Visualizing Nutrition
Everyday Choices

Fifth Edition

MARY B. GROSVENOR, M.S., RD

LORI A. SMOLIN, PH.D.
University of Connecticut

with
LAURA R. CHRISTOPH, PH.D.
Franklin Pierce University

57 Short
58 Normal
59 long

WILEY

SVP, PUBLISHING STRATEGY AND QUALITY	Elizabeth Widdicombe
EXECUTIVE EDITOR	Natalie Ruffatto
ASSISTANT EDITOR	Georgia Larsen
SENIOR MARKETING MANAGER	Brittany Hammond
SENIOR MANAGER, COURSE DEVELOPMENT AND PRODUCTION	Svetlana Barskaya
SENIOR COURSE PRODUCTION OPERATIONS SPECIALIST	Lauren Freestone
SENIOR COURSE CONTENT DEVELOPER	Laura Byrnes
EDITORIAL ASSISTANT	Samantha Hart
SENIOR CREATIVE PRODUCT DESIGNER	Thomas Nery
TYPESETTING	Lumina Datamatics, Inc.
COVER DESIGN	Wiley
COVER PHOTO CREDITS	Fresh Vegetables © anilakkus / Getty Images, Family staying fit © kali9 / Getty Images, Woman thinking what to eat © aldomurillo / Getty Images, Food research © View Stock / Getty Images

This book was typeset in 9.5/12 STIX Two Text at Lumina Datamatics.

Student Edition: 978-1-119-59287-7
Evaluation Copy: 978-1-119-74184-8

The inside back cover will contain printing identification and country of origin if omitted from this page. In addition, if the ISBN on the back cover differs from the ISBN on this page, the one on the back cover is correct.

Library of Congress Cataloging-in-Publication Data

Names: Grosvenor, Mary B., author. | Smolin, Lori A., author. | Christoph, Laura R., author.
Title: Visualizing nutrition : everyday choices / Mary B. Grosvenor, Lori A. Smolin, with Laura R. Christoph.
Description: Fifth edition. | Hoboken, NJ : Wiley, [2021] | Includes index.
Identifiers: LCCN 2020042684 (print) | LCCN 2020042685 (ebook) | ISBN 9781119592877 (paperback) | ISBN 9781119741800 (adobe pdf) | ISBN 9781119592853 (epub)
Subjects: LCSH: Nutrition—Textbooks.
Classification: LCC QP141 .G767 2021 (print) | LCC QP141 (ebook) | DDC 612.3—dc23
LC record available at https://lccn.loc.gov/2020042684
LC ebook record available at https://lccn.loc.gov/2020042685

Printed in the United States of America.

10 9 8 7 6 5 4 3 2 1

57 Short
58 Normal
59 long

About the Authors

MARY B. GROSVENOR holds a Bachelor of Arts in English and a Master of Science in nutrition science, affording her an ideal background for nutrition writing. She is a registered dietitian who has taught at the community college level and worked in clinical and research settings in hospitals and communities large and small in the western United States. She has published articles in peer-reviewed journals in nutritional assessment and nutrition and cancer. Her training and experience provide practical insights into the application and presentation of the science in this text.

LAURA R. CHRISTOPH holds a Bachelor of Science in nutrition and a Ph.D. in public health with a concentration in Nutrition and Community Health Education. Her doctoral research focused on obesity prevention interventions for low-income adolescents. She has published work related to public health initiatives addressing food insecurity and social justice, as well as sport nutrition. She has over a decade of experience teaching at the community college and university level. She is currently an associate professor of health sciences at Franklin Pierce University, where she coordinates the Nutrition and Public Health minors and oversees an NIH-Inbre funded exercise physiology and sport nutrition undergraduate research lab.

LORI A. SMOLIN received a Bachelor of Science degree from Cornell University, where she studied human nutrition and food science. She received a doctorate from the University of Wisconsin at Madison, where her doctoral research focused on B vitamins, homocysteine accumulation, and genetic defects in homocysteine metabolism. She completed post-doctoral training both at the Harbor–UCLA Medical Center, where she studied human obesity, and at the University of California–San Diego, where she studied genetic defects in amino acid metabolism. She has published articles in these areas in peer-reviewed journals. Dr. Smolin is currently at the University of Connecticut, where she has taught both in the Department of Nutritional Science and in the Department of Molecular and Cell Biology. Courses she has taught include Introductory Nutrition, Life Cycle Nutrition, Food Preparation, Nutritional Biochemistry, General Biochemistry, and Introductory Biology.

Dedication

To my husband and sons in appreciation for many hours of patience, support, and editorial assistance. Thanks for helping me keep balance in my life.

(from Mary Grosvenor)

To my sons, Zachary and Max, who help to keep me focused on the important things in life. To my husband, David, who has continuously provided his love and support and is always there to assist with computer, technological, and life issues that arise.

(from Lori Smolin)

To my husband, Geoff, who helps me balance my intensity with laughter and relaxation. To my students and colleagues at Franklin Pierce University, who provide opportunities for growth and development in my teaching and research.

(from Laura Christoph)

57 Short
58 Normal
59 long

Letter to Students

Dear Students,

Welcome to nutrition. We all have some knowledge of the subject: We know we need to eat to survive and we need to eat well to thrive. This sounds simple, but it encompasses many aspects of our lives. What we eat defines—and is defined by—our social interactions, our economic situation, our surroundings, and our health. Regardless of our personal choices or circumstances, one thing is clear: We are exposed to a bottomless well of nutrition information, often containing conflicting and contradictory messages. This is where *Visualizing Nutrition: Everyday Choices* steps in.

Our goal is to present the science of nutrition in an accessible, engaging, and visually-appealing format. We want you to understand the principles of nutrition and apply evidence-based science to the issues you encounter in your daily lives. We give you the tools and critical thinking skills to make everyday choices that are personally, socially, and environmentally, as well as nutritionally sound.

Since we began writing nutrition texts, our central goals have remained the same, but we continue to adapt our format. As we developed learning tools for the text, we applied these to the online platform in our e-book and the online course. We worked to develop state of the art, easy to use, scientifically sound diet analysis software that provides clear, comprehensive reports and analyses. We have provided options other than a costly hard copy text such as book rentals and e-books.

With each edition, we rewrite the entire text to ensure you are not distracted by changes in tone or approach, and we continue to refine critical thinking materials and exercises that encourage you to apply your nutrition skills. By helping you understand the "whys" and "hows," we hope we can satisfy and encourage your growing curiosity about nutrition in whatever direction it takes you, whether that means making more informed choices about your own diet and lifestyle, helping others do the same, or even pursuing a career in the field.

What Is Unique about Wiley's Visualizing Nutrition?

Visualizing Nutrition: Everyday Choices, 5e is an introductory text for undergraduate students with little or no nutrition background. The goal in creating this text is to provide students with a basic knowledge of nutrition along with the critical thinking skills they need to apply this knowledge to their everyday food and nutrition choices. The text uses a concise writing style combined with an engaging, consistent art program that make the scientific concepts accessible and understandable. Student interest is maintained by integrating health and disease discussions throughout the text as these are often of personal interest to students. The presentation of metabolism is also integrated, allowing this challenging material to be taught incrementally, reinforcing understanding while not overwhelming students.

1. **Visual Approach to Learning.** As part of the Wiley Visualizing series, *Visualizing Nutrition: Everyday Choices, 5e* uses a visual approach to learning. Information that would be buried in the text of other books is presented within the context of colorful illustrations and vibrant photographs. The images grab students' attention and, along with the text, tell the engaging story of nutrition. The art is pedagogically designed to work with the text, present key concepts and complex processes in clear steps, organize information, and integrate related pieces of information with one another. Illustrations are consistent in style and color scheme so students can easily recognize material they have encountered earlier in the text and build on this previous knowledge. For example, a figure in Chapter 3 provides an overview of metabolism. Using the same style and colors, figures in subsequent chapters build on this visual base adding more information about the metabolism of carbohydrates, lipids, proteins, and micronutrients, and then integrating this knowledge with an illustration of energy metabolism during exercise.
2. **Critical Thinking Focus.** *Visualizing Nutrition: Everyday Choices, 5e* emphasizes critical thinking as it teaches students to evaluate information and then apply their knowledge to the myriad of nutrition, health, and food decisions they are faced with in their daily lives. The *Thinking It Through* case study found in each chapter is a unique critical thinking exercise that walks students stepwise through the thought processes needed to address nutrition issues. This prepares them to apply this logic to their own nutrition concerns. These exercises become more challenging as the text progresses and as students develop their critical thinking skills. Other boxed features including *Debate*, *What a Scientist Sees*, and *What Is Happening in This Picture?* are also designed to encourage students to think critically and apply their knowledge. Critical thinking questions are included with these features and also appear with many of the photos and illustrations throughout the book, linking critical thinking to visual learning. In addition, the *Critical and Creative Thinking Questions* provided in the online course ask students to use their knowledge of nutrition science to assess the quality of their own diets as well as address community nutrition issues and clinically-oriented problems.
3. **Designed with Interactive Multimedia.** *Visualizing Nutrition: Everyday Choices, 5e* is tightly integrated with the online learning environment, which provides interactive multimedia activities that allow learners to actively engage with the materials. The combination of textbook and the online course provides learners with multiple entry points to the content, giving them greater opportunity to explore concepts and assess their understanding as they progress through the material. The online course is a key component of the Wiley Visualizing learning and problem-solving experience. This sets Wiley Visualizing apart from other textbooks whose online components are mere drill-and-practice.

Visualizing Nutrition and the Online Course Are Designed to Be a Natural Extension of How We Learn

To understand why the Visualizing approach is effective, it is first helpful to understand how we learn.

1. Our brain processes information using two main channels: visual and verbal. Our *working memory* holds information that our minds process as we learn. This "mental workbench" helps us with decisions, problem-solving, and making sense of words and pictures by building verbal and visual models of the information.
2. When the verbal and visual models of corresponding information are integrated in working memory, we form more comprehensive, lasting, mental models.
3. When we link these integrated mental models to our prior knowledge, stored in our *long-term memory*, we build even stronger mental models. When an integrated (visual plus verbal) mental model is formed and stored in long-term memory, real learning begins.

57 Short
58 Normal
59 long

The effort our brains put forth to make sense of instructional information is called *cognitive load*. There are two kinds of cognitive load: productive cognitive load, such as when we're engaged in learning or exert positive effort to create mental models; and unproductive cognitive load, which occurs when the brain is trying to make sense of needlessly complex content or when information is not presented well. The learning process can be impaired when the information to be processed exceeds the capacity of working memory. Well-designed visuals and text with effective pedagogical guidance can reduce the unproductive cognitive load in our working memory.

New to This Edition

This fifth edition of *Visualizing Nutrition: Everyday Choices* includes the most recent nutrition recommendations, new and improved illustrations and photos, and updated boxed features to promote critical thinking.

- **Updated recommendations:** The entire text has been updated to include the most recent nutrition and health guidelines. These include the Dietary Guidelines for Americans 2020–2025 and the new Dietary Reference Intake recommendations for sodium and potassium. Physical activity recommendations are based on the U.S. Department of Health and Human Services' 2018 Physical Activity Guidelines for Americans. Updated American Academy of Pediatrics recommendations on introducing solid foods are presented. The text and art in the book have been updated to reflect the FDA's revised Nutrition and Supplement Facts labels. The most recent clinical guidelines on body weight, cholesterol, and blood pressure management are included.

- **Most recent nutrition concepts:** Our understanding of nutrition is constantly evolving. New concepts and changes in the focus of nutrition science are incorporated throughout this latest edition. For example, the text gives more emphasis to the role of inflammation, immune function, and the intestinal microbiota in nutrition-related disease. An enhanced description of how atherosclerosis develops, an updated explanation of exercise-associated hyponatremia, and a new discussion of exercise and brain health are included. As the field of nutrition takes a broader view of the role of nutrition in health, coverage of the impact of overall dietary patterns, sedentary lifestyles, and food environment has been expanded.

- **Enriched art program:** With the goal of enhancing student understanding and visual appeal, new art has been added and existing art revamped. Over 45 completely new pieces of art have been added and approximately 40 others have been improved or updated. The new art includes a series of Nutrition Insight figures showcasing the impact of environmental, economic, and sociocultural factors on our food and activity choices (Chapters 1, 9, 10, 12, and 14) and new diagrams illustrating factors that affect the bioavailability of vitamins and minerals. New photos help students distinguish mandatory from voluntary fortification, differentiate naturally-occurring from added sugars, and explain sprouted grains. New illustrations help students understand biological processes such as why lactose intolerance causes GI symptoms, how blood glucose regulation is altered in type 1 and type 2 diabetes, how medium versus long-chain fatty acids are absorbed, and how antibiotic resistance develops.

- **New and updated *Debates*:** The *Debate* feature presents timely, controversial topics and asks students to think critically about the differing points of view. To support this goal, all *Debates* have been revised to reflect the most recent research and policy and new *Debate* topics have been added. For example, Chapter 1 discusses "Do DNA-Based Diets Improve Health Outcomes?," Chapter 6 asks "Will Going Vegan Save the Planet?," and Chapter 11 wonders "Does a Healthy Diet Cost More?"

- **Improved *Thinking It Through* cases studies:** *Thinking It Through* is the key feature in the text's critical thinking arsenal. To stay as current as possible while guiding students through the process of making logical decisions, a number of these exercises have been revised. For example, the case study in Chapter 10 addresses the confusing plethora of snack bars (keto, Paleo, etc.) available to athletes and guides students through the process of making the appropriate snack choice. The exercise in Chapter 13 has been expanded to better explain how an outbreak of food-borne illness is tracked to its source.

- **New *What a Scientist Sees:*** The *What a Scientist Sees* feature compares how a consumer might view a nutrition issue to how a scientist sees that same topic. In Chapter 1, "Behind the Claims" has been rewritten to explore claims made in a weight loss ad. In Chapter 5, a new *What a Scientist Sees* entitled "Is Keto OK?" examines the claims and science behind ketogenic diets, and the feature discussing the problem of food waste has been expanded in Chapter 14.

- **New and more visible *What Is Happening in This Picture?*:** This feature, at the end of each chapter, presents an intriguing image relevant to the chapter. It then tells a brief story related to that image and asks students to think critically about what they are seeing. A new feature in Chapter 1 focuses on food deserts and the difficulties in obtaining a healthy diet from the corner store. In Chapter 6, the feature asks student to evaluate the new generation of plant-based burgers and in Chapter 13, a new feature addresses the safety of raw milk.

How Does the Online Course Support Instructors and Students?

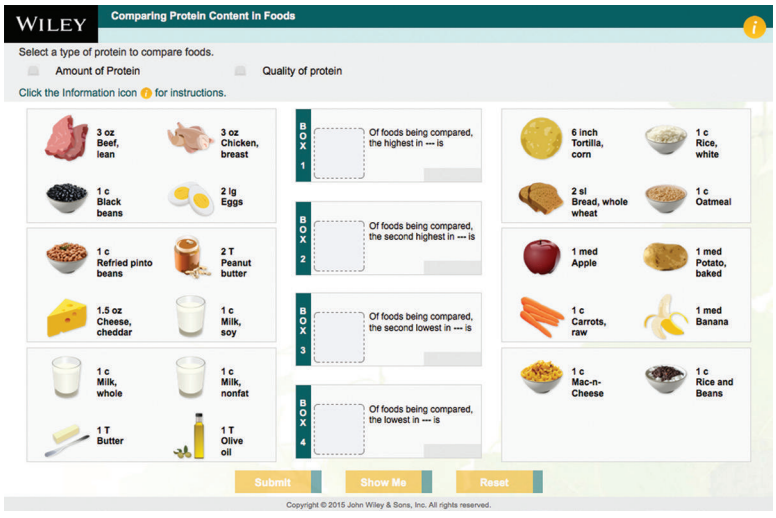
The online course is designed for personalized, active learning. Numerous resources are available for instructors and students within it.

