CHAPTER 1

An Introduction to Foods, Nutrients, and Human Health

Consumption of foods and fluids must occur on a regular basis for survival. Populations throughout the course of history, however, have survived despite poor nutrition and erratic eating patterns. The history of humankind has been shaped to a large degree by the varying success of cultures in producing, gathering, and securing foods. For tens of thousands of years, hunter-gatherer and similar societies survived rather precariously, barely increasing their population numbers, because the sporadic availability of uncultivated food was a critical limiting factor for survival. Only in the last 10,000 years of human history has the development of agriculture permitted the population growth that characterizes the modern world. The successful cultivation of cereal crops, the staples of life, has been a key element in the growth of most civilizations and today's global population (see **FIGURE 1.1**).

People do not automatically think of their foods as sources of energy and nutrients; rather, foods are eaten to satisfy hunger, a physiologic need that helps keep the body's functions operating. In today's world, however, many occasions of eating are social as well. Moreover, the foods consumed on both ordinary and special occasions, such as weddings and celebrations, often take on special meanings (see **FIGURE 1.2**). Economic factors also are significant in determining the kinds and amounts of foods that can be cultivated, purchased, and consumed. The food habits of a society are influenced by a variety of cultural, social, psychological, economic, and environmental factors. Supplying enough food to meet the body's needs, promote health, and prevent disease is key to a society's survival.

Foods, and the nutrients derived from them, serve many ends, not the least of which are meeting the body's needs. The body's needs are met by consuming the essential nutrients, both macronutrients and micronutrients, and newly recognized important phytochemicals, in amounts sufficient to maintain health. Macronutrients—fats, carbohydrates, and proteins—are those nutrients that provide energy for the body's systems. Micronutrients are nutrients that are required in small quantities for survival. They include vitamins and minerals. Phytochemicals (sometimes referred to as

FIGURE 1.1 Emergence of Agriculture. The development of agriculture approximately 10,000 year ago permitted the increases in human population growth that characterize the modern world.

FIGURE 1.2 Ample Food Availability. Advances in agriculture and food processing have produced an abundance of food in many parts of the world. In many societies, food plays a key role in the celebration of special occasions.

phytomolecules) are plant-derived molecules that are increasingly being noted for their role in maintaining human health.

Nutrition, as a field of study, represents a broad area of knowledge encompassing information from the basic sciences, behavioral sciences, and other fields of investigation. Because of new findings from current research investigations, nutrition is evolving quite rapidly, but putting the new information into clinical practice or incorporating it into public policy takes time, often decades. New research findings are not rapidly implemented into clinical practice, even though the findings may be encouraging. This chapter examines several important nutrition topics in order to lay the foundation for additional study.

nutrition The branch of science dealing with foods, nutrient composition, eating habits, nutritional status, and health and diseases of individuals and populations.

nutrient Essential or non-essential molecules or minerals derived from foods that are used by cells in the body to complete diverse functions.

non-nutrient Food molecules that are not considered nutrients because they are not essential for cellular or tissue needs. However, they may be important for other aspects of human health; for example, dietary fibers and many phytomolecules may protect against cancer and other chronic diseases.

macronutrient Class of nutrients that generate energy (carbohydrates, fats, proteins) and provide nitrogen (N) and amino acids (protein). Sometimes other molecules, such as dietary fiber and water, are included in this class because they are consumed in large amounts.

Food and Nutrients

The body's needs for macronutrients, micronutrients, and water relate to metabolic requirements and the role these nutrients play in forming biological compounds. Other dietary components that impact health are alcohol, dietary fiber, and phytochemicals. **Table 1.1** lists the **nutrients** and **non-nutrients** that are required across the human life cycle. As you learn more about nutrition, keep in mind the increasingly important roles of non-nutrient plant molecules that promote health.

Macronutrients

The **macronutrients**—carbohydrates, fats, and proteins—exist mainly as polymers or long chains. They provide energy, expressed as kilocalories (kcal), plus a few other unique structures required in human tissue. Fats and carbohydrates provide the bulk of energy, whereas proteins provide a smaller amount. The primary energy-providing macronutrients—carbohydrates and fats derived from plants and animals—provide approximately 85% of energy (expressed as kilocalories or kilojoules) intake by humankind in the Western world and perhaps 90% or more in other parts of the world. Protein provides nearly all of the remaining energy consumed on a daily basis. In addition to

TABLE 1.1
Required Nutrients and Non-Nutrients

Nutrients	Non-Nutrients
Macronutrients	**Dietary Fiber**
Carbohydrates Fats Proteins	Cellulose Lignans Hemicelluloses Others
Micronutrients	**Select Phytochemicals***
Vitamins	Alkaloids Anthocyanins Carotenoids Flavonoids Monoterpenes
Water soluble Fat soluble	
Minerals	
Macrominerals Microminerals	

* Note that there are actually thousands of phytochemicals found in nature. Some of the more important classes of phytochemicals are listed here.

their constituent amino acids, proteins are essential because they provide nitrogen that is needed for the synthesis of deoxyribonucleic acid (DNA) and related molecules.

Micronutrients

The **micronutrients** are represented by vitamins and minerals, which have specific roles in metabolism. The micronutrients are needed in small quantities each day. **Vitamins** are categorized as water soluble or fat soluble. The distinction between these two types of vitamins lies in their solubility in water or in organic solvents, including fats and oils. Vitamins are needed for a large number of cellular and extracellular chemical reactions. For example, vitamins A and D are fat-soluble vitamins. Vitamin A plays a role in growth and vision; vitamin D, obtained from either the diet or synthesized when exposed to the sun, has an important role in calcium metabolism.

Minerals are used in chemical reactions as well as in structural components of cells and tissues. For example, calcium is a critical component of hard tissues such as bone and teeth and plays a variety of other roles. Macrominerals are needed in daily amounts greater than 100 milligrams per day. Microminerals are needed in amounts of less than 100 milligrams per day. Water often is considered with minerals.

Energy

Food **energy** is measured in kilocalories, often simply referred to as calories or kcals. This energy is derived from the breakage of hydrocarbon bonds, often written as C-H bonds, in macronutrients (i.e., carbohydrates, fats, proteins). Energy is not a nutrient per se; rather, energy is derived from macronutrients. Therefore, when energy is classified with the macronutrients, it is correctly called a dietary variable rather than a nutrient.

> "The body's needs for macronutrients, micronutrients, and water relate to metabolic requirements and the role these nutrients play in forming biological compounds."

micronutrient Class of nutrients that includes vitamins and minerals; nutrients consumed in small amounts each day.

vitamin An essential organic micronutrient needed in the diet in small amounts; consists of both water-soluble and fat-soluble vitamins.

mineral Elements in the earth's surface that are needed by the human body, such as calcium and iron.

energy (calorie) A physical unit of energy that is derived from food macronutrients and alcohol; 1 kilocalorie is the amount of heat required to raise the temperature of a gram of water 1°C. Energy also can expressed in joules, where 1 kilocalorie is equal to 4.2 kilojoules.

"Energy is not a nutrient per se; rather, energy is derived from macronutrients."

The recommended energy contribution of macronutrients to the diet by percentage typically breaks down to approximately 50% or more for carbohydrates, 35% or less for fats, and 15% or more for proteins. The percentage of energy from alcohol varies substantially, but the percentage of those who consume alcohol on a regular basis may be as high as 5%.

Atwater Equivalents

The **Atwater equivalents** system is used to provide a rough estimate of the available energy in foods. Atwater equivalents are estimates of the amount of energy in each of the macronutrients and alcohol (ethanol). These estimates are based on the energy in kilocalories generated when the hydrocarbon backbones of the molecules are completely oxidized to carbon dioxide and water. The Atwater system uses the average values of 4 kilocalories per gram for protein, 4 kilocalories per gram for carbohydrate, and 9 kilocalories per gram for fat. Alcohol is calculated at 7 kilocalories per gram.

The Problem of Too Much Energy

The greatest problem in the American diet today is the inability to maintain a healthy **energy balance**, which is the balance between energy intake and energy expenditure. Americans consume too much energy (calories) via the excessive intake of foods and beverages. Although average adult energy intake has decreased slightly since 2000, our energy expenditure for work and other activities has decreased even more! This energy imbalance leads to storage of excess calories in fat stores (adipose tissue deposits) scattered throughout the body as well as weight gain. Obesity, which reached epidemic proportions among American adults and children in the 1990s, results from the overconsumption of food energy coupled with a sedentary lifestyle. Although jogging and other sports activities have become popular with some health-conscious individuals, it has had relatively little effect on the U.S. population as a whole because of the high percentage of inactive individuals and because of the great amount of physical activity needed to balance energy intake, especially from excessive calories in the diet. This latter point—balancing energy intake with expenditure—is not readily embraced by most people.

Atwater equivalent The energy equivalent per gram of macronutrient or alcohol (ethanol): 1 gram of carbohydrate yields 4 kilocalories, 1 gram of fat yields 9 kilocalories, 1 gram of protein yields 4 kilocalories, and 1 gram of alcohol (pure or 200 proof) yields 7 kilocalories.

energy balance The balance between energy intake and energy expenditure. Energy imbalance represents either higher intake than expenditure or the reverse. Positive (+) energy balance results in weight gain. Negative (–) energy balance results in weight loss.

phytochemical (phytomolecule) Non-nutrient molecules made by plants and found in diverse fruits, vegetables, grains, nuts, and seeds. Many of these molecules, especially antioxidants, are thought to protect against cancer.

Non-Nutrient Phytochemicals

No new nutrients have been discovered since the mid-twentieth century, but scientists continue to identify new, beneficial, non-nutrient phytochemicals. Because these molecules are derived from plants, they are logically referred to as **phytochemicals** or phytomolecules. Phytochemicals are found only in plant-based foods. Plants produce phytochemicals to serve a variety of diverse functions. For example, fiber, which in human nutrition is referred to as dietary fiber, serves as a structural component of plant cell walls and provides rigidity to plant tissues.

