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Nutrition

Concepts & Controversies 16e



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Nutrition

Concepts & Controversies

16e

Frances Sienkiewicz Sizer | Ellie Whitney



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Frances Sienkiewicz Sizer
and Ellie Whitney

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About the Authors

Frances Sienkiewicz Sizer

M.S., R.D.N., F.A.N.D., attended Florida State University where, in 1980, she received her B.S., and in 1982 her M.S., in nutrition. She is certified as a fellow of the Academy of Nutrition and Dietetics. She is a founding member and vice president of Nutrition and Health Associates, an information and resource center in Tallahassee, Florida, that maintains an ongoing bibliographic database tracking research in more than 1,000 topic areas of nutrition. Her textbooks include the award-winning *Life Choices: Health Concepts and Strategies*; *Making Life Choices*; *The Fitness Triad: Motivation, Training, and Nutrition*; and others. She also authored *Nutrition Interactive*, an instructional college-level nutrition CD-ROM that pioneered animation of nutrition concepts in college classrooms. She has consulted with an advisory board of professors from around the nation with a focus on innovations in nutrition education. She has lectured at universities and at national and regional conferences and supports local hunger and homelessness relief organizations in her community.

For Cara and David, my alpha and omega, and for Philip.

—Fran

Eleanor Noss Whitney

Ph.D., received her B.A. in biology from Radcliffe College in 1960 and her Ph.D. in biology from Washington University, St. Louis, in 1970. Formerly on the faculty at Florida State University and a dietitian registered with the Academy of Nutrition and Dietetics, she now devotes her time to research, writing, and consulting in nutrition, health, and environmental issues. Her earlier publications include articles in *Science*, *Genetics*, and other journals. Her textbooks include *Understanding Nutrition*, *Understanding Normal and Clinical Nutrition*, *Nutrition and Diet Therapy*, and *Essential Life Choices* for college students and *Making Life Choices* for high school students. Her most intense interests currently include energy conservation, solar energy uses, alternatively fueled vehicles, and ecosystem restoration. She is an activist who volunteers full-time for the Citizens Climate Lobby.

To Max, Zoey, Emily, Rebecca, Kalijah, and Duchess with love.

—Ellie

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Preface

A billboard in Louisiana reads, “Come as you are. Leave different,” meaning that once you’ve seen, smelled, tasted, and listened to Louisiana, you’ll never be the same. This book extends the same invitation to its readers: come to nutrition science as you are, with all of the knowledge and enthusiasm you possess, with all of your unanswered questions and misconceptions, and with the habits and preferences that now dictate what you eat.

But leave different. Take with you from this study a more complete understanding of nutrition science. Take a greater ability to discern between nutrition truth and fiction, to ask sophisticated questions, and to find the answers. Finally, take with you a better sense of how to feed yourself in ways that not only please you and soothe your spirit but nourish your body as well.

For almost half a century, *Nutrition: Concepts and Controversies* has been a cornerstone of nutrition classes across North America, serving the needs of students and professors. In keeping with our tradition, in this, our 16th edition, we continue exploring the ever-changing frontier of nutrition science, confronting its mysteries through its scientific roots. We not only embrace the power of electronic media in education, but we also maintain our sense of personal connection with instructors and learners, writing for them in the clear, informal style that has always been our trademark.

Pedagogical Features

Throughout these chapters, features tickle the reader’s interest and inform. For both verbal and visual learners, our logical presentation and our lively figures keep interest high and understanding at a peak. The photos that adorn many of our pages add pleasure to reading.

Many tried-and-true features return in this edition: Each chapter begins with What Do You Think? questions to pique interest. What Did You Decide? at the chapter’s end asks readers to draw conclusions. A list of Learning Objectives (LO) offers a preview of the chapter’s major goals, and the LO reappear under section headings to make clear the main take-away messages. Do the Math margin features challenge readers to solve nutrition problems, with examples provided. Think Fitness reminders alert readers to links among nutrition, fitness, and health. Food Feature sections act as bridges between theory and practice; they are practical applications of the chapter concepts. The Consumer’s Guide sections lead readers through an often bewildering marketplace with scientific clarity, preparing them to move ahead

with sound marketplace decisions. Each Consumer’s Guide ends with review questions to improve recall of its main points.

By popular demand, we have retained our Snapshots of vitamins and minerals. These concentrated capsules of information depict food sources of vitamins and minerals, present DRI values, and offer the chief functions of each nutrient along with deficiency and toxicity symptoms.

New or major terms are defined in the margins of chapter pages or in nearby tables, and they also appear in the Glossary at the end of the book. Terms defined in margins are printed in **blue** boldface type; terms in tables are in **black**. Readers who wish to locate any term can quickly do so by consulting the Index, which lists the page numbers of definitions in boldface type. Each chapter closes with an indispensable Self Check that provides study questions, with answers in Appendix G to provide immediate feedback to the learner.

Controversies

The Controversies of this book’s title invite you to explore beyond the safe boundaries of established nutrition knowledge. These optional readings, which appear at the end of each chapter, delve into current research themes and ongoing debates among nutrition scientists. These fast-changing topics capture interest and demonstrate how scientific investigations both build nutrition knowledge and challenge it.

Chapter Contents

Chapter 1 begins the text with a personal challenge to students. It asks the question so many people ask of nutrition educators—“Why should people care about nutrition?” We answer with a lesson in the ways in which nutritious foods affect diseases, and present a continuum of diseases from purely genetic in origin to those almost totally preventable by nutrition. After presenting some beginning facts about genes, nutrients, bioactive food components, and motivations that drive people’s food choices, the chapter concludes with a discussion of scientific research and quackery.

Chapter 2 brings together the concepts of nutrient standards, such as the Dietary Reference Intakes, and diet planning using the Dietary Guidelines for Americans 2020–2025. Chapter 3 presents a thorough, but brief, introduction to the workings of the human body from the genes to the organs, with major emphasis on the digestive system and its microbiota. It ends with a discussion of alcohol consumption and its effects on body systems. Chapters 4 through 6 are devoted to the energy-yielding nutrients: carbohydrates,



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lipids, and protein. Controversy 4 turns its focus to theories and fables surrounding the health effects of added sugars in the diet. Controversy 5 considers the scientific underpinnings of lipid guidelines.

Chapters 7 and 8 present the vitamins, minerals, and water. Chapter 9 relates energy balance to body composition, obesity, and underweight and provides guidance on lifelong weight maintenance. Chapter 10 describes relationships among physical activity, athletic performance, and nutrition, with some guidance about products marketed to athletes. Chapter 11 applies the essence of the first 10 chapters to chronic disease development and prevention. The chapter also points out the critical roles of nutrition in maintaining the body's immune defenses, and ends by explaining potential harms that can arise when nutrients interact with medical drugs

Chapter 12 delivers urgently important concepts of food safety and ends with practical pointers for applying them in real-life situations. It also addresses the usefulness and safety of food additives, including low-calorie and artificial sweeteners. Chapters 13 and 14 emphasize the importance of nutrition through the life span. Chapter 13 focuses on the critical roles of nutrition during pregnancy and infancy, while Chapter 14 includes nutrition advice for feeding preschoolers, schoolchildren, teens, and the elderly.