Hear This Illustration Audio Tutorials

Select figures in each chapter are accompanied by audio that narrates and discusses the important elements of that particular illustration. All audio files are accompanied by downloadable scripts of the narration.

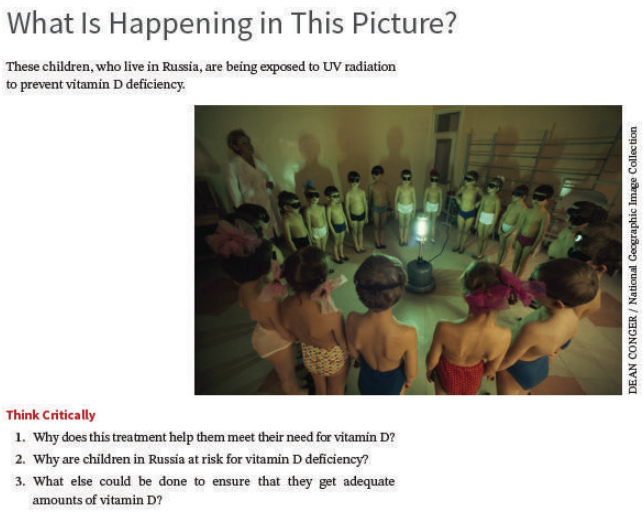
Nutrition Interactivities

There are several interactive options to promote understanding while making learning fun. These include the presentation of many of the text figures in an interactive format that allows students to move step-by-step through a figure and zoom in or out of different parts of the figure with a click. Practice activities include flash cards designed to help with active recall, drag-n-drop exercises to reinforce understanding and identify sources of specific nutrients, and computational activities that allow students to practice skills, such as calculating energy balance and percentage of calories from macronutrients. Each chapter includes an activity that asks students to create a balanced meal or snack to meet specific nutrient recommendations.



Critical Thinking Exercises and Questions

There are numerous assignments that support the text's critical thinking focus. The *Thinking It Through* case studies in each chapter walk students through the process of critical thinking. They are available as assignments in the print book, e-book, and the online course. In addition, a set of *Critical and Creative Thinking Questions* for each chapter, questions incorporated into the art program, those that accompany the videos, and the critical thinking questions in *What a Scientist Sees*, *Debate*, and *What Is Happening in This Picture?* are all assignable in the online course.



Diet Analysis Software

iProfile, a diet analysis software program developed using USDA and brand name food composition data, can be accessed through the online course. It provides all the tools students need to assess the nutrient content of a diet and compare intake with recommendations from the DRIs, MyPlate, and the Dietary Guidelines. The database is updated regularly to include new products and current food trends.

Computer-Gradable Diet Analysis Exercises

Most nutrition courses require students to complete a diet analysis project. These assignments are often challenging for students who struggle to accurately log food intake and interpret reports, and they are extremely time consuming for

57 Short
58 Normal
59 long

instructors who must guide students through the process and grade the final product. The author-developed computer-gradable iProfile Dietary Analysis exercises in the online course help students develop proficiency in collecting and entering data as well as teaching them to apply the quantitative reasoning and critical thinking skills needed to accurately analyze reports. This prepares students to do their own diet analyses and eases the burden for instructors when this is assigned.

Video Resources

In keeping with the visual nature of the text, the online course provides several types of videos, including *Food for Thought*, *Video Bites*, and *How It Works*. These were all developed or vetted by the authors to enhance learning while meeting the goals of the text. Some of these may be used as class or discussion starters; others teach and reinforce difficult topics. All can be assigned through the online course and have closed captioning for the hearing impaired.

How Does Wiley Visualizing Support Instructors and Students?

Wiley Custom Select

Wiley Custom Select gives you the freedom to build your course materials exactly the way you want them, offering your students a cost-efficient alternative to traditional texts. In a simple three-step process create a solution containing the content you want, in the sequence you want, delivered how you want. Visit Wiley Custom Select at http://customselect.wiley.com.

Instructor Resources

There are a variety of teaching tools available in the online course, including sample syllabi, lecture outlines, text images, and more.

PowerPoint Presentations

(available in the online course)

A complete set of highly visual PowerPoint presentations—one per chapter—by Ann Paterson, Williams Baptist College, is available in the online course to enhance classroom presentations. Tailored to the text's topical coverage and learning objectives, these presentations are designed to convey key text concepts, illustrated by embedded text art.

Test Bank

(available in the online course)

The Test Bank developed by Carolyn Williams, Shelton State Community College, has approximately 80 questions per chapter, many of which incorporate visuals from the book. The test items include multiple-choice and essay questions testing a variety of comprehension levels. The test bank is available online in MS Word files, as a TestGen Test Bank, and within the online course. The easy-to-use test-generation program fully supports graphics, print tests, student answer sheets, and answer keys. The software's advanced features allow you to produce an exam to your exact specifications.

Instructor's Manual

(available in the online course)

The Instructor's Manual includes an outline of each chapter, an explanation of the course assets, a list of suggested assignments organized by learning objective for each chapter, and a sample syllabus.

How Has Wiley Visualizing Been Shaped by Contributors?

Instructor Contributions

Throughout the process of developing our revisions, we benefited from the comments and constructive criticism provided by the instructors and colleagues listed below. We offer our sincere appreciation to these individuals for their helpful reviews, invaluable contributions to the online resources, and continued involvement with the Wiley nutrition program:

Katherine Alaimo, Michigan State University
Celine Santiago Bass, Kaplan University
William Banz, Southern Illinois University
Abbe Breiter-Fineberg, Kaplan University
Amy Allen-Chabot, Anne Arundel Community College
Elizabeth Chu, San Diego Mesa College
Kara Egan, Indiana University-Purdue University Indianapolis
Elizabeth Eilender, Montclair State University
Nicolle Fernandes, Ball State University
Katie Ferraro, University of California, San Francisco
Melany Gilbert, Ozarks Technical Community College
Mindy Haar, New York Institute of Technology
Donna Huisenga, Illinois Central College
Karen Friedman-Kester, Harrisburg Area Community College
Rose Martin, Iowa State University
Deborah Murray, Ohio University
Melissa Silva, Bryant University
Nancy Berkoff, Los Angeles Trade Technical College
Jayne Byrne, College of St. Benedict

Linda Brown, Florida State University
Melanie Burns, Easting Illinois University
James F. Collins, University of Florida
Sylvia Crixell, Texas State University
Barbara Goldman, Palm Beach State College
Timaree Hagenburger, Consumnes River College
Donna Handley, University of Rhode Island
Karen Israel, Anne Arundel Community College
Shanil Juma, Texas Women's University
Younghee Kim, Bowling Green State University
George Liepa, Eastern Michigan University
Owen Murphy, Central Oregon Community College
Judy Myhand, Louisiana State University
Cheryl Neudauer, Minneapolis Community and Technical College
Kristen Hilbert, SUNY Oneonta
Priya Venkatesan, Pasadena City College
Shahla Wunderlich, Montclair State University
Stephanie Colavita, Montclair State University
Jennifer Zimmerman, Tallahassee Community College
Jennifer Koslo, Maricopa Community Colleges

Special Thanks

- Special thanks to John Ambrose for providing a fresh eye to the material through the *Video Bites* series and revitalized chapter introductions.
- We are extremely grateful to the many members of the editorial and production staff at John Wiley & Sons who guided us through the challenging steps of developing this text. We thank executive editor Natalie Ruffatto for her support and for developing new ways to ensure this edition's success and Lauren Freestone, senior course production operations specialist, who guided the production process. Our sincere thanks also go to Laurie Rosatone, vice president and director, who oversaw the entire project; Brittany Hammond, senior marketing manager, who adeptly represents the nutrition texts; Laura Byrnes for her continued support in the many roles she has played throughout this project; and Alan Halfen, former senior editor, who supported the revision of this new edition. We are grateful to Georgia Larsen, assistant editor, and Samantha Hart, editorial assistant, for helping to bring this project to fruition. Thanks to development editor Sarah Wood for her patience and support and for doing whatever it took to guide us through the development of this text and its ancillary materials, and to Trish McFadden for keeping the lines of communication open and smoothing our path through production. We would also like to thank Lumina Datamatics, Inc. for their editorial and production support.

XPACIFICA / National Geographic Image Collection

Nutrition: Everyday Choices

How do you choose what to eat? For most of the world's population, the answer is simple: You eat what you can grow, raise, catch, kill, or purchase. Subsistence is the principal motivator of food consumption: If you don't eat, you die. Historically, the game or crops people could kill or cultivate successfully became staples of their diet. As food production became more sophisticated, a greater array of food choices became available. As people explored and migrated across continents, new foods were discovered: Corn became part of the diet of European settlers in North America, and the potato was brought to the Old World from the New. Today, in our global society, you may literally choose from the world's dinner table.

Biological, social, economic, ecological, and cultural factors as well as personal tastes affect what you choose from this plethora of foods. And what you choose affects how healthy you are. Because the nutrients in the foods you eat form and maintain the structure of your body, you really are what you eat. The challenge is to find a satisfying balance between what you like and what optimizes your health. The choice is yours.

CHAPTER OUTLINE

57 Short
58 Normal
59 long

1.1 Food Choices and Nutrient Intake

LEARNING OBJECTIVES

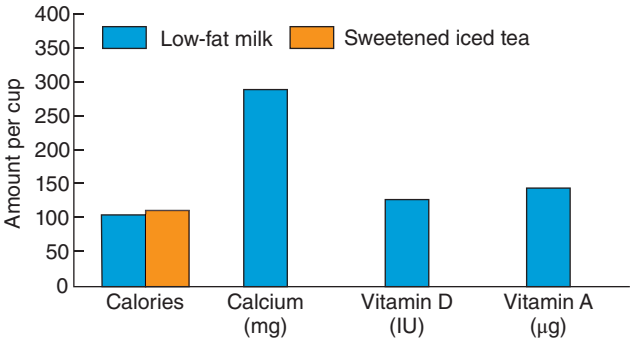
1. **Define** nutrient density.
2. **Compare** fortified foods with dietary supplements as sources of nutrients.
3. **Distinguish** essential nutrients from phytochemicals.
4. **Identify** factors in your food environment that influence your food choices.

What are you going to eat today? Will breakfast be a vegetable omelet or a bowl of sugar-coated cereal? How about lunch—a burger or a bean burrito? The foods we choose determine the **nutrients** we consume. To stay healthy, humans need more than 40 **essential nutrients**. Because the foods we eat vary from day to day, so do the amounts and types of nutrients and the number of **calories** we consume.

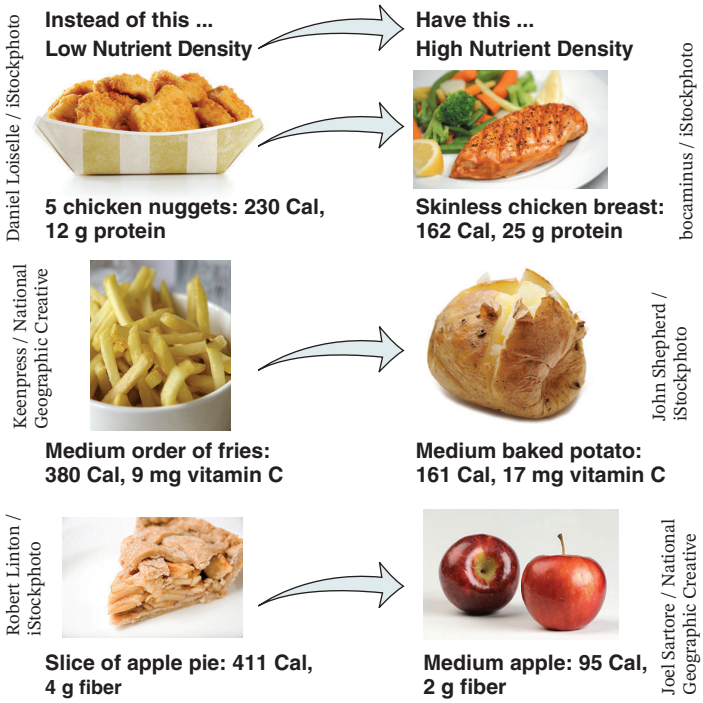
Nutrients from Foods, Fortified Foods, and Supplements

Any food you eat adds some nutrients to your diet, but to make your diet healthy, it is important to choose nutrient-dense foods. Foods with a high **nutrient density** contain more nutrients per calorie than do foods with a lower nutrient density. Foods low in nutrient density are often high in empty calories, which are calories that come with few nutrients (**Figure 1.1**).

FIGURE 1.1 Nutrient density Nutrient density is important in choosing a healthy diet. Nutrient-dense foods provide more nutrients in fewer calories.



a. An 8-ounce glass of low-fat milk provides you with about the same number of calories as 8 ounces of bottled iced tea, but the milk also provides calcium, vitamin D, vitamin A, and other nutrients, including protein. The calories in the iced tea are from added sugar.



b. Typically, less processed foods provide more nutrients per calorie. For example, a roasted chicken breast is more nutrient dense than chicken nuggets that are breaded and fried; a baked potato is more nutrient dense than French fries; and apples are more nutrient dense than apple pie.

nutrients Substances in food that provide energy and structure to the body and regulate body processes.

essential nutrient A nutrient that must be consumed in the diet because it cannot be made by the body or cannot be made in sufficient quantities to maintain body functions.

calorie A unit of heat used to express the amount of energy provided by food or expended by the body. We typically use the word "calorie" or "Calorie" to refer to the number of kilocalories; a kilocalorie is technically 1000 calories.

nutrient density A measure of the nutrients provided by a food relative to its calorie content.

57 Short
58 Normal
59 long

Unhealthy fats and added sugars provide empty calories. If a large proportion of your diet consists of foods that are low in nutrient density and high in empty calories, such as soft drinks, chips, and candy, you could have a hard time meeting your nutrient needs without exceeding your calorie needs. By choosing nutrient-dense foods, you can meet all your nutrient needs and have calories left over for occasional treats that are lower in nutrients and higher in calories.

In addition to nutrients that occur naturally in foods, we obtain nutrients from fortified foods. The **fortification** of foods was begun to help eliminate nutrient deficiencies in the population, with the federal government mandating that certain nutrients be added to certain foods. Foods such as milk with added vitamin D, salt with added iodine, and grain products with added B vitamins and iron are examples of this mandated fortification that have been part of the U.S. food supply for decades. These fortification programs have helped prevent deficiency diseases caused by low intakes of vitamin D, iodine, niacin, and iron (**Figure 1.2**).