Thousands of different of phytochemicals exist, each with a unique chemical structure and purpose. Many of these molecules are polyphenols. Some of these molecules have rather simple structures, such as phytate, whereas others, such as polyphenols, have more complex structures (see **FIGURE 1.3**).

Phytochemicals do not provide energy (i.e., calories) to humans, but they do play important roles in maintaining human health (see **FIGURE 1.4**). Returning to our example of fiber, in humans, fiber molecules play a role in maintaining the health of the gastrointestinal tract. Other phytochemicals act as antioxidants that protect cells against free radicals or highly reactive chemicals produced as a result of cell metabolic pathways (see **FOCUS BOX 1.1**). Because phytochemicals are made by plants to meet their own needs, not those of humankind, the assumption that all phytochemicals are beneficial to human health is incorrect. In fact, some phytochemicals are actually toxic and must be avoided.

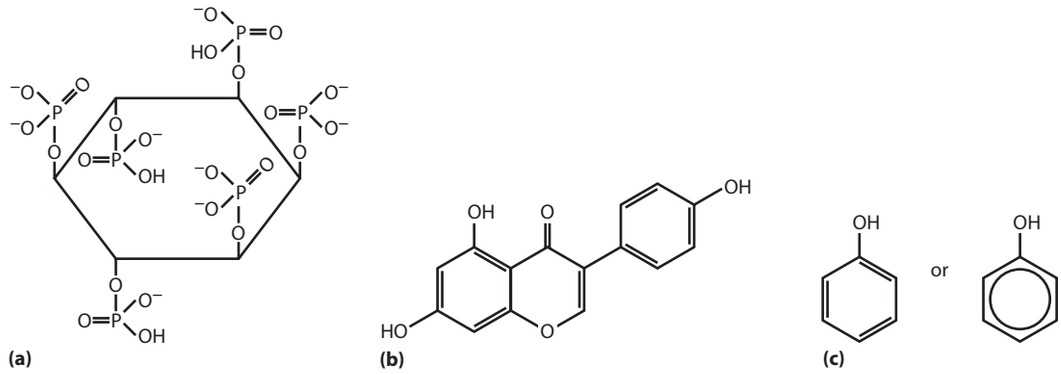

FIGURE 1.3 Phytochemicals. The molecular structures of phytochemicals vary. The molecular structure of three phytochemicals are shown: (a) phytate, (b) phytosterol, and (c) polyphenol.

FOCUS 1.1 Free Radicals

What are **free radicals**? Why should people be concerned about them? Free radicals are atoms that have an unpaired electron. Atoms with unpaired electrons can bond easily with other atoms with unpaired electrons, which means they are highly reactive! Many types of radicals are possible, but those of most concern in the human body are derived from oxygen. Collectively, the oxygen radicals are called reactive oxygen species. Damage to the body's cells and tissues occur when free radicals bond with other molecules or atoms. In particular, free radicals can do a lot of damage if they interact with cellular DNA or the cell membrane. However, the body has a way to fight the damage from reactive oxygen species: antioxidants. Antioxidants are molecules that can inactivate or neutralize free radicals, thus preventing them from causing cellular damage. Many of the phytochemicals in plants also act as antioxidants. ●

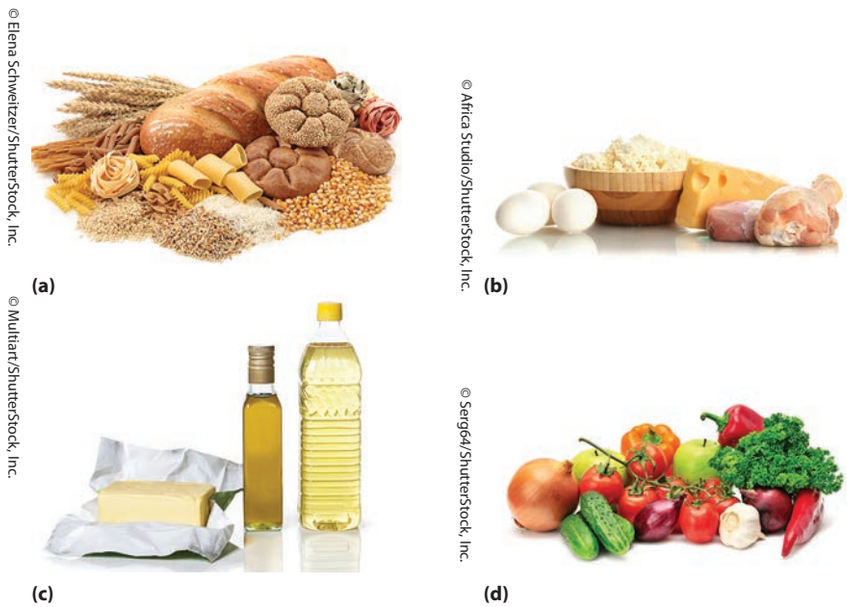

FIGURE 1.4 Food as a Source of Energy and Phytochemicals. Food provides energy due to the breakage of chemical bonds in (a) carbohydrates, (b) proteins, and (c) fats. Phytochemicals found in fruits and vegetables (d) are important to human health, but they do not supply energy.

free radical A highly reactive chemical species (of very short life)—typically oxygen atoms containing a free electron—that combine with a carbon atom of an unsaturated fatty acid (at the double bonds) or of other molecules, including proteins and DNA. This can result in an alteration at the point of the unsaturation as well as damage to DNA and mutations.

Guidelines and Recommendations

Healthy dietary patterns provide all of the essential nutrients, energy, and phytochemicals. For good health, the diet should include mostly nutrient-dense or nutrient-rich foods because they contain many micronutrients in addition to modest amounts of macronutrients for energy and protein. In contrast, energy-dense or calorie-dense foods are generally not recommended because they contain too much energy and too few micronutrients. In addition, diets that contain the amount of calories needed for good health help maintain a healthy body weight.

> "The three major determinants of food intake are availability of foods, purchasing power (money or barter), and social and cultural values placed on specific foods."

But what actually determines what people eat? The three major **determinants of food intake** are availability of foods, purchasing power (money or barter), and social and cultural values placed on specific foods (see **FIGURE 1.5** and **FOCUS BOX 1.2**). The first two factors are more important in developing countries, whereas the third becomes more important in developed countries where purchasing power and a wide availability of foods permit the selection of specific foods. (In these countries, food marketing and advertising may also contribute substantially to the consumption of specific food products, especially processed items such as chips, dips, soft drinks, and convenience foods.) **Food availability** is highly determined by one's geographic location due to production, distribution and cultivation being dependent on an area's climate, infrastructure and economy. **Social and cultural values** have historically been major factors contributing to food intake, and they remain so in many low-income nations, but they have become less influential in more affluent nations where markets have most foods available almost the entire year for those who can afford them.

Information, and even misinformation, on the nutritional quality of foods can be attained from the **food composition table**. Though only in the last century has this been recognized as a standard for good health, it is gradually becoming a fourth determinant of food intake. In general, a growing interest in the role of food in health and the wide prevalence of nutritional labeling on food packaging has fostered this new determinant of food intake. Foods supply the nutrient requirements and nonnutrient phytochemicals that are critical for both health promotion and disease prevention. Governments around the world, in particular the United States, offer dietary guidelines and recommendations to improve the health of their populations.

determinants of food intake The major factors that drive people to choose the foods that they consume: emotions, social and cultural factors, and food availability.

food availability The availability of food or foods in a particular geographic region because of production, distribution, or cultivation of the foods for human consumption. It is one of the basic determinants of food intake, particularly in poorer nations.

social and cultural values Values applied to foods by a group, culture, or society; in the United States, societal food values exist, but they have been greatly affected by the marketing of a tremendous array of processed foods. A major determinant of food habits.

food composition table A table or database that contains data on the nutrient content of foods. Such tables are published by U.S. government agencies, such as the USDA, and in other sources, such as *McCance and Widdowson's The Composition of Foods*.

(a)

(b)

FIGURE 1.5 Food Availability. In developed countries, a wide variety of foods are available in supermarkets (a) and farmers' markets (b), offering consumers many options for both healthful and unhealthful eating.

FOCUS 1.2 Money and Food

An old quote states that "Money makes the world go round"; in some cases money also can determine whether a person is able to maintain a healthful diet. **Purchasing power**, or money, is a major determinant of food intake. In some poor nations, food choices may be limited due to limited food availability and inadequate purchasing power. For example, people who do not have money or who are living in a war zone may find it difficult to obtain a variety of nutrient-rich foods, or even any food. Typically, people with limited financial resources have less healthy eating patterns because their limited funds do not permit them to purchase more costly meats, dairy foods, fruits, and vegetables. Their diets consist primarily of foods derived from low-cost grains. Over time, such a diet will result in disorders resulting from inadequate intake of certain macronutrients and micronutrients. To compound the problem, in many underdeveloped countries the poor must also contend with polluted water and unsanitary living conditions, which can exacerbate diseases resulting from malnutrition.

Money does not have as strong an influence on the dietary habits of populations in middle-income countries and in developed nations such as the United States and Canada. In the United States and other rich nations, a lower percentage of family income is spent on food by the vast majority of the population. Therefore, food habits are based less on purchasing power than on nutritional awareness, convenience, and cultural and family traditions. In the United States, in particular, poor eating habits are often associated with lower incomes and lower education levels. Lower-income consumers often exhibit relatively poor food habits. Middle- and upper-income consumers tend to consume more luxury items, more variety, more convenience foods, and more low-fat alternative foods. Because of their generally poor food habits, lower-income individuals have a substantially greater burden of obesity, hypertension, diabetes, and disorders associated with nutritional excesses and inadequacies. One solution is to provide better education on diet and exercise for low-income Americans. ●

purchasing power (money) The economic capability of a family (or individual) to purchase items for a family unit. A major determinant of food habits.