Chapter 15 devotes attention to hunger and malnutrition, both in the United States and worldwide. It also touches on the vast network of problems that threaten our future food supply, and explores potential paths to solutions.

Our Message to You

Our purpose in writing this text, as always, is to enhance our readers' understanding of nutrition science. We also hope the information on this book's pages will reach beyond the classroom into our readers' lives. Take the information you find inside this book home with you. Use it in your life: nourish yourself, educate your loved ones, and nurture the health of others. Stay up with the news, too—for despite all the conflicting messages, inflated claims, and even quackery that abound in the marketplace, true nutrition knowledge progresses with a genuine scientific spirit, and important new truths are constantly unfolding.

New to This Edition

Every section of each chapter of this text reflects advances in nutrition science occurring since the last edition. The changes range from subtle shifts of emphasis to entirely new sections that demand our attention. Appendix F supplies current references; older references may be viewed in previous editions, available from the publisher.

Notable Changes to the 16th edition

In addition to updated text material throughout, the following changes are notable.

Chapter 1

- Updated to Healthy People 2030.
- New section evaluating the reliability of research.

Chapter 2

- Introduced, defined, and discussed Chronic Disease Risk Reduction (CDRR).
- All text and figures updated to reflect the 2020–2025 Dietary Guidelines for Americans and food groups.
- Updated labeling figure and discussion.
- Reorganized and updated phytochemical Controversy.

Chapter 3

- Defined inflammation.
- Removed choking figure.
- New table of alcohol statistics.

Chapter 4

- New section and figure explaining glycemic response.
- New table of top U.S. sources of added sugars.

Chapter 5

- Improved figure of bile action.
- New figure of U.S. saturated fat sources.
- Explained fully hydrogenated versus partially hydrogenated fats.
- Expanded the Controversy discussion of arguments surrounding lipid guidelines.

Chapter 6

- Improved complementary protein figure.
- New figure comparing protein values on cereal labels.
- New emphasis on plant-based foods and diets.

Chapters 7 and 8

- New figure of valid quality testing symbols.
- Water safety information moved to Chapter 12.
- Sodium CDRR update.
- New discussion and table of plant-based calcium sources.

Chapter 9

- New obesity maps data.
- Expanded Do the Math activity.
- New “keto” and “paleo” diet discussions.
- New table of adverse effects of ketogenic diets.
- Moved prescription drug table to instructor's materials.
- New discussions and table of motivational interviewing and mindful eating.

Chapter 10

- Updated content and definitions to reflect the Physical Activity Guidelines for Americans, second edition.
- New figure of physical activity guidelines for adults.
- Discussion of lactate as fuel.
- Expanded Do the Math activity.
- Improved pregame meal figure.
- Added nitrate section to Controversy.

Chapter 11

- Added information about COVID-19 and ranking among leading causes of death.
- Revised and simplified table of chronic disease risk factors.
- New Consumer's Guide, Nutrition and the Immune System.
- Introduced the American Heart Association's "My Life Check" and Life's Simple 7.
- Reflects the latest information from the World Cancer Research Fund and the American Institute for Cancer Research.
- Controversy update: Nutrient-Drug Interactions: Who Should Be Concerned?

Chapter 12

- Expanded coverage of the Food Safety and Modernization Act.
- Reorganized safe food temperature and thermometer figures.
- New section, Water Safety and Sources.
- Table of contaminants in foods moved to instructors' materials.
- New genetically engineered U.S. crop data.
- New figure of USDA bioengineering food labels.

Chapter 13

- New table of food and nutrient strategies to promote healthy pregnancy outcomes.
- Included new information about preeclampsia.
- Added a brief discussion of COVID-19 and breastfeeding.
- New table of key recommendations for infants and toddlers from the 2020–2025 Dietary Guidelines.
- Introduced and defined baby-led weaning.
- Added a brief discussion of possible heavy-metal contamination of some infant and toddler foods.
- Controversy update: Nutritional genomics.

Chapter 14

- New figure of U.S. diet quality through the lifespan.
- Updated childhood and older adult resources and recommendations in agreement with the 2020–2025 Dietary Guidelines.
- New discussion and table of beverage suggestions for children.
- New Consumer's Guide on acne and nutrition.
- New table of key activity guidelines for older adults.
- New table of fluid strategies for older adults.
- Aging and telomere length discussion, with new table of factors associated with telomere length.
- Controversy update: Childhood obesity and early chronic diseases.

Chapter 15

- Updated U.S. and world food security discussions, statistics, and figures.
- New section addressing links between poverty, obesity, and chronic disease.

- New figure on how poverty fosters malnutrition and obesity.
- New figure on the environmental costs of producing food.
- New figure depicting the ecological footprints of countries.
- New figure of greenhouse gas emissions associated with dietary protein sources.

Ancillary Materials

Students and instructors alike will appreciate the innovative teaching and learning materials that accompany this text.

MindTap: MindTap forSizer/Whitney, *Nutrition: Concepts & Controversies*, 16e, today's most innovative online learning platform, powers your students from memorization to mastery. MindTap gives you complete control of your course to provide engaging content, challenge every individual and build students' confidence.

Instructor Companion Site: Everything you need for your course in one place! This collection of product-specific lecture and class tools is available online via www.cengage.com/login. Access and download PowerPoint presentations, images, instructors' manual, and more.

Test Bank with Cognero: Cengage Testing, powered by Cognero® is a flexible, online system that allows you to import, edit, and manipulate content from the text's test bank or elsewhere, including your own favorite test questions; create multiple test versions in an instant; and deliver tests from your LMS, your classroom, or wherever you want.

Diet & Wellness Plus: Diet & Wellness Plus helps you understand how nutrition relates to your personal health goals. Track your diet and activity, generate reports, and analyze the nutritional value of the food you eat. Diet & Wellness Plus includes over 75,000 foods as well as custom food and recipe features. Diet & Wellness Plus is also available as an app that can be accessed from the app dock in MindTap.

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We are also grateful to Linda DeBruyne, M.S., R.D.N. for her work in Chapters 11 and 13. Linda received her master's degree in nutrition from Florida State University and is a founding member of Nutrition and Health Associates. She also coauthors the college nutrition texts *Nutrition and Diet Therapy* and *Nutrition for Health and Health Care*.

