanitary engineer in any problem of water supply and waste disposal. These problems have been considered already in another chapter.

The duties of the *Division of Communicable Diseases* include activities in controlling and limiting the spread of various com-

municable diseases. Epidemiologists promptly investigate incipient epidemics and the division takes prompt steps in restricting the disease.

The *Division of Maternity, Infancy, and Child Hygiene* maintains a personnel of trained workers who make surveys, develop special state and local campaigns to improve the hygienic conditions of maternity, infancy, and childhood, and cooperate with private child health agencies throughout the state.

The *Division of Public Health Nursing* determines the qualifications of the public health nurse, employs a corps of nurses to assist district health officers, and broadens the work of those nurses who are employed by various communities in the state by affording them advice, assistance, and cooperation.

The *Division of Laboratories and Research* provides free laboratory diagnosis of communicable diseases, prepares and distributes vaccines and antitoxins to the medical profession, and carries on public health research.

The *Division of Tuberculosis* directs the operation of state tuberculosis hospitals and sanatoriums, and assists local communities to combat the disease by investigating conditions and showing the value of early reporting, dispensary service, and other measures.

Nearly all the states at one time established *divisions of venereal diseases* as a result of the campaign waged by the Federal Government. In several states this special division has now been discontinued and the work placed under the division of communicable diseases.

The organization of a state health department is flexible and the same divisions are not present in every state. New divisions may be established and old divisions may be abolished as needed.

LOCAL HEALTH ADMINISTRATION

Authority.—Some states have centralized systems with local health departments under the control of the state organization. Other state departments of health have only the power to advise and investigate, with no direct control over the local health authorities. A system that allows the state department limited, but not complete, control over local authorities with additional power in emergencies is preferable to either extreme. This plan

leaves the basic responsibility for community health with the local or municipal officials, but it gives power to the state health officer to protect the health of the whole state whenever it may be endangered by local inefficiency. The division of authority between the state and local health departments in each state is determined by the state laws which established these departments.

Local Health Organization.—The local health organization usually consists of a board of health with a health officer. The board determines policies and procedures. The health officer employs a staff with the approval of the board and is responsible for administration of the organization. In some states a health officer may be appointed in place of a board of health and in other instances legislation provides for a type of local organization with a health commissioner and an advisory committee. This places the responsibility on the health officer but gives him the benefit of advice and support from a committee or council. The scope of local health work in a large city usually embraces the following list of activities:

MUNICIPAL HEALTH DEPARTMENT ACTIVITIES

I. *Vital Statistics*
- Births
- Deaths
- Morbidity
- Maps
- Charts
- Records

II. *Communicable Disease Control*
- Isolation
- Quarantine
- Release
- Home instruction
- Diagnostic aid
- Epidemiology
- Hospitalization
- Immunization
- Biological products

Tuberculosis Control
- Diagnosis
- Follow-up
- Control of contacts
- Case finding
- Clinics
- Nursing
- Institutional care

Gonorrhea and Syphilis
- Reporting
- Follow-up
- Education
- Drugs
- Clinics
- Case finding

III. *Child Hygiene*
- Clinics
- Nursing
- Midwives
- Education

Infant Hygiene
- Well-baby clinics
- Nursing
- Institutional care

Preschool Hygiene
- Clinics
- Immunization
- Dental hygiene
- Mental hygiene
- Nutrition
- Correction of defects
- Nursing

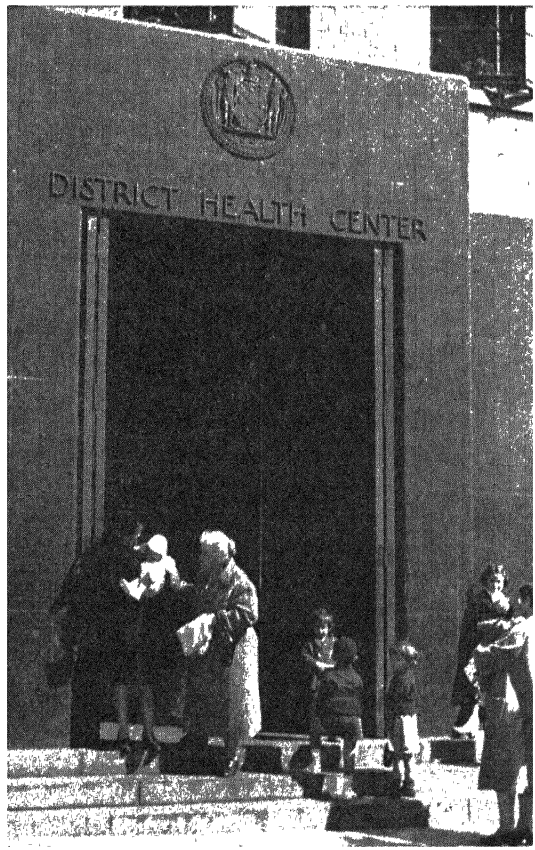
School Hygiene
- Sanitation
- Communicable disease control
- Examinations
- Follow-up
- Clinics
- Special classes
- Health education
- Physical education
- Healthful school living

