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nutrition

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FRANCES SIENKIEWICZ SIZER | ELLIE WHITNEY

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Frances Sienkiewicz Sizer and Ellie Whitney

Product Team Manager: Kelsey Churchman

Product Manager: Courtney Heilman

Content Manager: Carol Samet

Production Service: MPS Limited

Text and Photo Researcher: Lumina Datamatics

Art Director: Helen Bruno

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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 charter 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 *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 the 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 our newest granddaughter,
Karen Ann Sizer. Welcome,
baby girl!

—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 presently 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.

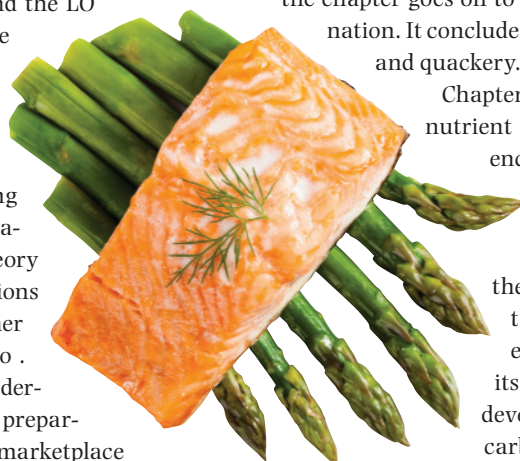
But leave different. Take with you from this study a more complete understanding of nutrition science. Take a greater ability to discern between nutrition truth and fiction, to ask sophisticated questions, and to find the answers. Finally, take with you a better sense of how to feed yourself in ways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

For more than four decades, *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 15th edition, we continue exploring the ever-changing frontier of nutrition science, confronting its mysteries through its scientific roots. We maintain our sense of personal connection with instructors and learners alike, writing for them in the clear, informal style that has become 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 sections, entitled A Consumer’s Guide To . . . , lead readers through an often bewildering marketplace with scientific clarity, preparing them to move ahead with sound marketplace



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

By popular demand, we have retained our Snapshots of vitamins and minerals, which now reflect the 2015 Daily Values. 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 the 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 the genes, nutrients, bioactive food components, and nature of foods, the chapter goes on to present the *Healthy People* goals for the nation. It 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 2015–2020. 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. Chapters 4 through 6 are devoted to the energy-yielding nutrients: carbohydrates, lipids, and protein. Controversy 4 has renewed its focus on 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 presents the 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.

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 artificial sweeteners and artificial fats. Chapters 13 and 14 emphasize the importance of nutrition through the life span, with issues surrounding childhood obesity in Controversy 13. 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 throughout the world. It also touches on the vast network of problems that threaten the 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 others to be healthy. 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 the changes 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.

Inside Front Cover Pages

- The DRI tables, previously located on the inside front cover pages, have joined other standards at the back of the book, pages A through C.

Chapter 1

- Updated leading causes of death figure.
- Updated midcourse review of HP2020.
- Defined term *macronutrients* and *micronutrients*.
- Defined term *meta-analysis*.

- Controversy definitions and descriptions follow Academy of Nutrition and Dietetics.
- Definition of Terms List (2017).
- Updated NDTR credentials.

Chapter 2

- Updated U.S. diet compared with ideals figure.
- Defined term *nutritional equivalents*.
- Major revision to diet planning section and tables.
- Expanded and clarified Food Lists for Weight Management coverage.
- New food label comparison figure.
- Improved phytochemical tables.
- Moved Table C2–3 to instructors' materials.

Chapter 3

- Reorganized chapter for greater focus on digestive tract and functions. Moved other body systems to instructors' materials.
- Revamped figure of pH values.
- Reorganized figure of small intestinal lining.
- Introduced and defined term *microbiome*.
- Reorganize table of foods and intestinal gas.
- Major reorganization, update, and streamlining of the alcohol Controversy.