Our special thanks to our publishing team—Courtney Heilman, Lori Hazzard, and Samantha Rundle—for their superb work and dedication to excellence.

Reviewers of Recent Editions

As always, we are grateful for the instructors who so carefully reviewed our work in this revision. Your suggestions were invaluable in strengthening the book and suggesting new lines of thought. We hope you will continue to provide your comments and suggestions.

Jill Tarver, *Santa Rosa Junior College*
Lisa Sheldon, *Greenfield Community College*
Jennifer Weinberg, *Monmouth University*
Tracy Stopler, *Adelphi University*

Carolyn Mentel, *Cowley County Community College, Butler County Community College*
Mark Bloom, *Dallas Baptist University*
Michelle Zuppe, *Brookdale Community College*
Elisabeth DeSwart, *Cuesta College*
Dr. Gina La Monica, *Ventura College*
Heather Casey, *Appalachian State University*
Keith Pearson, *Samford University*
Leticia Vega, *Barry University*
Marisela Contreras, *Dallas College-Richland Campus*
Glenda Johnson, *Southern University and A&M College*



1 Food Choices and Human Health

Controversy 1 Sorting Impostors from Real Nutrition Experts

Learning Objectives

After reading this chapter, you should be able to accomplish the following:

- | | | | |
|---------------|--|---------------|---|
| LO 1.1 | Describe the ways in which food choices impact a person's health. | LO 1.5 | Describe the science of nutrition. |
| LO 1.2 | Describe the relationship between nutrition and genetics with regard to disease development. | LO 1.6 | Describe the characteristics of the six stages of behavior change. |
| LO 1.3 | Name the six classes of nutrients. | LO 1.7 | Explain how the concept of nutrient density can facilitate diet planning. |
| LO 1.4 | Give examples of challenges and solutions people face in choosing a health-promoting diet. | LO 1.8 | Evaluate the authenticity of any given nutrition information source. |

What do you think?

- ▶ Can your diet make a real difference between getting **sick** or staying **healthy**?
- ▶ Are **supplements** more powerful than food for ensuring good nutrition?
- ▶ What makes your favorite foods your **favorites**?
- ▶ Are **news and media nutrition reports** informative or confusing?

If you care about your body, and if you have strong feelings about **food**, then you have much to gain from learning about **nutrition**—the science of how food nourishes the body. Nutrition is a fascinating, much-talked-about subject. Each day, newspapers, websites, radio, and television present stories of new findings on nutrition and heart health or cancer prevention, and at the same time, advertisements and commercials bombard us with multicolored pictures of tempting foods—pizza, burgers, soft drinks, and chips. If you are like most people, when you eat you sometimes wonder, “Is this food good for me?” or you berate yourself, “I probably shouldn’t be eating this.”

When you study nutrition, you learn which foods serve you best, and you can work out ways of choosing foods, planning meals, and designing your **diet** wisely. Knowing the facts can enhance your health and your enjoyment of eating while relieving your feelings of guilt or worry that you aren’t eating well.

This chapter addresses these “why,” “what,” and “how” questions about nutrition:

- *Why* care about nutrition? Why be concerned about the **nutrients** in your foods? Why not just take supplements?
- *What* are the nutrients in foods, and what roles do they play in the body? What are the differences between vitamins and minerals?
- *What* constitutes a nutritious diet? What factors motivate your food and beverage choices?
- *How* do we know what we know about nutrition? How does nutrition science work, and how can a person keep up with changing information?

Controversy 1 concludes the chapter by offering ways to distinguish between trustworthy sources of nutrition information and those that are less reliable.

A Lifetime of Nourishment

LO 1.1 Describe the ways in which food choices impact a person’s health.

If you live for 65 years or longer, you will have consumed more than 70,000 meals, and your remarkable body will have disposed of 50 tons of food. The foods you choose exert cumulative effects on your body.^{1*} As you age, you will see and feel those effects—if you know what to look for.

Your body renews its structures continuously. Each day, it builds a little muscle, bone, skin, and blood, replacing old tissues with new. It may also add a little fat if you consume excess food energy (calories) or subtract a little if you consume less than you require. Some of the food you eat today becomes part of “you” tomorrow.

The best food for you, then, is the kind that supports the growth and maintenance of strong muscles, sound bones, healthy skin, and sufficient blood to cleanse and nourish all parts of your body. This means you need food that provides not only the right

*Reference notes are in Appendix F.



Sufiyan Hussein/Stock/Getty Images

When you choose foods with nutrition in mind, you choose in favor of your health.

food scientifically, materials, usually of plant or animal origin, that contain essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals, and that are ingested and assimilated by an organism to produce energy, stimulate growth, and maintain life; socially, a more limited number of such materials defined as acceptable by a culture.

nutrition the study of the nutrients in foods and in the body; sometimes also the study of human behaviors related to food.

diet the foods (including beverages) a person usually eats and drinks.

nutrients components of food that are indispensable to the body’s functioning. They provide energy, serve as building material, help maintain or repair body parts, and support growth. The nutrients include water, carbohydrate, fat, protein, vitamins, and minerals.

Table 1–1

**Leading Causes of Death
Linked with Diet and Alcohol**

In 2020, the infectious disease COVID-19 ranked third among causes of U.S. deaths, behind heart disease and cancers.

	Percentage of Total Deaths
■ Heart disease	20.5
■ Cancers	17.8
■ Accidents	5.5
■ Strokes	5.2
■ Diabetes	3.0

malnutrition any condition caused by excess or deficient food energy or nutrient intake or by an imbalance of nutrients. Nutrient or energy deficiencies are forms of undernutrition; nutrient or energy excesses are forms of overnutrition.

chronic diseases degenerative conditions or illnesses that progress slowly are long in duration, and lack an immediate cure. Chronic diseases limit functioning, productivity, and the quality and length of life. Examples include heart disease, cancer, and diabetes.

anemia a blood condition in which red blood cells, the body's oxygen carriers, are inadequate or impaired and so cannot meet the oxygen demands of the body.

amount of energy but also sufficient nutrients—that is, enough water, carbohydrates, fats, protein, vitamins, and minerals. If the foods you eat provide too little or too much of any nutrient today, your health may suffer just a little today. If the foods you eat provide too little or too much of one or more nutrients every day for years, then in later life you may suffer severe disease effects.

A well-chosen diet supplies enough energy and enough of each nutrient to prevent **malnutrition**. Malnutrition includes deficiencies, imbalances, and excesses of nutrients, alone or in combination, any of which can take a toll on health over time.

Key Points

- The nutrients in food support growth, maintenance, and repair of the body.
- Deficiencies, excesses, and imbalances of energy and nutrients bring on the diseases of malnutrition.

