Bogert's

Nutrition and Physical Fitness

TENTH EDITION

GEORGE M. BRIGGS, Ph.D.
DORIS HOWES CALLOWAY, Ph.D.

Bogert's

Nutrition and Physical Fitness

TENTH EDITION

GEORGE M. BRIGGS, Ph.D.

Professor of Nutrition
Department of Nutritional Sciences
University of California at Berkeley

DORIS HOWES CALLOWAY, Ph.D.

Professor of Nutrition
Department of Nutritional Sciences
University of California at Berkeley

W. B. SAUNDERS COMPANY

PHILADELPHIA • LONDON • TORONTO

W. B. Saunders Company: West Washington Square
Philadelphia, Pa. 19105

1 St. Anne's Road
Eastbourne, East Sussex BN21 3UN, England

1 Goldthorne Avenue
Toronto, Ontario M8Z 5T9, Canada

Library of Congress Cataloging in Publication Data

Briggs, George McSpadden, 1919–

Nutrition and physical fitness.

Ninth ed., published in 1973, by L. J. Bogert, G. M. Briggs, and D. H. Calloway.

Includes bibliographies and index.

1. Nutrition. I. Calloway, Doris Howes, joint author. II. Bogert, L. Jean, 1888–1970. Nutrition and physical fitness. III. Title.

TX354.B6 1979 641.1 78–21302

ISBN 0–7216–1987–8

Cover illustration courtesy of Four By Five, Inc., New York, N.Y.

Bogert's Nutrition and Physical Fitness ISBN 0-7216-1987-8

Last digit is the print number: 9 8 7 6 5 4 3 2

Preface

The overall aim of this tenth edition is to provide the student, in as simple and interesting a manner as possible, with sufficient knowledge about foods and nutrition for development of good eating habits. This knowledge, along with other good health practices, will greatly help one to have a healthy and vigorous life now and over a lifetime. This has been the overall aim since the first edition was written by the late Dr. L. Jean Bogert in 1931, about *fifty years* ago. Since that time each edition has not only included the years of cumulated experience of, and experimentation by, the authors and the discoveries of nutritionists throughout the world, but also has benefited greatly by suggestions which have come from teachers and students.

The book is written primarily for college students taking their first course in nutrition. It is written so that it may be useful and readily understood not only by the food, dietetics, and nutrition majors, but also by nonmajor students who are interested in what to eat for a healthy life but who are in other fields such as health sciences, mathematics, physical education, history, English, chemistry, agriculture, sociology, humanities, and other nonnutrition areas.

The book does not require the student to have knowledge of biology, chemistry, or biochemistry (though such subjects will be of help to students majoring in foods and nutrition or such fields as health sciences, and the like). Portions of the book which are useful to students with a biology background are given in smaller type, such as in Chapters 7 to 12, and could be omitted when the text is used by nonscience majors or the interested lay person. Formulas are given in the appendix rather than the text for the most part.

Fortunately, because of increased emphasis on science in secondary schools, most present-day college students have already acquired some knowledge of fundamental scientific terms and concepts through courses (general science, biology, chemistry, physics) in high school or even at grade school levels. Hence, college students may be expected to comprehend a presentation of nutrition which relies on an elementary understanding of science.

We firmly believe that only by thoroughly knowing basic facts about foods and nutrition can one build a real understanding of applied nutrition topics and the ability to sort out and accept new developments certain to come along in this field. Only with a strong background can one learn to handle by one's self new claims, fads, and even frauds which continually reach the mass media. This, for instance, is why the first half of the book is primarily a presentation of the "basic facts."

Research in nutrition has concentrated more and more on the study of the basic life processes—the chemistry of the cell, the chemical changes that take place in the various tissues, and the role of enzymes, vitamins, and mineral elements in catalyzing these processes. This deeper inquiry into the need for and functions of the various nutrients is often a team effort, involving the collaboration of biochemists with physiologists and microbiologists. Looking at the vast amount of data and numerous fundamental discoveries which have been accumulated by this type of research, it becomes apparent that even though this material may be somewhat difficult to translate into terms which are understandable to less advanced college students, it cannot be ignored; to

be as meaningful as it should be, nutrition must be treated in greater depth than was formerly the case.