IV. *Sanitation*
- Housing
- Vermin and insects
- Milk
  - Standards
  - Dairy inspection
  - Pasteurization
  - Laboratory testing
- Food
  - **Food handlers**
  - Food establishments
- Water and sewage
  - Inspection
  - Laboratory control

V. *Laboratories*
- Diagnostic
- Food
- Water

VI. *Health Education*
- School
- Public

VII. *Industrial Hygiene*
- Education
- Engineering
- Toxicology



The open door of a health center. (Courtesy Bureau of Health Education, Department of Health, City of New York.)

The Health Center.—The health center has been established in many communities as a place where health conservation is sought "through the physical examinations of well people, through readily available health consultations, through well-baby clinics and the prenatal clinic, through special classes, through education by means of health talks, leaflets, posters, lantern slides and window exhibits." Certain activities of both health department and private health agencies, such as the Red Cross and Visiting Nurse Association, are carried on at the health center. It is a physical center for public health work.

County Health Unit.—The first county health department in the United States was established in Yakima County, Washington, in 1911. There are now about two thousand. Vigorous efforts are being made to provide adequate local health departments in rural areas throughout the country. A unit of rural population of some twenty-five thousand to fifty thousand people is conveniently served by a county health department. In some cases a department covers more than one county in order to have a suitable population group. Small cities up to ten or twenty thousand people are usually included in the county health department project, but large cities usually have their own health department separate from that of the surrounding rural areas. A budget of one dollar per capita is regarded as adequate. This budget does not include the cost of hospitalization for tuberculosis or other communicable diseases or the cost of an intensive home nursing program. In some cases local funds are augmented somewhat by grants from the state or the Federal government.

The modern county health department has a trained full-time personnel consisting of a health officer, public health nurses, sanitary inspectors, and a clerk. A health educator is now widely considered as essential in this minimum staff, although he or she may be employed jointly by the health department and the school system. Also a nutritionist and a social worker are often to be found on a full-time staff. In addition, part-time physicians or dentists are commonly employed to staff such clinics as may be operated. Tuberculosis clinics, immunization clinics, venereal disease clinics, and dental clinics for children are commonly organized in cooperation with the county medical and dental societies.

Prenatal clinics and well-baby clinics are less practical in rural areas.

The county board of health under which the department operates consists of three to five prominent citizens, some but not all of whom should be physicians. A position on the board is honorary and carries no remuneration. The board makes general policies, approves the budget, approves the sanitary code, and selects the health officer. It does not have administrative responsibility.

The work of the county health unit, like that of other local health departments, is directed toward the prevention and control of disease through the sanitation of the environment, isolation, and immunization, as well as the promotion of positive health through health education and other appropriate means.

The Health Officer.—Public health administration involves a variety of tasks. The local health officer must understand disease control, sanitation, hygiene, and the principles of public health law. The physician is best adapted for this type of work, but he needs supplementary training in a school of public health. Public health administration is a distinct calling that demands a knowledge of a group of subjects different from those that are the basis of any other profession.

UNOFFICIAL HEALTH AGENCIES

There are many national health organizations and many local health societies in the United States interested in specific or general health problems. The function of these private health organizations is to develop those phases of health activities which the health department of a community is not yet ready to handle or which it cannot handle well because of the particular problem involved. For example, cancer research cannot be carried out by the individual community; it is being done by the U. S. Public Health Service, but an excellent and extensive program is being carried forward by the *American Cancer Society.* These typically American agencies have been especially helpful in educating the general public concerning health needs. Health progress is usually rapid when a large group of interested citizens undertake to solve a health problem.