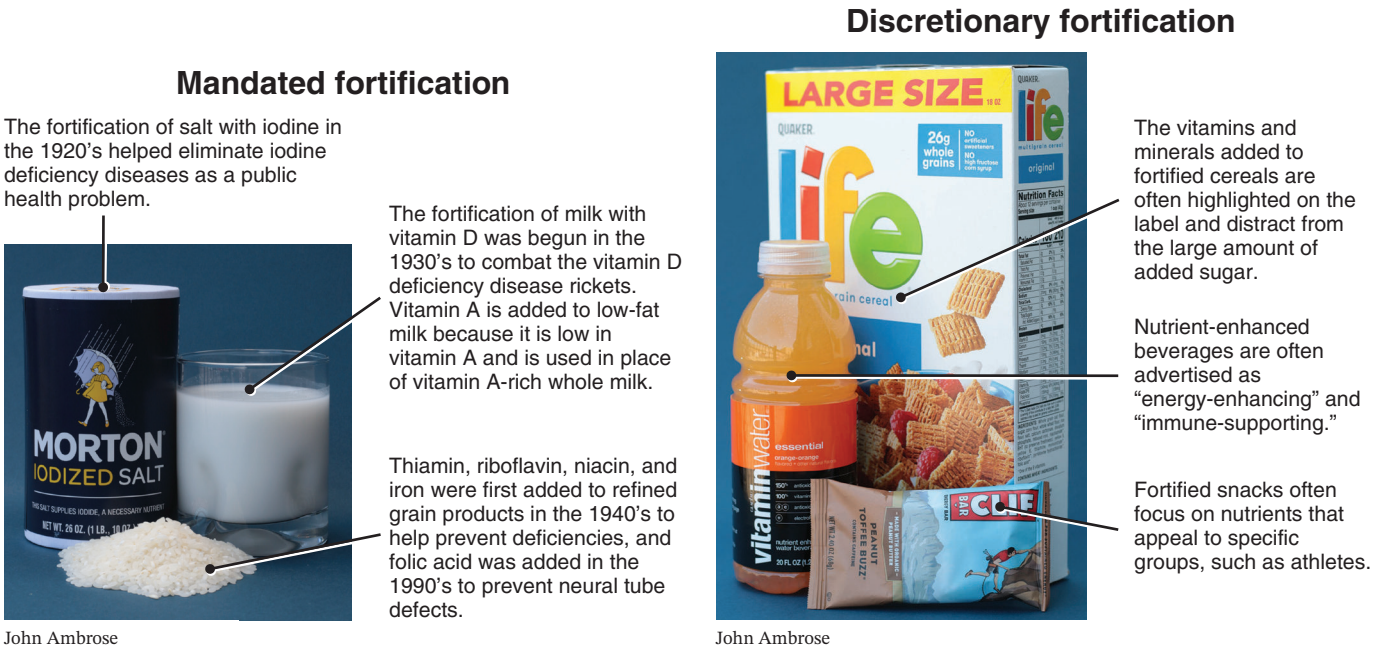
Discretionary fortification of foods is also now common practice (see Figure 1.2). Vitamins and minerals are routinely added to a variety of foods, including breakfast cereals and snack foods. The amounts and types of nutrients added to these voluntarily fortified foods are at the discretion of the manufacturer. These added nutrients contribute to the diet but are not necessarily designed to address deficiencies and may increase the likelihood of consuming an excess of some nutrients (see *Debate* in Chapter 7).

Dietary supplements are another source of nutrients, but they do not offer all the benefits of food (see Chapters 2 and 7). More than half of U.S. adults take some sort of daily dietary supplement to enhance their nutrient intake.[1] Most supplement use is based on personal preference; only 23% of supplements used are taken at the recommendation of a health professional.[2]

Food Provides More Than Nutrients

In addition to nutrients, food contains substances that, though not essential to life, can be beneficial for health. In plants,

FIGURE 1.2 **Fortified foods** Each of these foods is fortified. In some foods, like the rice and salt shown in the photo on the left, the nutrients are added to address deficiencies in the population's diet. Other foods have nutrients added to replicate those in a food they replace; for example, reduced-fat milk is fortified with vitamin A to replace the vitamin A that is lost when the fat is removed from whole milk. Some foods, such as those shown in the photo on the right, are fortified with nutrients chosen by the manufacturer as a marketing tool and are not necessarily healthy choices.



John Ambrose

John Ambrose

fortification The addition of nutrients to foods.

57 Short
58 Normal
59 long

FIGURE 1.3 Foods that are high in phytochemicals[3,4] Fruits, vegetables, and whole grains provide a variety of phytochemicals, such as those highlighted here. Supplements of individual phytochemicals are available, but these supplements do not provide the combinations of nutrients and phytochemicals provided by a diet rich in plant foods.

Todd Gipstein / National Geographic Creative

these health-promoting substances are called **phytochemicals** (**Figure 1.3**). Although fewer such substances have been identified in animal foods, animal foods also contain substances with health-promoting properties. These are called **zoochemicals**.

Some foods, because of the complex mixtures of nutrients and other chemicals they contain, provide health benefits that extend beyond basic nutrition. Such foods have been termed **functional foods**. The simplest functional foods are unmodified whole foods, such as broccoli and fish, that naturally contain substances that promote health and protect against disease. However, some foods fortified with nutrients or enhanced with phytochemicals or other substances are also classified as functional foods, for example oatmeal with added soy protein, and orange juice with added calcium (**Table 1.1**).[6] Functional foods are also called *nutraceuticals*,

TABLE 1.1 Functional foods provide benefits beyond their nutrients[5]

Food	Potential health benefit
Fruits and vegetables	May reduce the risk of heart disease and various cancers.
Breakfast cereal with added flaxseed	Helps reduce blood cholesterol levels and the overall risk of heart disease and may reduce the risk of certain cancers.
Yogurt (fermented dairy)	May reduce the risk of certain cancers and help control diarrhea.
Garlic	Helps reduce cancer risk and lowers blood cholesterol levels and the overall risk of heart disease.
Oatmeal	Helps reduce blood cholesterol and the risk of heart disease.
Orange juice with added calcium	Helps prevent osteoporosis.
Salmon	Reduces the risk of heart disease.
Green tea	May reduce the risk of certain types of cancer.
Soybeans	May reduce blood cholesterol and heart disease, alleviate menopause symptoms, and reduce the risk of osteoporosis.

phytochemical A substance found in plant foods that is not an essential nutrient but may have health-promoting properties.

functional food A food that has health-promoting properties beyond basic nutritional functions.

57 Short
58 Normal
59 long

from "nutrition" and "pharmaceutical." The terms *functional food* and *nutraceutical* are not defined by the FDA, and therefore their usage varies.

What Determines Food Choices?

Do you eat oranges to boost your vitamin C intake or ice cream to add a little calcium to your diet? Probably not. We need these nutrients to survive, but we generally choose foods for reasons other than the nutrients they contain.

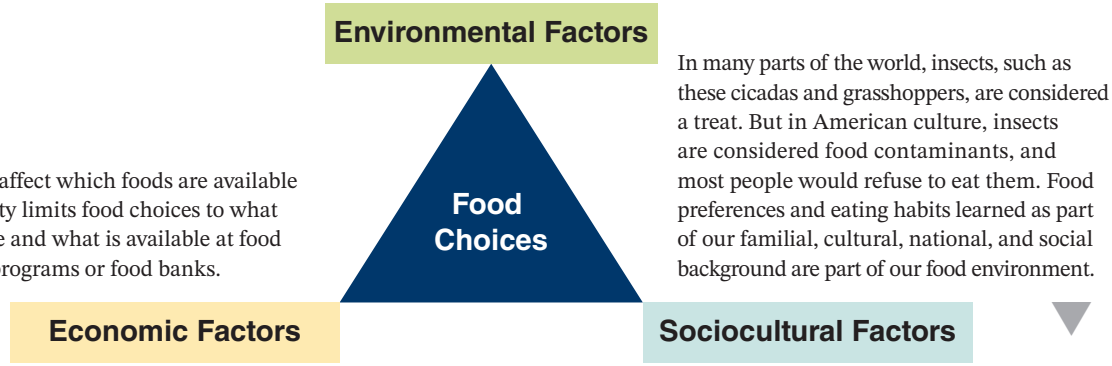
The factors around us that influence what we choose to eat are referred to as our **food environment**. This includes the environmental, sociocultural, and economic factors that affect eating habits and patterns (**Figure 1.4**). It involves factors such as access to grocery stores and restaurants, availability of products and pricing of food in those stores and restaurants, and the acceptability of those foods based on

NUTRITION INSIGHT

FIGURE 1.4 Our food environment affects what we eat. As seen in these examples, food environment is influenced by our surroundings, as well as by economic and sociocultural factors.

Richard Levine / Alamy Stock Photo

Living in a food desert, where your only convenient shopping option is a small corner market, makes it difficult to choose a varied diet that includes recommended amounts of fresh fruits and vegetables.



Economics affect which foods are available to us. Poverty limits food choices to what is affordable and what is available at food assistance programs or food banks.

In many parts of the world, insects, such as these cicadas and grasshoppers, are considered a treat. But in American culture, insects are considered food contaminants, and most people would refuse to eat them. Food preferences and eating habits learned as part of our familial, cultural, national, and social background are part of our food environment.

SDI Productions / E+ / Getty Images

Kevin Foy / Alamy Stock Photo

57 Short
58 Normal
59 long

food environment The physical, economic, and social factors that affect eating habits and patterns.

our family and cultural traditions. What we choose to eat is also influenced by what we are enticed to eat. Across much of America, fast-food restaurants dominate the landscape, and advertisements for these foods bombard us in the media. The availability, affordability, and familiarity of fast food results in increased consumption.

Food environment can also reduce the consumption of healthy foods. For example, in many inner city and rural areas, supermarkets are scarce, so food choices are limited. An area with limited access to affordable fruits, vegetables, and other foods that make up a healthy diet is referred to as a **food desert** (see Figure 1.4). Farmer's markets improve the food environment by increasing access to fresh locally grown produce.

Food environment also involves social interactions and family and cultural traditions; if we were never exposed to a food as a child, it would not be part of our food environment, and we might be less likely to choose it as an adult (see Figure 1.4). The foods we desire when we are sick, cold, tired, depressed, or lonely depend on what we learned to eat from our family, culture, and friends. What we choose to eat is also affected by our personal convictions, such as environmental consciousness or vegetarianism, as well as our personal preferences for taste, smell, appearance, and texture.

Concept Check

1. **Which** has a higher nutrient density: sugar-sweetened soda or low-fat milk?
2. **Why** are foods fortified?
3. **Why** is it better to meet your vitamin C needs by eating an orange than by taking a dietary supplement?
4. **What** factors determine what you will eat for lunch?

1.2 Nutrients and Their Functions

LEARNING OBJECTIVES

1. **List** the six classes of nutrients.
2. **Discuss** the three functions of nutrients in the body.

There are six classes of nutrients: carbohydrates, lipids, proteins, water, vitamins, and minerals. Carbohydrates, lipids, proteins, and water are considered **macronutrients** because they are needed in large amounts. Vitamins and minerals are referred to as **micronutrients** because they are needed in small amounts. Together, the macronutrients and micronutrients in our diet provide us with energy, contribute to the structure of our bodies, and regulate the biological processes that go on inside us. Each nutrient provides one or more of these functions, but all nutrients together are needed to provide for growth, maintain and repair the body, and support reproduction.

The Six Classes of Nutrients

Carbohydrates, lipids (commonly called fats), and proteins are all **organic compounds** that provide energy to the body. Although we tend to think of each of them as a single nutrient, there are actually many different types of molecules in each of these classes. **Carbohydrates** include starches, sugars, and **fiber** (**Figure 1.5a**). Several types of **lipids** play important roles in our diet and in our health (**Figure 1.5b**). The most recognizable of these are **cholesterol**, **saturated fats**, and **unsaturated fats**. There are thousands of different **proteins** in our bodies and our diets. All proteins are made up of units

organic compound A substance that contains carbon bonded to hydrogen.

carbohydrates A class of nutrients that includes sugars, starches, and fibers. Chemically, they all contain carbon, along with hydrogen and oxygen, in the same proportions as in water (H_2O).

fiber A type of carbohydrate that cannot be broken down by human digestive enzymes.

lipids A class of nutrients, commonly called fats, that includes saturated and unsaturated fats and cholesterol; most do not dissolve in water.

cholesterol A type of lipid that is found in the diet and in the body. High blood levels increase the risk of heart disease.

saturated fat A type of lipid that is most abundant in solid animal fats and is associated with an increased risk of heart disease.

unsaturated fat A type of lipid that is most abundant in plant oils and is associated with a reduced risk of heart disease.

protein A class of nutrients that includes molecules made up of one or more intertwining chains of amino acids.

57 Short
58 Normal
59 long

called **amino acids** that are linked together in different combinations to form different proteins (**Figure 1.5c**).

Water, unlike the other classes of nutrients, is only a single substance. Water makes up about 60% of an adult's body weight. Because we can't store water, the water the body loses must constantly be replaced by water obtained from the diet.

Vitamins are organic molecules that are needed in small amounts to maintain health. There are 13 vitamins, which perform a variety of unique functions in the body, such as regulating energy metabolism, maintaining vision, protecting cell membranes, and helping blood to clot. **Minerals** are **elements** that are essential nutrients needed in small amounts to provide a variety of diverse functions in the body. For example, iron is an element needed for the transport of oxygen in the blood, calcium is an element important in keeping bones strong. We consume vitamins and minerals

FIGURE 1.5 Carbohydrates, lipids, and proteins Varying combinations of carbohydrates, lipids, and proteins provide the energy in the foods we eat.

a. Some high-carbohydrate foods, such as rice, pasta, and bread, contain mostly starch; some, such as berries, kidney beans, and broccoli, are high in fiber; and others, such as cookies, cakes, and carbonated beverages, are high in empty calories from added sugars.

Jeffrey Coolidge / Getty Images

Charles D. Winters / Science Source

b. High-fat plant foods such as vegetable oils, avocados, olives, and nuts are high in healthy unsaturated fats. High-fat animal foods such as cream, butter, meat, and whole milk are sources of cholesterol and are high in saturated fat, which increases the risk of heart disease.

Jeffrey Coolidge / Getty Images, Inc.

c. The proteins we obtain from animal foods, such as meat, fish, and eggs, better match our amino acid needs than do most individual plant proteins, such as those in grains, nuts, and beans. However, when plant sources of protein are combined, they can provide all the amino acids we need.

57 Short
58 Normal
59 long

in almost all the foods we eat. Some are natural sources: Oranges contain vitamin C, milk provides calcium, and carrots give us vitamin A. Other foods are fortified with vitamins and minerals; a serving of fortified breakfast cereal often has 100% of the recommended intake of many vitamins and minerals. Dietary supplements are another source of vitamins and minerals for some people.

What Nutrients Do

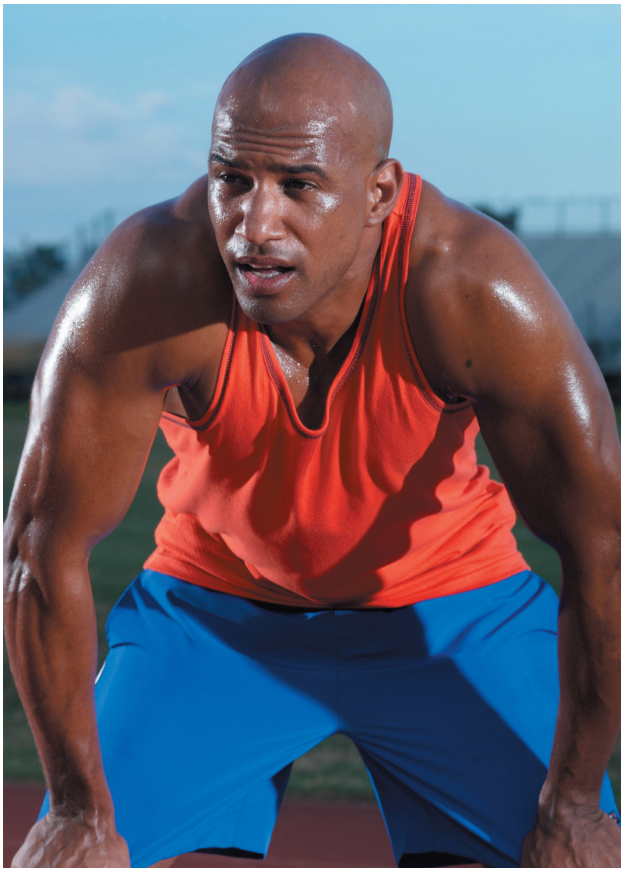
Nutrients are involved in providing energy, forming body structures, and regulating physiological processes (**Figure 1.6**). Carbohydrates, lipids, and proteins are often referred to as **energy-yielding nutrients**; they provide energy that can be measured in calories. The calories people talk about and see

NUTRITION INSIGHT

FIGURE 1.6 Nutrient functions The nutrients we consume in our diet provide energy, form body structures, and regulate body processes.

