

Essentials of Nutrition and Diet Therapy



Sixth Edition

Sue Rodwell Williams

Essentials of Nutrition and Diet Therapy

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PREFACE

Through five previous editions, this compact “little” book has served the needs of students and teachers in the health sciences in many colleges and universities and has provided a sound but simple reference for busy practitioners. In truth, in all its editions, it has captured and distilled the essence of my larger, more comprehensive textbook, *Nutrition and Diet Therapy*, to lay a faithful foundation for further study and practice.

In this new sixth edition I have adhered to these same fundamental goals. But as in the previous completely reformatted edition, here I have rewritten much of the material to reflect a rapidly developing science and society. Thus its expanded current material and its organization continue to meet the more comprehensive needs of beginning students in the allied health professions today. All the while, it retains its sound, simple, substantive content, thoroughly updated and realistically applied to meet human health needs in our rapidly changing world.

New to this Edition

As indicated, this book is in essence an abridgement of my larger text. It follows a similar format and style to facilitate learning and lay a beginning foundation for sound clinical practice. To achieve these goals in this current edition, I have made a number of changes:

New Chapters. Several new chapters apply the expanding science of nutrition to changing health care needs and developing technologic tools for its clinical practice and management. I have included two new chapters to help meet current practice needs: Chapter 18, Feeding Methods: Enteral and Parenteral Nutrition, to update and expand information about these rapidly developing means of special nutrition support; and Chapter 24, Nutrition and AIDS, to provide current coverage of the special nutritional needs of the rapidly growing number of HIV-infected and AIDS patients worldwide.

New Chapter Order and Coordination. Several chapters have been repositioned or combined to aid learning and reflect current science and practice.

Chapter 2, Digestion, Absorption, and Metabolism,

has been repositioned before the chapters on the macronutrients—carbohydrates, fats, and proteins—at the request of teachers and students using this beginning text, to provide basic knowledge of the body systems involved.

Chapter 6, Energy Balance and Weight Management, combines two topics previously treated in separate chapters for a better understanding of their basic relationship in practice.

Chapter 13, Nutrition for Adults: Early, Middle, and Later Years, provides a more balanced and comprehensive view of the varying needs of adults at different age periods, rather than the previous limited focus mainly on the aged, to better reflect the current health care emphasis on health maintenance and disease prevention.

Chapter 19, Gastrointestinal Diseases, has been expanded to include increased current knowledge and changes in nutritional management of problems of the gastrointestinal tract and its accessory organs. For example, new knowledge has changed the treatment of peptic ulcer disease; discovery of the cystic fibrosis gene and its biochemical mechanism effect on pancreatic secretions has changed treatment of the resulting pancreatic insufficiency and malabsorption; and advancing knowledge of viruses causing liver disease has led to new vaccines and reinforced nutritional care of the various stages of the disease, including advanced cirrhosis and encephalopathy.

Chapter 20, Diseases of the Heart, Blood Vessels, and Lungs, has been rewritten and renamed to reflect the coordinated functions of each component of the overall circulatory system and newly discovered unique actions of system sections, such as the role of the arterial vessels’ inner endothelial lining in controlling hypertension.

Chapter 26, Nutrition Support in Disabling Disease and Rehabilitation, has been rewritten and expanded to include late-breaking news of current discoveries, treatment, and rehabilitative care in the fields of *musculoskeletal problems* such as rheumatoid arthritis and osteoarthritis; *neuromuscular injury and disease* from the growing problem of neurologic injuries or from developmental disabilities of childhood (cerebral palsy, epi-

lepsy, spina bifida, Down's syndrome); and *progressive neurologic disorders* of middle and older adulthood (Parkinson's and Huntington's diseases, Guillain-Barré syndrome, amyotrophic lateral sclerosis or Lou Gehrig disease, multiple sclerosis, myasthenia gravis, Alzheimer's disease). In each case I have focused on life-changing effects and the role of nutritional support.