Chapter 4

- New explanation of energy nutrients percentages in relation to total calorie intake.
- New figure of percentages of energy nutrients.
- Moved figure of fiber composition to instructors' materials.
- New figure of strategies to increase fiber intake.
- Shortened glycemic index coverage.
- Major diabetes coverage moved to Chapter 11.
- New section on diabetes and hypoglycemia, explaining failure of blood glucose control.
- New section on sugar alcohols.
- New sugar alcohol table.
- Controversy is streamlined and updated.

Chapter 5

- Defined term *shortening*.
- Defined term *inflammation*.
- Updated and improved coverage of EPA and DHA.
- Moved figure of fish oil supplement label to instructors' materials.
- New bar graph figure of lipids in grain foods.
- Updated Controversy.

Chapter 6

- Added bone broth discussion to Consumer's Guide.
- Removed adult bone loss from protein excess.
- New figure comparing energy and protein in Greek-style yogurt and a commercial highprotein shake.
- Condensed and combined tables in Controversy section.
- New sample 2,000-calorie menu for a day of vegetarian meals.

Chapter 7

- Fully updated each vitamin section.
- Converted photos to figures, as follows: Vitamin E in Oils; Vitamin K for newborns; Folate and neural tube defects.
- Moved table of Vitamin D in disease to instructors' materials.
- New Consumer's Guide on food processing and vitamins.
- New figure of the effect of folic acid fortification on neural tube defect prevalence in selected countries of the world.
- Updated Controversy section; addressed current supplement contamination concerns.
- New figure of how to read a food label.

Chapter 8

- Reorganized, updated water section.
- Reorganized sodium sections.
- Replaced figure of sodium sources.
- New figure of sodium on a food label.
- Created new figures from photos as follows: Osmosis (egg-plant); goiter; iodized salt label; nonheme iron absorption; zinc deficiency.
- New figure of average daily sodium intakes in U.S. adults.
- New photo of calcium sources.
- Moved section on tracking calcium to instructors' materials.
- Updated Controversy.

Chapter 9

- New obesity maps reflecting newer analytical methods.
- Defined clinical term *adiposity-based chronic disease*.
- Added sleep function of ghrelin.
- Refined section on microbiome and obesity.
- Addressed efficacy of artificial sweeteners.
- Added discussion of genetic alterations in obesity.
- New summary figure of factors in obesity development.
- Added sleeve gastrectomy to surgical options.
- New explanation of intermittent fasting.
- Defined term *exergaming*.
- Addressed cultural differences in dietary energy density.
- Updated terminology associated with female athlete triad.
- New table of harms from anorexia nervosa.

Chapter 10

- Reorganized several major sections.
- Addressed energy availability and energy need concepts.
- Addressed gastrointestinal effects of ultraendurance events.
- New carbohydrate and protein recommendations from the Academy of Nutrition and Dietetics (AND).
- New figure of anemia in female athletes.
- New hydration schedule from AND.
- Applied guidelines for nutrient timing from the International Society of Sports Nutrition.
- New discussion of beetroot and dietary nitrite among ergogenic aids.

Chapter 11

- Complete chapter reorganization to focus on nutrition and chronic diseases.
- Removed discussion of infectious disease.

- New table of chronic disease risk factors.
- New table of adult blood pressure standards.
- New major section on diabetes; new table of misconceptions about diabetes.
- Introduced term *precision medicine*.
- Addressed consumer privacy in genetic testing.

Chapter 12

- Defined terms *pathogen*, *intoxication*, and *endemic*.
- Added term *toxin-mediated infections*.
- New section on the FDA Food Safety Modernization Act, with definition.
- Expanded coverage of package dating.
- Defined FDA's new Produce Safety Rule.
- Moved kitchen test table to new Food Feature.
- Restructured thermometer and safe temperature figures for clarity.
- New Food Feature: *Handling Real-Life Challenges to Food Safety*.
- New figure on selective breeding.
- Defined *gene editing* and CRISPR technology.
- Described and added new figure of genetically engineered salmon.
- Added consumer concerns about glyphosate to summary table.