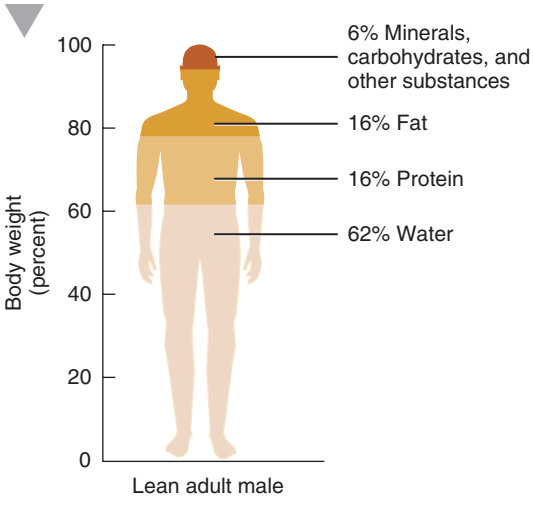
Skip Brown / National Geographic Creative

Energy Whether riding a bike through the fall foliage, walking to the mailbox, or gardening, physical activity is fueled by the carbohydrates, fat, and protein in the food we eat.

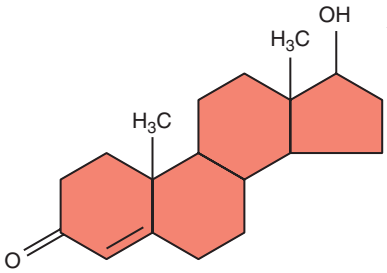


Wendy Hope / Stockbyte / Getty Images

Structure Proteins, lipids, carbohydrates, minerals, and water all contribute to the shape and structure of our bodies.



Regulation Water helps regulate body temperature. When body temperature increases, sweat is produced, cooling the body as it evaporates from the skin.



Regulation Lipids, such as the hormone testosterone, illustrated here, help regulate body processes. Testosterone is made from cholesterol. In men, it stimulates sperm production and the development of secondary sex characteristics, such as body and facial hair, a deep voice, and increased muscle mass.

(continues)

57 Short
58 Normal
59 long

FIGURE 1.6 *(continued)*

GrapeImages / E+ / Getty Images

Energy The fat stored in our bodies acts as an energy reserve for when intake is less than needs.

rattanachot kasa / 123RF

Structure Calcium, along with phosphorus and a few other minerals, form the structure of our bones.

listed on food labels are actually **kilocalories** (abbreviated kcalorie or kcal), units of 1000 calories. When spelled with a capital *C*, Calorie means kilocalorie. Carbohydrates provide 4 Calories/gram; they are the most immediate source of energy for the body. Lipids also help fuel our activities and are the major form of stored energy in the body. One gram of fat provides 9 Calories. Protein can supply 4 Calories/gram but is not the body's first choice for meeting energy needs because protein has other roles that take priority. Alcohol, though it is not a nutrient because it is not needed for life, provides about 7 Calories/gram. Water, vitamins, and minerals do not provide energy (calories).

With the exception of vitamins, all the classes of nutrients are involved in forming and maintaining the body's structure. Fat deposited under the skin contributes to our body shape, for instance, and proteins form the ligaments and tendons that hold our bones together and attach our muscles to our bones. Minerals harden bone. Proteins and water make up the structure of the muscles, which help define our body contours, and proteins and carbohydrates form the cartilage that cushions our joints. On a smaller scale, lipids, proteins, and water form the structure of individual cells. Lipids and proteins make up the membranes that surround each cell, and water and dissolved substances fill the cells and the spaces around them.

All six classes of nutrients play important roles in regulating body processes. Keeping body temperature, blood pressure, blood sugar level, and hundreds of other parameters relatively constant involves thousands of chemical reactions and physiological processes. Proteins, vitamins, and minerals are regulatory nutrients that help control how quickly chemical reactions take place throughout the body. Lipids and proteins are needed to make regulatory molecules called **hormones** that stimulate or inhibit various body processes. Water helps regulate body temperature, as well as lubricate surfaces, and transport materials throughout the body.

Figure 1.6 illustrates some of the ways various nutrients are involved in providing energy, forming body structures, and regulating physiological processes.

Concept Check

1. **Which** classes of nutrients provide energy?
2. **What** are the three overall functions that nutrients provide?

1.3 Nutrition in Health and Disease

LEARNING OBJECTIVES

1. **Describe** the causes of malnutrition.
2. **Explain** ways in which nutrient intake can affect health in both the short term and the long term.
3. **Discuss** how the genes you inherit affect the impact your diet has on your health.

57 Short
58 Normal
59 long

What we eat has an enormous impact on how healthy we are now and how likely we are to develop chronic diseases such as heart disease, obesity, and diabetes. Consuming either too much or too little of one or more nutrients or energy will result in **malnutrition**. Malnutrition includes both

malnutrition A condition resulting from an energy or nutrient intake either below (undernutrition) or above (overnutrition) that which is optimal.

FIGURE 1.7 Undernutrition Nutrient deficiencies may be mild enough to cause no obvious symptoms or severe enough to cause debilitating illness and death.

Rich Reid / National Geographic Image Collection / Alamy Stock Photo

a. Even though this child looks normal and healthy, she has low iron stores. If the iron content of her diet is not increased, she will eventually develop iron deficiency anemia. Mild nutrient deficiencies like hers may go unnoticed because the symptoms either are not immediately apparent or are nonspecific. Two common nonspecific symptoms of iron depletion are fatigue and decreased ability to fight infection.

W.E. Garrett / National Geographic Creative

b. The symptoms of starvation, the most obvious form of undernutrition, occur gradually over time when the energy provided by the diet is too low to meet the body's needs. Body tissues are broken down to provide the energy to support vital functions, resulting in loss of body fat and wasting of muscles.

undernutrition, which is due to a deficiency of energy or nutrients, and **overnutrition**, which occurs when there is an excess of energy or nutrients. Both undernutrition and overnutrition can affect your health not just today but 20, 30, or 40 years from now. The impact of your diet on your health is also affected by your genetic makeup.

Undernutrition and Overnutrition

Undernutrition occurs when intake doesn't meet the body's needs: The more severe the deficiency, the more dramatic the symptoms (**Figure 1.7**). Some nutrient deficiencies occur quickly. Dehydration, a deficiency of water, can cause symptoms in a matter of hours. Drinking water can relieve the headache, fatigue, and dizziness caused by dehydration almost as rapidly as these symptoms appeared. Other nutritional deficiencies may take much longer to become evident. Symptoms of scurvy, a disease caused by a deficiency of vitamin C, appear after months of deficient intake; **osteoporosis**, a condition in which the bones become weak and break easily, may result after years of consuming a calcium-deficient diet.

We typically think of malnutrition as undernutrition, but overnutrition, an excess intake of nutrients or calories, is also a concern. An overdose of iron can cause liver failure, for example, and too much vitamin B_6 can cause nerve damage. These nutrient toxicities usually result from taking large doses of vitamin and mineral supplements because foods generally do not contain high enough concentrations of nutrients to be toxic. However, chronic overconsumption of calories and certain nutrients from foods can also cause health problems. The typical U.S. diet, which provides more calories than are needed, has resulted in an epidemic of obesity in which more than 40% of adults have obesity (**Figure 1.8a**).[7] Diets that are high in sodium contribute to high blood pressure; an excess intake of saturated fat contributes to heart disease; and a dietary pattern that is high in red meat and saturated fat and low in fruits, vegetables, and fiber may increase the risk of certain cancers.[8] Diseases related to a poor diet are the leading causes of death in the United States, exceeding deaths related to smoking or alcohol consumption (**Figure 1.8b**).[9]

Diet–Gene Interactions

What you eat affects your health, but diet alone does not determine whether you will develop a particular disease. Each of us inherits a unique combination of **genes**. Some of these genes affect your risk of developing chronic diseases, such as heart disease, cancer, high blood pressure, and diabetes, but their impact is affected by what you eat. Your genetic makeup determines the impact a certain nutrient will have on you. For example, some people inherit a combination of genes that makes their blood pressure sensitive to sodium intake. When these individuals consume even an average amount of sodium, they may develop high blood pressure (see Chapter 8). Others inherit genes that allow them to consume more sodium without much of a rise in blood pressure. Those whose genes dictate a significant rise in blood pressure with a high-sodium diet can reduce their blood pressure, and the complications associated with high blood pressure, by eating a diet that is low in sodium.

Our increasing understanding of human genetics has given rise to the discipline of **nutritional genomics**, which explores the interaction between human genes, nutrition, and health (**Figure 1.9**).[12] It encompasses both the effects that the genes people inherit have on how their diet affects health (**nutrigenetics**) and the effects the nutrients and other food components they consume have on gene activity

genes Units of a larger molecule called DNA that are responsible for inherited traits.

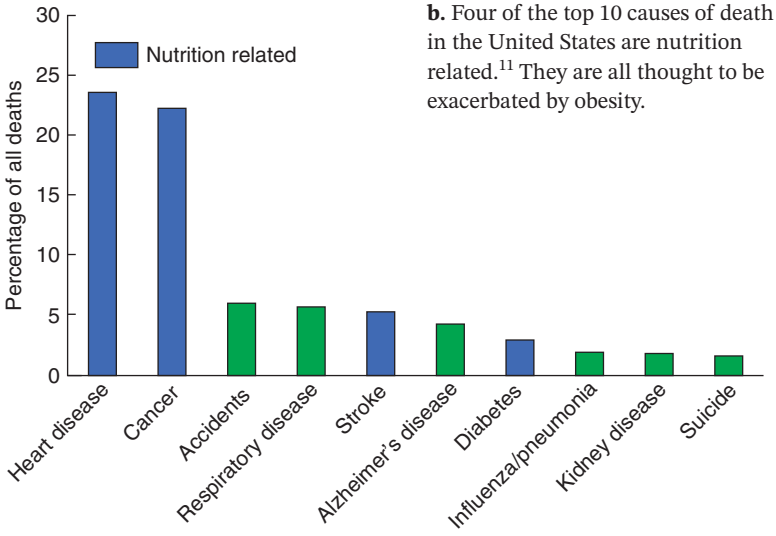
nutritional genomics The study of how our genes affect the impact of nutrients or other food components on health (nutrigenetics) and how nutrients affect the activity of our genes (nutrigenomics).

57 Short
58 Normal
59 long

FIGURE 1.8 Overnutrition Obesity is a form of overnutrition that increases the risk of a variety of other nutrition-related chronic diseases that contribute to death.

Karan Kapoor / Getty Images

a. Obesity occurs when energy intake surpasses energy expenditure over a long period, causing the accumulation of an excessive amount of body fat. Adults are not the only ones whose weight is affecting their health; 18.5% of U.S. children and adolescents, ages 2 to 19 years, are obese.[10]



b. Four of the top 10 causes of death in the United States are nutrition related.[11] They are all thought to be exacerbated by obesity.

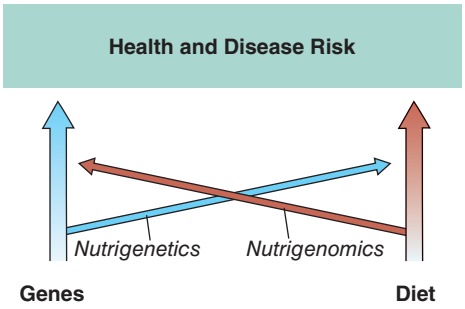
Interpret the Data

Based on this graph showing the leading causes of death in the United States, about what percentage of all deaths are due to nutrition-related diseases?

a. 5% **c. 50%**

b. 10% **d. 90%**

FIGURE 1.9 Nutritional genomics Both the genes you inherit and your dietary choices directly affect your health and disease risk. There is also interplay between these factors such that your genes, through nutrigenetics, influence how your diet affects your health, and your diet, through nutrigenomics, affects how your genes impact your health.



zhijian Huang / iStockphoto

The genes you inherit affect your tendency to develop nutrition-related chronic diseases such as heart disease and diabetes.

Tom Grill / Corbis / Getty Images

The diet you consume affects your risk of developing nutrition-related chronic diseases.

Think Critically

Can you become obese even if both of your parents are thin?

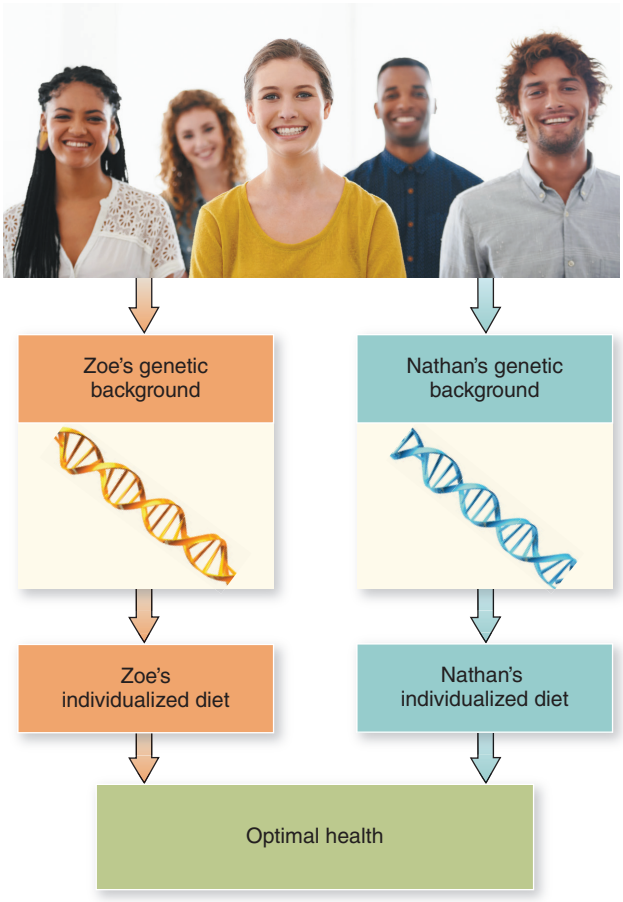
57 Short
58 Normal
59 long

Debate

Do DNA-Based Diets Improve Health Outcomes?

The risk of developing chronic diseases such as diabetes and heart disease is affected by the genes we inherit and the lifestyle we lead. If a genetic analysis could identify your risk and the best diet to reduce that risk, would you be willing to change your diet?

Current nutrition recommendations are designed for the majority of healthy people but are not optimum for everyone. Nutritional genomics suggests that we can reduce our disease risk by tailoring our diet to our individual genetic makeup (see figure).[13,14] Although millions of people send samples to DNA-testing companies every year,[15] currently only a few of these companies provide customers with a personalized diet based on their genes.[16,17] Can these "DNA-based diets" deliver accurate recommendations?



PeopleImages / E+ / Getty Images

The genetics of nutrition-related diseases are complicated, and some argue that it will be years before the science catches up with the promises of genetic testing. This is exemplified by a study that looked at whether variations in three genes that affect carbohydrate and fat metabolism could predict whether subjects would lose more weight on a low-fat or low-carbohydrate diet. The study found no difference in weight loss based on diet or genetic variation.[18] Although this study examined only three genes among the dozens of genes and gene interactions that play a role in weight loss, it suggests that we do not yet have the knowledge to prescribe an optimal personalized weight-loss diet based on our genes.