The Diet–Health Connection

Your choice of diet profoundly affects your health, both today and in the future. Among the common lifestyle habits that alter people's development of serious diseases, only two are more influential than food habits: smoking and using other forms of tobacco and drinking alcohol in excess. Of the leading causes of death listed in Table 1–1, four—heart disease, cancers, strokes, and diabetes—are directly related to nutrition, and another—accidents—is related to drinking alcohol.

Many people suffer from debilitating conditions that could have been largely prevented had they applied the nutrition principles known today.² The major **chronic diseases**—heart disease, some kinds of cancer, strokes, and diabetes, along with dental disease, and adult bone loss—all have a connection to poor diet. These diseases cannot be prevented by a good diet alone; they are to some extent determined by a person's genetic constitution, activities, and lifestyle. Within the range set by your genetic inheritance, however, the likelihood of developing these diseases is strongly influenced by your daily choices.

Key Point

- Nutrition profoundly affects health.

Other Lifestyle Choices

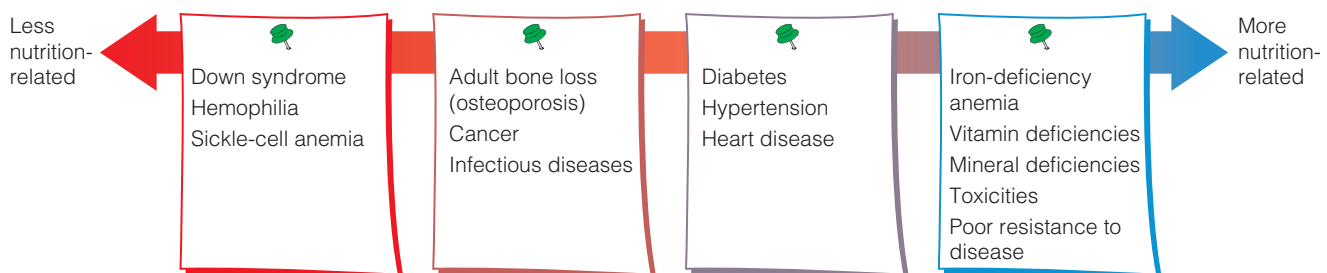
Besides food choices, what other lifestyle choices affect people's health? Tobacco use and alcohol and other substance abuse can destroy health. Physical activity, sleep, emotional stress, and other environmental factors can also modify the severity of some diseases. Physical activity is so closely linked with nutrition in supporting health that most chapters of this book offer a feature called Think Fitness, such as the one near here.

Much of this text centers on the nutrients at the core of nutrition science. As your course of study progresses, the individual nutrients will become like old friends, revealing more and more about themselves as you move through the chapters.

Figure 1–1

Nutrition and Disease

Not all diseases are equally influenced by diet. Some, such as sickle-cell anemia, are almost purely genetic. Some, such as diabetes, may be inherited (or the tendency to develop them may be inherited in the genes) but may be influenced by diet. Some, such as vitamin-deficiency diseases, are purely dietary.



Key Point

- Life choices, such as being physically active or using tobacco or alcohol, can improve or damage health.

Genetics, Nutrition, and Individuality

LO 1.2 Describe the relationship between nutrition and genetics with regard to disease development.

Figure 1–1 demonstrates that genetics and nutrition affect different diseases to varying degrees. The **anemia** caused by sickle-cell disease, for example, is purely hereditary and thus appears at the left of Figure 1–1 as a genetic condition largely unrelated to nutrition. Nothing a person eats affects the person's chances of contracting this anemia, although nutrition therapy may help ease its course. At the other end of the spectrum, iron-deficiency anemia most often results from undernutrition. Diseases and conditions of poor health appear all along this continuum, from almost entirely genetically based to purely nutritional in origin; the more nutrition-related a disease or health condition is, the more successfully sound nutrition can prevent it.

Furthermore, some diseases, such as heart disease and cancer, are not one disease but many. Two people may both have heart disease but not the same form; one person's cancer may be nutrition-related, but another's may not be. Individual people differ genetically from each other in thousands of subtle ways, so no simple statement can be made about the extent to which diet can help any one person avoid such diseases or slow their progress.

The human **genome** represents the entire sequence of the **genes** in human **DNA**. In essence, it constitutes the body's instructions for making all of the working parts of a human being. The human genome is 99.9 percent the same in all people; all of the normal variations such as differences in hair color, as well as variations that result in diseases such as sickle-cell anemia, lie in the 0.1 percent of the genome that varies.

genome (GEE-nome) the full complement of genetic information in the chromosomes of a cell. In human beings, the genome consists of about 35,000 genes and supporting materials. The study of genomes is *genomics*. Also defined in Controversy 13.

genes units of a cell's inheritance; sections of the larger genetic molecule DNA (deoxyribonucleic acid). Each gene directs the making of one or more of the body's proteins.

DNA an abbreviation for deoxyribonucleic (dee-OX-ee-RYE-bow-nu-CLAY-ick) acid, the thread-like molecule that encodes genetic information in its structure; DNA strands coil up densely to form the chromosomes (Chapter 3 provides more details).

personalized nutrition an emerging science-based approach to nutrition advice that employs an individual's genetic and other information to promote diet-related behaviors that result in measurable health outcomes.

Think Fitness

Why Be Physically Active?

Why should people bother to be physically active? A person's daily food choices can powerfully affect health, but the combination of nutrition and physical activity is more powerful still. People who combine regular physical activity with a nutritious diet can expect to receive at least some of these benefits:

- Reduced risks of cardiovascular diseases, diabetes, certain cancers, hypertension, and other diseases.
- Increased endurance, strength, and flexibility.
- More cheerful outlook and less likelihood of depression.
- Improved mental functioning.
- Feeling of vigor.
- Feeling of belonging—the companionship of sports.

- Stronger self-image.
- Reduced body fat and increased lean tissue.
- A more youthful appearance, healthy skin, and improved muscle tone.
- Greater bone density and lessened risk of adult bone loss in later life.
- Increased independence in the elderly.
- Sound, beneficial sleep.
- Faster wound healing.
- Reduced menstrual distress.
- Improved resistance to infection.

If even half of these benefits were yours for the asking, wouldn't you step up to claim them? In truth, they are yours to claim, at the price of including

physical activity in your day. Chapter 10 lists the Physical Activity Guidelines for Americans, which specify activity amounts needed for health.

Start now! Ready to make a change? Keep track of your physical activities—all of them—for three days. (You may choose to use pencil and paper, an internet wellness program, a cell phone application, or any other method for tracking.) After you have recorded your activities, see how much time you spent exercising at a moderate to vigorous level (described in Table H-1 of Appendix H at the back of the book). Should you increase the intensity level or amount of your activity? If so, write down some realistic ways in which you might increase your activity, and then apply them. Notice and keep track of any benefits that your new level of activity brings.