An important local voluntary health agency to be found in most large communities is the *Visiting Nurse Association.* These

associations provide expert nursing care to the sick on an hourly basis. Those who can afford to pay for this service do so, usually at a cost of $1.50 per nursing visit. Through philanthropy these services are provided free to the poor. Prepayment plans for complete medical service often include such hourly nursing care. These private nurses who render bedside nursing care are not to be confused with the public health nurses employed by the health department who instruct the family concerning health procedures but do not do bedside nursing. The cost of this nursing service is so great that it has not seemed practical to add the bedside nursing program to the tax-supported nursing activities in the health department. Over the last fifty years the visiting nurse associations have rendered a distinguished service and have become an accepted community agency.



At the national level there is a long list of distinguished voluntary health agencies. Their development and activities have been well described by Cavins.[2] Typical of these important agencies are *The National Red Cross, The National Tuberculosis Association,* and *The National Foundation for Infantile Paralysis.*

We have already mentioned *The National Tuberculosis Association* in our discussion of tuberculosis. It is one of the oldest voluntary health agencies and has had a distinguished career of service in promoting the treatment of tuberculosis and in the development of preventive and health education activities. It has state and local associations throughout the country and is supported by the sale of Christmas seals.

The *National Red Cross* is a semiofficial organization since it is chartered as a disaster relief agency by the United States Govern-

ment. In war the Red Cross supplements the work of the medical corps of the Army and Navy particularly in supplying nursing care for the civilian population. In time of disaster it supplies food, shelter, clothing, and medical, nursing, and hospital care. It does much in the rehabilitation of devastated areas. It has promoted public health nursing in sparsely settled areas and instruction in first aid and home nursing throughout the country.

The *National Foundation for Infantile Paralysis* with its local chapter in each county is somewhat unique in that it pays medical and hospital costs for persons who are attacked by poliomyelitis and who are not able to meet the high costs without severe inroads upon the economic status of the family. It does not furnish medical care directly nor does it dictate in any way the nature of the treatment to be given. It only insists that the treatment shall be under the direction of registered and accredited physicians. Its research program is one of the most extensive carried on in connection with any disease. Health education regarding poliomyelitis and the training of various types of experts needed in the battle against the disease are also important activities. The annual March of Dimes provides a medium through which millions of persons support this organization.

Other voluntary health agencies include *The American Cancer Society, The American Hearing Society, The American Heart Association, The American Social Hygiene Association, The National Committee for Mental Hygiene, The National Dental Hygiene Association, The National Foot Health Council, The National Safety Council, The National Society for the Prevention of Blindness,* and *The National Woman's Christian Temperance Union.* The *National Congress of Parents and Teachers* has an important health program.

In addition there are of course many associations of professional workers concerned with public health. The *American Public Health Association* includes the majority of persons who are professionally engaged in public health. Its official organ is the *American Journal of Pubic Health.* Other professional groups concerned with public health include *The American Association for Health, Physical Education, and Recreation, The American Dental Association, The American Dietetics Association, The American Home Economics Associaation, The American Medical*

Association, The American Nurses Association, The American School Health Association, and *The National Organization for Public Health Nursing.*

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CHAPTER XXIX

MATERNAL AND CHILD HYGIENE

In the discussion of personal hygiene in Part I, many facts have been presented bearing indirectly upon maternal and child hygiene. It is the purpose of this chapter to consider the special problem of safeguarding the health of the mother, the infant, and the young child, to present the broad outlines of the problems involved, and to show how scientific aid may be utilized in meeting them.

MATERNAL HYGIENE

Childbirth is an exceedingly important affair that involves the future health of two persons. While pregnancy is a normal experience for the mother, it taxes her system heavily, and unless she has proper care and follows a consistent program of hygienic living in preparation for it, both she and the child may suffer injury. It is not to be feared, but it is to be approached with hygienic living and under medical supervision so that any untoward conditions may be discovered and corrected. There is no phase in the development and birth of the baby that should injure or impair the health of any woman who is reasonably well at the beginning of pregnancy and who has proper care.

Many states average fewer than two maternal deaths per thousand live births. Rates vary in different areas and among different groups. They are highest where ignorance and poverty are greatest. Of such deaths as do occur, 40 per cent are due to sepsis, 25 per cent to toxemia, 25 per cent to hemorrhage, and 10 per cent to all other causes.

Medical science can reduce the maternal death rate, since the chief factor contributing to it is lack of proper care. The medical profession cannot reduce the number of deaths, however, unless expectant mothers place themselves under medical care early in pregnancy. This is in part the husband's responsibility. He must see that proper medical care is provided for his family when it is needed.

Problems of Maternal Care.—The special problems that accompany maternity and make expert supervision necessary are particularly concerned with the diet, with the elimination of body waste, with the size of the birth canal, and with the mother's general physical condition. Since the baby grows within the mother's body and obtains all its nutrition from the mother's blood stream, the mother must take care to provide all the essentials of an adequate diet in abundant quantity. This necessarily involves extra feeding. If it is not provided, the mother suffers more than the child.