Chapter 13

- Deleted the infant mortality figure.
- Replaced the spina bifida figure.
- Added a new table of seafood advice for pregnant and lactating women.
- Replaced the sketched figure of facial characteristics of FAS with photo of FAS child.
- Reorganized table of supplements for breastfed infants.
- Added a discussion and definition of responsive feeding.
- Added hunger and satiety signals to the table of infant development.
- New table of parental strategies against childhood obesity.
- New adequate sleep section and table.

Chapter 14

- Updated MyPlate figure.
- Updated and improved allergy section.
- Condensed and updated PMS coverage.
- New section on weight loss and overweight in aging.
- Restructured, updated vitamin D section.
- Addressed the Mediterranean Eating Pattern in Alzheimer's disease development.
- New figure of controllable factors associated with dementia in aging.
- New figure of caffeine sources.

Chapter 15

- New figure of trends in prevalence of food insecurity.
- Updated hunger sections.
- Several new figures.

Appendix Changes:

- Deleted the Table of Food Composition.
- Previous Appendix I, Chemical Structures, is now Appendix A.

Ancillary Materials

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

MindTap: A new approach to highly personalized online learning. Beyond an eBook, homework solution, digital supplement, or premium website, MindTap is a digital learning platform that works alongside your campus LMS to deliver course curriculum across the range of electronic devices in your life. MindTap is built on an “app” model allowing enhanced digital collaboration and delivery of engaging content across a spectrum of Cengage and non-Cengage resources.

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

Test Bank with Cognero: Cengage Learning Testing Powered by Cognero is a flexible online system that allows you to:

- Author, edit, and manage test bank content from multiple Cengage Learning solutions.
- Create multiple test versions in an instant.
- 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. The new Behavior Change Planner helps you identify risks in your life and guides you through the key steps to make positive changes. Diet & Wellness Plus is also available as an app that can be accessed from the app dock in MindTap.

Global Nutrition Watch: Bring currency to the classroom with Global Nutrition Watch from Cengage Learning. This user-friendly website provides convenient access to thousands of trusted sources, including academic journals, newspapers, videos, and podcasts, for you to use for research projects or classroom discussion. Global Nutrition Watch is updated daily to offer the most current news about topics related to nutrition.

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We are also grateful to the nutrition professionals who updated sections of this edition.

- Linda DeBruyne, M.S., R.D.N. (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*.
- Shannon Dooies Gower-Winter, M.S., R.D.N./L.D.N. (Chapter 7). Shannon graduated from Florida State University with her master’s degree in nutrition. She has taught nutrition at Florida State University and lectured on topics related to childhood nutrition throughout the state. She has conducted research in the area of nutritional neuroscience, where her work focused on various roles of zinc in the brain. Her research has been presented at regional and national scientific conferences, and she has coauthored multiple articles in peer-reviewed journals.

Our special thanks to our publishing team—Miriam Myers, Lori Hazzard, and Carol Samet—for their superb work and dedication to excellence.

We would also like to thank **MPS North America LLC** for their work on the student and instructor ancillaries for the 15th edition, which includes the test bank, instructors’ manual, and PowerLecture.

Reviewers of Recent Editions

As always, we are grateful for the instructors who took the time to comment on 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.

Samuel Adeyeye, *Georgia Southern University*
Katherine Alaimo, *Michigan State University*
Linda Armstrong, *Normandale Community College*
Tammy Lee Christensen, *Hostos Community College (CUNY)*
Dorinda M. Cosimano, *Kean University*
Katie Ferraro, *Santa Rosa Junior College*
Shoshana Freedman, *Glendale Community College*
Keith R. Hench, Ph.D., *Kirkwood Community College*
Rachel K. Johnson, *University of Vermont*
Lauren Lavretsky, *University of Texas at El Paso*
David Lightsey, M.S., *Bakersfield College*
Cheryl McAfee, RDN, LD, *Prince George’s Community College*
Letty Moreno-Brown, *El Paso Community College/University of Texas, El Paso*
Molly Ranney, *Finger Lakes Community College*
Victoria Rethmeier, *Southeast Community College*
Laura Rokosz, *EGGLOCK Nutrition, LLC*
Laurie Runk, *Coastline Community College*
Christie Shubert, *University of North Florida*
Taylor C. Wallace, *George Mason University*