Dietary Guidelines for Americans

The ***Dietary Guidelines for Americans***, a report jointly produced by the U.S. Department of Agriculture (USDA) and Department of Health and Human Services (DHHS), provides the U.S. population with general recommendations for food consumption that will result in good health and will reduce the burden of diet-related chronic diseases. The *Guidelines* emphasize the benefits of eating a variety of foods; consuming less sugar and salt; eating more fruits and vegetables and low-fat dairy products; and balancing energy intake with expenditure. The *Guidelines* also discourage the consumption of foods low in complex carbohydrates and high in saturated fats. A current selection from the *Dietary Guidelines for Americans* is provided in **Table 1.2**. Note that the *Guidelines* provides an up-to-date summary of what foods should be consumed, but not the amounts or numbers of servings.

MyPlate

The plant and animal foods commonly consumed in the United States and other developed countries are clustered into five general groups—grains, vegetables, fruits, meats and proteins, and dairy foods—as well as an additional miscellaneous group. The groups contain related foods and their products resulting from minimal processing of the raw foods. Food pyramids and food guides utilize these groups for making recommendations of the number of servings from each group on a daily basis. The USDA's **MyPlate** (see ChooseMyPlate.gov) is an example of such a food guidance system (see **FIGURE 1.6**). With MyPlate, food groups are represented as proportions on a plate relative to the recommended daily amounts. The plate shown in Figure 1.4 is the most recent visual diagram prepared by the USDA to convey important dietary information to the U.S. population. Note that MyPlate and the older **MyPyramid** (see **FIGURE 1.7**) replace the old USDA food pyramid.

Dietary Guidelines for Americans Document prepared by a committee representing both the USDA and the Department of Health and Human Services that provides guidelines that Americans should follow to ensure a healthy diet. The guidelines stress reductions in the consumption of fat, cholesterol, and sodium; increased consumption of complex carbohydrates, dietary fiber, and fruits and vegetables; maintenance of a desirable body weight; and limited alcohol consumption. The guidelines are updated every 5 years.

MyPlate The food guidance system developed by the USDA for the U.S. population. It includes five food groups: grains, proteins, vegetables, fruits, and dairy. It uses an icon that shows a plate and drink to provide a pictorial display of the how much of a meal should be represented by each food group. It provides an entire website with menus, a food composition table, and many other dietary tools.

MyPyramid An update on the earlier U.S. food guide pyramid that was replaced by MyPlate. It stressed activity and moderation along with a proper mix of food groups in one's diet. MyPyramid was designed to educate consumers about a lifestyle consistent with the *2005 Dietary Guidelines for Americans*.

TABLE 1.2
Examples from the *Dietary Guidelines for Americans*

- Prevent and/or reduce overweight and obesity through improved eating and physical activity behaviors.
- Reduce daily sodium intake to less than 2,300 milligrams (mg) and further reduce intake to 1,500 mg among persons who are 51 and older and those of any age who are African American or have hypertension, diabetes, or chronic kidney disease.
- Consume less than 10% of calories from saturated fatty acids by replacing them with monounsaturated and polyunsaturated fatty acids.
- Reduce the intake of calories from solid fats and added sugars.
- Limit the consumption of foods that contain refined grains, especially refined grain foods that contain solid fats, added sugars, and sodium.
- Increase vegetable and fruit intake.
- Eat a variety of vegetables, especially dark-green and red and orange vegetables and beans and peas.
- Increase intake of fat-free or low-fat milk and milk products, such as milk, yogurt, cheese, or fortified soy beverages.

Data from U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans 2010.* 7th ed. Washington, DC: U.S. Government Printing Office, 2010.

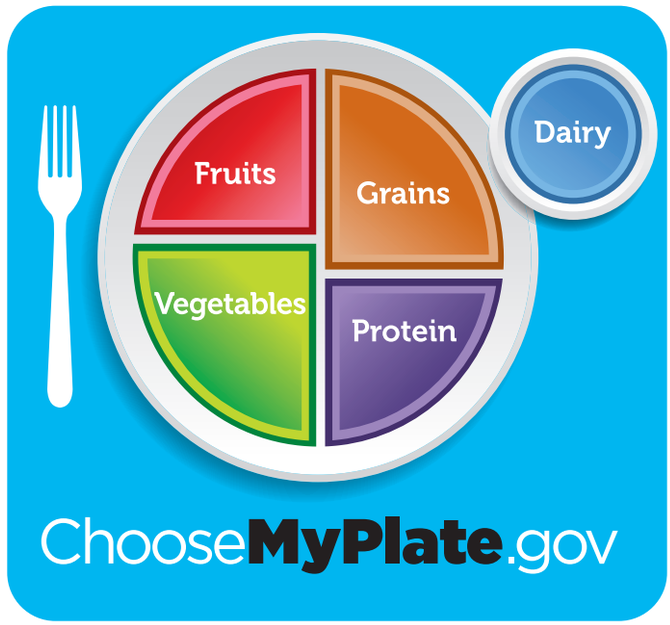

FIGURE 1.6 MyPlate. Released in 2011, MyPlate is a visual guide that helps consumers implement the principles of the *Dietary Guidelines for Americans, 2010* and other nutritional standards.

Courtesy of the U.S. Department of Agriculture.

Dietary Reference Intakes

Dietary needs are typically met by the consumption of a variety of foods in a balanced manner over a period of approximately a week, not necessarily every day. Nutrients, energy, and phytochemicals are needed for good health throughout the life cycle, but nutritional needs are typically higher during childhood and adolescence as well as pregnancy and lactation. Growth and development of the body and its organs early in life represent the first major challenges for obtaining sufficient amounts of all the essential nutrients. Maintenance and active functioning of the fully grown adult body require these same nutrients. Finally, nutrient requirements later in life typically decline as lean body mass (i.e., the mass of the body minus body fat) also decline. Foods provide all the nutrients, but all foods are not equal in their nutrient composition. Thus, it is important to choose a variety of foods each day to ensure that all the essential nutrients are consumed in a 24-hour period. Eating a variety of foods should supply the macronutrients and micronutrients needed by our cells and tissues at all stages of the life cycle.

Recommendations for the intake of different nutrients across the life cycle, including pregnancy and lactation, have been established for the populations of the United States and Canada. These recommendations are known as **Dietary Reference Intakes (DRIs)** (see **FIGURE 1.8**). The DRIs represent a set of recommended intakes for nutrients, energy, water, and dietary fiber that support health and prevent disease across the various stages of the life cycle, from birth to old age and during pregnancy and lactation. The DRIs serve as the standards for specific dietary recommendations as well as the upper limits of safe intakes. Four new categories have been added to the terminology of the DRIs in an effort to broaden understandings of how the DRIs are established. The four new categories and their acronyms are: **Estimated Average Requirement (EAR)**, **Recommended Dietary Allowance (RDA)**, **Adequate Intake (AI)**, and **Tolerable Upper Limit (UL) of Safety** (safe intake). Intakes of nutrients beyond their UL are not considered safe.

Dietary Reference Intake (DRIs) Recommended intakes of nutrients that are presented in a series of books from the Institute of Medicine. Each nutrient either has a Recommended Dietary Allowance (RDA) or an Adequate Intake (AI), depending on the availability of information upon which to make a recommendation.

Estimated Average Requirement (EAR) The amount of intake of a nutrient needed by the average individual to maintain good health. If a nutrient has an EAR, its Recommended Dietary Allowance (RDA) is based on the mean (average) and +2 standard deviations above the mean.

Recommended Dietary Allowance (RDA) Recommended intakes of specific nutrients; generally the Estimated Average Requirement (EAR) plus an additional safety factor specific for each nutrient. Age-gender groups are considered for different RDAs, as are women who are pregnant or lactating.

Adequate Intake (AI) A designation under the Dietary Reference Intakes (DRIs) of recommended intakes for several nutrients that do not have an Estimated Average Requirement (EAR). Usually used with nutrients where not enough information is available to set a more exact requirement (RDA).

Tolerable Upper Limit of Safety (UL) The safe upper limit of intake of a nutrient from foods and supplements; determined when establishing the Dietary Reference Intake (DRI) of a nutrient.