The baby requires much calcium in laying the foundation for the bony framework of the body. If the mother's diet does not supply this in sufficient quantity, it will be absorbed from her own bony structures. In addition, the baby's teeth, which begin to form in the third month of prenatal life, will be of poor quality. Proper care of the diet can prevent all these undesirable conditions.

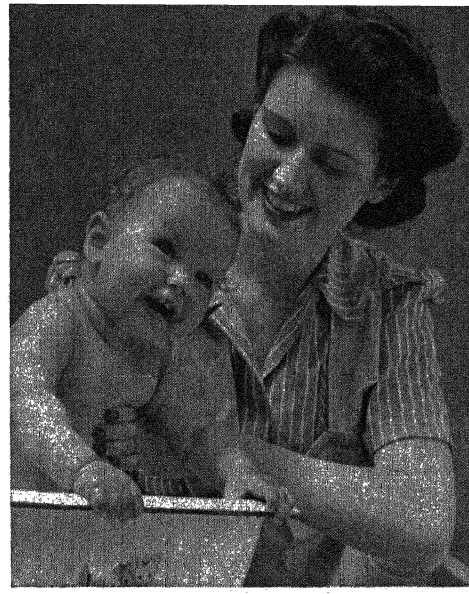
The elimination of waste material for the fetus puts an added burden on the mother's organs of excretion during pregnancy. It is particularly important that the condition of the kidneys be watched, for they must remove all the nitrogenous waste. Any abnormality that occurs in these organs must be detected early and suitable treatment must be prescribed.

It frequently happens that the bones of the pelvis are narrow, making the normal birth of the child difficult or impossible. By careful pelvic measurements this can be determined in advance and suitable steps can be taken for making birth possible. This may consist of controlling the size of the child or of arranging for birth by cesarean section.

In addition to these special problems of maternity there are the usual health hazards that anyone may meet but which, because of the added burden under which the body is now working, may prove more serious in their consequences. The mother needs the extra protection that medical supervision can give. Such supervision enables the physician to start treatment in time if anything is wrong. It provides an opportunity to give definite instruction in hygiene and to make effective preparations for proper care

through hospitalization or otherwise at the time of childbirth.

It is important to the health of the baby that the mother should avoid infectious disease during the first months of pregnancy, particularly the second month. There is clear-cut evidence that German measles at this time produces defects in the central nervous system of the infant. Other infections at this stage of pregnancy are suspected of injuring the fetus.



(H. Armstrong Roberts)

Hygienic care brings health to mother and child.

Thousands of babies are delivered by midwives every year. Health authorities have been carrying on an important and beneficial campaign for some time to raise the requirements for the practice of midwifery. Trained midwives are capable of attending normal deliveries and of recognizing those conditions that require the care of a physician. In certain foreign lands well-trained and supervised midwives are supplied to women of limited means, and the maternal mortality of those countries compares favorably with the mortality of the United States. Medical care is obviously preferable. A well-equipped hospital is the preferred place for delivery. One advantage is that any possible complication could receive most effective attention.

Miscarriage occasionally occurs. Medical care early in pregnancy will give the physician an opportunity to prevent the miscarriage wherever possible and to take care of the patient in any case. Prompt treatment is important, since any abortion or miscarriage is dangerous, whether accidental or induced.

Community Standards of Maternity Care.—The responsibility of the community or the state in providing the proper facilities for suitable maternity care is set forth in the following list of requirements, suggested by various authorities:

1. Maternity or prenatal centers, sufficient to provide for all cases not receiving prenatal supervision from private physicians. The work of such a center should include:

(a) Complete physical examination by a physician as early in pregnancy as possible, including pelvic measurements, examination of heart, lungs, abdomen, and urine, and the taking of blood pressure; examination of urine every four weeks during early months, at least every two weeks after six months, and more frequently if indicated; Wassermann or other blood test.

(b) Instruction in hygiene of maternity and supervision throughout pregnancy, through at least monthly visits to maternity centers until end of sixth month, and every two weeks thereafter. Literature to be given mother to acquaint her with the principles of infant hygiene.

(c) Employment of sufficient number of public health nurses to do home visiting and to give instruction to expectant mothers in hygiene of pregnancy and early infancy; to make visits and to care for patient in confinement; and to see that every infant is referred to a children's health center.