1 Food Choices and Human Health

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 1.2** List the seven major categories of nutrition and weight-related objectives included in the publication *Healthy People 2020*.
- LO 1.3** Name the six classes of nutrients.
- LO 1.4** Give examples of the challenges and solutions to choosing a health-promoting diet.
- LO 1.5** Describe the science of nutrition.
- LO 1.6** Describe the characteristics of the six stages of behavior change.
- LO 1.7** Explain how the concept of nutrient density can facilitate diet planning.
- 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?



Jack Frog/Shutterstock.com

When you choose foods with nutrition in mind, you can enhance your own well-being.

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.

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.

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, Internet websites, radio, and television present stories of new findings on nutrition and heart health or nutrition and cancer prevention, and at the same time, advertisements and commercials bombard us with multicolored pictures of tempting foods—pizza, burgers, cakes, 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? How can you choose foods wisely, for nutrition’s sake? What factors motivate your 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 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.

*Reference notes are in Appendix F.

Table 1–1

Leading Causes of Death in the United States

Chronic diseases cause the great majority of deaths among U.S. adults and account for more than 85 percent of U.S. health-care costs.

	Percentage of Total Deaths
1. Heart disease	23.5
2. Cancers	22.5
3. Chronic lung disease	5.7
4. Strokes	5.0
5. Accidents	5.0
6. Alzheimer's disease	3.3
7. Diabetes mellitus	2.9
8. Pneumonia and influenza	2.2
9. Kidney disease	1.8
10. Suicide	1.6

Note: The diseases highlighted in bold have relationships with diet.

Sources: National Center for Chronic Disease Prevention and Health Promotion, *Chronic disease prevention and health promotion*, www.cdc.gov/chronicdisease, 2017, updated regularly; J. Q. Xu and coauthors, *Deaths: Final data for 2013*, National Vital Statistics Reports 64 (Hyattsville, MD: National Center for Health Statistics, 2016).

The Diet–Health Connection

Your choice of diet profoundly affects your health, both today and in the future. Among the common lifestyle habits that profoundly affect development of these 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 older people suffer from debilitating conditions that could have been largely prevented had they applied the nutrition principles known today. The **chronic diseases**—heart disease, diabetes, some kinds of cancer, 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.

Genetics, Nutrition, and Individuality

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

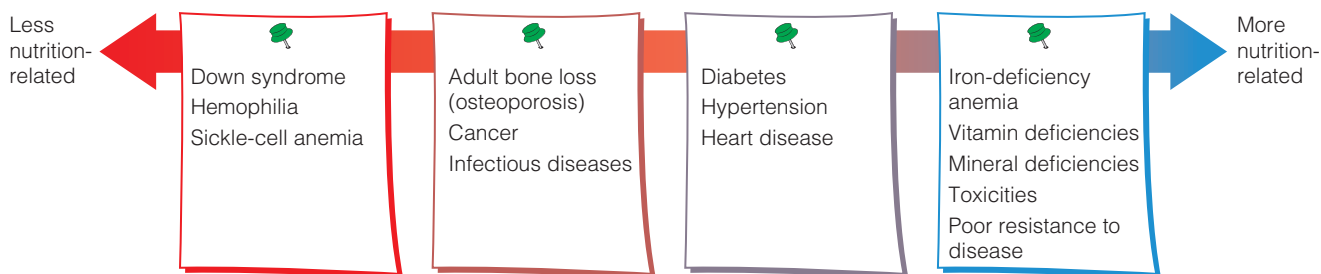
chronic diseases degenerative conditions or illnesses that progress slowly are long in duration, and lack an immediate cure. Chronic diseases limit functioning, productivity, and the quality and length of life. Examples include heart disease, cancer, and diabetes.