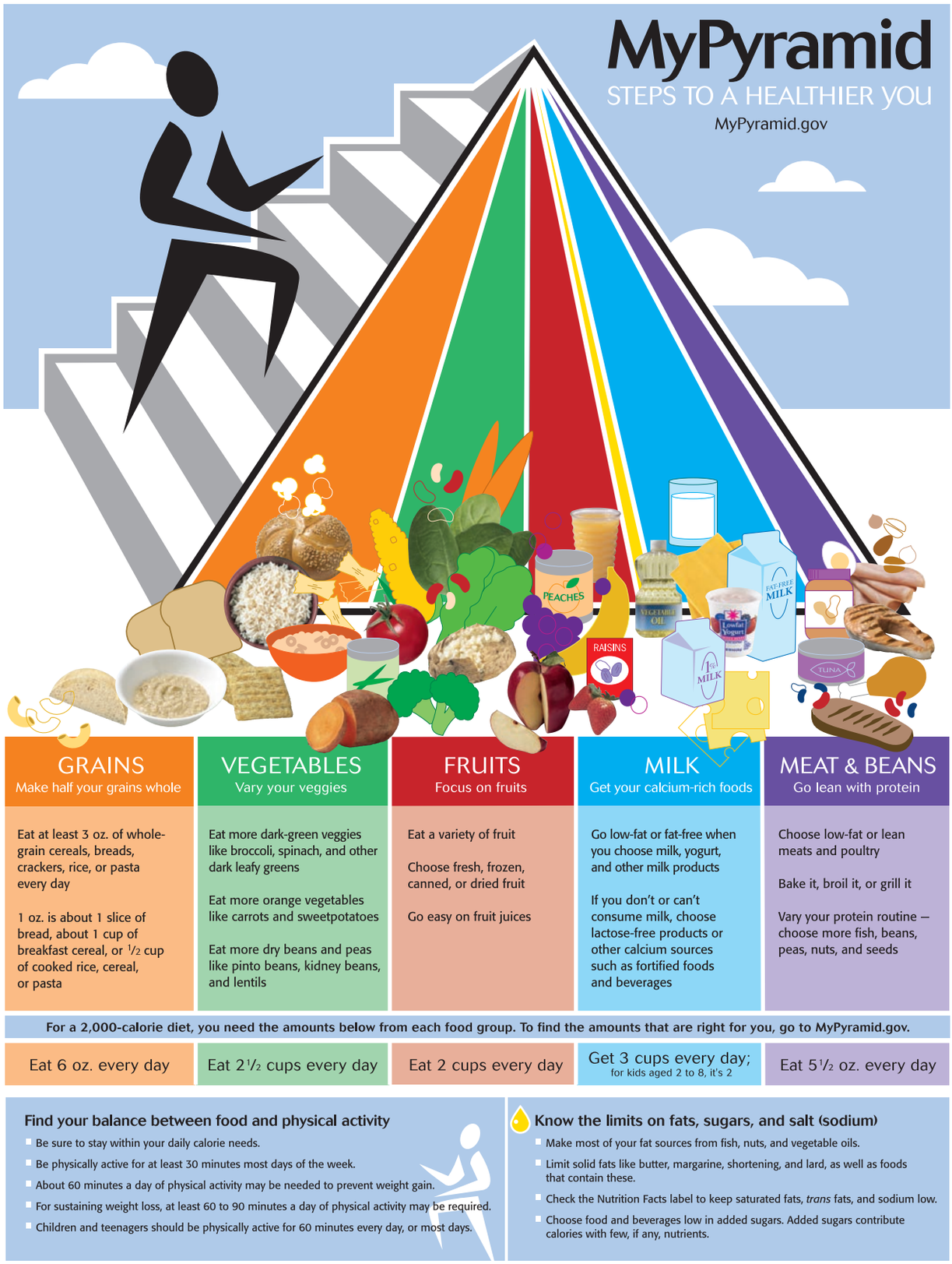

FIGURE 1.7 MyPyramid. Released in 2005, MyPyramid is an Internet-based educational tool that helps consumers implement the *Dietary Guidelines for Americans* and other nutritional standards.

Courtesy of the U.S. Department of Agriculture.

These measures have resulted from advances in our knowledge of the amounts of each nutrient needed to support human functioning at optimal levels. The RDA is the average daily dietary intake level that would adequately meet the nutritional needs of nearly all healthy persons. An EAR, which is the amount of a certain nutrient needed by an average individual, must be established for each age group and gender across the life cycle before an RDA for the nutrient can be estimated. Typically, an RDA is two standard deviations (SDs) greater than the EAR. These two standard deviations are considered a safety factor so that approximately 97.5% of the population at each age and gender will meet their requirements for the nutrient. For example, the EAR for protein for an adult male (18 to 50 years) is approximately 48 grams per day; two standard deviations of the EAR is ~15 grams per day, thus the RDA for protein is 63 grams per day. Similarly, the RDA for protein for adult females (18 to 50 years) is set at 50 grams per day. In general, the RDAs for the other nutrients have been established in a similar manner. Note that the DRI for energy has no safety factor added; the RDAs are the same as the EARs for each gender across the life cycle.

For a few nutrients, however, less is known about their metabolism in the body and the amount required in the diet each day. Therefore, an EAR cannot be established, and thus no RDA can be estimated. For these few nutrients, AIs have been generated because of the inability to establish EARs over the life cycle. AIs are essentially "guesstimates" arbitrarily selected by a panel of investigators as safe intake that will support all functions for the nutrient. Other countries and the World Health Organization (WHO) also have established recommendations for nutrient intakes but the rationales behind these guidelines often differ from those used in the United States and Canada. In reality, the same set of guidelines should probably fit all populations of the world.

FIGURE 1.8 Dietary Reference Intakes. The Dietary Reference Intakes (DRI) publication is a system of nutritional recommendations from the Institute of Medicine. The DRI system is used by both the United States and Canada and is intended for the general public and health professionals.

American Eating Trends

Americans have access to the *Dietary Guidelines for Americans*, and many are familiar with the USDA's MyPlate as well as how to read a Nutrition Facts panel. These are labels on packaged food and provide information on serving size, calories, nutrients, and ingredients. Despite this new information, what do most Americans actually eat, and how have **American eating trends** changed over time? The traditional or so-called standard American diet has historically been based on the consumption of meats and dairy products, with cereals, vegetables, and fruits being used to provide the remaining energy and bulk. This "meat and potatoes" eating pattern, however, has undergone major changes in recent decades. Dietary trends since World War II include increased macronutrient consumption, the rise of fast foods, the emergence of fortified and functional foods, and the use of nutrient supplements. These are primarily U.S.–specific consumption patterns, but many of these trends have also emerged to some degree in other Western nations and even in some Asian countries.

> "The traditional or so-called standard American diet has historically been based on the consumption of meats and dairy products, with cereals, vegetables, and fruits being used to provide the remaining energy and bulk."

Trends in Macronutrient Intake

Since 1960, five trends in macronutrient intake, as reported by the USDA, have revealed notable changes in American eating patterns (see **Table 1.3**). The first trend is a decrease in the consumption of animal fat, largely from meats and dairy products (see **FOCUS BOX 1.3**). This trend is encouraging because of the established association between intake of saturated animal fats (and cholesterol) and the incidence of obesity, type 2 diabetes mellitus, coronary heart disease, and other chronic diseases. However, major concerns have been voiced over our high intakes of salt and sugar and our relatively low intakes of vegetables, fruits, and whole grain cereals that supply many micronutrients and dietary fiber in addition to unsaturated fats.

American (U.S.) eating trends Trends since 1980 include decreases in the consumption of animal fats, cholesterol, meats, eggs, and dairy products, especially whole milk, and increases in the consumption of vegetable oils, poultry, fish, vegetables, fruits, low-fat dairy products, and whole grain products.

TABLE 1.3
Five Post-World War II U.S. Food Consumption Trends

The USDA has reported notable changes in U.S. eating patterns since 1960:

1. Decline in consumption of animal fat.
2. Increased consumption of processed vegetable oils (fats).
3. Decline in intake of complex carbohydrates and dietary fiber.
4. Increased consumption of animal protein (small increase).
5. Increased consumption of sugar.

Data from U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2010.* 7th ed. Washington, DC: U.S. Government Printing Office; 2010.

FOCUS 1.3 Vegetarian Eating Patterns

A survey conducted by Harris Interactive found that in 2012 approximately 9 million Americans were vegetarian and that many others were following a vegetarian-inclined diet. People adopt a **vegetarian eating pattern**, which entails removing meat from their diet, for a number of reasons. First, some view eating meat as environmentally unsustainable due to the low energy efficiency in raising animals for their meats from grains. Second, many believe that consumption of meat is not healthful. Third, some consider the raising and slaughtering of animals for their meat to be inhumane and a form of animal cruelty.

With regard to health concerns, many consumers and scientists think that most meats contain too much saturated fat and cholesterol. Meat consumption may also contribute to overnutrition because of large portion sizes and to undernutrition because of the avoidance of plant foods, which typically contain many essential micronutrients, plus phytochemicals and dietary fiber. Research has shown that high serum cholesterol concentrations are more likely to result from overconsumption of meats and other animal products.

An **omnivorous eating pattern** entails eating both plant and animal foods, whereas vegetarians emphasize plant foods (i.e., vegetables, fruits, cereals). Vegetarian eating practices actually vary quite widely. A list of the different types of vegetarian eating patterns is provided in **Table A**. The most liberal form allows eggs and dairy products (lacto-ovo-vegetarian), whereas the most conservative type (vegan) permits only plant foods—fruits, vegetables, cereals, nuts, and seeds. About two to three million people in the United States are vegans. In general, the term *vegetarian diet* includes all the types of vegetarians mentioned in Table A.

Vegetarians, in general, have learned to select and prepare mostly plant foods so that they consume virtually all the required nutrients in the appropriate quantities to ensure good health. Vegetarians who consume some egg and dairy products are, in general, healthier than the rest of the U.S. population, as evidenced by disease rates of Seventh-day Adventists, a Christian denomination that advocates a vegetarian eating pattern. Vegetarians have lower rates of most chronic diseases, such as heart disease, cancer, hypertension, and type 2 diabetes mellitus. Aspects of the vegetarian lifestyle other than diet may also contribute to their better health,

(continues)

vegetarian eating pattern A diet in which no meats are consumed. The strictest type of vegetarian diet, the vegan diet, does not include any animal products. Other types of vegetarian eating patterns allow consumption of dairy products and eggs.

omnivorous eating pattern Dietary pattern where an individual eats food from both plants and animals.

FOCUS 1.3 Vegetarian Eating Patterns (*continued*)

TABLE A
Different Types of Vegetarians, by Animal Products Permitted, Compared to Omnivores

Type of Diet	Animal Foods Allowed
Omnivore	No limits
Flexitarian	Limited in white meats, fish, dairy, eggs
Vegetarian	Generally no animal foods
Lacto-ovo-vegetarian	Dairy and eggs only
Pescatarian	Fish only
Vegan	No animal foods at all

but diet remains a very significant contributor to lower rates of obesity and other chronic diseases among vegetarians.

Many plant foods are sufficiently rich in calcium, nonheme iron, and riboflavin to provide adequate amounts of these micronutrients in the vegan diet. Micronutrient-rich plant-based foods include dark green, leafy vegetables (e.g., broccoli, kale, collard and mustard greens, bok choy); beans (e.g., pinto, garbanzo, navy, kidney, black); soybeans; and black strap molasses. Fruits also are typically rich in micronutrients.