(d) Confinement in a hospital or at home by a physician or a properly trained and qualified attendant.

(e) Hospital care or nursing service at home at the time of confinement and during the lying-in period.

(f) Daily visits for five days, and at least two other visits during second week by physician or nurse.

(g) At least ten days' rest in bed after a normal delivery, with sufficient household service for four to six weeks to allow mother to recuperate.

(h) Examination by physician six weeks after delivery before discharging patient.

(Where these centers have not yet been established, as many as possible of the provisions here enumerated should be carried out by the community nurse, under the direction of the health officer or local physician.)

2. Clinics, such as dental clinics and venereal disease clinics, for needed treatment during pregnancy.

3. Maternity hospitals, or maternity wards in general hospitals, sufficient to provide care in all complicated cases and for all women wishing hospital care; free or part-payment obstetrical care to be provided in every necessitous case at home or in a hospital.

4. All midwives to be required by law to show adequate training, and to be licensed and supervised.

5. Adequate income to allow the mother to remain in the home through the nursing period.

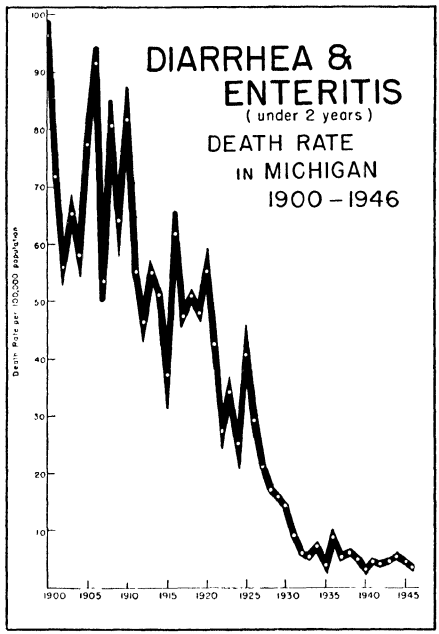
6. Education of general public to problems presented by maternal and infant mortality and their solution.

THE INFANT

Infancy is the first year of a child's life. It is a period fraught with great dangers. At no other year in life until extreme old age is the death rate so high. Sir Arthur Newsholme said: "Infant mortality is the most sensitive index we possess of social wel-

fare. If babies were well born and well cared for, their mortality would be negligible."

The general trend of infant mortality in the United States has been downward during the past quarter century and more. The rate varies in different communities, depending on the extent to which hygienic and sanitary practices are carried on by the people and on the economic status of the population. The drop in the infant death rate reflected in the following table is typical of what has taken place over the country.



(Michigan Department of Health)

The chief causes of infant deaths are those that can be controlled by intelligent care of the infant and the mother. Prematurity, acute respiratory diseases, acute gastrointestinal disease, and congenital debility lead the list of specific causes of death. State health departments help to make baby incubators available for infants born prematurely; and constant progress is being made in reducing the amount of communicable disease.

A relatively rare hemolytic disease of the newborn, erythroblastosis fetalis, has been found to be due to an inherited mendelian factor, called the Rh factor (so named from the Rhesus monkey used experimentally). Over 85 per cent of the population are Rh positive. There is danger only when an Rh-positive man marries an Rh-negative woman. The first child of such a marriage is usually normal, but while the fetus is in the uterus the Rh substance passes through the placental membrane and sensitizes the mother who produces antibodies against it. These antibodies are capable of destroying the red blood cells of Rh-positive blood. If the mother developes a large amount of antibody, children from succeeding pregnancies may develop anemia directly after birth.

INFANT MORTALITY RATES IN NEW YORK CITY (1900-1945)

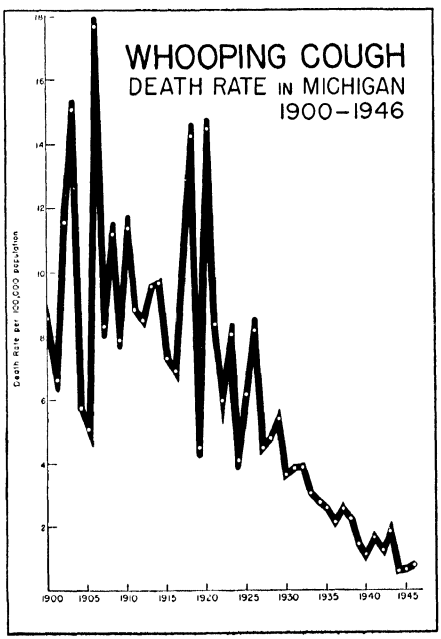
YEAR	NUMBER DEATHS UNDER ONE YEAR PER 1,000 LIVE BIRTHS
1900	135
1905	122
1910	113
1915	98
1920	85
1925	64
1930	57
1935	48
1940	35
1945	30

If the condition is known, the infant may be successfully treated by prompt blood transfusion, using blood from an Rh-negative person. If a woman has repeated abortions her blood and that of her husband should be tested for Rh factor. Many hospitals test for this factor routinely in cases of pregnancy.