The dependence upon the scientific method for providing proven facts about foods and nutrition is often a difficult concept for today's student to accept. Though we could not exist in America without a responsible food industry, the student today has seen evidence of certain segments of the food industry putting the consumer at the low end of the priority list. The student has learned, rightly or wrongly, to mistrust certain intentional food additives, highly processed foods, foods treated with "synthetic chemicals," certain food advertising, high food prices, and even college teachers of a different generation. We recommend that teachers using this book in classes comprised mainly of nonscience-trained students spend the first few days or so of class discussing the meaning of science, the scientific method, a controlled experiment, the placebo, and the difference between a true scientific publication (with its system of peer review) and a scare magazine or newspaper article. (Chapter 1 will assist you somewhat in this.)

Many improvements have been made in this edition, including the addition of Chapter 18, Food Nonnutrients, Enrichment, and Labels, and Chapter 25, Malnutrition: A Global Perspective. Extensive revisions have been made throughout the text with much totally new material on the basic nutrients—amino acids, carbohydrates, fiber, energy concepts, vitamins, and minerals. The subject of alcohol has been expanded. The applied nutrition section is greatly improved and consolidated. In these sections especially we have focused directly on nutrition problems existing today that concern students' own lives and future careers.

One of the greatest strengths of this book, we feel, is that current issues and references to the literature are as accurate and up to date as possible within publication time lags. We have supplied a list of "additional readings" in the current literature that should be readily accessible for use by the student interested in gaining more information about a subject than can be found in the book (which, because it is introductory, must necessarily leave out many important facts). These literature citations will provide important leads for student projects. Each edition, because of space, must eliminate most of the older readings. Teachers interested in older literature citations will find it useful to keep older editions for this purpose.

Nutrition as a field is a constantly evolving and controversial topic because of its essentiality to physical fitness and health, because of its economic, ecological, and environmental aspects, and because of the use of food to provide political influence. No textbook can contain the latest information on all nutrition and food topics. We suggest, therefore, that teachers and students wanting the newest information make widespread use of current literature and of the periodicals and agencies listed at the end of Chapter 1. One will need to keep abreast of information on newer Recommended Dietary/Nutrient Allowances as they appear. We suggest especially current issues of such useful publications as the Journal of the American Dietetic Association, American Journal of Clinical Nutrition, CNI Weekly, Journal of Nutrition Education, Journal of Home Economics, New England Journal of Medicine, and the American Journal of Public Health.

We are pleased that instructors' guides for the teacher and study guides for the student are available for this edition of the textbook. We recommend the use of any such reliable guides, but especially those prepared by Kay Franz and Ruth Walker, available from the W. B. Saunders Company.

We have attempted, as did Dr. Bogert, not to straddle the fence on controversial issues but to give our informed opinion on such issues when valid information exists. We hope you will find the book better able to meet your needs than ever before. Your comments are always most welcome.

GEORGE M. BRIGGS
DORIS HOWES CALLOWAY

Acknowledgments

The authors are indebted to many persons who have helped in one way or another in making it possible for this tenth edition to be published. Suggestions from teachers, teaching assistants, and students who have used earlier editions have been especially helpful. We appreciate, too, the help of a number of persons at the W. B. Saunders Company, including Robert E. Lakemacher, Richard H. Lampert (who made the early arrangements), and the copy editor, designer, indexer, artists, printers, proofreaders, and still others who have worked exceedingly well.