Today, scientists are working to apply this wealth of knowledge to benefit human health. New treatments for formerly untreatable conditions, including some forms of cancer, are emerging from genomics research. In the future, **personalized nutrition** may allow dietitians to take into account variations in a client's genome to more precisely meet the nutrient needs of the individual.³ Later chapters expand on the emerging story of nutrition and the genes.

Key Points

- Diet influences long-term health within the range set by genetic inheritance.
- Nutrition exerts little influence on some diseases but strongly affects others.

The Human Body and Its Food

LO 1.3 Name the six classes of nutrients.

As your body moves and works each day, it must use **energy**. The energy that fuels the body's work comes indirectly from the sun by way of plants. Plants capture and store the sun's energy in their tissues as they grow. When you eat plant-derived foods such as fruit, grains, or vegetables, you obtain and use the solar energy they have stored. Plant-eating animals obtain their energy in the same way, so when you eat animal tissues, you are eating compounds containing energy that originally came from the sun.

The body requires six kinds of nutrients—families of molecules indispensable to its functioning—and foods deliver these. Table 1–2 lists the six classes of nutrients. Four of these are **organic**; that is, the nutrients contain the element carbon derived from living things.

Meet the Nutrients

The human body and foods are made of the same materials, arranged in different ways (see Figure 1–2). When considering quantities of foods and nutrients, scientists often measure them in **grams** or fractions of grams, units of weight.

The Energy-Yielding Nutrients Of the four organic nutrients, three are **energy-yielding nutrients**, meaning that the body can use the energy they contain. These are carbohydrate, fat, and protein, often referred to as the **macronutrients**, and they contribute to the calories you consume. Among them, protein stands out for doing double duty: it can yield energy, but it also provides materials that form

energy the capacity to do work. The energy in food is chemical energy; it can be converted to mechanical, electrical, thermal, or other forms of energy in the body. Food energy is measured in calories, defined on page 7.

organic carbon containing. Four of the six classes of nutrients are organic: carbohydrate, fat, protein, and vitamins. Organic compounds include only those made by living things and do not include compounds such as carbon dioxide, diamonds, and a few carbon salts.

grams (g) metric units of weight. About 28 grams equal an ounce. A *milligram* is one-thousandth of a gram. A *microgram* is one-millionth of a gram.

energy-yielding nutrients the nutrients the body can use for energy: carbohydrate, fat (also called *lipids*), and protein. These also may supply building blocks for body structures.

macronutrients another name for the energy-yielding nutrients: carbohydrate, fat, and protein.

Table 1–2

Elements in the Six Classes of Nutrients

The nutrients that contain carbon are organic.

	Carbon	Oxygen	Hydrogen	Nitrogen	Minerals
Carbohydrate	✓	✓	✓		
Fat	✓	✓	✓		
Protein	✓	✓	✓	✓	^b
Vitamins	✓	✓	✓	✓ ^a	^b
Minerals					✓
Water		✓	✓		✓

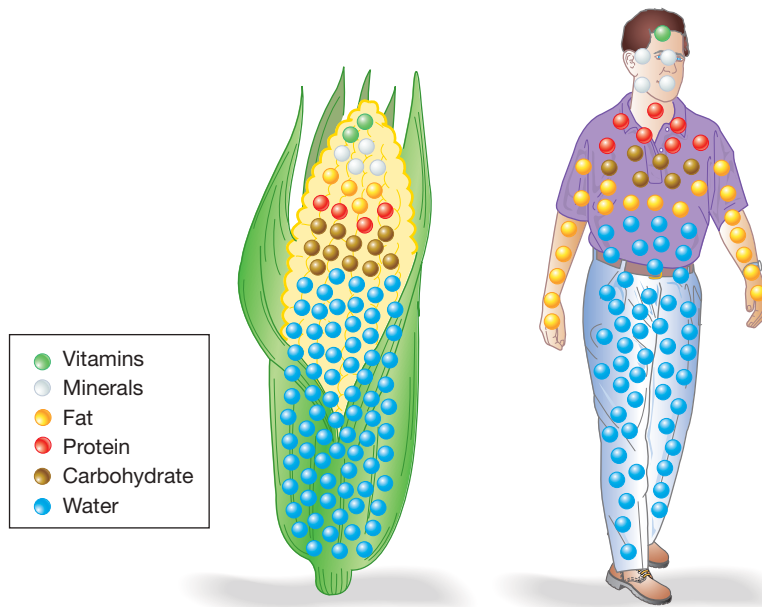
^aAll of the B vitamins contain nitrogen; amine means nitrogen.

^bProtein and some vitamins contain the mineral sulfur; vitamin B₁₂ contains the mineral cobalt.

Figure 1–2

Components of Food and the Human Body

Foods and the human body are made of the same materials.



structures and working parts of body tissues. (Alcohol yields energy, too—see Table 1–3 comments.)

Vitamins and Minerals The fourth and fifth classes of nutrients are the vitamins and the minerals, most of which are known as **micronutrients** because they are present in tiny amounts in living tissues. These provide no energy to the body. A few minerals serve as parts of body structures (calcium and phosphorus, for example, are major constituents of bone), but all vitamins and minerals act as regulators. As regulators, the vitamins and minerals assist in all body processes: digesting food; moving muscles; disposing of wastes; growing new tissues; healing wounds; obtaining energy from carbohydrate, fat, and protein; and participating in every other process necessary to maintain life. Later chapters are devoted to these six classes of nutrients.

Water Although last on the list, water is foremost in quantity among the six classes of nutrients in the body. The body constantly loses water, mainly through sweat, breath, and urine, and that water must constantly be replaced. Without sufficient water, the body’s cells cannot function.

The Concept of Essential Nutrients When you eat food, then, you are providing your body with energy and nutrients. Furthermore, some of the nutrients are **essential nutrients**, meaning that if you do not ingest them, you will develop deficiencies; the body cannot make these nutrients for itself. Essential nutrients are found in all six classes of nutrients. Water is an essential nutrient; so is a form of carbohydrate; so are some lipids, some parts of protein, all of the vitamins, and the minerals important in human nutrition.

You may wonder why **fiber**, famous for its beneficial health effects, is not listed among the essential nutrients. The reason is that most fiber passes through the body unabsorbed, and omitting it from the diet does not reliably cause a specific deficiency disease. Even so, in research, health benefits often follow eating a fiber-rich diet (Chapter 4 has details).

Calorie Values Food scientists measure food energy in kilocalories, units of heat. This book uses the common word **calories** to mean the same thing. It behooves the person who wishes to control food energy intake and excess body fat to study Table 1-3

Table 1–3

Energy-Yielding Nutrients

The energy a person consumes in a day’s meals comes from these three energy-yielding nutrients; alcohol, if consumed, also contributes energy at a rate of about 7 calories per gram (see note).