We may not yet have the technology to provide complete DNA-based nutrition prescriptions, but someday we probably will. Will this approach improve individual or public health?[14] In many cases, DNA-based advice is no different from general recommendations. For example, if your DNA increases your risk of developing heart disease, you could decrease your risk by limiting saturated fat and increasing fiber intake. But even if you don't have this genetic variant, healthy diet recommendations tell us to reduce our saturated fat and increase our fiber intake.

Those who advocate personalized diets point out that people often do not follow general dietary guidance and may be more likely to stick to individualized recommendations. One study found that personalized nutrition advice resulted in greater dietary improvements than general recommendations,[19] but not all studies support this finding. A meta-analysis (a study that combines the results of many studies) examining whether awareness of one's genetic risk influenced diet or other risk-reducing behaviors found that it had no effect.[20] For example, telling people that they had an increased genetic risk for diabetes did not motivate them to improve their diet or increase their activity. Perhaps the priority for public health dollars should not be to fine-tune diet prescriptions but rather to find out what will motivate people to change their diets and live healthier lives.

In the future, we may be filling our plates based on our genes. This could mean planning an individual plate for each person at the table. Will eating these personalized diets make us healthier than following general nutrition recommendations? Will personalized diets limit the pleasure we get from food and change the cultural and social roles that food plays in our lives?

Think Critically

If genetic testing determines that you are unlikely to become obese, does this mean that you can eat as much as you want without worrying about weight gain? Why or why not?

(**nutrigenomics**). Research in these areas has led to the development of the concept of "personalized nutrition." The goal of personalized nutrition is to prescribe a diet based on the genes an individual has inherited in order to prevent, moderate, or cure chronic disease. We know that certain dietary patterns can reduce the risk of many chronic diseases, but it is not clear whether personalized diets based on genetic analysis have the potential to improve individual or public health (see *Debate: Do DNA-Based Diets Improve Health Outcomes?*).

Concept Check

1. **What** causes malnutrition?
2. **How** can your diet today affect your health 20 years from now?
3. **Why** might the diet that optimizes health be different for different people?

57 Short
58 Normal
59 long

1.4 Choosing a Healthy Diet

LEARNING OBJECTIVES

1. **List** three reasons it is important to eat a variety of foods.
2. **Explain** why you can sometimes eat foods that are low in nutrient density and still have a healthy diet.
3. **Discuss** how dietary moderation can reduce the risk of chronic disease.

A healthy diet is one that provides the right number of calories to keep your weight in the desirable range; the proper balance of carbohydrates, proteins, and fat; plenty of water; and sufficient but not excessive amounts of vitamins and minerals. This healthy diet is rich in whole grains, fruits, and vegetables; high in fiber; and low in added sugars, sodium, and unhealthy fats. In short, a healthy diet is based on variety, balance, and moderation (see *What Should I Eat*?).

Eat a Variety of Foods

In nutrition, choosing a variety of foods is important because no single food can provide all the nutrients the body needs for optimal health. *Variety* means choosing foods from different food groups—vegetables, grains, fruits, dairy products, and high-protein foods. Some of these foods are rich in vitamins and phytochemicals, others are rich in protein and minerals, and all are important.

Variety also means choosing diverse foods from within each food group. Different vegetables provide different nutrients. Potatoes, for example, are the only vegetable in many Americans' diets. Potatoes provide vitamin C but are low in vitamin A. If potatoes are your only vegetable, it is unlikely that you will meet your nutrient needs. If instead you have a salad, potatoes, and broccoli, you will be getting plenty of vitamins C and A, as well as many other vitamins and minerals. Choosing from all the food groups and making varied choices from within each food group is also important because nutrients and other food components interact. Such interactions may be positive, enhancing nutrient utilization, or negative, inhibiting nutrient availability. Variety averages out these interactions. Some foods may also contain toxic substances. Eating a variety of foods reduces the risk that you will consume enough of any one toxin to be harmful. For example, tuna may contain traces of mercury, but as long as you don't eat tuna too often, you are unlikely to consume a toxic amount.

Variety involves choosing different foods not only each day but also each week and throughout the year. If you had apples and grapes today, for example, have blueberries and cantaloupe tomorrow. If you can't find tasty tomatoes in December, replace them with a winter vegetable such as squash.

Balance Your Choices

Choosing a healthy diet is a balancing act. Healthy eating doesn't mean giving up your favorite foods. There is no such thing as a good food or a bad food—only healthy diets and unhealthy diets. Any food can be part of a healthy dietary pattern, as long as your intake throughout the day or week provides enough of all the nutrients you need without excesses of any. When you choose a food that is low in nutrient density, balance it with one that is high in nutrient density. For example, when you choose chips for a snack, choose fruit for dessert.

A balanced diet also balances the calories you take in with the calories you burn in your daily activities so that your body weight stays in the healthy range (**Figure 1.10**).

What Should I Eat?

Variety, Balance, and Moderation

Eat a variety of foods

- Mix up your snacks. For example, have salsa and chips one day and fruit, yogurt, or nuts another day.
- Add almonds and diced apples to your salad.
- Try a new vegetable or fruit each week. Tired of carrots? Try jicama.
- Vary your protein sources. Eat fish one day and beef the next—or skip the meat and have beans.

Balance choices to assure nutrient density

- Going out to dinner? Have a salad for lunch.
- If you eat some extra fries, take some extra steps.
- When you have cookies for a snack, have fruit for dessert.
- If you had salty chips with lunch, snack on carrots before dinner.

Choose moderate amounts

- Push back from the table before you are stuffed and go for a walk.
- Reduce your portions by using a smaller bowl.
- Next time you go out for ice cream, get one scoop instead of two.
- Split your restaurant meal with a friend.

Use iProfile to calculate the calories in your favorite fast-food meal.

57 Short
58 Normal
59 long

FIGURE 1.10 Balance calories in with calories out To keep your weight stable, you need to burn the same number of calories as you consume. Consuming extra calories during the day can be balanced by increasing the calories you burn in physical activity. You may be surprised how much activity is needed to burn off extra calories.

If you grab 4 potato chips and pop them in your mouth, you will need to burn about 30 extra Calories to maintain your weight.

John Ambrose

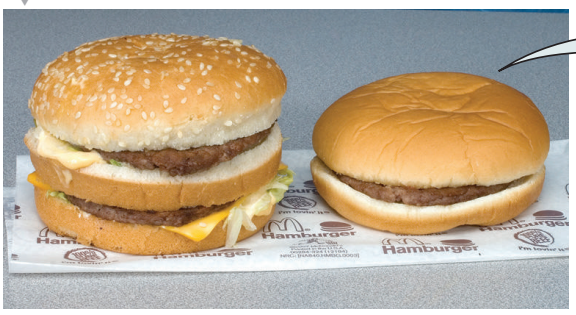
You can do this by doing jumping jacks for 3 minutes.

Mirage_studio / Shutterstock

You could do this by playing golf for about an hour, carrying your own clubs.

Andy Washnik

Choosing a Big Mac over a smaller burger means you will need to increase your energy expenditure by 300 Calories to maintain your weight.



Andy Washnik

Andy Washnik

Choosing a grande Mocha Frappuccino over a regular iced coffee means you will need to increase your energy expenditure by 350 Calories to maintain your weight.

Kate Thompson / National Geographic Creative

You could do this by jogging for about 30 minutes.

Ask Yourself

If you add a daily grande Mocha Frappuccino to your usual diet, how many minutes of jumping jacks would you need to do to burn off the extra calories?

Practice Moderation

Moderation means not overdoing it—not having too many calories, too much saturated fat, too much sugar, too much salt, or too much alcohol. Choosing moderate amounts will help you maintain a healthy weight and prevent some of the chronic diseases, such as heart disease and cancer, that are on the rise in the U.S. population.

The fact that Americans are gaining weight suggests that we have not been practicing moderation when it comes to calorie intake.[21] Larger food portions are one factor contributing to our increasing intake. The sandwiches, soft drinks, and

57 Short
58 Normal
59 long

Thinking It Through

A Case Study on Choosing a Healthy Diet

For many college students, their freshman year is the first time they are making all their own food choices, and they don't always make the best ones. Learning to apply the principles of variety, balance, and moderation can help improve these choices.

Maya doesn't really know how to choose a healthy diet, so she picks what is familiar, inexpensive, and saves her time. Every day for breakfast she eats the same cereal, a glass of apple juice, and coffee.

Suggest ways that Maya could increase the variety in her breakfast while still keeping her food choices inexpensive and quick.

Your answer:

For lunch Maya has fast food—usually a burger and fries. She knows this is not the most nutrient-dense choice, but she is always in a hurry, rushing between school and work. The drive-thru often seems like the best option.

Suggest some fast and easy lunch choices that would be more nutrient dense than Maya's current lunch choice.

Your answer:

Suggest some snacks that would add variety and help to balance Maya's repetitious breakfast and lunch.

Your answer:

Maya has gained a few pounds and is worried that she will become a victim of the "freshman 15"—the 15 or so pounds frequently gained by college students during the first year away from home. She thinks her weight gain is due to the dinner that she eats in the college dining hall. Her evening meal plan is "all-you-can-eat," so she piles food on her plate and always takes a dessert to get the most for her money.

Suggest two changes that Maya could make to moderate her dinner choices.

Your answer:

It is Mexican night at the dining hall. Maya knows that beans are a healthy choice, so she takes two beef and bean burritos as shown in the photo.

Joshua Resnick / 123 RF

How does Maya's Mexican dinner stack up in terms of variety, balance, and moderation?

Your answer:

Check your answers in Appendix L.

French fry orders served in fast-food restaurants today are two to five times larger than what they were 50 years ago. The sizes of the snacks and meals we eat at home have also increased. As these portion sizes have grown, so has the amount we eat—and so has our weight.[22] Moderation makes it easier to balance your diet and allows you to enjoy a greater variety of foods (see *Thinking It Through*).

Concept Check

1. **Why** is variety in a diet important?
2. **What** could you have for lunch to balance a breakfast that doesn't include any fruits or vegetables?
3. **Why** does moderation allow more variety in your diet?

1.5 Evaluating Nutrition Information

LEARNING OBJECTIVES

1. **List** the steps of the scientific method and give an example of how it is used in nutrition.
2. **Discuss** three different types of experiments used to study nutrition.
3. **Describe** the components of a sound scientific experiment.
4. **Distinguish** between reliable and unreliable nutrition information.

57 Short
58 Normal
59 long

We are bombarded with nutrition information almost every day. The evening news, the morning papers, and the World Wide Web continually offer us tantalizing tidbits of nutrition advice. Food and nutrition information that used to take professionals years to disseminate now travels with lightning speed, reaching millions of people within hours or days. Much of this information is reliable, but some can be misleading. In order to choose a healthy diet, we need to be able to sort out the useful material in this flood of information.

The Science Behind Nutrition

Like all other sciences, the science of nutrition is constantly evolving. As new discoveries provide clues to the right combination of nutrients needed for optimal health, new nutritional principles and recommendations are developed. Sometimes established beliefs and concepts give way to new information. Understanding the process of science can help consumers understand the nutrition information they encounter.

The systematic, unbiased approach that allows any science to acquire new knowledge and continuously revise and update our understanding based on new information is the **scientific method**. The scientific method involves making observations of natural events, formulating **hypotheses** to explain these events, designing and performing experiments to test these hypotheses, and developing **theories** that explain the observed phenomenon based on the results of many studies (**Figure 1.11**). In nutrition, the scientific method is used to develop nutrient recommendations, understand the functions of nutrients, and learn about the role of nutrition in promoting health and preventing disease.

How Scientists Study Nutrition

Many different types of studies are used to expand our knowledge of nutrition. Some make observations about relationships between diet and health; these are based on the science of **epidemiology**. Other types of studies evaluate the effect of a particular dietary change on health. Some of these use human subjects, others use animals; some look at whole populations, others study just a few individuals; and some use just cells or molecules (**Figure 1.12**).

A sound nutrition experiment examines the right experimental population, collects quantifiable data, includes proper

PROCESS DIAGRAM

FIGURE 1.11 The scientific method The scientific method is a process used to ask and answer scientific questions through observation and experimentation.

1 The first step of the scientific method is to make an observation and ask questions about that observation.

Observation
More people get colon cancer in the United States than in Japan.

2 The next step is to propose an explanation for this observation. This proposed explanation is called a hypothesis.

Hypothesis
The lower incidence of colon cancer in Japan than in the United States is due to differences in the diet.

3 Once a hypothesis has been proposed, experiments like this one are designed to test it. To generate reliable theories, the experiments done to test hypotheses must produce consistent, quantifiable results and must be interpreted accurately.

Experiment
Compare the incidence of colon cancer of Japanese people who move to the United States and consume a typical U.S. diet with the American population as a whole. **Result:** The Japanese people who eat the U.S. diet have the same higher incidence of colon cancer as the general population.

4 If the results from repeated experiments support the hypothesis, a scientific theory can be developed. A single experiment is not enough to develop a theory; rather, repeated experiments showing the same conclusion are needed to develop a sound theory.

Courtesy Lori Smolin

5 If experimental results do not support the hypothesis, a new hypothesis can be formulated.

Theory
The U.S. diet contributes to the development of colon cancer.

6 As new information becomes available, even a theory that has been accepted by the scientific community for years can be proved wrong.

Think Critically

A scientist has hypothesized that the difference in the incidence of colon cancer in Japan and the United States is due to differences in the genetic makeup of the populations. Based on the results of the experiment described in this illustration, explain why this hypothesis is not supported.

hypothesis A proposed explanation for an observation or a scientific problem that can be tested through experimentation.

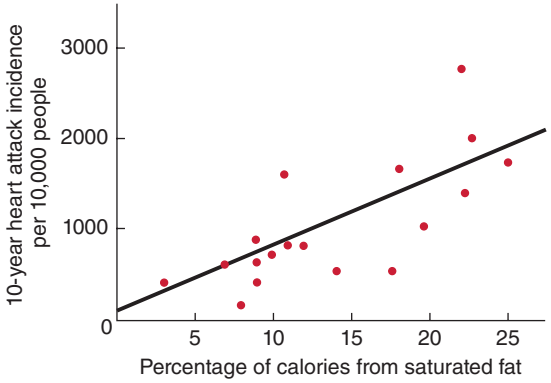
theory A formal explanation of an observed phenomenon made after a hypothesis has been tested and supported through extensive experimentation.

epidemiology The branch of science that studies health and disease trends and patterns in populations.

57 Short
58 Normal
59 long

NUTRITION INSIGHT

FIGURE 1.12 Types of nutrition studies Scientists use a variety of methods to expand our understanding of nutrition.



a. Epidemiological studies Comparing saturated fat intake to the incidence of heart attacks in different populations indicates that diets with a high percentage of calories from saturated fat are associated with an increased incidence of heart attacks.

Think Critically

Does this graph indicate that a high intake of saturated fat causes heart attacks? Explain your answer.

Epidemiology does not determine cause-and-effect relationships; it just identifies patterns, which can be used to generate hypotheses. Many kinds of experiments can be used to test hypotheses generated through epidemiology.

Dmytro / 123 RF

b. Clinical trials In nutrition, studies called clinical trials explore the health effects of altering people's diets—for instance, the possible effects of reducing saturated fat intake on blood cholesterol levels.

Greg Dale / National Geographic Creative

c. Biochemistry and molecular biology Biochemistry can be used to study the chemical reactions that provide energy or synthesize molecules, such as cholesterol, and molecular biology can be used to study how nutrients interact with our genes.

kickers / Getty Images

d. Animal studies Because studying humans is costly, time-consuming, inconvenient for the subjects, and in some cases impossible for ethical reasons, many studies are done using animals. Guinea pigs provide a good model for studying heart disease. However, even the best animal model is not the same as a human, and care must be taken when extrapolating animal results to humans.