The manuscript has been typed by Mrs. Beatrice Myers and Mrs. Joyce Booth, who have also given much help in proofreading and other especially detailed work with references and readings. We are particularly indebted to those who have had a major role in the preparation of various chapters, including: Dr. Marilyn Crim (Chapter 15), Dr. Christine Wilson, Ms. Susan McKeehan (Chapter 18, as well as help with certain other sections), Catherine Briggs, M.D. (Chapters 21 and 23), Mr. Leonard Joy (Chapter 25), and Dr. John Tarr (Chapter 8). Much assistance has been given also by Mrs. Lori Moore with Chapter 9, Dr. Diane Bray with Chapter 11, Dr. Judy Turnland with Chapter 12, Mrs. Joyce Booth with the revision of Chapter 16, and Ms. Karen MacEwan with Chapter 17. Ms. Elena Garcia has provided much assistance with the literature citations.

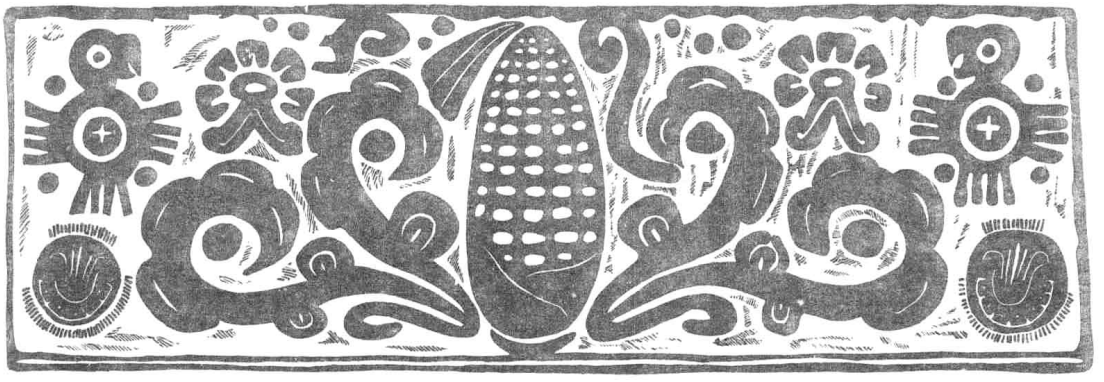
We acknowledge, also, the additional help in reading and proofreading various portions from Mrs. Eleanor Briggs and Ms. Marilyn Briggs. Our thanks, too, go to those who supplied photographs and other material for the text.

GEORGE M. BRIGGS
DORIS HOWES CALLOWAY

Contents

Part 1

Nutrients and Their Functions



Chapter 1

Food and Its Relation to Physical Fitness

Why do we need to eat? What should we eat? The answers to these questions are what nutrition — and this book — is all about.

The foods we eat contain 42 to 44 highly important substances (the "nutrients") *that each of us must consume in adequate amounts in order to have energy, grow, reproduce, and lead a full healthy life*. The water we drink, another form of food, and the oxygen of the air we breathe are equally essential.

From these rather few essential nutrients that we must get from a source outside the body, our body tissues make literally thousands of substances essential for life and good physical fitness. Most of these substances are far more complicated in structure than the original nutrients. If our bodies could manufacture, in some manner, these essential nutrients that we now get from our food, we would not have to eat at all.

But, of course, this is impossible. In common with green plants and all other forms of life, we must be provided first with water plus 18 or so minerals from some outside source (see Chapters 10 to 12). However, our bodies are more specialized than green plants. We must breathe oxygen, and we must get from our food 24 or more additional nutrients in order to have normal human life and physical fitness as we know it. These additional nutrients (the vitamins, amino acids, fats, and probably several carbohydrates for energy and roughage) are, with few exceptions, rather simple organic chemicals. They are present in foods as part of thousands of organic substances that plants make for themselves, only a few of which are essential for the human body.

These essential nutrients provide fuel, catalysts, and machinery so that we can grow, move about, see, hear, taste, smell, feel, speak, think, learn and remember, sing, walk, run, play, enjoy pleasures, argue, make decisions, love, and be innovative and creative. All of these things, and more, are possible only if we first consume in our food at least minimal amounts of each of the 42 to 44 essential nutrients in some form or another on a regular basis. If an inadequate amount is eaten, or too much of some, these functions will be impaired. Life itself is dependent on what we eat.