New Illustrations and Design. A new four-color design, incorporating numerous color illustrations, greatly enhances the overall visual appeal and provides learning support. These added graphs, charts, and photographs portray concepts introduced and help students grasp the clinical problems encountered in patient care.

Enhanced Readability and Student Interest. A large amount of the text has been rewritten to incorporate new material. The writing style is designed to capture student interest and present comprehensive subject matter in a sound and simple manner. Many new advances in basic and clinical science are explained and applied. Issues of student interest and public-professional controversy are discussed. The many examples used open up meaning and understanding. Topics of current relevance clarify questions and concerns.

Learning Aids Within the Text

This new edition continues to use many learning aids throughout the text.

Chapter Openers. To alert students to the topic of each chapter and draw them into its study, each chapter opens with an illustration, and brief focusing paragraphs on the Chapter topic.

Chapter Outlines. The major sections are listed at the beginning of each chapter and indicated by special type for ease in reading comprehension.

Key Terms. Key terms important to the student's understanding and application of the material in patient care are presented in three steps. They are first identified by boldface type in the body of the text. Some are particularly pertinent to the discussion and defined on the right-hand side of each right page. And finally, all are collected in a comprehensive glossary for easy reference at the end of the book. This three-level approach to vocabulary development greatly improves the overall study and use of the text.

Chapter Summaries. To help the student pull the chapter material together again as a whole, each chap-

ter concludes with a summary of the key concepts presented and their significance or application. The student can then return to any part of the material for repeated study and clarification as needed.

Review Questions for Testing Comprehension. To help the student understand key parts of the chapter or apply it to patient problems, questions are given after each chapter text for review and analysis of the material presented.

Chapter References. To provide immediate access to all references cited in the chapter text, a full list of these key references is given at the end of each chapter, rather than collected at the end of the book as in the previous edition.

Further Reading. In addition to referenced material in the text, an annotated list of suggestions for further reading for added interest and study is provided at the end of each chapter. These selections extend or apply the material in the text according to student needs or areas of special interest. The annotations themselves improve the student's ability to use them by identifying pertinent parts of that reference.

Issues and Answers. A special feature of each chapter is a concluding brief article on nutrition-related issues or controversies based on the text discussion. These interesting and motivating studies help the student to see the importance of scientific thinking and develop sound judgment and openness to different points of view.

Case Studies. In many chapters realistic case studies lead the student to apply the text material to related patient care problems. Each case is accompanied by questions for case analysis. These cases also help alert the student to applications of nutritional therapy for similar patient care needs in their own clinical assignments.

Diet Guides. A variety of diet guidelines are highlighted in the clinical chapters in Part Three.

Appendixes. The revised Appendixes include a number of materials for use as reference tools and guidelines in learning and practice. Food value tables include nutrient and energy references for a variety of basic foods.

Index. The index extends the basic text cross-referencing and provides a quick reference to the book's content.

Supplementary Materials

Several supplements enhance the teaching-learning process. Further information on these helpful packages may be obtained from your publisher's representative.

Instructor's Manual. Prepared by Joanne Spaide, University of Northern Iowa, this valuable tool features suggested course syllabuses; chapter reviews; behavioral objectives; key terms; chapter outlines with teaching notes on controversial topics; nutrition in the news; additional resources, including slides, films, and filmstrips; transparency masters; and an extensive test-item band of approximately 1500 questions.

Computerized Test Bank. Qualified adopters of the text receive a computerized test bank package compatible with the IBM, Macintosh, Apple IIc, or Apple IIe computers. This software provides a unique combination of user-friendly aids and enables the instructor to select, edit, delete, or add questions and construct and print tests and answer keys. The Gradebook segment features computerized record-keeping, with class, test, or individual grade analysis displayed as bar charts. The Proctor segment allows instructors to set up student tutorials, using items from the test bank or specially written tests.

Overhead Transparency Acetates. Illustrations of important, hard-to-understand concepts are available as transparency acetates. These useful tools facilitate learning of key concepts discussed in the text and are available to qualified adopters of the text.