Energy Nutrient	Energy
Carbohydrate	4 cal/g
Fat (lipid)	9 cal/g
Protein	4 cal/g

Note: Alcohol is not classed as a nutrient because it interferes with growth, maintenance, and repair of body tissues.

micronutrients nutrients required in very small amounts: the vitamins and most minerals.

essential nutrients the nutrients the body cannot make for itself (or cannot make fast enough) from other raw materials; nutrients that must be obtained from food to prevent deficiencies.

fiber a collective term for various indigestible plant materials, many of which bear links with human health. See also Chapter 4.

calories units of energy. In nutrition science, the unit used to measure the energy in foods is a kilocalorie (also called *kcalorie* or *Calorie*): it is the amount of heat energy necessary to raise the temperature of a kilogram (a liter) of water 1 degree Celsius. This book follows the common practice of using the lowercase term *calorie* (abbreviated *cal*) to mean the same thing.

Do the Math: Calculate calories from grams of energy nutrients.

The calories (cal) provided by a food equal the sum of its calories from carbohydrate, protein, and fat, measured in grams (g).

Reminder:

- carbohydrate = 4 cal per g
- protein = 4 cal per g
- fat = 9 cal per g

Look at any food label to find grams of these nutrients in a serving. Now, calculate the calories in a serving of the food.

1. Multiply grams of each energy nutrient by its calorie value.

Example: 1 slice of toasted bread with 1 tablespoon of peanut butter provides 16 g carbohydrate, 7 g protein, and 9 g fat:

$$16 \text{ g carbohydrate} \times 4 \text{ cal/g} = 64 \text{ cal}$$

$$7 \text{ g protein} \times 4 \text{ cal/g} = 28 \text{ cal}$$

$$9 \text{ g fat} \times 9 \text{ cal/g} = 81 \text{ cal}$$

2. Add the three calorie values:

$$64 + 28 + 81 = 173 \text{ total calories}$$

dietary supplements pills, liquids, or powders that contain purified nutrients or other ingredients (see Controversy 7).

elemental diets diets composed of purified ingredients of known chemical composition; intended to supply, to the greatest extent possible, all essential nutrients to people who cannot eat foods.

phytochemicals bioactive compounds in plant-derived foods (*phyto*, pronounced FYE-toe, means “plant”).

bioactive having chemical or physical properties that affect the functions of the body tissues. See Controversy 2.

and learn the calorie values of the energy nutrients listed there. The most energy-rich of the nutrients is fat, which contains 9 calories in each gram. Carbohydrate and protein each contain only 4 calories in a gram. Weight, measure, and other conversion factors needed for the study of nutrition appear in Appendix C at the back of the book.

Scientists have worked out ways to measure the energy and nutrient contents of foods. They have also calculated the amounts of energy and nutrients various types of people need—by sex, age, life stage, and activity. Thus, after studying human nutrient requirements (in Chapter 2), you will be able to state with some accuracy just what your own body needs—this much water, that much carbohydrate, so much vitamin C, and so forth. So why not simply take pills or **dietary supplements** in place of food? Because, as it turns out, food offers more than just the six basic nutrients.

Key Points

- The energy-yielding nutrients are carbohydrate, fat (lipid), and protein.
- The regulator nutrients are vitamins and minerals.
- Foremost among the nutrients in food is water.
- Essential nutrients in the diet prevent deficiencies.
- Food energy is measured in calories; nutrient quantities are often measured in grams.

Can I Live on Just Supplements?

Nutrition science can state what nutrients human beings need to survive—at least for a time. Scientists are becoming skilled at making **elemental diets**—life-saving liquid diets of precise chemical composition for hospital patients and others who cannot eat ordinary food. These formulas, administered for days or weeks, support not only continued life but also recovery from nutrient deficiencies, infections, and wounds.

Liquid nutritional supplements, sometimes called formula diets, are essential to help sick people to survive, but they do not enable people to thrive over long periods. Even in hospitals, diet formulas do not support optimal growth and health. Lately, marketers have taken these liquid supplement formulas out of the medical setting and have advertised them heavily to healthy people of all ages as “meal replacers” or “insurance” against malnutrition. The truth is that real food is the superior source of nutrients and other food constituents needed by the body. Most healthy people who eat a nutritious diet need no dietary supplements at all.

Food Is Best Even if a person’s basic nutrient needs are perfectly understood and met, concoctions of nutrients still lack something that foods provide. Hospitalized clients who are fed nutrient mixtures through a vein often improve dramatically when they can finally eat food. Something in real food is important to health—but what is it? What does food offer that cannot be provided through a needle or a tube? Science has some partial explanations, some physical and some psychological.

In the digestive tract, the stomach and intestine are dynamic, living organs, changing constantly in response to the foods they receive—even to just the sight, aroma, and taste of food. When a person is fed through a vein, the digestive organs, like unused muscles, weaken and grow smaller. The digestive organs also release hormones in response to food, and these send messages to the brain that bring the eater a feeling of satisfaction: “There, that was good. Now I’m full.” Eating offers both physical and emotional comfort. Medical science now dictates that a person should be fed through a vein for as short a time as possible and that real food taken by mouth should be reintroduced as early as possible.

Complex Interactions Foods are chemically complex. In addition to their nutrients, foods contain **phytochemicals**, compounds that confer color, taste, and other characteristics to foods. Some may be **bioactive** food components that interact with metabolic processes in the body and may affect disease risks. Even an ordinary baked potato contains hundreds of different compounds. Nutrients and other food components interact with each other in the body and operate best in harmony with one another. In view of all this, it is not surprising that food gives us more than just nutrients. If it were otherwise, *that* would be surprising.

Key Points

- Nutritious food is superior to supplements for maintaining optimal health.
- Most healthy people who eat a nutritious diet do not need supplements at all.

The Challenge of Choosing Foods

LO 1.4 Give examples of challenges and solutions people face in choosing a health-promoting diet.

Well-planned meals convey pleasure and are nutritious, too, fitting your tastes, personality, family and cultural traditions, lifestyle, and budget. Given the astounding numbers and varieties available, consumers can easily lose track of what individual foods contain and how to put them together into a health-promoting diet. Figure 1-3 illustrates the contrast between whole foods and foods that are ultra-processed. A few definitions and basic guidelines can help.

An Abundance of Foods

A list of the foods available 100 years ago would be relatively short. It would consist mostly of **whole foods**—foods that have been around for a long time, such as vegetables, fruits, meats, milk, and grains (Table 1–4 defines food types, p. 10; terms in tables are in black bold type, margin definitions are in blue). These foods have been called basic, unprocessed, natural, or farm foods. By any name, these foods form the basis of a nutritious diet. On a given day, however, well over 80 percent of our population consumes too few servings of fruit and vegetables each day.⁴ And when people do eat a vegetable, the one they most often choose is potatoes, usually prepared as French fries. Such choices, repeated over time, make development of chronic diseases more likely.