Nutrition, then, may be defined as *the science of food as it relates to optimal health and performance.*

Each of us is, or should be, vitally interested in promoting or protecting our own health, since upon it depends our

well-being, our work capacity, and even our length of life. How we choose our food, as well as how and where we choose to eat, also affects our budget, our environment, and our social and cultural life. Nutrition is more than just eating the right nutrients — as a field of study it has physiological, biochemical, and behavioral aspects, and reaches into the realms of agriculture, food technology, medicine, economics, ecology, business, politics, and international stability.

Why Study Nutrition?

The rapidly developing science of nutrition has accumulated a mass of facts about how foods are used for building healthy bodies, and what constitutes the best type of diet, within budget limitations.

Some knowledge of the basic facts of nutrition is helpful to anyone who has to make food choices. A more detailed and scientific background of knowledge is essential for those who have the responsibility of feeding others and for those participating in health education — such as homemakers, nurses, doctors, dentists, elementary school teachers, home economists, social workers, health and physical education teachers, extension workers in the field of nutrition, public health workers, food scientists, food industry and advertising personnel, food policy makers, and managers of public eating places and school lunchrooms. Complete training and up-to-date knowledge of nutrition is required by nutritionists at all levels, such as teachers of nutrition, public health nutritionists, dietitians, and nutritional scientists in public and private institutions.

People in the United Nations food and health agencies are concerned with attempting to bring more of the right kinds of food to countries all over the world, many of whose people now exist at a semistarvation level. It should be clear to all, including our national leaders, that no country can achieve the vigor essential for economic, social, and political stability without adequate nutrition for all its people.

People in countries such as our own, with a plentiful supply of a wide variety of foods, do not necessarily choose the right kind and amount of food to eat. Good health resulting from good nutrition cannot be taken for granted. Signs of malnutrition, hunger, and poor eating practices exist all around us. Many of our health problems stem from overeating or from eating too freely of certain types of food (sugar, fats, and alcohol) at the expense of better and lower-calorie foods. This contributes to overweight and the diseases that are often associated with it (diabetes, high blood pressure, heart disease, etc. — see Chapter 24).

Moreover, although proper nutrition provides an essential basis for health, good health also depends on one's lifestyle, heredity, environment, and freedom from disease and accidents. Infection, disease, stress, emotional instability, excessive drugs and alcohol, smoking, and lack of exercise may counterbalance the effects of a good diet. Persons who do not eat luxuriously but whose mode of life involves more exercise may often be more healthy. Less physical work in factory and home, together with the almost universal use of the automobile for getting about, results in the average American getting less exercise than formerly. A survey of pupils in New York City public schools has served to point up the need for regular programs to improve physical fitness. Nearly a third of the pupils failed to qualify at initial testing, but after about 6 weeks of the physical activity program, nearly two-thirds of those who had previously failed were now able to qualify.[1] The young respond quickly to the right conditions; unfortunately, the reconditioning of a sedentary and perhaps overweight adult is of necessity a slower and more gradual process.

Good Nutrition and Good Health

It is true that in many parts of the world peoples who know little or nothing of the science of nutrition have subsisted for generations on diets that maintained strong bodies. Sometimes, with even a limited variety of foods, those available were such that all the requirements for good nutrition were provided. Other primitive peoples were not so fortunate; either the food supply was inadequate or the cultural habits prompted selection of foods that resulted in an improperly balanced diet lacking some factors necessary for growth and health.

McCarrison made some early studies on diets used in different sections of India and their relation to the health of the respective tribes.[2] In the southern sections of the country, the diet consisted chiefly of milled rice, fruits, and vegetables, with little flesh foods or milk; these peoples were of smaller size and inferior strength, and were short-lived, as well. The peoples of tribes farther north, who used unmilled millet or wheat along with goats' milk and butter, had splendid physiques and enough stamina to make good soldiers. In remote sections of the Himalaya Mountains, people were found whose frugal diet was made up mostly of apricots (sun-dried for winter use), vegetables, and goats' milk, with meat eaten only on feast days; these peoples were unusually strong, healthy, and long-lived.