Self-Study Guide. This concise little companion continues to serve as a general learning aid during initial courses, as well as a tool for review of the text for professional examinations or for practitioners needing to update knowledge. It includes many items to support learning of each chapter's content: (1) chapter focus; (2) summary-review quiz; (3) discussion questions to stimulate thinking; (4) true-false and multiple choice test items to test comprehension; (5) numerous guides for individual and group projects that involve experiments, case studies, and situational problems that apply learning; and (6) inquiry questions that relate an "Issues and Answers" article to current health care problems.

Mosby Diet Simple 2.0 Software. This interactive nutrient analysis software includes a unique food list with

more than 2250 items, selected activities, and food exchange lists. The program allows students to input food intake and physical activities to determine total calories consumed and expended over a certain period of time.

Personal Approach. My person-centered approach in past editions remains in this new text. It is enhanced by (1) a personal writing style that reflects my own convictions and commitments about student learning and patient care; (2) extensive use of ever-expanding personal files and materials gathered from current research, my own clinical practice, teaching, and biochemical-metabolic work; and (3) practical applications of scientific knowledge in realistic *human* terms to find personal solutions to individual problems.

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Many persons have helped me in this book project, and I am grateful for their contributions. To these persons I give my thanks: my editor-in-chief Jim Smith, whose demands for scientific integrity strengthen my own convictions and guide my work; the editorial staff, especially Vicki Malinee, Loren Stevenson, and Terry Eynon, for their constant skill and support; the project managers in Book Production Editing for their constant push toward perfection; the reviewers for their valuable time and suggestions:

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*Sue Rodwell Williams
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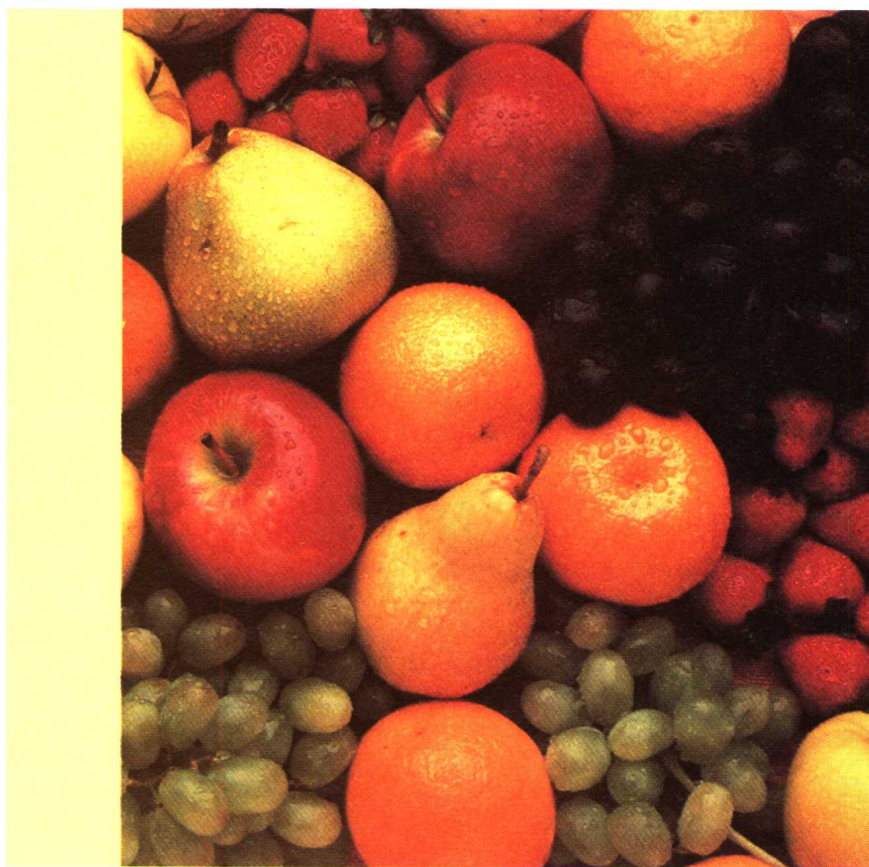
Introduction to Human Nutrition

CHAPTER 1

Nutrition and Health

CHAPTER OUTLINE

Nutrition and Human Health
Nutrition and National Health
Problems
Nutritional Guides for Health
Promotion
Personal Assessment of Food
Patterns



This chapter introduces the study of nutrition in health and health care. Whatever the basis of your present interest, a sound base of nutrition knowledge and skills is fundamental.