The terms defined in Table 1–4 reveal that all types of foods and beverages—including **fast foods**, **processed foods**, and **ultra-processed foods and beverages**—offer various constituents to the eater, some more health-promoting than others.⁵ Often deemed the least supportive of human nutrition and health, ultra-processed foods and beverages currently make up more than half of the nation's diet.⁶ You may also hear about **functional foods**, a marketing term coined to identify foods containing



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Some foods offer phytochemicals in addition to the six classes of nutrients.

Figure 1–3

Grocery Options

Whole foods are foods in their natural state. Ultra-processed foods are manufactured to taste delicious, need little preparation, and compete for shoppers' attention.



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Table 1–4

Glossary of Food Types

- **enriched foods** and **fortified foods** foods to which nutrients have been added. If the starting material is a whole, basic food such as milk or whole grain, the result may be highly nutritious. If the starting material is a concentrated form of sugar or fat, the result is less nutritious.
- **fast foods** restaurant foods that are available within minutes after customers order them—traditionally, hamburgers, French fries, and milkshakes; more recently, salads and other vegetable dishes as well. These foods may or may not meet people's nutrient needs, depending on the selections provided and on the energy allowances and nutrient needs of the eaters.
- **functional foods** a marketing term for foods that contain bioactive food components believed to provide health benefits, such as reduced disease risks, beyond the benefits that their nutrients confer. However, all nutritious foods support health in some ways; Controversy 2 provides details.
- **medical foods** foods specially manufactured for use by people with medical disorders and administered on the advice of a physician.
- **natural foods** a term that has no legal definition but is often used to imply wholesomeness.
- **organic foods** understood to mean foods grown without synthetic pesticides or fertilizers. In chemistry, however, all foods are made mostly of organic (carbon-containing) compounds.
- **processed foods** foods subjected to any process, such as milling, alteration of texture, addition of additives, cooking, or others. Depending on the starting material and the process, a processed food may or may not be nutritious.
- **staple foods** foods used frequently or daily—for example, rice (in East and Southeast Asia) or potatoes (in Ireland). Many of these foods are sufficiently nutritious to provide a foundation for a healthful diet.
- **ultra-processed foods and beverages** highly palatable manufactured food and beverage products often high in industrial ingredients, such as sugars, refined starches, modified protein, hydrogenated fats, salt, and additives intended to disguise or improve undesirable sensory qualities of the final product. Additives may include colorants, flavorings, moisturizers, sweeteners, and many others. Examples of ultra-processed foods and beverages include, sugary refined breakfast cereals, candies, cookies, fried chicken nuggets, liquid nutritional supplements, potato “tots,” snack chips and cakes, and soft drinks.
- **whole foods** dairy products; meats and similar foods such as fish and poultry; vegetables, including dried beans and peas; fruits; and grains. These foods are generally considered to form the basis of a nutritious diet. Also called *basic foods*.

dietary pattern the combination of foods and beverages that constitute an individual's complete dietary intake over time; a person's usual diet. Also called *eating pattern*.

adequacy the dietary characteristic of providing all of the essential nutrients, fiber, and energy in amounts sufficient to maintain health and body weight.

balance the dietary characteristic of providing foods of a number of types in proportion to each other, such that foods rich in some nutrients do not crowd out the diet foods that are rich in other nutrients.

calorie control the dietary characteristic of controlling energy intake; a feature of a sound diet plan.

moderation the dietary characteristic of providing constituents within set limits, not to excess.

variety the dietary characteristic of providing a wide selection of foods—the opposite of monotony.

substances, natural or added, that might lend protection against chronic diseases. The trouble with trying to single out the most health-promoting foods is that almost every naturally occurring food—even chocolate—is functional in some way with regard to human health.

The extent to which foods support good health depends on the calories, nutrients, and phytochemicals they contain. In short, to select well among foods, you need to know more than their names; you need to know the foods' inner qualities. Even more important, you need to know how to combine foods into nutritious diets. Foods are not nutritious by themselves; each is of value only insofar as it contributes to a nutritious diet. A key to wise diet planning is to make sure that the foods you eat daily, your **staple foods**, are especially nutritious.

Key Point

- Foods that form the basis of a nutritious diet are whole foods, such as ordinary dairy products; meats, fish, and poultry; vegetables and dried peas and beans; fruits; and grains.

How, Exactly, Can I Recognize a Nutritious Diet?

A nutritious diet is really a **dietary pattern**, a habitual way of choosing foods, with five characteristics. First is **adequacy**: the foods provide enough of each essential nutrient, fiber, and energy. Second is **balance**: the choices do not overemphasize one nutrient or food type at the expense of another. Third is **calorie control**: the foods provide the amount of energy you need to maintain appropriate weight—not more, not less. Fourth is **moderation**: the foods do not provide excess fat, salt, sugar, or other unwanted constituents. Fifth is **variety**: the foods chosen differ from one day to the next. In addition, to maintain a steady supply of nutrients, meals should occur with regular timing throughout the day. To recap, then, a nutritious diet is a dietary pattern that follows the A, B, C, M, V principles: Adequacy, Balance, Calorie control, Moderation, and Variety.

Adequacy Any nutrient could be used to demonstrate the importance of dietary adequacy. Iron provides a familiar example. It is an essential nutrient: you lose some every day, so you have to keep replacing it, and you can get it into your body only by eating foods that contain it.* If you eat too few iron-containing foods, you can develop iron-deficiency anemia. With anemia, you may feel weak, tired, cold, sad, and unenthusiastic; you may have frequent headaches; and you can do very little muscular work without disabling fatigue. Some foods are rich in iron; others are notoriously poor. If you add iron-rich foods to your diet, you soon feel more energetic. Meat, fish, poultry, and **legumes** are rich in iron, and an easy way to obtain the needed iron is to include these foods regularly.

Balance To appreciate the importance of dietary balance, consider a second essential nutrient, calcium. A diet lacking calcium causes poor bone development during the growing years and increases a person's susceptibility to disabling bone loss in adult life. Most foods that are rich in iron are poor in calcium. Calcium's richest food sources are dairy products, which happen to be extraordinarily poor iron sources. Clearly, to obtain enough of both iron and calcium, people have to balance their food choices among the types of foods that provide both nutrients. Balancing the whole diet to provide enough of every one of the 40-odd nutrients the body needs for health requires considerable juggling, however. As you will see in Chapter 2, food group plans ease this task by clustering rich sources of nutrients into food groups that will help you achieve both dietary adequacy and balance within a dietary pattern that meets your needs.