The long-lived Balkan peoples eat little meat, but use whole-grain cereals, cheeses, and the fermented milk known as koumiss. Studies of African tribes have shown that, of two tribes living not far apart, one may have relatively large-sized and healthy bodies, while the other may have bodies that are puny and disease-ridden owing to defective diet[3], though genetic differences may also exist. The diet of many poorer classes in Central and South American countries often comes almost entirely from beans and corn. On such a diet, young children, after weaning, often develop severe nutritional deficiency symptoms, and those who manage to survive may never reach their normal growth potential (Fig. 1–1).

In extensive studies on undernutrition, Keys and coworkers,[4] in classic studies on human volunteers in World War II, showed that changes in behavior and work capacity result from prolonged underfeeding. Today, hundreds of research studies are being conducted in many countries on animals and man that demonstrate clearly that inadequate nutrition can result in lowered intelligence, poor mental health, abnormal behavior, damage to nerve and brain tissue, and poor physical fitness.[4, 5]

Malnutrition Still Widespread Throughout the World

Malnutrition is a term widely used to mean *faulty or poor nutrition in all of its aspects, whether from inadequate intake of nutrients or overconsumption of foods.*

In spite of years of accumulated knowledge of the importance of adequate food and of good nutrition for the health of people, hunger and malnutrition exist throughout the world — even in the so-called "developed" countries.

In the United States, typical of many highly industrialized countries, the nutritional situation is little better today than it was 10 or 20 years ago, if at all.[6] At least 30 percent of the United States population have diets that fail to measure up to standards for one or more nutrients, especially iron, calcium, vitamin A, vitamin C, riboflavin, and calories. Malnutrition can show up as anemia or obesity, or in close association with diseases related to poor nutrition, such as those of the circulatory system (heart disease, hypertension, stroke, etc.), diabetes, severe dental and periodontal disease, digestive diseases, and alcoholism. Especially vulnerable to malnutrition are young children, adolescents, pregnant women, families of the poor, handicapped persons, alcoholics,

Figure 1–1 A group of Guatemalan boys, showing stunted growth caused by the inadequate native diet, as compared with two boys of the same racial stock who had superior type diet and are of normal weight and height for their age. The boy at left (normal) is 4½ years old, while the four boys next to him range from 5 to 7 years of age. The boy third from right is nearly 7 years old and is of normal height; the three smaller boys beside him are 7–8 and the two boys to his right (approx. same height) are 11 and 12 years old. (Courtesy Dr. Miguel A. Guzmán, Institute of Nutrition for Central America and Panama.)

and people over 65 years of age. Many billions of dollars are wasted each year in the United States from misuse of food.

Our situation in the United States is not much different from most other industrialized countries, such as Canada, the European countries, Australia, and Japan. However, the prevalence of hunger and malnutrition is still much more widespread in most of the nonindustrialized and the developing countries — especially those in the tropical areas of South and Central America and the West Indies, in Africa, in India, and in many other Asian countries, including the numerous islands from the Philippines to New Guinea and the East Indies. In some of these countries hunger unfortunately is widespread. Effects of malnutrition are common, including blindness from vitamin A deficiency, anemia, scurvy, and poor growth of babies and children due to deficiencies of protein, calories, and many other nutrients (Fig. 1–2). Eventually chronic malnutrition in a society can be a direct or indirect cause of high mortality figures at all age levels.

Many national and international groups — such as the World Health Organization (WHO), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and the Food and Agricultural Organization (FAO) of the United Nations — and many public and private groups are attempting to solve the world malnutrition problem, but the task is immense (see list of supplementary readings at the end of this chapter and Chapter 25).