57 Short
58 Normal
59 long

experimental controls, and interprets the data accurately. The experimental population must be chosen to answer a specific question. For example, if a dietary supplement claims to increase bone strength in older women, a study to test this should use older women as subjects. For an experiment to determine whether a treatment does or does not have an effect, it must include enough subjects to demonstrate that the treatment causes the effect to occur more frequently than it would by chance. The number of subjects needed depends on how likely an effect is to occur without the treatment. For example, if weight training without a muscle-building supplement causes an increase in muscle mass, a large number of experimental subjects may be needed to demonstrate that there is a greater increase in muscle mass with the treatment—in this case, the muscle-building supplement. Results from studies with only a few subjects may not be able to distinguish effects that occur due to chance and should therefore be interpreted with caution.

Data collected in experiments must be quantifiable—that is, data must include parameters that can be measured reliably and repeatedly, such as body weight or blood pressure. Individual testimonies or opinions alone are not quantifiable, objective measures.

In order to know whether what is being tested has an effect, one must compare it with something. A **control group** acts as a standard of comparison for the factor, or **variable**, being studied. A control group is treated in the same way as the **experimental group** except that the control group does not receive the treatment being tested. For example, in a study examining the effect of a dietary supplement on weight loss, the control group would consist of individuals of similar age, gender, height, weight, and body composition, eating similar diets and following similar activity patterns as individuals in the experimental group. While the experimental group would consume the supplement, the control subjects would consume a **placebo**, a harmless, inactive substance that is identical in appearance to the dietary supplement.

When an experiment has been completed, the results must be interpreted. Accurately interpreting results is just as important as conducting a study carefully. If a study conducted on a large group of young women indicates that a change in diet reduces breast cancer risk later in life, the results of that study cannot be used to claim that the same effect will occur if older women make a similar dietary change. Likewise, if the study looks only at the connection between a change in diet and breast cancer, the findings can't be used to claim a reduced risk for other cancers.

One way to ensure that the results of experiments are interpreted correctly is to have them reviewed by experts in the field who did not take part in the study being evaluated. Such a **peer-review process** is used in determining whether experimental results should be published in scientific journals. The reviewing scientists must agree that the experiments were conducted properly and that the results were interpreted appropriately. Nutrition articles that have undergone peer review can be found in many journals, including *The American Journal of Clinical Nutrition*, *The Journal of Nutrition*, *The Journal of the Academy of Nutrition and Dietetics*, *The New England Journal of Medicine*, and *The International Journal of Sport Nutrition*. Newsletters from reputable institutions, such as the *Tufts Health and Nutrition Letter*, the *Harvard Health Letter*, and *Nutrition Action Healthletter* are also reliable sources of nutrition and health information. The information in these newsletters comes from peer-reviewed articles but is written for a consumer audience.

Recommendations and policies regarding nutrition and healthcare practices are made by compiling the evidence from the wealth of well-controlled, peer-reviewed studies that are available. This is referred to as **evidence-based practice**.

Judging for Yourself

Not everything you hear is accurate. Because much of the nutrition information we encounter is intended to sell products, that information may be embellished to make it more appealing. Understanding the principles scientists use to perform nutrition studies can help consumers judge the nutrition information they encounter in their daily lives (see *What a Scientist Sees: Behind the Claims*). Some things that may tip you off to misinformation are claims that sound too good to be true, information from unreliable sources, information intended to sell a product, and information that is new or untested. The following questions can help you evaluate the validity of any nutrition information you encounter.

Does it make sense? Some claims are too outrageous to be true. For example, if a product claims to increase your muscle size without any exercise or decrease your weight without a change in diet, common sense should tell you that the claim is too good to be true. In contrast, an article that tells you that adding exercise to your daily routine will help you lose weight and increase your stamina is not so outrageous.

What's the source? If a claim seems reasonable, find out where it came from. Personal testimonies are not a reliable source of information. These individual success stories are not subjected to scientific evaluation, and therefore it cannot be assumed that similar results will occur in other people. Claims based on well-controlled research studies can provide reliable, reproducible results as long as the data is interpreted correctly.

Government recommendations regarding healthy dietary practices and information disseminated by universities generally are reliable information sources. Government recommendations are developed by committees of scientists who interpret the latest well-conducted research studies and use their conclusions to develop recommendations for the population as a whole. The information is designed to improve the health of the population. Information that comes from universities is supported by research studies that are well scrutinized and published in peer-reviewed journals. Many universities also provide information that targets the general public. Not-for-profit organizations such as the Academy of Nutrition and Dietetics and the American Medical Association are also reliable sources of nutrition information.

control group In a scientific experiment, the group of participants used as a basis of comparison. They are similar to the participants in the experimental group but do not receive the treatment being tested.

experimental group In a scientific experiment, the group of participants who undergo the treatment being tested.

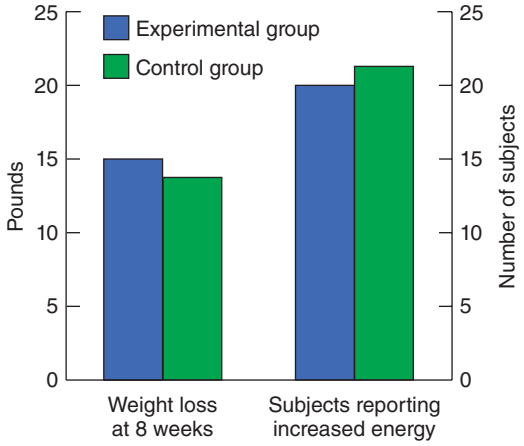
57 Short
58 Normal
59 long

What a Scientist Sees

Behind the Claims

Consumers who want to slim down may think this product looks amazing. It will allow them to lose weight and to increase their energy level! However, a scientist looking at the same ad may have some concerns. First of all, the testimonial about weight loss is based on Janet's experience, and not everyone will have the same weight-loss result. And, although she claims to have more energy than ever, Janet is basing this statement on her feelings and not objective measures.

A scientist would want to carefully examine the research study to see if the data supports the claim that the product promotes weight loss. A review of the full study shows that it involved 50 overweight subjects. Half of them consumed a reduced-calorie diet along with one SlimEazzy tablet per day. The other half ate the same reduced-calorie diet but took a placebo instead of SlimEazzy. Body weight was measured at the beginning of the study and after 8 weeks of the diet. As seen in the graph, both the control and experimental groups lost weight. The amount lost in the experimental group is slightly greater, but statistical analysis found that the difference was insignificant. The implication that taking the supplement helped subjects to lose 15 pounds is misleading because those taking the placebo lost a similar amount of weight. The ad also claims that the supplement energizes you but does not tell you that a comparable energizing effect occurred in those not taking the supplement; when interviewed, 20 of 25 subjects in the experimental group said they felt energized, and 21 subjects in the control groups said they felt energized (see graph).



Think Critically

Do you think the claims made in the ad are supported by the information in the graph? Explain why you would or would not recommend this product.

57 Short
58 Normal
59 long

If you are looking at an article in print or posted on a Web site, checking the author's credentials can help you evaluate the credibility of the information. Where does the author work? Does this person have a degree in nutrition or medicine? Although "nutritionists" and "health coaches" may provide accurate information, these terms are not legally defined and can be used by individuals with no formal nutrition or medical training.

One reliable source of nutrition information is a registered dietitian (RD), also called a registered dietitian nutritionist (RDN). RD/RDNs are nutrition professionals who are certified to provide nutrition education and counseling. To obtain certification, an RD/RDN must earn a four-year college degree that includes coursework approved by the Academy of Nutrition and Dietetics, complete a supervised internship, and pass a national exam.

Is it selling something? If a person or company will profit from the information presented, be wary. Advertisements are designed to increase product sales, and the company stands to profit if you believe the claims that are made. Information presented online, in newspapers and magazines, and on television may also be biased or exaggerated because it is designed to help boost sales, not necessarily to promote health and well-being. Even a well-designed, carefully executed study published in a peer-reviewed journal can be a source of misinformation if its results have been interpreted incorrectly or exaggerated (**Figure 1.13**).

Has it stood the test of time? Often the results of new scientific studies are on the news the same day they are presented at a meeting or published in a peer-reviewed journal. However, a single study cannot serve as a basis for a reliable theory. Results need to be reproduced and supported numerous times before they can be used as a foundation for nutrition recommendations.

Headlines based on a single study should therefore be viewed skeptically. The information may be accurate, but there is no way to know because there has not been enough time to repeat the work and reaffirm the conclusions. If, for example, someone has found the secret to easy weight loss, you will undoubtedly encounter this information again at some later time if the finding is valid. If the finding is not valid, it will fade away with all the other weight-loss concoctions that have come and gone.

FIGURE 1.13 Results may be misinterpreted in order to sell products These rats, which were given large doses of vitamin E, lived longer than rats that consumed less vitamin E. Does this mean that dietary supplements of vitamin E will increase longevity in people? Not necessarily. The results of animal studies can't always be extrapolated to humans, but they are often the basis of claims in ads for dietary supplements.

Joel Sartore / National Geographic Image Collection

Concept Check

1. **What** is the difference between a hypothesis and a theory?
2. **How** is an epidemiologic study different from a clinical trial?
3. **Why** are control groups important in any scientific experiment?
4. **Why** are personal testimonies not a source of reliable nutrition information?

What Is Happening in This Picture?

This modest display of fruits and vegetables is typical of what is available in an inner city corner store. These stores usually also offer an abundance of candy, chips, beverages, and other snack foods along with a small selection of staples such as eggs, milk, pasta, bread, and canned goods. For some people, this is their only shopping option close to home.

Think Critically

1. If your fruit and vegetable intake was limited to those in the photo, how would it affect the variety, balance, and moderation in your diet?
2. Suggest two reasons why this store offers so few options for fresh produce.
3. Propose a community initiative that would help increase the availability of fruits and vegetables in an urban setting.

John Ambrose

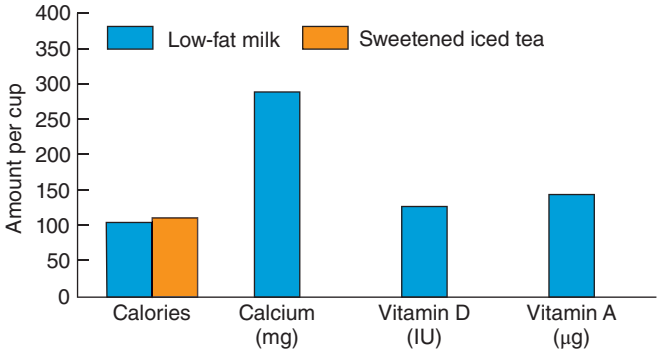
57 Short
58 Normal
59 long

Summary

1 Food Choices and Nutrient Intake 2

- The foods you choose determine which **nutrients** you consume. Choosing foods that are high in **nutrient density** allows you to obtain more nutrients in fewer calories, as shown in this graph. Fortified foods, or foods to which nutrients have been added, and **dietary supplements** can also contribute nutrients to the diet.

Figure 1.1a Nutrient density



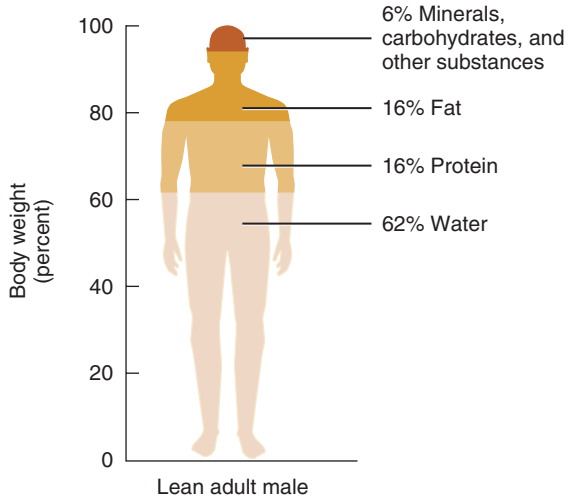
- Food contains not only nutrients but also nonnutritive substances, such as **phytochemicals**, that may provide additional health benefits. Foods that provide health benefits beyond basic nutrition are called **functional foods**. Some foods are naturally functional, and others are made functional through **fortification**.
- The food choices we make are affected not just by personal taste but by our **food environment**, which includes the environmental, sociocultural, and economic factors that affect our eating habits and patterns. What foods are available in our community, what foods are advertised, how much food costs, and what we learn to eat from family, culture, and traditions are all part of our food environment.

2 Nutrients and Their Functions 6

- Nutrients are grouped into six classes. **Carbohydrates**, **lipids**, **proteins**, and water are referred to as **macronutrients** because they are needed in large amounts. **Vitamins** and **minerals** are **micronutrients** because they are needed in small amounts to maintain health.
- Carbohydrates, lipids, and proteins are nutrients that provide energy, typically measured in **calories**. Lipids, proteins, carbohydrates, minerals, and water perform structural roles, as shown in the following illustration, forming and maintaining the structure of our bodies. All six classes of nutrients help regulate body processes. The energy, structure, and regulation provided by nutrients are needed for growth, maintenance and repair of the body, and reproduction.

57 Short
58 Normal
59 long

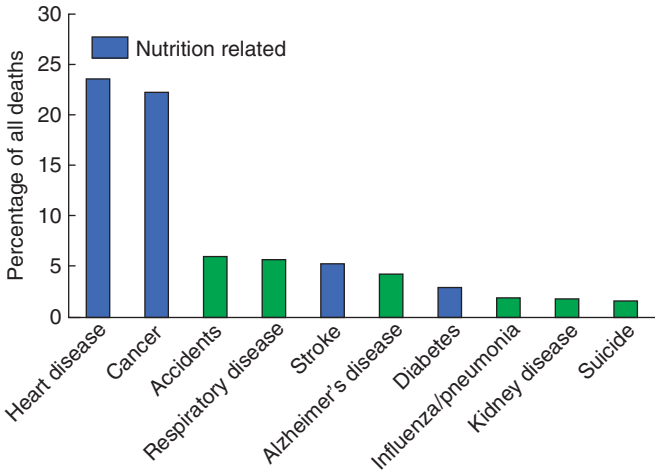
Figure 1.6b Nutrient functions



3 Nutrition in Health and Disease 9

- Your diet affects your health. The foods you choose contain the nutrients needed to keep you alive and healthy and prevent **malnutrition**, which includes both **undernutrition** and **overnutrition**. Undernutrition results from consuming too few calories and/or too few nutrients. Overnutrition can result from a toxic dose of a nutrient or from a chronic excess of nutrients or calories, which over time contributes to chronic diseases, such as those shown in this graph.

Figure 1.8b Overnutrition



- Your genetic makeup and the diet you consume interact to affect your health risks. **Nutritional genomics** studies how the genes you inherit affect the impact of diet on health and how the diet you choose affects the activity of your genes.

4 Choosing a Healthy Diet 13

- A healthy diet includes a variety of nutrient-dense foods from the different food groups as well as a variety of foods from

within each group. Variety is important to ensure that nutrient needs are met because different foods provide different nutrients and health-promoting substances as well as a variety of tastes.

- Balance means mixing and matching foods and meals in order to obtain enough of the nutrients you need and not too much of the ones that can potentially harm your health. Extra calories you consume during the day can be balanced by increasing the calories you burn in physical activity, as shown.

Figure 1.10 Balance calories in with calories out

John Ambrose

Mirage_studio / Shutterstock.com

- Moderation means not ingesting too many calories or too much saturated fat, sugar, salt, or alcohol. Eating moderate portions helps you maintain a healthy weight and helps prevent chronic diseases such as heart disease, diabetes, and cancer.