Current knowledge of nutrition and its basic science foundations reflect our rapidly changing world in terms of a changing food supply, expanding population, and phenomenal scientific knowledge. Nutrition is rapidly emerging as a vital component in personal health care and in our national nutrition and health policies to meet human need.

A primary means of promoting health and preventing disease for all people rests on a wholesome food supply and the sound nutrition it pro-

vides. In this first chapter we introduce this person-centered approach to nutrition and health care, an important focus throughout your study.

Nutrition and Human Health

The Science of Nutrition

For the most part, knowledge about nutrition builds on two fundamental areas of science. First, the physical sciences of biochemistry and physiology help us to see how nutrition relates to our physical health and well-being. Second, behavioral sciences help us to better understand how nutrition is interwoven with our unique nature as human beings. Throughout our study here, you will see both of these areas of learning at work in our lives.

Basic principles of biochemistry show us that human organisms are marvelously complex groupings of chemical compounds constantly at work in an array of reactions designed to sustain life. Nutrients, the basic currency of nutrition, are chemical compounds or elements. The integrating work of human physiology brings the beauty of order out of a seeming internal chaos of individually functioning cells and organs, blending them into a total functioning whole. Physiologists call this highly sensitive level of internal control **homeostasis**.

However, if we were defined only by our physical components, we would not be fully human. We learn human aspects of being and nutrition from the behavioral sciences, which are rooted in our earliest awareness of psychosocial beginnings and life experiences. Attitudes toward food and eating patterns develop throughout our lifespan from the acculturating influences of family, group, ethnic group, community, nation, even our world. How we perceive ourselves and our food, what we choose to eat, why we eat what we do and in what manner, all become integral parts of human nutrition.

Food and Nutrients

The word **nutrition** refers to nourishment that sustains life. The science and art of human nutrition both focus on nourishing human life. They do this in many ways. From the moment of conception until death, the body needs energy to carry out vital functions such as breathing. In addition, people need energy to support physical activity. They must constantly replenish these energy needs with food to sustain physical life. But food also nourishes the human spirit. We all have our particular “soul foods,” “comfort foods,” or special “warm fuzzies” for the human spirit.

Nutrition is thus defined as the food people eat and how it nourishes their bodies. **Nutritional science** com-

prises the body of scientific knowledge governing the nutritional requirements of humans for maintenance, growth, activity, and reproduction. **Dietetics** is the health profession having primary responsibility for the practical application of nutritional science to persons and groups of persons in various states of health and disease. The **registered dietitian (RD)**, especially the **clinical nutrition specialist**, is the nutrition authority on the health care team. The RD, in collaboration with the physician and nurse, carries the major responsibility for nutritional care of patients and clients. The **public health nutritionist** is responsible for nutritional care of groups of people in the community, especially those high-risk groups who require assessment of need and community programs to meet these needs.

Functions of Food and Nutrients

The respective functions of food and nutrients in human nutrition need to be distinguished. First of all, dispense with the myth that any particular food or food combination is required by the body for health. The human race has subsisted for centuries with wide varieties of foods, depending on what was available to eat and what the culture designated as human food. Various foods serve as important vehicles for taking nutrients into the body and bringing human pleasure and comfort. Instead, it is these specific chemical compounds or elements—the **nutrients**—in a wide variety of foods that the body requires. Approximately 40 essential nutrients are known; others are probably yet to be discovered. Known essential nutrients include **macronutrients**—carbohydrates, fats, and proteins—whose constituent substances supply energy and build tissue, and **micronutrients**, vitamins and minerals that the body uses in much smaller amounts to regulate and control body processes. Water is the overall vital nutrient sustaining all life processes. The term **metabolism** refers to the sum of these chemical processes in the body that sustain life and health. The first part of this text will cover your study of these important nutrients.