Factors Affecting What We Eat

Our food habits often stem from prejudices acquired in childhood, either from parental examples or from childish

whims that are indulged. *Education* that explains why foods selected should include those needed to supply all the essentials for an adequate diet will provide *motivation* to change old food habits for new ones. This is expecially true when food habits in the home are based on cultural or religious practice. *Deeply rooted food habits*, if bad, can often be overcome by suggesting that larger amounts of certain liked or permitted foods be taken or that new foods be prepared in favorite or familiar styles. *Diet fads and advertising* may also induce a person to subsist on unbalanced diets that furnish too little of certain essential nutrients. The foods we eat are also determined by what we can afford to buy — our *economic* condition.

Complacency, or indifference, is also a strong factor working against change of food habits. Unless a person has a vision of the greater vitality to be attained by improving his food habits, he is apt to believe that he is well enough off as he is. There must be education as to why certain foods are essential for health. Remote goals, including longevity, can strongly influence choice of foods in the diet. With teenagers and young adults, a more immediate objective, such as the physical prowess, athletic ability, and good looks that are associated with buoyant health, may prove more effective in stimulating interest in good food habits. Young college women, as prospective mothers, should be vitally interested in good diets to safeguard their own health and that of their children; instead, they are often careless in eating habits or follow *reducing fads* in order to retain slender figures.

One of the aims of nutrition should be to prolong the vitality of the prime of life into later years. There is still much room for dietary improvement, provided nutritional teaching can convince people that alteration of their dietary habits is worthwhile.

Basic Causes of Hunger and Malnutrition

Why is there so much malnutrition in the supposedly enlightened world of today? Poor food habits and lack of nutrition knowledge are but two reasons. To summarize, a list of basic causes of mal-

Figure 1–2 Sad and listless, these children show all the signs of advanced malnutrition. Scene is the Southern Islands General Hospital in Cebu, the Philippines. (Courtesy of UNICEF and Mallica Vajrathon. Used with permission.)

nutrition in modern industrial countries includes such factors as:

1. Lack of adequate *nutrition education* in schools and in the home; poor or faulty nutrition knowledge.

2. Complacency, indifference, and poor or misdirected *motivation* to eat properly; lack of goals.

3. *Deeply rooted poor food habits* based on cultural, social, or religious practices; changes in life-styles.

4. *Diet fads* based on unsound nutrition practices.

5. *Unavailability of adequate food* due to poverty, distance from markets, inability to choose or purchase foods for oneself as in the case of those dependent on others (infants, children, severely handicapped persons, and the aged).

6. *Widespread availability of good-tasting, low-value foods*, usually highly processed and containing chiefly energy. Often these are the most heavily advertised.

7. *Inadequate recognition of the importance of good nutrition* by local, state, and national leaders.

8. *Inadequate nutrition training* of physicians, other health professionals, teachers, social workers, food editors of newspapers, and nutrition writers.

You can, no doubt, think of still other reasons for the presence of malnutrition in your own community. Such factors as peer pressures to consume poor foods, improper food labeling, lack of home gardens, ease of obtaining poor foods and candy in vending machines and at store counters and fast-food service establishments, lack of adequately prepared meals in the home, skipped breakfasts and other meals, the low incidence of breast feeding, poor snacking habits, the widespread availability of inferior imitation and fabricated foods, lack of a national food policy (including inadequate enrichment standards and insufficient public service messages on television), and lack of physical activity are all related to poor nutrition.

In developing countries of the world there are many other causes of malnutrition, including *prevailing poverty, overpopulation, illiteracy, social deprivation, poor sanitation and disease, indifference, and the "inability to cope."* Persons working to combat malnutrition in the United States or any place in the world will recognize that working toward the reversal of these causes of malnutrition is necessary if we are ever going to have healthy nations.

Food Is a Basic Human Right

Having sufficient food is a basic need of all individuals — probably more basic than any other human need. Most modern countries, including our own, consider *having sufficient food as a basic human right*. More human effort, on a world basis, goes toward the production, processing, marketing, and consumption of food than toward any other human need, and rightly so.