5 Evaluating Nutrition Information 15

- Nutrition uses the **scientific method** to study the relationships among food, nutrients, and health. The scientific method, illustrated below, involves observing and questioning natural events, formulating **hypotheses** to explain these events, designing and performing experiments to test the hypotheses, and developing **theories** that explain the observed phenomena based on the experimental results.
- To be valid, a nutrition experiment must provide quantifiable measurements, study the right type and number of subjects, and use appropriate **control groups**. When a study has been completed, the results must be interpreted fairly and accurately. The **peer-review process** ensures that studies published in professional journals adhere to a high standard of experimental design and interpretation of results.
- Not all the nutrition information we encounter is accurate. The first step in deciding whether a nutritional claim is valid is to ask whether the claim makes sense. If it sounds too good to be true, it probably is. It is also important to determine whether the information came from a reliable source, whether it is trying to sell a product, and whether it has been confirmed by multiple studies.

Figure 1.11 The scientific method

1 The first step of the scientific method is to make an observation and ask questions about that observation.

Observation
More people get colon cancer in the United States than in Japan.

2 The next step is to propose an explanation for this observation. This proposed explanation is called a hypothesis.

Hypothesis
The lower incidence of colon cancer in Japan than in the United States is due to differences in the diet.

3 Once a hypothesis has been proposed, experiments like this one are designed to test it. To generate reliable theories, the experiments done to test hypotheses must produce consistent, quantifiable results and must be interpreted accurately.

Experiment
Compare the incidence of colon cancer of Japanese people who move to the United States and consume a typical U.S. diet with the American population as a whole. **Result:** The Japanese people who eat the U.S. diet have the same higher incidence of colon cancer as the general population.

4 If the results from repeated experiments support the hypothesis, a scientific theory can be developed. A single experiment is not enough to develop a theory; rather, repeated experiments showing the same conclusion are needed to develop a sound theory.

Courtesy Lori Smolin

5 If experimental results do not support the hypothesis, a new hypothesis can be formulated.

Theory
The U.S. diet contributes to the development of colon cancer.

6 As new information becomes available, even a theory that has been accepted by the scientific community for years can be proved wrong.

57 Short
58 Normal
59 long

Key Terms

- amino acid 7
- calorie 2
- carbohydrates 6
- cholesterol 6
- control group 18
- dietary supplement 3
- element 7
- energy-yielding nutrient 8
- epidemiology 16
- essential nutrient 2
- evidence-based practice 18
- experimental group 18
- fiber 6
- food desert 6
- food environment 5
- fortification 3
- functional food 4
- genes 10
- hormone 9
- hypothesis 16
- kilocalorie 9
- lipids 6
- macronutrient 6
- malnutrition 9
- micronutrient 6
- mineral 7
- nutrient density 2
- nutrients 2
- nutrigenetics 10
- nutrigenomics 12
- nutritional genomics 10
- organic compound 6
- osteoporosis 10
- overnutrition 10
- peer-review process 18
- phytochemical 4
- placebo 18
- protein 6
- saturated fat 6
- scientific method 16
- theory 16
- undernutrition 10
- unsaturated fat 6
- variable 18
- vitamin 7
- zoochemical 4

CHAPTER 2

REX A. STUCKY / National Geographic Image Collection

Guidelines for a Healthy Diet

"What you don't know could kill you" may have been the first nutrition recommendation. To swallow the wrong berry or gulp down water from a suspect source could have been fatal to early humans. Such lessons served as anecdotal guideposts to survival. As societies developed, dietary cautions turned into taboos, sometimes laws, and, ultimately, nutrition recommendations.

Governments have been providing what we would call modern nutrition information for the past 150 years. As the Industrial Revolution swept through Great Britain, urban populations—and poverty and hunger—swelled. To ensure a healthy workforce, the British government developed minimum dietary guidelines utilizing the cheapest foods. It wasn't until World War I that the British Royal Society determined that a healthy workforce required a healthy diet—not necessarily the cheapest. So fruits, vegetables, and milk became elements of nutritional guidance. Since then, virtually every nation has sought to establish dietary standards for its citizens.

Today, modern public health agencies provide valuable information regarding healthy food choices. However, this information isn't always understood or used properly. As portion sizes grow, so do waistlines—and the attendant health concerns. "What you don't know could kill you" remains as vital an admonition today as it was 40,000 years ago.

CHAPTER OUTLINE

57 Short
58 Normal
59 long

2.1 Nutrition Recommendations

LEARNING OBJECTIVES

1. **Explain** the purpose of government nutrition recommendations.
2. **Discuss** how the focus of U.S. nutrition recommendations has changed over the past 100 years.
3. **Describe** the information needed to assess an individual's nutritional status.

What should we be eating if we want to satisfy our nutrient needs? Our personal preferences and our food environment influence the foods we choose; however, these choices may not always be healthy ones. Our taste buds respond to flavor rather than sensible nutrition, and restaurants and food manufacturers want to sell their products—not necessarily promote a healthy diet. Government recommendations, on the other hand, are designed with individual health as well as public health in mind. They can be used to plan diets and to evaluate what we are eating, both as individuals and as a nation.

Past and Present U.S. Recommendations

The U.S. federal government has been making nutritional recommendations for over 100 years. These recommendations have changed over time as our food intake patterns have changed and our knowledge of what constitutes a healthy diet has evolved.

The first dietary recommendations in the United States, published in 1894 by the U.S. Department of Agriculture (USDA), suggested amounts of protein, carbohydrate, fat, and "mineral matter" needed to keep Americans healthy.[1] At the time, specific vitamins and minerals essential for health had not been identified; nevertheless, this work set the stage for the development of the first **food guides**, which are designed to help people choose foods that make up a healthy diet. Over the years the recommendations and format of food guides have evolved (**Figure 2.1**). The latest, *MyPlate*, is available online along with extensive educational tools for making healthy food choices.

In the early 1940s, as the United States entered World War II, the Food and Nutrition Board was established to advise the Army and other federal agencies regarding problems related to food and the nutritional health of the armed forces and the general population. The Food and Nutrition Board developed the first set of recommendations for specific amounts of nutrients. These came to be known as the Recommended Dietary Allowances (RDAs). The original RDAs made recommendations on amounts of energy and on specific nutrients that were most likely to be deficient in people's diets—protein, iron, calcium, vitamins A and D, thiamin, riboflavin, niacin, and vitamin C. Recommended intakes were based on amounts that would prevent nutrient deficiencies.

Over the years since those first standards were developed, dietary habits and disease patterns have changed, and dietary recommendations have had to change along with them. Overt nutrient deficiencies are now rare in the United States, but the incidence of nutrition-related chronic diseases, such as heart disease, diabetes, osteoporosis, and obesity, has increased. To combat these more recent health concerns, recommendations are now intended to promote health as well as prevent deficiencies (see *Debate: How Involved Should the Government Be in Your Food Choices?*). The original RDAs have been expanded into the Dietary Reference Intakes, which address problems of excess as well as deficiency. The *Dietary Guidelines for Americans*, which make diet and lifestyle recommendations that promote health and reduce the risks of obesity and other chronic diseases, were introduced in 1980 and have been revised every five years.[2] Early food guides have evolved into *MyPlate*, which is built around the Dietary Guidelines recommendations for amounts and types of food from five food groups (see Figure 2.1). In addition, standardized food labels have been developed to help consumers choose foods that meet these recommendations.

How We Use Nutrition Recommendations

Nutrition recommendations are developed to address the nutritional concerns of the population and help individuals meet their nutrient needs. These recommendations can also be used to evaluate the nutrient intake of populations and of individuals within populations. Determining what people eat and how their nutrient intake compares to nutrition recommendations is important for assessing their **nutritional status**.

When evaluating the nutritional status of a population, food intake can be assessed by having individuals record or recall their food intake or by using information about the amounts and types of food available to the population to identify trends in the diet (see *What a Scientist Sees: Trends in Milk Consumption*).

When an individual's food intake is evaluated in conjunction with information about his or her health and medical history,

nutritional status An individual's health, as it is influenced by the intake and utilization of nutrients.

57 Short
58 Normal
59 long

FIGURE 2.1 A timeline of food guides How food guides present recommendations has changed over the years, but the basic message has stayed the same: Choose the right combinations of foods to promote health.

1917

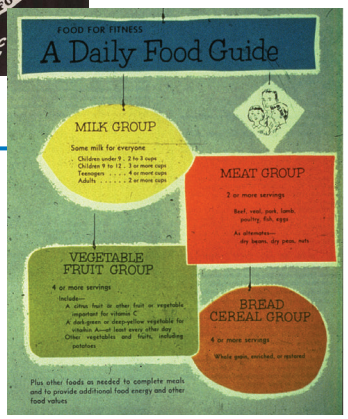
The food guide *How to Select Foods,* published in 1917, made recommendations to meet nutritional needs economically. It was based on five food groups: Meat and milk, cereals, vegetables and fruit, fats and fatty foods, and sugars and sugary foods.

1943

During World War II, the USDA introduced a food guide with seven food groups, called the "Basic Seven." It was intended to help maintain nutritional health under wartime rationing.

1956

Nutrition recommendations were simplified from seven guidelines to four (The Basic Four) and focused on getting adequate amounts of nutrients by specifying amounts from each food group.



1979

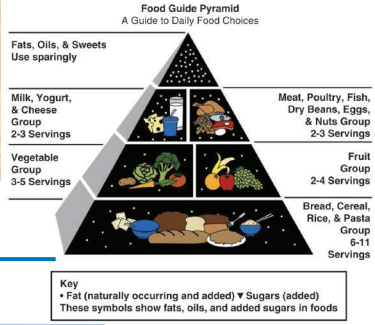
The Basic Four was modified to include a fifth group to highlight the need to limit sweets, fats, and alcohol, creating the Hassel Free Food Guide.

1984

The Food Wheel, released in 1984, divided fruits and vegetables into two groups and added recommendations for varying calorie needs.

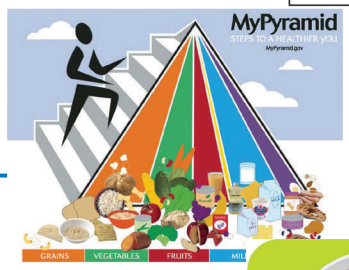
1992

The Food Guide Pyramid included goals for both adequate amounts of nutrients and avoiding excesses. It organized food groups into a pyramid shape to emphasize the relative contribution of each group.



2005

MyPyramid: Steps to a Healthier You, changed the shapes an arrangement of the food groups to stress the importance of portions size in choosing the appropriate amount of food from each food group. It added a band for oils and the concept of physical activity.



2011

MyPlate uses a plate visual to show how much of your plate should be filled with various food groups to meet nutrient needs and avoid excess.

57 Short
58 Normal
59 long

Debate

How Involved Should the Government Be in Your Food Choices?

The Issue

Poor dietary habits in the United States contribute to a high incidence of nutrition-related chronic disease. Should the government intervene to change the types of food available to us?

The typical U.S. diet is not as healthy as it could be. The types and amounts of food we choose contribute to our high rates of obesity, diabetes, high blood pressure, and heart disease. For example, low intake of fruits and vegetables is linked to an increased risk of nutrition-related chronic conditions, including heart disease and obesity.[3] The quality of the American diet creates challenges not only for the individuals whose lives are affected by these conditions, but also for the government, which must manage and fund the health care of the American public. The direct annual healthcare cost of obesity alone is estimated to be over $480 billion, and almost one in four military applicants is rejected for being overweight, which some suggest is a potential threat to national security and military readiness.[4,5]

So, who is responsible for our unhealthy diet, and who should be responsible for changing what we eat? Advocates of more government involvement in our food choices suggest that our food environment is the cause of our unhealthy eating habits. Obesity expert Dr. Kelly Brownell believes that environment plays a more powerful role in determining food choices than does personal irresponsibility.[6] Areas with a high concentration of fast-food restaurants and other sources of foods high in saturated fat, added sugars, and/or sodium have been found to have higher rates of obesity.[7] Brownell and other supporters of government intervention argue that our noxious food environment, like any other public health threat, should be managed by developing programs to keep us safe and healthy. Similar to how federal and state regulations help to ensure that our food is not contaminated with harmful bacteria, regulations could ensure that restaurant meals do not provide excessive amounts of nutrients that contribute to our risk of chronic disease. Unfortunately, unlike bacteria, individual foods are difficult to classify as healthy or unhealthy. Almost all food has some nutritional benefits, and the arguments are ongoing as to which foods we should or should not eat. Nonetheless, many people believe there are steps we can take to promote healthier choices.

Proponents of government intervention support both punitive measures and incentives. Punitive measures include taxing junk food to make it more expensive (see figure), implementing zoning restrictions to keep fast-food restaurants away from schools and child-care facilities, placing limitations on the types of foods that can be advertised on children's television, and restricting the portion sizes that can be sold. Incentives include programs that make fruits and vegetables less expensive, reimburse food assistance recipients for the purchase of fruits and vegetables, or double food assistance dollars spent on these foods.[8,9] All these ideas have pros and cons and will support, but not excuse, each individual's responsibility for making healthier food choices.

Joe Raedle / Getty Images News / Getty Images

To reduce consumption, a number of cities in the United States including Chicago, Philadelphia, and Berkeley California have implemented a tax on sugary drinks.

Opponents of government involvement believe it is not the government's responsibility and even an infringement on personal freedom to intervene with Americans' food choices, and suggest that individuals need to take responsibility for their actions. They propose that the food industry work with the public to make healthier food more available and affordable. Many food companies have already responded to the need for a better diet; General Mills and Kellogg's offer whole-grain cereals, and the giant food retailer Wal-Mart is working with suppliers to reduce the amount of sodium and added sugars in packaged foods.

Our current food environment makes unhealthy eating easy. High-calorie, salty, and sugary foods are available 24/7, and the portions offered are often excessive. To preserve our public health, the United States needs to change the way it eats. This change could be driven by government regulations and taxes, incentive programs, and changes in the food industry, or it could come from individuals taking more responsibility for their choices and their health. A synergy of policy intervention, industry cooperation, and personal efforts is likely needed to solve the crisis.

Think Critically

The government has taken both punitive and incentive-based approaches to improve Americans' food choices. Suggest some pros and cons of each approach.

57 Short
58 Normal
59 long

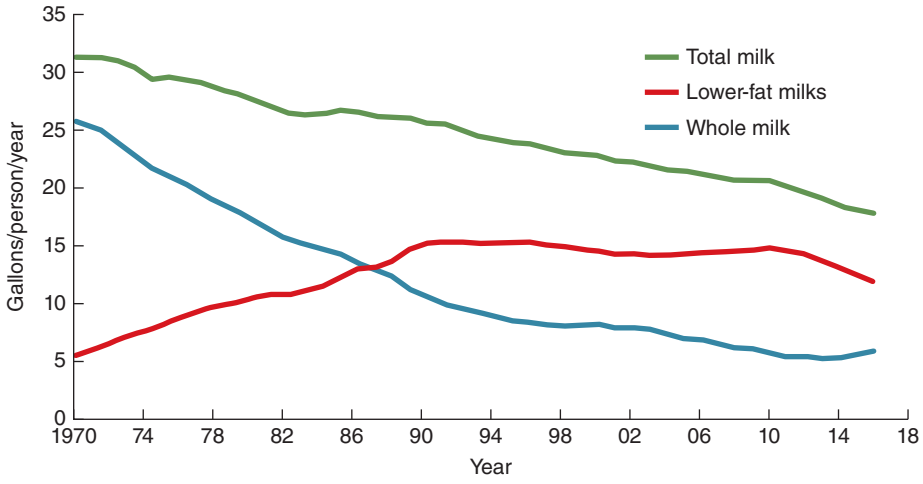
What a Scientist Sees

Trends in Milk Consumption

The graph below shows estimates of milk consumption in the United States based on the amount of milk available for human consumption over the last several decades.[10] Anyone looking at the graph can tell that consumption of total milk as well as whole milk declined, while consumption of lower-fat milks increased. A nutrition scientist looking at this graph, however, would see not just changes in the amount of milk Americans drank but the nutritional and public health implications of these changes as well.