However, because vegans avoid all animal foods, their diets may be low in several important micronutrients, whereas macronutrient intakes can typically be kept at comparable intake levels as in omnivorous diets. Concerns have been raised regarding the nutritional status of vegans because of potentially marginal intakes of micronutrients such as iron, zinc, vitamin B_{12} (cobalamin), calcium, and riboflavin, which are found in good amounts in animal products. Thus, vegan diets must be supplemented with vitamin B_{12} and other micronutrients.

Vegetarian diets that include dairy foods and eggs may be safer and healthier than strict vegan diets because the broader selection of foods provides more opportunities to obtain all the essential nutrients. However, this has not been substantiated by research evidence. (Adding fish and other seafoods to a vegetarian diet would ensure that practically all trace elements would be consumed in sufficient amounts, but by definition seafoods are not part of a vegetarian diet.) Despite the few concerns raised, the health benefits of vegetarian diets need to be emphasized: Those adhering to vegetarian diets typically use raw or minimally processed foods only; they consume good amounts of fruits, vegetables, grains, nuts, and seeds; their meals almost always contain a wide variety of foods; and they generally limit intakes of excessive amounts of energy-rich macronutrients typically consumed in the standard American diet. Their protein intakes are adequate, phytochemical and fiber intakes are high, and their diets provide the essential amino acids needed for growth and tissue repair. In sum, the evidence suggests that vegetarian diets generally confer health benefits that start early and continue late into life. ●


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> "Trans fats have largely been removed from processed foods, especially fast foods."

The second trend is a corollary to the first: an increase in the consumption of vegetable oils (i.e., fat from plant sources). Earlier, this trend reflected an increase in the consumption of trans fats, but the consumption of trans fats leveled out around 2000 and has since declined to very minimal amounts. Many vegetable oil products, such as margarines, contain these trans fats, which today are recognized as being detrimental to human health. Most **trans fats** result from the chemical modification (i.e., hydrogenation, or the addition of hydrogen) of plant oils that makes products containing trans fats more stable, giving them a longer shelf life. Trans fats were once common in processed foods such as margarine, baked goods, french fries, and snack foods. However, in recent years, due to concerns about their negative effects on health, trans fats have been removed from many processed foods, especially fast foods, in the United States and Europe.

A third trend has been the decline in complex carbohydrate intake from vegetables, particularly potatoes. This third trend has resulted in a substantial reduction in the intake of dietary fiber, which is found within plant cells, particularly plant cell walls.

A fourth trend is a slight (10%) rise in the consumption of animal protein, bringing protein consumption up to approximately 17% of total daily calories. This trend results primarily from increased use of poultry and, less so, of fish and other seafoods.

A fifth trend is the increase in sugar consumption, which was first observed in the 1950s, more than half a century ago. Although total carbohydrate intake has been decreasing, mainly because of the declining use of grains, vegetables, and fruits, which contain the complex carbohydrates, our appetite for the simple sweet carbohydrates, especially in snack foods and soft drinks, has become voracious. What this portends for future disease risk remains uncertain. Increased dietary sugar may elevate the total amount of energy consumed, thus contributing to the increased incidence of obesity.

trans fat A type of fat added to vegetable oil products through the chemical process known as hydrogenation (adding hydrogen) in order to prevent these oils from spoiling. They are harmful to health because they raise bad cholesterol more so than other types of fats.

According to the Institute of Medicine (IOM) of the National Academies of Science, the current contribution of macronutrient sources to total food energy for U.S. adults is approximately 50% carbohydrates, 35% fats, and 15% proteins (see **FIGURE 1.9**). This macronutrient distribution is based on the current recommended percentages for healthy living. The percent contribution of macronutrients in the U.S. population remains fairly constant across the life cycle, but total energy intake decreases with each decade beyond 60 years, as expenditure of energy in activities also decreases.

Over the last 30 years or so, the incidence of adult and child **obesity** has steadily increased in the United States. Total caloric intake rose gradually over the last few decades of the twentieth century; this, in turn, gave rise to the gradual increase in obesity during the same time frame (see **FIGURE 1.10**). Contributing to these trends is a major change in where meals are prepared and eaten. Currently, more than one in every three meals is consumed away from home, and this figure is growing. Institutional cafeterias, restaurants, and fast-food establishments supply the bulk of these meals. Fast-food

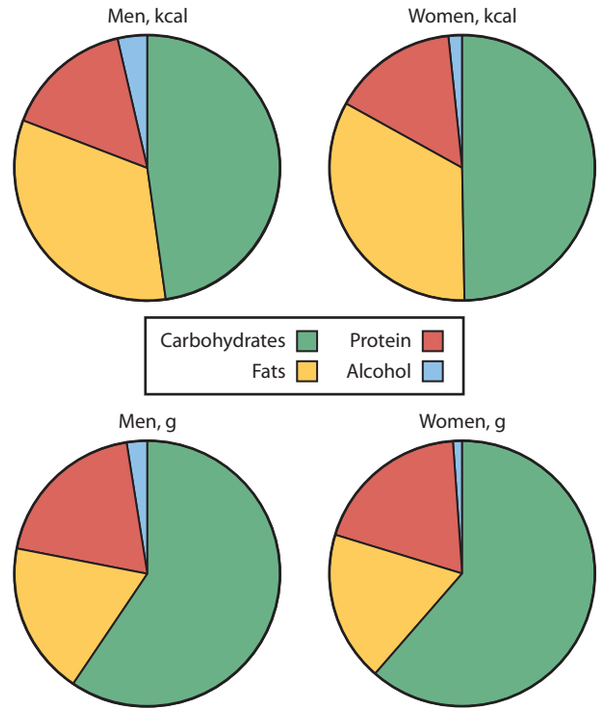


FIGURE 1.9 Distribution of Macronutrients in the U.S. Diet by Calories and Weight.

Data from Austin GL, Ogden LG, Hill JO. Trends in carbohydrate, fate, and protein intakes and association with energy intake in normal-weight, overweight, and obese individuals: 1971–2006. *Am J Clin Nutr*. 2011;93:836–843.

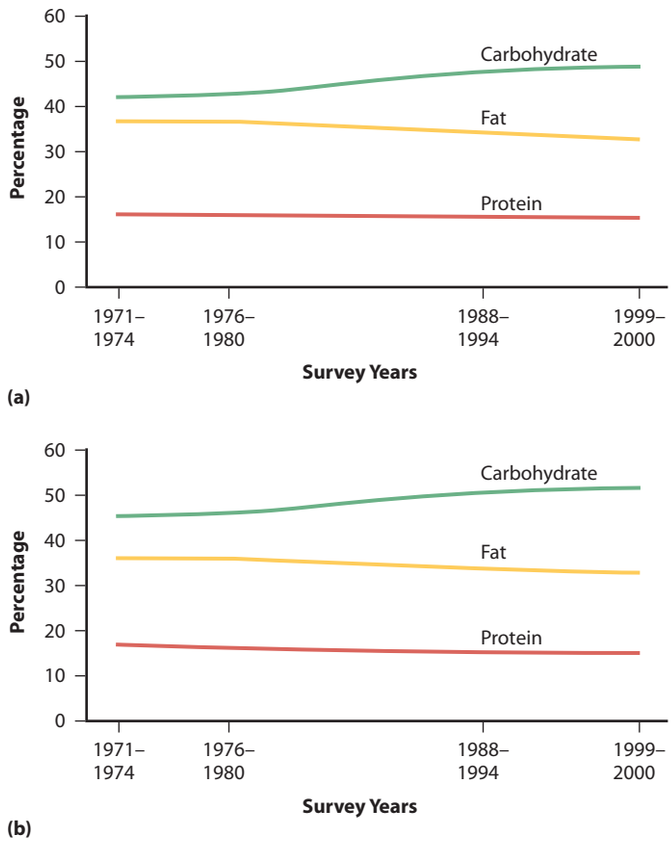


FIGURE 1.10 Trends in Calorie Consumption in the United States from 1971 to 2000. The increase in calories consumed since the 1970s is correlated with the gradual rise in obesity prevalence. (a) NHANES data for men. (b) NHANES data for women.

Reproduced from Wright JD, Kennedy-Stephenson J, Wang CY, McDowell MA, Johnson CL. Trends in intake of energy and macronutrients—United States, 1971–2000. *MMWR*. 2004;53(4):80–82.

obesity Excess accumulation of body fat mass. By definition, an individual is obese when his or her BMI is 30 or greater.

FIGURE 1.11 Fast-Food Restaurants. Fast-food outlets have dramatically grown in number and have influenced the eating patterns of many Americans.

FIGURE 1.12 Seafood Products. The nutrient content of most seafood products is largely unaffected by commercial food processing. Thus, boiled or grilled seafood products can be a good choice at fast-food outlets.

outlets, in particular, have grown in number and today have a strong influence on U.S. eating patterns (see **FIGURE 1.11**).

Fast Foods

Fast foods generally provide large amounts of energy from fats and sugars and too little in the way of complex carbohydrates, phytochemicals, and dietary fiber. The widespread satisfaction with fast foods, in general, is due to their convenience, taste and flavor, and reasonable prices, not their nutritional quality. An occasional meal at a fast-food outlet doesn't hurt, but a steady diet of fast foods provides, for the average person, excessive energy and sodium and too little vitamin A, iron, phytochemicals, and dietary fiber, leading to a nutritionally unbalanced pattern of eating.

Certain food items, such as meat-containing items like pizza, Mexican foods, and chili, provide a better balance, in general, than fast-food sandwiches, but they still remain fairly high in saturated fats from the cheese and sour cream often used in these dishes. Also, more salt is consumed with cheese because of the processing. The amounts of protein and most micronutrients appear to be adequate in fast foods. However, many of the processed foods used by fast-food vendors are lacking in a variety of trace minerals. An exception to this rule holds for most seafood products, the nutrient content of which is almost unaffected by commercial processing (see **FIGURE 1.12**).