The hygienic practices particularly needed by the infant are feeding, rest, and cleanliness. The formation of correct habits, almost from the time of birth, is important to the child's physical and emotional health. During the first months, when the "flame of life is feeble" and most rapid growth is taking place, it is exceedingly important that the mother learn from her physician, from the health center, or from literature on infant hygiene, the essentials in caring for her baby.

Feeding the Infant.—Breast feeding is always preferable to bottle feeding if the mother is properly nourished and is able to supply sufficient milk. It should be remembered, however, that a deficient maternal diet may seriously interfere with the quality of mother's milk.

In the United States there are four deaths among bottle-fed babies to one death among breast-fed babies. The possibilities of infection and of digestive disturbances are greatly increased with the necessity of handling bottles. The greatest of care is needed in keeping bottles sterilized.



(Michigan Department of Health)

If cow's milk is used, it should be pasteurized and given subsequent protection from contamination. Pasteurizing requires little special equipment and can readily be done in the home, if necessary. There are some chances of imperfect pasteurization under home conditions, however, and it is much safer to bring the milk to the boiling point for one minute. Such milk should be cooled

again quickly. Boiling for one minute is just as effective as pasteurization and tends to make the milk easier to digest.

The table on page 50 shows the quantitative (but not the qualitative) differences in the protein, carbohydrate, and fat content of cow's milk and human milk. Cow's milk must be modified to make it suitable for infant feeding. When using dried milk instead of the fresh, it is important to select whole milk. Skim milk lacks the butter fat required by the baby. Unsweetened evaporated milk should be used in preference to condensed milk to which sugar has been added. The evaporated milk is an excellent food that can be properly modified.

Infant Care.—Babies should be weighed regularly and their feeding directed by those who, by experience and training, are best qualified. The introduction at the appropriate time of supplementary foods such as orange juice, cod-liver oil, egg yolk, and vegetables to the diet of both the breast-fed and the bottle-fed baby is important. The feedings must be carefully regulated according to the age of the infant. Unless supplementary food is given, there is danger of rickets or scurvy in varying degrees. Undisturbed rest, fresh air, sunshine, and loving care are important to the welfare of the infant.

The young infant should be vaccinated against smallpox before he is a year old regardless of whether or not smallpox is prevalent. Immunization against diphtheria, tetanus, and whooping cough are usually given at the age of six months or soon thereafter. Six months later the Schick test should be given to determine whether protection against diphtheria has been established.

At the time of birth the baby's eyes are treated with two drops of 1 per cent silver nitrate solution to prevent ophthalmia neonatorum, or babies' sore eyes, which may cause blindness.

Measles and whooping cough are both highly fatal in infancy. Children should always be protected from exposure as long as possible. As indicated a vaccine is being used successfully against whooping cough. In the case of measles if the baby is inoculated within a week after exposure with serum from a person who has recovered from measles, the disease can be prevented or made very mild. Gamma globulin is very effective in preventing or modifying measles. This is prepared as a clear colorless solution of

the protein substances from human blood which contain the immune bodies against infectious disease. It appears to be of value also in preventing whooping cough, complications from mumps in adults, and possibly some other infections.

Babies should be kept away from any person who has tuberculosis, even though it be the father or mother. They should be protected from anyone with a chronic cough, since this may be unrecognized tuberculosis. Babies are very susceptible to colds and should be isolated from any person with one. Acute respiratory disease is always a leading cause of infant deaths. Care should be taken to avoid all possibility of conveying germs from the nose or mouth to the baby, since some persons carry infection although they show no symptoms.

Caring for a baby is so important that it requires not only intelligence but also preparation and guidance. In this chapter we have indicated only a few of the problems that require attention. The aid of the physician or the health department of city or state should be sought. These agencies have available a wealth of excellent literature.

Community Standards of Child Welfare.—The duty of the community is set forth by the Children's Bureau in the following set



The visiting nurse teaches infant care to the mother in the home. (Courtesy National Organization for Public Health Nursing.)

of standards for child welfare relating to infants and preschool children:

1. Complete birth registration by adequate legislation requiring reporting within three days after birth.

2. Prevention of infantile blindness by making and enforcing adequate laws for treatment of eyes of every infant at birth and supervision of all positive cases.