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.

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.



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 11.

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).

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 identification of the human **genome** establishes the entire sequence of the **genes** in human **DNA**. This work has, in essence, revealed 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. Nutrition scientists are working industriously to apply this

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 symptoms.
- 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 explores the topics of fitness and physical activity.

start now! Ready to make a change? Go to this book's website at www.cengage.com, access MindTap, and open the Diet & Wellness Plus program. Track your physical activities—all of them—for three days. After you have recorded your activities, see how much time you spent exercising at a moderate to vigorous level. Should you increase the intensity level and amount of your activity?

new wealth of knowledge to benefit human health. 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.

Other Lifestyle Choices

Besides food choices, 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 previous one.

KEY POINT

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

The Nation's Nutrition Objectives

LO 1.2 List the seven major categories of nutrition and weight-related objectives included in the publication *Healthy People 2020*.

The U.S. Department of Health and Human Services has set specific 10-year objectives to guide national health promotion efforts.² The vision of its *Healthy People 2020* is a society in which all people live long, healthy lives. Table 1–2 (p. 6) provides a quick scan of the nutrition and weight-related objectives set for this decade. The inclusion of nutrition and food-safety objectives shows that public health officials consider these areas to be top national priorities.

In 2015, the nation's health report was mixed: more adults reported spending the recommended amount of leisure time in physical activity; at the same time, most people's diets still lacked vegetables, and obesity rates were creeping higher.³ To fully meet the *Healthy People* nutrition goals, our nation must change its eating habits.

The next section shifts focus to 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.

KEY POINT

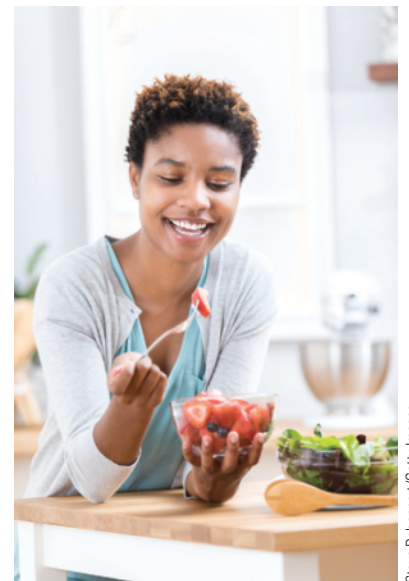
- Each decade, the U.S. Department of Health and Human Services sets health and nutrition objectives for the nation.

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 came originally from the sun.

The body requires six kinds of nutrients—families of molecules indispensable to its functioning—and foods deliver these. Table 1–3 (p. 6) lists the six classes of nutrients. Four of these six are **organic**; that is, the nutrients contain the element carbon derived from living things.



Steve Debenport/Getty Images

The aim of Healthy People 2020 is to help people live long, healthy lives.

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 8.

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.

Table 1–2

Healthy People 2020, Selected Nutrition and Body Weight Objectives

Many other Objectives for the Nation are available at www.healthypeople.gov.

1. Chronic Diseases

- Reduce the proportion of adults with osteoporosis.
- Reduce the death rates from cancer, diabetes, heart disease, and stroke.
- Reduce the annual number of new cases of diabetes.

2. Food Safety

- Reduce outbreaks of certain infections transmitted through food.
- Reduce severe allergic reactions to food among adults with diagnosed food allergy.

3. Maternal, Infant, and Child Health

- Reduce the number of low-birthweight infants and preterm births.
- Increase the proportion of infants who are breastfed.
- Reduce the occurrence of fetal alcohol syndrome (FAS).
- Reduce iron deficiency among children, adolescents, women of childbearing age, and pregnant women.
- Reduce blood lead levels in lead-exposed children.
- Increase the number of schools offering breakfast.

4. Food and Nutrient Consumption

- Increase vegetables, fruit, and whole grains in the diets of those aged 2 years and older, and reduce solid fats and added sugars.