The major nutritional disadvantages of the offerings of fast-food chains are the limited choice of foods, large serving sizes, the large amounts of animal fat from beef and other meats, the presence of trans fats, and high amounts of salt. In addition, many fast foods, especially "nonmilk" shakes and soft drinks, are high in sugar. Large portion sizes tend to be the rule for fast foods. Fast foods also contain much less of the micronutrients and fiber provided by plant foods. As a consequence of the narrow choices of food items, the development of healthy individual food habits is difficult to achieve when relying on fast foods. The taste, flavor, and convenience of fast foods have had a powerful influence on the food-related behaviors of Americans. These new behaviors, and the accompanying decline in traditional food habits (i.e., the consumption of balanced meals with adequate servings of fruits, grains, and vegetables), may have long-term negative health risks (see **FIGURE 1.13**).

> "Fast foods generally provide large amounts of energy from fats and sugars and too little in the way of complex carbohydrates, phytochemicals, and dietary fiber."

fast foods Foods obtained quickly from outlets that typically are designed to prepare food rapidly and often for take-out. Many fast foods are high in calories and low in nutrients. There are many fast-food chains in the United States.

FIGURE 1.13 Fast-Food Meal. Most fast foods are high in fat, sugar, and salt and low in dietary fiber.

TABLE 1.4
Advantages and Disadvantages of Fast Foods

Advantages	Disadvantages
High-quality protein	High in energy
Adequate in iron	High in fat, especially saturated fat
Good salads	High in sugar and high-fructose corn syrup
Good coffee	Limited offerings of fruits and vegetables
Convenient	Low in calcium
Cheap	Typically nutritionally unbalanced
Predictable	High in salt

Data from the U.S. Department of Agriculture.

Because of the high prevalence of obesity in the United States, fast-food providers have been coming under increasing attack for selling high-fat, high-energy foods that are prepared in extra-large servings. Of course, fast foods are not totally responsible for the great increase in body size over the last few decades, but the fast-food nation that we have become is probably a major contributor to our becoming a "fat nation." **Table 1.4** lists several of the advantages and disadvantages of fast foods.

PRACTICAL APPLICATIONS 1.1

Compare the Energy and Protein Content of McDonald's Big Mac vs. Wendy's Grilled Chicken Sandwich

Using a fast-food nutrient content table, find the total energy (kilocalories), total fat (grams), and protein (grams) content for a McDonald's Big Mac and a Wendy's grilled chicken sandwich. How do these sandwiches differ with regards to total energy, fat, and protein? How healthy do you consider each sandwich to be? Explain.

	McDonald's Big Mac	Wendy's Grilled Chicken Sandwich
Energy (kcal)		
Total fat (g)		
Protein (g)		

For each sandwich, can you estimate total carbohydrate intake as a percentage of total energy intake? ■

Fortification of Foods

"Fortification of foods with folate has led to a decrease in neural tube defects in children."

The **fortification of food** provides additional nutrients to ensure consumption of all essential micronutrients (i.e., vitamins and minerals). Food fortification is the process of adding fortificants (i.e. essential trace elements and vitamins) to food during processing. These extra nutrients are beneficial to the food because public health policy aims to reduce the amount of people with dietary deficiencies in a population. A good example of the benefits of nutrient fortification is the use of folic acid, or folate, which has been added to flours, cereals, and other grain products since the late 1990s. Women who are or may become pregnant are encouraged to consume folate-containing foods because it has been shown to reduce the risk of neural tube defects, such as spina bifida, in children. Other nutrients are also used in fortifying foods and as components of supplements; for the most part, such fortification is generally considered to be healthful.

PRACTICAL APPLICATIONS 1.2

Fortification of a Ready-to-Eat Breakfast Cereal

Obtain a box of Cheerios cereal and look at the Nutrition Facts panel. Find the listing of vitamins and minerals. Note that most of these are added to the raw cereal during processing. The following vitamins and minerals are fortificants: iron, zinc, vitamin C, B vitamins (niacin, pyridoxine, riboflavin, thiamin, folic acid, and cobalamin [B_{12}]), vitamin A, and vitamin D. Examine the Nutrition Facts panel of a different cereal and identify all the vitamins and minerals used to fortify the cereal. Which ingredient weighs the most? (See the first ingredient in the list.) ■

Functional Foods

"Functional foods are specially designated as having health benefits or having advantages in reducing the risks of one or more chronic diseases."

Functional foods are specially designated as having health benefits or having advantages in reducing the risks of one or more chronic diseases. The U.S. Food and Drug Administration (FDA) permits several specific foods to be classified as functional foods because of the quantitatively large amount of a particular nutrient or phytochemical contained in one serving of the food. The designation functional food can be applied to a food that naturally contains a bioactive ingredient (i.e., nutrient or phytochemical) with major benefits to health beyond basic nutrition, especially for promoting health and preventing disease. The health benefit of the specific nutrient or ingredient (molecule) of interest must be supported by published research.

The focus is on the health effects of individual foods. Typically, a health claim for a functional food is made on the label or carton of a specific food, including fortified foods. The term *functional food* does not generally refer to additives, supplements, or herbals (botanicals). Examples of functional foods include blueberries, cranberry juice, tomatoes, spinach, broccoli, garlic, soybeans, green tea, fish, nuts, and oats. Red wine also may be considered a functional food. Epidemiologic studies have shown demonstrated health benefits of these foods for humans, such as reduction of cardiovascular diseases. An example of a "super" functional food, the blueberry, is highlighted in **FOCUS BOX 1.4**.

The view taken by the authors is that functional foods can be a great way to meet daily nutrient requirements. A food-based approach for meeting nutrient requirements, rather than focusing on supplements or herbals/botanicals that are not truly foods, is critical for healthy eating patterns. Nutrient-rich foods and plant foods also rich in phytomolecules support body functions better than nutrient-poor, energy-dense foods.

fortification of foods The addition of nutrients to foods for the purpose of improving intakes of nutrients that are not consumed in adequate amounts.

fortificant The specific nutrient added to a food during fortification.

functional food A food that contains, in addition to normal amounts of nutrients and nonnutrients, other molecules that promote health or prevent disease. Functional foods are often rich in phytochemicals. Examples include blueberries, broccoli, and salmon. They also are referred to as pharmfoods or neutraceuticals.

FOCUS 1.4 A Phytochemical Powerhouse: The Blueberry

Functional foods are foods that have a potentially positive effect on health beyond basic nutrition. A good example of a functional food is the blueberry (see **FIGURE A**), which is not only a good source of vitamins and minerals, but is also rich in phytochemicals. Blueberries are good sources of phytochemicals such as flavonoids, resveratrol, and anthocyanins (and their sugar-containing derivatives, the anthocyanidins). The phytochemicals in blueberries have considerable antioxidant properties; that is, they help reduce the presence of highly reactive oxygen molecules (species) in the cells, thereby protecting cells from oxidative damage. Specifically, studies on animals have found blueberries may help to protect the brain from oxidative stress, reducing the effects of age-related conditions such as Alzheimer's disease or dementia. Similar to cranberries, blueberries make it more difficult for bacteria to adhere to the mucosa of the urethra and bladder, thus reducing the risk of urinary tract infections. Many other berries have similar antioxidant properties because of their phytochemical content. The strong antioxidant properties of blueberries make them an excellent example of a functional food. ●

FIGURE A Blueberries. Blueberries are a major functional food, offering a variety of proven health benefits due to their high phytochemical content.

Nutrient Supplements

Nutrient supplements, typically pills containing multiple nutrients, provide an easy way for consumers to obtain all the essential micronutrients (i.e., vitamins and minerals) they need each day (see **FIGURE 1.14**). Note that a supplement may not contain all of the required essential nutrients. Some supplement formulations are targeted to specific age groups (e.g., children, adult women, pregnant women, adult men, and older adults). In the future, nutrient supplements may be formulated to meet the needs of specific individuals, especially those who have genetic-related nutrient deficits!

FIGURE 1.14 Supplement Label. The label on a supplement package lists all the vitamins and minerals as well as the amounts they supply.

Nutritional Status and Health

What does all of this nutrition information mean for individuals? How can people apply the guidelines and recommendations to achieve better health? How can governments assess the health of their populations to determine whether diet is a concern for the population? **Nutritional status** is important to both an individual and nation's health surveillance. A number of different tools are available to evaluate the health and nutritional status of both individuals and populations. Two of the tools that are particularly useful are nutrition assessments and body mass index (BMI). These tools are used by nutritionists, registered dietitians, physicians, and personal trainers—basically anyone seeking to gain insight into a person's nutrition and health status.

nutrient supplement A product that provides nutrients in pill, tablet, or powder form for the purpose of improving nutritional status. Many micronutrients are available in pill form. Protein and energy also may be obtained through specific macronutrient supplements.

nutritional status The health of an individual with respect to nutrient intake. Also known as nutritional state.

Nutritional Assessment

A **nutritional assessment** is an in-depth evaluation of both objective and subjective data related to an individual's food and nutrient intake, lifestyle, and medical history. Once the data on an individual is collected and organized, the nutritional status of that person can be assessed and evaluated. An assessment can lead to the development of a plan to help the individual either maintain the assessed status or attain a healthier status.

Nutrition assessment can be achieved by completing a 24-hour food recall or a quantitative food frequency questionnaire. Current methods used to assess daily intake of nutrients and phytochemicals analyze all foods and beverages consumed during a day or over several days and then the nutrient content of the diet is calculated using food composition tables. The USDA website, ChooseMyPlate.gov, offers a useful tool that enables a person to perform a nutrition analysis of his or her 24-hour intake.