3. Sufficient number of children's health centers to give health instruction under medical supervision for all infants and children not under the care of a private physician, and to give instruction to mothers in breast feeding and in care and feeding of children, at least once a month throughout the first year, and at regular intervals throughout preschool age. This center to include a nutrition and dental clinic.

4. Children's health center to provide or to cooperate with sufficient number of public health nurses to make home visits to all infants and children of preschool age needing care—one public health nurse for an average general population of 2,000. Visits to the home are for the purpose of instructing the mother in—

(a) Value of breast feeding.

(b) Technic of nursing.

(c) Technic of bath, sleep, clothing, ventilation, and general care of the baby, with demonstrations.

(d) Preparation and technic of artificial feeding.

(e) Dietary essentials and selection of food for the infant and for older children.

(f) Prevention of disease in children.

5. Dental clinics; eye, ear, nose, and throat clinics; venereal disease clinics; and other clinics for the treatment of defects and disease.

6. Children's hospitals, or beds in general hospitals, or provision for medical and nursing care at home, sufficient to care for all sick infants and young children.

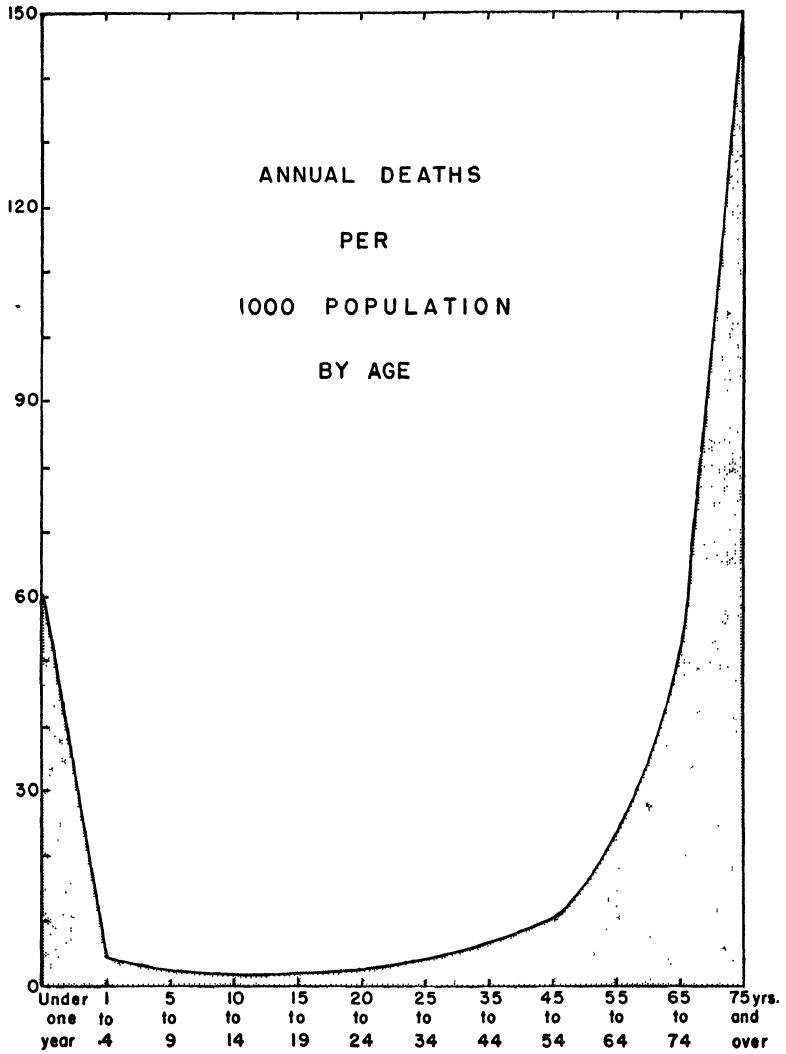
7. State licensing and supervision of child-caring institutions or homes in which infants or young children are cared for.

8. General educational work in prevention of communicable disease and in hygiene and feeding of infants and young children.

It will be interesting for the student to investigate the extent to which these standards are met by his own community.