Calorie Control Your intake of energy (calories) should not exceed or fall short of energy needs. Named *calorie control*, this characteristic ensures that energy intakes from food balance energy expenditures required for body functions and physical activity. Eating such a diet helps control body fat content and weight. You will read about many strategies that promote this goal in Chapter 9.

Moderation Your intakes of certain food constituents such as saturated fats, added sugars and salt should be limited for your health's sake. Some people take this to mean that they must never indulge in a delicious hot-fudge sundae or a hot dog with relish, but they are misinformed: moderation, not total abstinence, is the key. A steady diet of ice cream and hot dogs might be harmful, but once a week as part of an otherwise healthful dietary pattern, these foods may have little impact; as once-a-month treats, these foods would have practically no effect at all. Moderation also means that limits are necessary, even for desirable food constituents. For example, a certain amount of fiber in foods contributes to the health of the digestive system, but too much fiber leads to nutrient losses.

Variety As for variety, nutrition scientists agree that you should not eat the same foods, even highly nutritious ones, day after day, for a number of reasons. First, a varied diet is more likely to be adequate in nutrients. Second, some less-well-known nutrients and phytochemicals could be important to health, and some foods may be better sources of these than others. Third, a monotonous diet may deliver large amounts of toxins or contaminants. Such undesirable compounds in one food are diluted by all the other foods eaten with it and are diluted still further if the food is not eaten again for several days. Finally, variety adds interest—trying new foods can be a source of pleasure.

Variety applies to nutritious foods consumed within the context of all of the other dietary principles just discussed. Relying solely on the principle of variety to dictate food choices could easily result in a low-nutrient, high-calorie dietary pattern with a variety of nutrient-poor snack foods and sweets. If you establish the habit of using all of the principles just described, you will find that choosing a healthful diet becomes as automatic as brushing your teeth or falling asleep. Establishing the A, B, C, M, V habit may take some effort, but the payoff in terms of improved health is overwhelming



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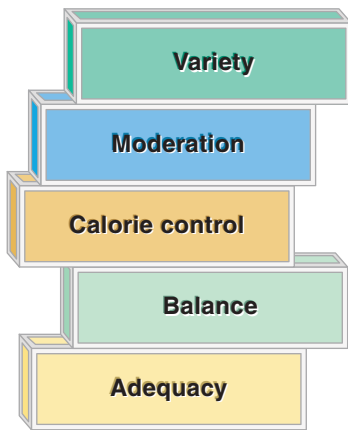
legumes (leg-GOOMS, LEG-yooms) beans, peas, and lentils, valued as inexpensive food sources of protein, vitamins, minerals, and fiber that contribute little fat to the diet. Also defined in Chapter 6.

*A person can also take supplements of iron, but as later discussions demonstrate, eating iron-rich foods is preferable.

Figure 1-4

Components of a Nutritious Diet

All of these factors help to build a nutritious diet:



cuisines styles of cooking.

foodways the sum of a culture's habits, customs, beliefs, and preferences concerning food.

ethnic foods foods associated with particular cultural subgroups within a population.

cultural competence having an awareness and acceptance of one's own and others' cultures and abilities, leading to effective interactions with all kinds of people.

omnivorous people who eat foods of both plant and animal origin, including animal flesh.

vegetarians people who exclude from their diets animal flesh and possibly other animal products such as milk, cheese, and eggs.

(Figure 1-4 sums up these principles). Table 1-5 takes an honest look at some common excuses for *not* eating well.

Key Point

- A well-planned diet is adequate, balanced, moderate in energy, and moderate in unwanted constituents and offers a variety of nutritious foods.

Why People Choose Foods

Eating is an intentional act. Each day, people choose from the available foods, prepare the foods, and decide where to eat, which customs to follow, and with whom to dine. Many factors influence food-related choices.

Cultural and Social Meanings Attached to Food Like wearing traditional clothing or speaking a native language, enjoying traditional **cuisines** and **foodways** can be a celebration of your own or a friend's heritage. Sharing **ethnic foods** can be symbolic: people offering foods are expressing a willingness to share cherished values with others. People accepting those foods are symbolically accepting not only the person doing the offering but also the person's culture. Developing **cultural competence** is particularly important for professionals who help others to achieve a nutritious diet.⁷

Cultural traditions regarding food are not inflexible; they keep evolving as people move about, learn about new foods, and teach each other. Today, some people are ceasing to be **omnivorous** and are becoming **vegetarians**. Vegetarians often choose this lifestyle because they honor the lives of animals or because they have discovered the health and other advantages associated with dietary patterns rich in beans, whole grains, fruit, nuts, and vegetables. Controversy 6 explores the strengths and weaknesses of both vegetarians' and meat eaters' diets.

Factors that Drive Food Choices Taste prevails as the number-one factor driving people's food choices, with price following closely behind.⁸ Consumers also value convenience so highly that they are willing to spend almost half of their food budgets on meals prepared outside the home.

Fewer people are learning the skills needed to prepare nutritious meals at home. Instead, they frequently eat out, bring home ready-to-eat meals, or have food delivered. When they do cook, they want to prepare meals in 15 to 20 minutes, using only a few ingredients. Such convenience incurs a cost in terms of nutrition, however: eating away from home reduces intakes of fruit, vegetables, milk, and whole grains. It also increases intakes of calories, saturated fat, sodium, and added sugars. Convenience doesn't have to mean that nutrition flies out the window, however. This chapter's Food Feature (p. 20) explores the trade-offs of time, money, and nutrition that many busy people face today.

Table 1-5

What's Today's Excuse for Not Eating Well?

If you find yourself saying, "I know I should eat well, but I'm too busy" (or too fond of fast food, or have too little money, or a dozen other excuses), take note:

- **No time to cook.** Everyone is busy. Convenience packages of fresh or frozen vegetables, jars of pasta sauce, and prepared meats and salads make nutritious meals in little time.
- **Not a high priority.** Priorities change drastically and instantly when illness strikes—better to spend a little effort now nourishing your body's defenses than to spend enormous resources later fighting illnesses.
- **Crave fast food and sweets.** Occasional fast-food meals and sweets in moderation are acceptable in a nutritious diet.
- **Too little money.** Eating right might cost a little more than eating poorly, but the cost of coping with a chronic illness is unimaginably high.
- **Take vitamins instead.** Vitamin pills or even advertised "nutritional drinks" cannot make up for consistently poor food choices.

Source: D. P. Reidlinger, T. A. Sanders, and L. M. Goff, *How expensive is a cardioprotective diet? Analysis from the CRESSIDA study*, *Public Health Nutrition* (2017), *epub ahead of print*, doi: 10.1017/S1368980016003529.