Health Assessment

Various tools are currently used to assess health, including **body mass index (BMI)** and serum measurements of important molecules or biomarkers. BMI has become a standard assessment calculation based on weight and height to establish overweight and obesity as well as underweight ranges. Other measurements—for example, those resulting from whole-body scans (e.g., CAT scans, MRIs, X-rays)— also can be used, but these generally have less association with nutritional intake. In addition, simple measurements of girth can be useful. For example, waist and hip circumferences can be used to calculate a waist-to-hip ratio, an index of visceral (abdominal) body fat. Visceral fat is considered to be more metabolically active than fat around the buttocks and thighs; hence, this type of fat distribution (i.e., android or visceral) is considered to increase an individual's risk for chronic diseases more than the common female fat distribution (i.e., gynoid or hips; see **FIGURE 1.15**). The BMI ranges for underweight, normal weight, overweight, and obesity are listed in **Table 1.5**.

> "BMI has become a standard assessment calculation based on weight and height to establish overweight and obesity as well as underweight."

nutritional assessment A complete nutritional assessment of an individual includes the ABCDs: anthropometric measurements, biochemical measurements, clinical evaluation for physical signs and other changes from normal, and dietary assessment (dietary questionnaires).

body mass index (BMI) An estimation of body fatness based on the equation of weight (kg)/height $(m)^2$ that is used to delineate overweight and obesity. Also referred to as the Quetelet index.

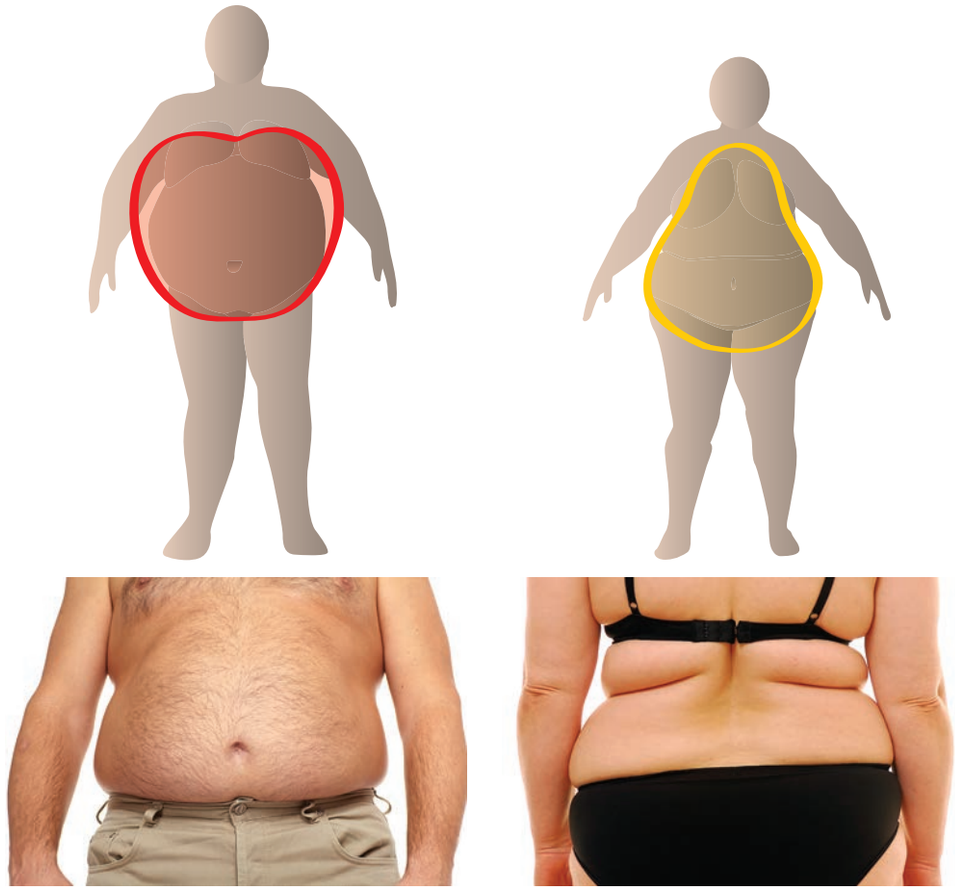
PRACTICAL APPLICATIONS 1.3

Calculate Your BMI

It is easy to calculate your BMI. Just grab a calculator!

1. Convert your weight in pounds to kilograms by dividing by 2.2.
2. Convert your height in inches to meters by multiplying by 0.0254.
3. Square your height in meters (m).
4. Divide your weight in kilograms by meters squared to determine your BMI.

Consider an example. An adult male weighs 198 pounds and is 6 feet tall (72 inches). The metric conversions result in a weight of 90 kilograms and a height of 1.83 meters. Squaring of 1.83 equals 3.35, resulting in a BMI of 90/3.35, or 29.9. This man's BMI places him in the overweight category; in fact, he is almost obese! However, he is a weightlifter with large muscle mass. Would you still consider him to be overweight? ■



(a) (b)

FIGURE 1.15 Obesity. (a) Android obesity is characterized by an excess of fat around the abdomen. (b) Gynoid obesity is characterized by an excess of fat around the hips and thighs.

Excessive macronutrient intake contributes to four conditions that may lead to chronic disease: hypertension, hypercholesterolemia, impaired glucose tolerance, and obesity. The theory that unhealthy eating patterns involving excessive energy intake from all macronutrients plus too little physical activity contribute to the development of

> "Excessive nutrient intakes contribute to four risk factors for the development of chronic disease: hypertension, hypercholesterolemia, impaired glucose tolerance, and obesity."

TABLE 1.5
Body Mass Index (BMI) Classifications

Classification	BMI Range
Underweight	< 18.5
Normal	18.5–24.9
Overweight	25–29.9
Obesity	> 30

BMI = weight (in kg)/height $(m)^2$

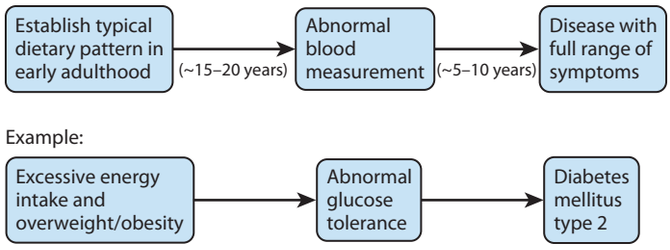


FIGURE 1.16 Diet–Disease Linkage. Dietary patterns established in early adulthood that may contribute to the development of a chronic disease, such as type 2 diabetes mellitus, later in life.

Reproduced from Anderson JJB. *Nutrition and Health: An Introduction.* Durham, NC: Carolina Academic Press; 2005.

chronic disease has been instructive to researchers studying diseases such as stroke, type 2 diabetes mellitus, and diet-related cancers. **FIGURE 1.16** illustrates the linkage between dietary risk factors and type 2 diabetes mellitus. Other diet-related diseases, such as hypertension and cardiovascular diseases, may also follow obesity. All of these examples show **diet-disease linkage**, where one's diet can adversely affect him or her, and possibly result in a disease.

Nutritional Status: Normal Nutrition, Undernutrition, and Overnutrition

> "Nutritional status relates to the overall health of an individual or of a nation, as determined by assessment of nutritional intake, body composition, and biochemical measures."

Nutritional status relates to the overall health of an individual or of a nation, as determined by assessment of nutritional intake, body composition, and biochemical measures. Normal nutrition and health is distinguished from under- and overnutrition by specific types of information obtained from body weight and height; dietary intake patterns; biochemical measures of blood variables, such as fasting glucose; and clinical assessment of the skin, hair, and other visible or measurable features. The National Health and Nutrition Examination Survey (NHANES) provides this detailed information for U.S. subpopulations. For individuals, physicians and other healthcare professionals provide routine physical examinations and related tests. Prior to World War II, undernutrition was a serious problem that affected many; today, however, overnutrition—as evidenced by high rates of overweight and obesity—dominates the nutritional status of the nation. Other Western countries have also experienced increases in obesity, but not to the same extent as in the United States, where excessive body weight, coupled with inactivity, is the number one health problem. Extremes of nutrition intake (under- and overnutrition) are associated with a variety of negative health outcomes (see **FIGURE 1.17**).

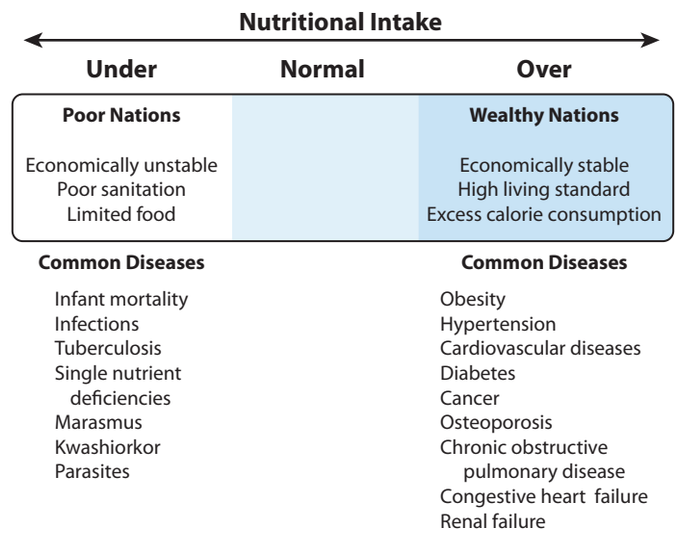


FIGURE 1.17 Nutrition and Health. Over- and underconsumption of nutrients both lead to negative health outcomes.

Reproduced from Anderson JJB. *Nutrition and Health: An Introduction.* Durham, NC: Carolina Academic Press; 2005.

diet–disease linkage The linkage between a long-term dietary pattern and the development of a chronic disease.