5. Eating Disorders

- Reduce the proportion of adolescents who engage in disordered eating behaviors in an attempt to control their weight.

6. Physical Activity and Weight Control

- Increase the proportion of children, adolescents, and adults who are at a healthy weight.
- Reduce the proportions of children, adolescents, and adults who are obese.
- Reduce the proportion of people who engage in no leisure-time physical activity.
- Increase the proportion of schools that require daily physical education for all students.

7. Food Security

- Eliminate very low food security among children in U.S. households.

Source: www.healthypeople.gov.

Table 1–3

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.

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 structures and working parts of body tissues. (Alcohol yields energy, too—see Table 1–4 comments.)

Vitamins and Minerals The fourth and fifth classes of nutrients are the vitamins and the minerals, sometimes referred to 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.

Figure 1–2

Components of Food and the Human Body

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

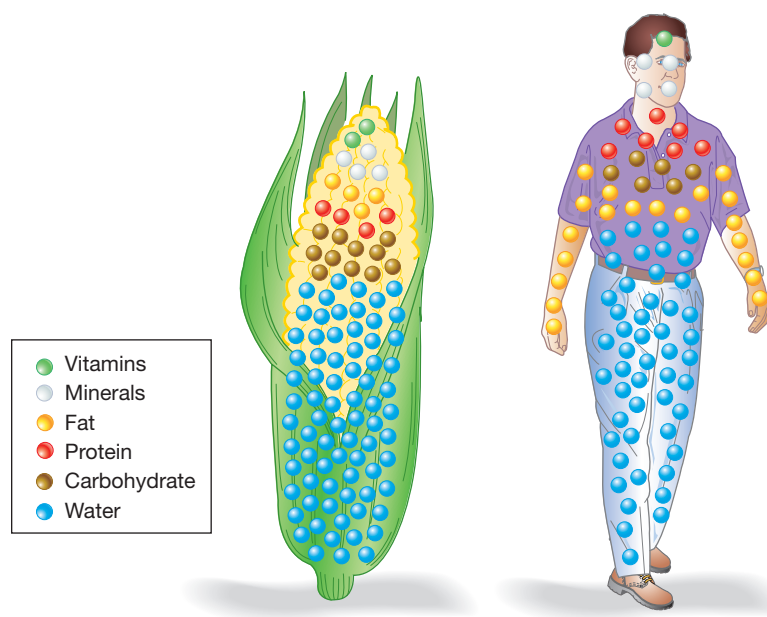


Table 1–4

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.

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.

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

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).⁴

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 body fatness to learn the calorie values of the energy nutrients, listed in Table 1–4. 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 gender, 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 carbohydrates, fats (lipids), 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. Formulas can also stave off weight loss in the elderly or anyone in whom eating is impaired.⁵

Formula diets are essential to help sick people to survive, but they do not enable people to thrive over long periods. Even in hospitals, elemental diet formulas do not support optimal growth and health and may even lead to medical complications. Although serious problems are rare and can be detected and corrected, they show that the composition of these diets is not yet perfect for all people in all settings.

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 superior to such supplements. 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. Medical wisdom 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

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.

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.

should be reintroduced as early as possible. 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.

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 the challenges and solutions to 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. A few definitions and basic guidelines can help.

The Abundance of Foods to Choose From

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, fruit, meats, milk, and grains (Table 1–5 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.⁶ And when people do choose to 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 number and types of foods supplied by the food industry today is astounding, as Figure 1–3 (p. 10) illustrates. Tens of thousands of foods now line the market shelves—many are processed mixtures of the basic ones, and some are constructed entirely from highly processed ingredients.⁷ Ironically, this abundance often makes it more difficult, rather than easier, to plan a nutritious diet.

The food-related terms defined in Table 1–5 reveal that all types of food—including **fast foods**, **processed foods**, and **ultra-processed foods**—offer various constituents to the eater, some more health-promoting than others.⁸ You may also hear about **functional foods**, a marketing term coined to identify those foods containing 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.⁹

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



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

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.