THE PRESCHOOL CHILD

The preschool child is the child from one to six. This is a time when habits that are vital in the mental and physical life of the child are being formed for good or ill. Because the child is able to run about, he is more independent than the infant, and hence



Death rates at different ages. Note the shape of the curve and the relatively high death rates in infancy and old age.

more difficult to care for. Much time is required to give him the necessary training. Unfortunately, this is not always provided. The preschool age is sometimes called the "neglected age."

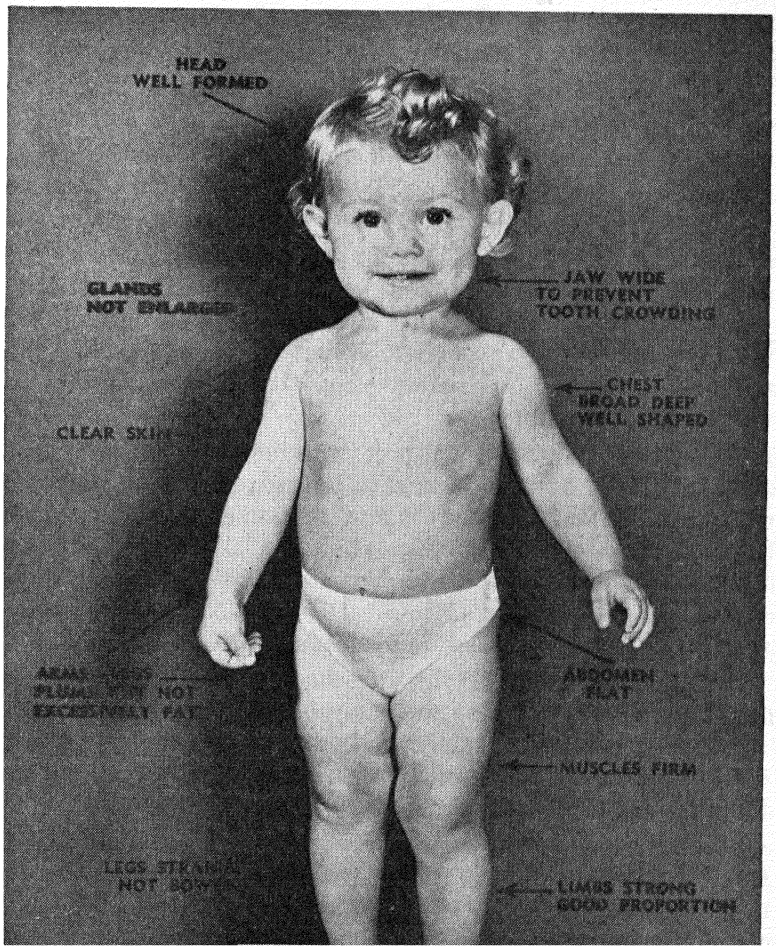
The Health Program for the Preschool Child.—A glance at the chart giving distribution of deaths by ages shows that the death rates for the preschool child are much lower than those for infancy. Nevertheless, supervision by a physician is necessary not only to keep the child well but also to insure his proper development. A health examination twice a year by a doctor who has had experience in the care of children will enable the parent to learn of any abnormalities that need attention; to know whether the child is growing properly; and to determine whether his nutritional needs are being amply met. Deviation from normal in eyesight or in hearing can be most satisfactorily corrected if found and treated before the age of 6. Defects of adenoids and tonsils need medical attention to see whether they should be removed.

The dentist should watch the growth of the teeth, clean them, and fill cavities. The deciduous teeth are very important in the development of a normal jaw and in bringing in the permanent teeth with proper alignment. It is a mistake to allow these to be neglected on the score that they are only "temporary" teeth. The term "temporary teeth" is no longer regarded by the dental profession as a desirable one in view of the great importance of these teeth in normal growth. A visit to the dentist every six months or as often as the dentist deems necessary is important from the time the child is 2 years old.

In addition to this expert aid from the physician and dentist, the child should have a well-planned regimen with attention to diet, sleep, play, and exercise in the sunshine. He should also be guided in the formation of good habits with regard to cleanliness and elimination.

Communicable diseases usually show a higher fatality during infancy and the preschool period than later in life. So far as possible the child should be protected from them. Each year that they are postponed increases his chance of complete recovery.

Persons who are sick should keep away from young children. The common cold, often discounted as "only" a cold, may have


HEAD
WELL FORMED
GLANDS
NOT ENLARGED
CLEAR SKIN
JAW WIDE
TO PREVENT
TOOTH CROWDING
CHEST
BROAD DEEP
WELL SHAPED
ABDOMEN
FLAT
MUSCLES FIRM
LIMBS STRONG
GOOD PROPORTION