The assessment of the nutritional status of individuals and populations involves both measurements and observation, as undertaken by the periodic NHANES in the United States. Nutrition assessment often includes four components, sometimes referred to as the ABCDs of assessment:

- *Anthropometry*: Includes measurements of height and weight.
- *Biochemical assessment*: Includes biochemical measurements of blood or urine.
- *Clinical assessment*: Includes observations of the skin, hair, tongue, and mouth to look for abnormal physical signs.
- *Dietary assessment*: Involves estimations of dietary intake through 24-hour recalls or food frequency instruments.

TABLE 1.6
Physical Characteristics of Good Health

Characteristic	Description
Body size and shape	Appropriate weight for height (BMI)
Skin	No rashes or abnormal swelling
Hair	Shiny and not falling out
Lips and mouth	Not swollen, smooth, good color
Teeth	Not missing, no cavities, no pain
Eyes	Clear and shiny, pink membranes

These approaches, and other measurements of body composition, are used to try to determine the health of individuals as related to their usual nutritional intake.

A person's health status may be visually assessed by closely observing the body surface, skin, and hair and noting any excess fat accumulation in the body, including girth from abdominal fat or fat distribution on the buttocks and thighs (see **Table 1.6**). Undernutrition was widespread throughout the United States during the Great Depression of the 1930s, as illustrated by thin hungry adult males waiting in line for food handouts (doles) (see **FIGURE 1.18**).

FIGURE 1.18 Undernourished Men During the Great Depression. Undernutrition was common in the United States during the Great Depression of the 1930s.

Changing Understandings Based on Nutrition Research

The great change in the field of nutrition over the last few decades has been the enormous increase in overweight and obesity in the U.S. population, primarily among adults but also among children and adolescents. For example, in 2005 approximately 60% to 70% of all adults were either overweight or obese. A huge question for nutritionists is how nutrition is contributing to this enormous epidemic, an epidemic of relative affluence that also is affecting the rest of the industrialized world.

This increase in overweight and obesity is negatively influencing health and rates of **chronic diseases**, which are diseases typically diagnosed in adulthood as a result of dietary patterns, environmental risk factors, hormonal factors, or heredity. In fact, a cluster of chronic diseases or conditions is emerging that derives from obesity: high blood glucose, hypertension, abnormal blood lipids, and a large waist measurement. This cluster of conditions is commonly called metabolic syndrome because so many of the changes involve metabolic parameters, especially insulin resistance, resulting from excessive energy consumption and too little physical activity.

Scientific advances, whether from the laboratory, clinical research units, or epidemiological investigations, are being made at a fairly rapid pace. New studies often cast doubt on the validity of earlier studies. They also often complicate simpler interpretations of disease causation by uncovering additional complexities in diet–disease relationships. Re-evaluation of our knowledge base and disease concepts is an ongoing process.

chronic disease A disease typically diagnosed in adulthood as a result of suboptimal dietary intake patterns, environmental risk factors, hormonal factors, or heredity. Common chronic diseases include cardiovascular disease, type 2 diabetes, chronic obstructive pulmonary disease (COPD), and cancer.

"A cluster of chronic diseases or conditions is emerging that derives from obesity: high blood glucose, hypertension, abnormal blood lipids, and a large waist measurement. This cluster of conditions is commonly called metabolic syndrome because so many of the changes involve metabolic parameters, especially insulin resistance, resulting from excessive energy consumption and too little physical activity."

Consumers need to keep an open mind that the most recently published report does not necessarily contradict earlier reports and understandings. In addition, consumers need to keep an eye open for fantastical claims by new fad diets or supplements (see **FOCUS BOX 1.5**). Typically, scientific studies need to be replicated at least once to be certain that the first study was not a "fluke" and that the subsequent studies corroborate the findings of the first report on the same study question.

FOCUS 1.5 Nutritional Science vs. Quackery

The difficulty for many consumers, at least in the United States, is recognizing the difference between legitimate scientific results and **quackery** based on poor or ill-conceived studies or testimonials. In a society that permits freedom of speech, almost anything on a nutrition topic can be written and published, whether based on science or not. When specific programs for improving health, such as a weight-loss program based on a fallacious concept of human biology, are advertised to consumers, the FDA or the Federal Trade Commission (FTC) has the authority to step in and stop the advertising and sale of the product. Keep a wary eye on advertisements that sound too good to be true! They most likely are. Quackery is just as alive today as it was in the past. In the late 1800s, an old-fashioned liquid elixir known as Lydia Pinkham's Vegetable Compound (see **FIGURE A**) was sold with claims that it could heal all manner of dysfunction and illness (it did not). Public awareness of the potential for quackery should be based on better understandings of foods, food ingredients, supplements, food labeling, and the roles of nutrients in health. This text should help you gain these understandings.

With obesity at an all-time high, people are so willing to try anything to lose weight that they are spending millions of dollars on every kind of product and program that promises results, especially quick results. So much money and effort are being put into the programs aimed at weight reduction that many wacky schemes have been invented to convince people that by using them they will accomplish their weight loss. Quackery and gimmicks that have no scientific validity abound in the realm of weight-loss products. ●

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FIGURE A Quackery in Nutrition. Lydia Pinkham's Vegetable Compound was a quack remedy popular in the late 1800s. Today, quack remedies are just as widespread, and just as ineffective, for maintaining health.

quackery The distribution and promotion of false and misleading information. In the nutrition world, this consists of programs for health improvement, weight-loss and fad diets that are not backed in scientific data.

SUMMARY

Nutrients derived from foods must be consumed to maintain healthy human body tissues. The development of agriculture enabled human civilizations to develop because a steady supply of food was available to meet the population's needs. The body requires macronutrients (fats, proteins, and carbohydrates) and micronutrients (vitamins and minerals) to meet the body's energy needs and form biological compounds. The human body also requires water, dietary fiber, and phytochemicals, which are plant-based chemicals that have been found to be beneficial for human health. The energy in food is released from the breakage of hydrocarbon bonds and is measured in kilocalories. The recommended energy contribution for the macronutrients is 50% carbohydrates, 35% fats, and 15% proteins. Most Americans meet this distribution of macronutrients but consume too many calories, which often leads to overweight and obesity.

The three major determinants of food intake are availability of foods, purchasing power (money or barter), and social and cultural values placed on specific foods. More and more Americans are trying to make better food choices based on the nutritional quality of different foods. Various agencies in the U.S. government provide guidelines and tools to help Americans make better choices with regards to their nutrient intake. The *Dietary Guidelines for Americans* offers guidelines for making better food choices. The USDA's MyPlate is a visual tool to remind people to eat in the right proportions from the food groups. The Dietary Reference Intakes are guidelines for the intake of different macronutrients and micronutrients with the goal of meeting the health needs of approximately 98% of the U.S. population.

Dietary trends since World War II include increased macronutrient consumption, the rise of fast foods, the emergence of fortified and functional foods, and the use of nutrient supplements. These are primarily U.S.–specific consumption patterns, but many of these trends also have emerged to some degree in other Western nations and even in some Asian countries. In addition, more and more Americans are adopting vegetarian dietary patterns.

A variety of tools are available for evaluating the nutrition and health of both populations and individuals. Nutrition assessment is an in-depth evaluation of an individual's nutrient intake, lifestyle, and medical history. These data can be analyzed to find areas for improvement. Health assessments can be made by using BMI and serum measurements of biomarkers. Unhealthy dietary patterns can contribute to the development of chronic disease. In particular, obesity and overweight can lead to heart disease, high blood pressure, and type 2 diabetes. Diseases of overnutrition are becoming serious problems in developed countries. Diseases associated with undernutrition afflict the populations of poor countries. Nutrition research is continuing at a rapid pace to untangle the complexities of diet-related diseases.

STUDENT ACTIVITIES

1. List the three major determinants of food intake.
2. What are the three macronutrients? Which two macronutrients contribute the most energy to the diet?
3. What is the most common explanation for the current high rates of overweight and obesity in the United States?
4. What are phytochemicals? What is one of the major roles of phytochemicals in the human body?
5. What are the Atwater equivalents for the three macronutrients?
6. How do food guidelines and food pyramids differ? Briefly state the main difference between them, especially in terms of purpose and general content.
7. List recent trends (1970–2000) in consumption of macronutrients in the United States. Which macronutrient has seen increased consumption over this period?
8. List the advantages and disadvantages of fast foods.
9. Define the term *nutrient fortification*. Give an example.
10. Define *functional food.* How does a functional food differ from other foods?
11. Define *nutrient supplement*. Give an example. How does a nutrient supplement differ from adding nutrients (i.e., additives) to foods?
12. What is BMI? How is it calculated?
13. In the United States, prior to 1950 most nutrition-related problems, conditions, or diseases were of one type, whereas since 1950, they have been of another type. Explain why.

WEBSITES FOR FURTHER STUDY

Academy of Nutrition and Dietetics
www.eatright.org
American College of Nutrition
www.americancollegeofnutrition.org
American Society for Nutrition
www.nutrition.org
Centers for Disease Control and Prevention
www.cdc.gov
Food and Drug Administration
www.fda.gov
Canada's Food Guide
www.healthcanada.gc.ca/foodguide
Office of Dietary Supplements, NIH: Background Information on Dietary Supplements
http://ods.od.nih.gov/factsheets/DietarySupplements.asp
The Nutrition Society (British)
www.nutritionsociety.org
United States Department of Agriculture (USDA)
www.usda.gov
Vegan Health
www.veganhealth.org
Vegetarian Nutrition Resource, National Agricultural Library/USDA
http://snap.nal.usda.gov/resource-library/eat-healthy-every-day/vegetarian-nutrition
Vegetarian Resource Group
www.vrg.org
Position of the American Dietetic Association: Food and Nutrition Misinformation
www.eatright.org/WorkArea//DownloadAsset.aspx?id=8450
Nutrition and Well-Being A to Z from faqs.org: Quackery
www.faqs.org/nutrition/Pre-Sma/Quackery.html
Top 10 Tips to Identify Nutrition Quacks from Ask the Dietitian®
www.dietitian.com/quack.html

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