Functions of Food

We have defined nutrition earlier as the science of food as it relates to optimal health and performance — that is, providing adequately for the body's *growth, maintenance, repair,* and *reproduction*. Except for the *water* we drink and oxygen taken in from the air we breathe, the needs of the body must be met by the intake of foods. To nourish the body and to qualify as a food, foods must contain substances that *function* in one or more of *three* ways:

1. Furnish body fuel, substances whose oxidation in the body sets free the *energy* needed for its activities;

2. Provide materials for the *building* or *maintenance* of body *tissues;* and

3. Supply substances that act to *regulate body processes*.

An individual food may fulfill all three of these functions or only one, but all three functions must be served by the diet as a whole in order to maintain the

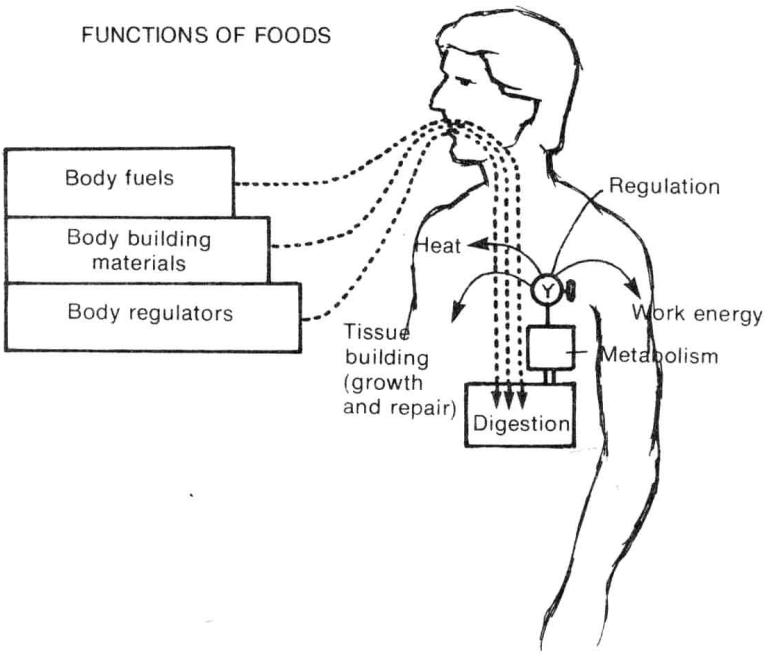


Figure 1–3 Diagram summarizing the functions of foods. To qualify as a food, it must provide substances that act as body fuel to provide energy, serve to build or maintain body tissues, or act as regulators of body processes. Many foods contain substances that serve all three purposes.

body in health. Most foods can fulfill more than one function because they are *mixtures* of a number of chemical substances (see Fig. 1–3).

Other important functions of food, though not essential, are to satisfy our individual requirements of taste, to combat temporary hunger pangs, and to fill certain social needs (discussed in later chapters).

Essential Nutrients

Six general classes, or *kinds of nutrients* found in foods, that are necessary to the body are:

1. Carbohydrates
2. Fats
3. Proteins (amino acids)
4. Vitamins
5. Minerals
6. Water

Carbohydrates, fats, and proteins are often spoken of as the fuel or *energy nutrients*, since they are the only substances that the body can use to supply energy for work and heat. They belong to the great division of chemical substances known as *organic* compounds, which contain *carbon* and are combustible. The *mineral elements* and *water* are sometimes called *inorganic nutrients*, since they do not contain carbon.

Proteins, minerals, and water all enter into the composition of body tissues, and hence are necessary for *building* new *tissues* or repair of those already built. *Vitamins* are chemically diverse organic substances which occur in minute quantities in foods but are essential for normal growth and health. Certain ones may be built into or stored in the tissues, but their chief function is to serve in regulating body processes. Mineral salts and vitamins act as *body regulators* by promoting oxidative processes, normal functioning of nerves and muscles, and vitality of tissues, and are of assistance in many other bodily functions. Water also serves as an important regulating substance in the body. It holds substances in solution in the digestive juices, blood, and tissues, and aids in regulation of body temperature, excretion, circulation, and many other body processes. Vegetable fiber acts along with water to promote intestinal elimination.

The three energy nutrients — carbohydrates, fats, and proteins — can be used