Nutrient Interrelationships

An important nutritional metabolic fact will emerge increasingly in your study of nutrition, the fundamental principle of *nutrient interaction*. The principle states that:

1. Individual nutrients have many specific metabolic functions, including primary and supporting roles, and
2. No nutrient ever works alone

The human body is a fascinating whole made up of many parts and processes. Intimate metabolic relationships exist among all the basic nutrients and their **metabolites**. This key principle of nutrient interaction will be demonstrated more clearly in the following chap-

ters. Remember, we may separate nutrients for study purposes, but they do not exist that way in the body. Nutrients are always interacting as a dynamic whole to produce and maintain the human body, providing energy, building and rebuilding tissue, and regulating metabolic processes.

Energy Sources

The energy-yielding macronutrients—carbohydrates, fats, and proteins—provide primary and alternate sources of energy.

Carbohydrates

Dietary carbohydrates, starches and sugars, provide the body's primary source of fuel for heat and energy. Carbohydrates also maintain a backup source of quick energy known as *glycogen*, sometimes called "animal starch" because its structure is similar to that of plant starch. Each gram of carbohydrate consumed yields **4 kilocalories** (kilocalories or kcal). This number is called the "fuel factor" for carbohydrates. A well-balanced diet for a healthy person should supply approximately 50% to 60% of the total calories from carbohydrates. The

majority of these calories should be derived from complex carbohydrate foods, the starches, rather than from simple carbohydrate foods, the sugars.

Fats

Dietary fats from animal and plant sources provide the body's alternate or storage form of heat and energy. Fats are a more concentrated fuel, yielding 9 calories for each gram consumed. The fuel factor of fats is therefore 9. Fats should supply no more than 25% to 30% of the total calories of a healthy person's well-balanced diet. The majority of these calories, approximately two thirds, should consist of vegetable oil products (unsaturated fats) rather than animal food products (saturated fats).

Proteins

The body may draw on dietary or tissue protein to obtain needed energy when the fuel supply from carbohydrates and fats is insufficient. Protein yields 4 calories per gram, making its fuel factor 4. Quality protein should provide approximately 15% to 29% of the total calories of a healthy person's well-balanced diet. Thus,

clinical nutrition specialist • Specialty practice of a registered dietitian with an advanced degree in nutritional science and training in clinical nutrition.

dietetics • Management of diet and the use of food; the science concerned with the nutritional planning and preparation of foods.

homeostasis • State of relative dynamic equilibrium within the body's internal environment; a balance achieved through the operation of various interrelated physiologic mechanisms.

kilocalorie • The general term *calorie* refers to a unit of heat measure and is used alone to designate the *small calorie*. The calorie used in nutritional science and the study of metabolism is the *large calorie*, 1000 calories, or kilocalorie, to be more accurate and avoid use of very large numbers in calculations.

macronutrients • The three large energy-yielding nutrients: carbohydrates, fats, and proteins.

metabolism • Sum of all the various biochemical and physiologic processes by which the body grows and maintains itself (anabolism) and breaks down and reshapes tissue (catabolism), transforming energy to do its work. Products of these various reactions are called *metabolites*.

metabolites • Any substance produced by metabolism or by a metabolic process.

micronutrients • The two classes of small non-energy-yielding elements and compounds: minerals and vitamins, essential in very small amounts for regulation and control functions in cell metabolism and building certain body structures.

nutrients • Substances in food that are essential for energy, growth, normal functioning of the body, and maintenance of life.

nutrition • The sum of the processes involved in taking in food nutrients, assimilating and using them to maintain body tissue and provide energy; a foundation for life and health.

nutritional science • The body of scientific knowledge, developed through controlled research, that relates to the processes involved in nutrition—national, international, community, and clinical.

public health nutritionist • A professional nutritionist, accredited by academic degree course of university and special graduate study (MPH, DrPH) in schools of public health accredited by the American Association of Public Health, responsible for nutrition components of public health programs in varied community settings—county, state, national, international.

registered dietitian (RD) • A professional dietitian, accredited by academic degree course of university and graduate study (MS, PhD), clinical and administration training, and having passed required registration examinations administered by the American Dietetic Association.

although protein's primary function is tissue building, some may be available for energy as needed.

Tissue Building

Protein is the primary nutrient used in tissue building; minerals, vitamins, and fatty acids also play a role.

Proteins

The primary function of protein is tissue building. Dietary protein foods provide **amino acids**, the building units necessary for constructing and repairing body tissues. This is a constant, dynamic process of modeling and remodeling according to need that ensures growth and maintenance of a strong body structure and vital substances for tissue functioning.

Minerals

Two of the major minerals, calcium and phosphorus, help build and maintain bone tissue. Iron helps build hemoglobin, a red blood cell's vital oxygen carrier.

Vitamins

As just one example, vitamin C helps develop the cementing intercellular ground substance necessary to build strong tissue and prevent bleeding in the tissues.

Metabolic Regulation and Control

All of the multiple biochemical processes that comprise body metabolism, which are required to provide energy and build tissue, must be controlled in exquisite detail to maintain a smooth-running, balanced operation. Otherwise, there would be chaos within the body system and death would eventually result. Life and health result from a dynamic balance, a state of *homeostasis*, among all of the body parts and processes. Vitamins and minerals are nutrients that play a vital role in metabolic regulation and control; water provides the necessary fluid environment.

Vitamins

Many vitamins function as coenzyme factors, or components of cell enzyme systems, to govern chemical reactions in cell metabolism. This is true, for example, of most B-complex vitamins.

Minerals

Many minerals also serve as coenzyme factors in cell metabolism. An interesting structural example is that of the trace element cobalt, a central constituent of vitamin B₁₂ (cobalamin), which functions with this vitamin to combat pernicious anemia.

Other Nutrients

Water and dietary fiber also function as regulatory agents. In fact, water is *the* fundamental agent for life

itself, providing the essential solution base for all metabolic processes. Dietary fiber helps regulate the passage of food through the gastrointestinal tract and influences absorption of various nutrients.

Levels of Nutritional Status

Individual nutritional status will vary depending on a person's living situation, available food supply, and health. You will be concerned with these varying levels as you assess your own nutritional status or that of others.

Ideal Nutrition

Evidence of sound positive nutrition includes a well-developed body, ideal weight for body composition (ratio of muscle mass to fat) and height, and good muscle development and tone. The skin is smooth and clear, the hair glossy, the eyes clear and bright. Posture is good; facial expression is alert. Appetite, digestion, and elimination are normal. Detailed characteristics of good and poor states of nutrition are given in Table 1-1. Begin to think about these signs as you get into your nutrition study and look for them as you become a more skilled observer. Well-nourished persons are much more likely to be alert, both mentally and physically. They are meeting not only their day-to-day needs but also maintaining essential nutrient reserves for resisting infectious diseases and generally extending their years of normal functioning.

Borderline Nutrition

As the descriptive label indicates, persons with only a borderline nutritional status may manage to meet their minimum day-to-day nutritional needs. However, they lack nutritional reserves to meet any added physiologic or metabolic demand resulting from injury or illness, sustain fetal development during pregnancy or attain proper growth in childhood. A state of borderline nutrition may exist in persons with poor eating habits or those who are living in stressed environments on low incomes. Dietary surveys have shown that approximately one third of the U.S. population is living on diets below the optimal level. This does not necessarily mean that these Americans are undernourished; some persons can maintain general health on somewhat less than the optimal amounts of various nutrients. On the average, however, persons who do not get enough of these nutrients have greater risk of physical illness than persons who are well nourished. The human body has great capacity to adapt to lowered nutritional states, but it can only sustain a given amount of physiologic stress before signs of malnutrition appear.

Malnutrition

Signs of malnutrition appear when nutritional reserves are depleted and nutrient and energy intake is insuffi-

TABLE 1-1

Clinical Signs of Nutritional Status

Features	Good	Poor
General appearance	Alert, responsive	Listless, apathetic, cachexic
Hair	Shiny, lustrous, healthy scalp	Stringy, dull, brittle, dry, depigmented
Neck glands	No enlargement	Thyroid enlarged
Skin, face, neck	Smooth, slightly moist, good color, reddish pink mucous membranes	Greasy, discolored, scaly
Eyes	Bright, clear, no fatigue circles	Dryness, signs of infection, increased vascularity, glassiness, thickened conjunctivae
Lips	Good color, moist	Dry, scaly, swollen, angular lesions (stomatitis)
Tongue	Good pink color, surface papillae present, no lesions	Papillary atrophy, smooth appearance, swollen, red, beefy (glossitis)
Gums	Good pink color, no swelling or bleeding, firm	Marginal redness or swelling, receding, spongy
Teeth	Straight, no crowding, well-shaped jaw, clean, no discoloration	Unfilled cavities, absent teeth, worn surfaces, mottled, malpositioned
Skin, general	Smooth, slightly moist, good color	Rough, dry, scaly, pale, pigmented, irritated; petechiae, bruises
Abdomen	Flat	Swollen
Legs, feet	No tenderness, weakness, swelling, good color	Edema, tender calf, tingling, weakness
Skeleton	No malformations	Bowlegs, knock-knees, chest deformity at diaphragm, beaded ribs, prominent scapulas
Weight	Normal for height, age, body build	Overweight or underweight
Posture	Erect, arms and legs straight, abdomen in, chest out	Sagging shoulders, sunken chest, humped back
Muscles	Well-developed, firm	Flaccid, poor tone, undeveloped, tender
Nervous control	Good attention span for age, does not cry easily, not irritable or restless	Inattentive, irritable
Gastrointestinal function	Good appetite and digestion, normal, regular elimination	Anorexia, indigestion, constipation or diarrhea
General vitality	Endurance, energetic, sleeps well at night, vigorous	Easily fatigued, no energy, falls asleep in school, looks tired, apathetic

cient to meet day-to-day needs or added metabolic stress. A large number of malnourished people live in high-risk conditions of poverty. These conditions influence the health of all persons involved, but especially the lives of the most vulnerable ones—infants, children, pregnant women, and elderly adults. Infant mortality rates continue at a high level, especially among Black and other minority populations.¹ Prenatal care for many women who are young, poor, and uneducated is not of even minimally acceptable quality.² One out of four young children in the United States lives in poverty and suffers from stunted growth and deficiency diseases such as **anemia**. These children also have lowered resistance to infection and disease, impaired learning ability, apathy, and reduced activity levels.³ Low socioeconomic status and malnutrition are positively related in the increasing American population of older adults.^{4,5} Many studies also document widespread hunger and malnutrition among the poor, especially among the growing number of homeless persons.⁶⁻⁸

We also find malnutrition in our hospitals and long-term care facilities. For example, hypermetabolic disease or prolonged illness, especially among older persons with chronic conditions, places added stress. In these situations, the person's daily nutrient and energy intake is often insufficient to meet needs. Nutrition as-

essment procedures fundamental to appropriate clinical care are described in Chapter 16.

Overnutrition

Some persons may be in a state of overnutrition that gradually results in degrees of overweight and obesity from excess energy intake over time. In a sense, overnutrition can be viewed as another form of malnutrition, especially when excess caloric intake produces gross harmful body weight and fatness—morbid obesity. Childhood and adolescent obesity may set the stage for continuing adult obesity, increasing the risk for chronic disease. Harmful overnutrition also occurs in persons who use excessive “megadoses” of nutrient supplements that, over time, produce damaging tissue effects.

amino acid • An acid containing the essential element nitrogen (in the chemical group $-NH_2$). Amino acids are the structural units of protein and the basic building blocks of the body.

anemia • Blood condition characterized by decreased number of circulating red blood cells, hemoglobin, or both.