Because whole milk is high in saturated fat, replacing whole milk with lower-fat milk decreases saturated fat intake, potentially reducing the risk of heart disease. However, milk is the most important source of calcium in the North American diet, and calcium is needed for bone health, so a reduction in total milk consumption could contribute to an increase in the incidence of fractures due to low bone density, a condition called osteoporosis.[11]

Scott Camazine / Science Source



Interpret the Data

If 1 gallon of milk has 4.8 grams of calcium, how much less calcium per person was consumed from milk in 2016 compared with 1970?

the person's nutritional status can be assessed (**Figure 2.2**). Obtaining an accurate record of an individual's food intake is difficult. Food records and recalls rely on the memory and reliability of the consumer so may be inaccurate. Food frequency questionnaires, which ask consumers about their food intake patterns, also rely on subjective responses so are prone to similar errors. Combining one or more methods often provides a more accurate picture of an individual's typical intake.

When food intake and health information is surveyed within populations, relationships between dietary intake and health and disease can be identified. This is important for developing public health policies and programs that address nutritional problems. For example, population surveys such as the National Health and Nutrition Examination Survey (NHANES) helped public health officials recognize that low iron levels are a problem for many people, including young women, preschool children, and older adults. This information led to the fortification of grain products with iron beginning in the 1940s. Recent NHANES data have also shown that the number of calories Americans consume per day has increased over the past few decades and that the incidence of obesity has increased dramatically during the same period. This has led public health experts to develop programs to improve both the diet and the fitness of Americans.

57 Short
58 Normal
59 long

PROCESS DIAGRAM

FIGURE 2.2 Assessing nutritional status A complete assessment of an individual's nutritional status includes a diet analysis, a physical exam, a medical history, and an evaluation of nutrient levels in the body. An interpretation of this information can determine whether an individual is well-nourished, malnourished, or at risk for malnutrition.

How It Works

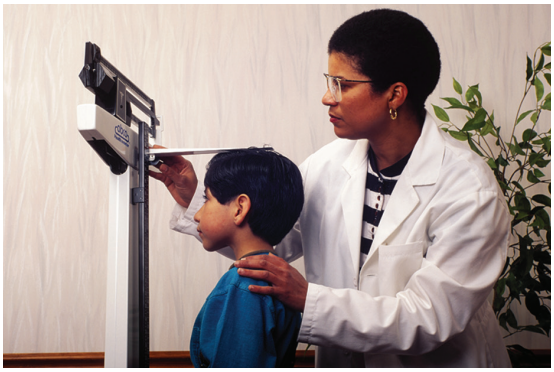
Dragon Images / Shutterstock

1 **Determine typical food intake.** Typical food intake can be estimated by having people recall what they have eaten with the help of a trained interviewer or record all the food and beverages they consume as they consume them. A cell phone app is a convenient way to log food as it is consumed and has been shown to be more accurate than trying to recall food intake at a later time. Because food intake varies from day to day, to obtain a realistic picture, intake should be tracked for more than one day.

Nutrient	My DRI	My intake	Percent of my DRI (0% 50% 100%)
Vitamin A (RAE)	700 µg	525	75%
Vitamin C	75 mg	86	115%
Iron	18 mg	9.7	54%
Calcium	1000 mg	750	75%
Saturated fat	< 23.8 g	31.9	Above recommended range

2 **Compare intake to recommendations.** A quick diet assessment can be done by comparing an individual's food intake to the food group recommendations of MyPlate. A more thorough analysis compares intake of individual nutrients to recommendations. In this example, which shows only a few nutrients, intakes of vitamin A, iron, and calcium are below the recommended amounts, and intakes of vitamin C and saturated fat are above the recommended amounts.

3 **Evaluate physical health.** A physical examination can detect signs of nutrient deficiencies or excesses. Measures of height and weight can be monitored over time or compared with standards for a given population. Drastic changes in measurements or measurements that are significantly above or below the standards could indicate nutritional deficiency or excess.

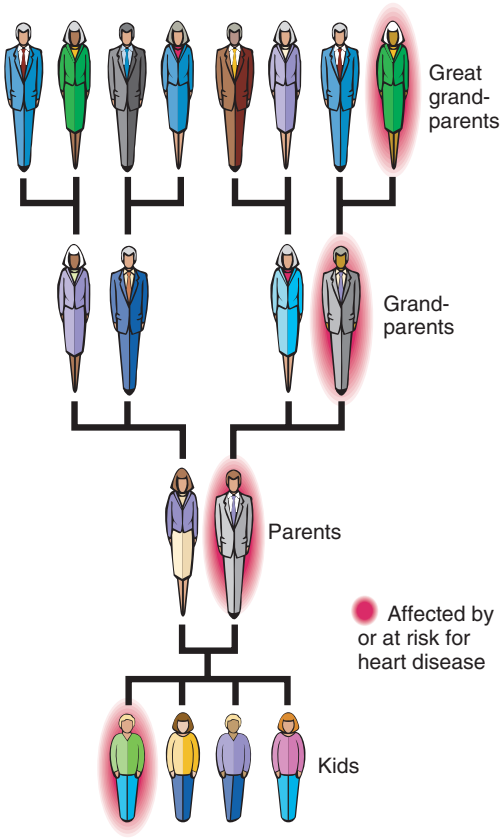


Blair Seitz / Science Source

(continues)

57 Short
58 Normal
59 long

FIGURE 2.2 *(continued)*



4 **Consider medical history and lifestyle.** Personal and family medical histories are important because genetic risk factors affect an individual's risk of developing a nutrition-related disease. For example, if you have high blood cholesterol and your father died of a heart attack at age 50, you have a higher-than-average risk of developing heart disease. Lifestyle factors such as physical activity level and eating habits can add to or reduce your inherited risk.

AlexRaths / Getty Images

5 **Assess with laboratory tests.** Measures of nutrients, their by-products, or their functions in the blood, urine, and body cells can help detect nutrient deficiencies and excesses or the risk of nutrition-related chronic diseases (see Appendix F). For instance, an individual's iron status can be assessed by drawing a blood sample, measuring hemoglobin (an iron-carrying protein) and hematocrit (the proportion of blood volume that is red blood cells), and then comparing the values to the healthy range.

Think Critically

If your food record shows that your saturated fat intake is above recommendations, what other components of nutrition assessment would help you determine your overall risk for heart disease? Why?

The information obtained from population health and nutrition surveys is also used to determine whether the nation is meeting health and nutrition goals, such as those established by **Healthy People**.[12] Healthy People is a set of health-promotion and disease-prevention objectives designed to eliminate health disparities and increase the quality of life for all segments of the population. These objectives are revised every 10 years; the most recent objectives have been released as *Healthy People 2030* (see Appendix C).

Concept Check

1. **How** do nutrition recommendations benefit individual and public health?
2. **Why** do the current DRIs focus on preventing chronic disease?
3. **How** is an individual's dietary intake used in assessing their nutritional status?

57 Short
58 Normal
59 long

2.2 Dietary Reference Intakes (DRIs)

LEARNING OBJECTIVES

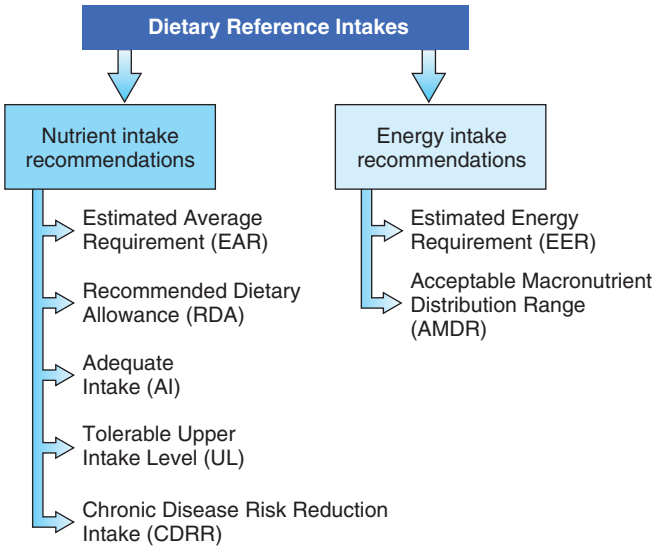
1. **Summarize** the purpose of the DRIs.
2. **Describe** the five sets of DRI values used in recommending nutrient intake.
3. **List** the factors that are considered when estimating an individual's energy needs (EERs).
4. **Explain** the concept of the Acceptable Macronutrient Distribution Ranges (AMDRs).

The **Dietary Reference Intakes (DRIs)** are recommendations for the amounts of energy, nutrients, and other food components that healthy people should consume in order to stay healthy, reduce the risk of chronic disease, and prevent deficiencies.[13] The DRIs can be used to evaluate whether a person's diet provides all the essential nutrients in adequate amounts. They include several types of recommendations that address both nutrient intake and energy intake and include values that are appropriate for people of different genders and stages of life (**Figure 2.3**).

Recommendations for Nutrient Intake

The DRI recommendations for nutrient intake include five sets of values. The **Estimated Average Requirements (EARs)** are average amounts of nutrients or other dietary components required by healthy individuals in a population (**Figure 2.4**). They are used to assess the adequacy of a population's food supply or typical nutrient intake and are not appropriate for evaluating an individual's intake. The **Recommended Dietary Allowances (RDAs)** are set higher than the EARs and represent amounts of nutrients and other dietary components that meet the needs of most healthy people (see Figure 2.4). When there aren't enough data about nutrient requirements to establish RDAs, **Adequate Intakes (AIs)** are set, based on what healthy people typically eat. RDA or AI values can be used as goals for individual intake and to plan and evaluate individual diets (see Appendix A). They are meant to represent the amounts that most healthy people should consume, on average, over several days or even weeks, not each and every day. Because they are set high enough to meet the needs of almost all healthy people, intake below the RDA or AI does not necessarily mean that an individual is deficient, but the risk of deficiency is greater than if the individual consumed the recommended amount.

FIGURE 2.3 DRIs for all population groups The DRIs include five types of nutrient intake recommendations and two types of recommendations related to energy intake. Because gender and life stage affect nutrient needs, recommendations have been set for each gender and for various life-stage groups. These values take into account the physiological differences that affect the nutrient needs of men and women, infants, children, adolescents, adults, older adults, and pregnant and lactating women.



Christopher Futcher / iStockphoto / Getty Images

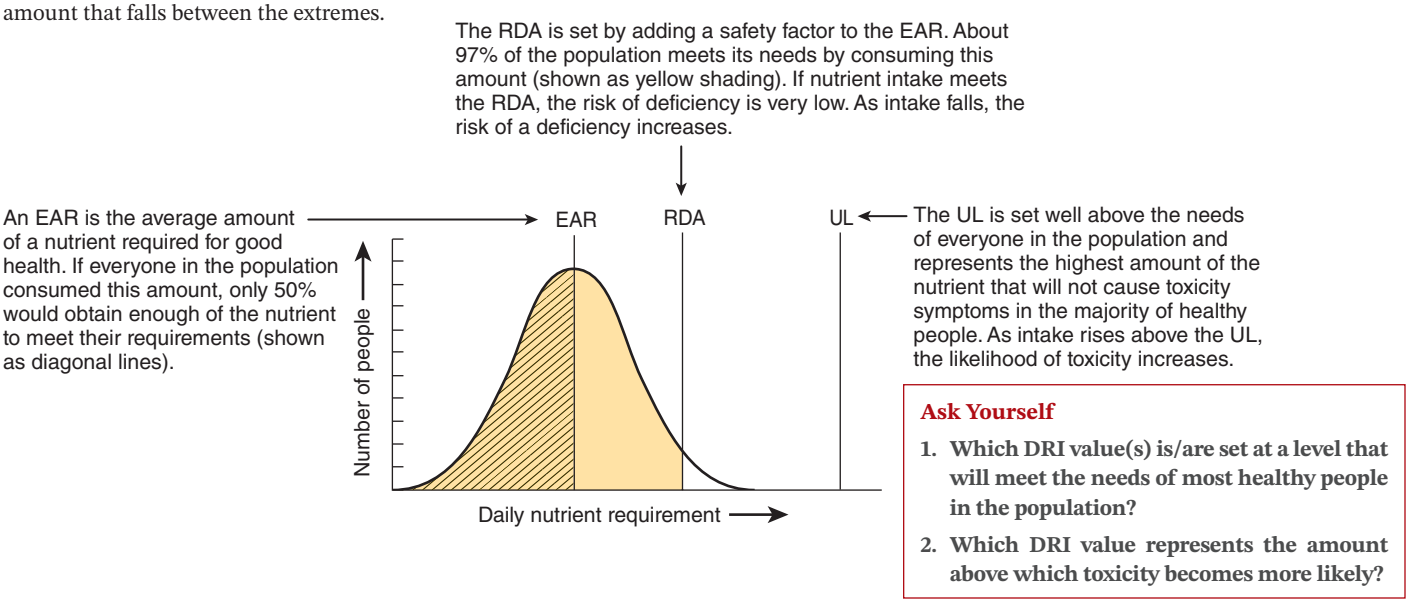
Estimated Average Requirements (EARs) Nutrient intakes estimated to meet the needs of 50% of the healthy individuals in a given gender and life-stage group.

Recommended Dietary Allowances (RDAs) Nutrient intakes that are sufficient to meet the needs of almost all healthy people in a specific gender and life-stage group.

Adequate Intakes (AIs) Nutrient intakes that should be used as a goal when no RDA exists. AI values are an approximation of the nutrient intake that sustains health.

57 Short
58 Normal
59 long

FIGURE 2.4 Understanding EARs, RDAs, and ULs The EAR and RDA for a nutrient are determined by measuring the amount of the nutrient required by different individuals in a population group and plotting all the values. The resulting plot is a bell-shaped curve; a few individuals in the group need only a small amount of the nutrient, a few need a large amount, and the majority need an amount that falls between the extremes.



Ask Yourself

1. **Which DRI value(s) is/are set at a level that will meet the needs of most healthy people in the population?**
2. **Which DRI value represents the amount above which toxicity becomes more likely?**

There are two sets of values that address nutrient excess. The **Tolerable Upper Intake Levels (ULs)**, specify the maximum amount of a nutrient that most people can consume on a daily basis without some adverse effect (see Figure 2.4). For most nutrients, it is difficult to exceed the UL by consuming food. Most foods do not contain enough of any one nutrient to cause toxicity; however, some dietary supplements and fortified foods may. For some nutrients, the UL is set for total intake from all sources, including food, fortified foods, and dietary supplements. For other nutrients, the UL refers to intake from supplements alone or from supplements and fortified foods. For many nutrients, there is no UL because not enough information is available to determine it.

The second set of values that addresses nutrient excesses is called the **Chronic Disease Risk Reduction Intake (CDRR)**. The CDRR was recently added to the DRIs and can be established when there is at least moderate evidence of a cause and effect relationship between nutrient intake and chronic disease risk in an apparently healthy population.[13] Intakes above the CDRR increase the risk of chronic disease; reducing intake to the CDRR or below is expected to reduce the risk. A CDRR has been established for sodium; reduction of sodium intakes to the CDRR or below is expected to reduce the risk of high blood pressure and heart disease within a healthy population.

Recommendations for Energy Intake

The DRIs make two types of recommendations about energy intake. The first, called **Estimated Energy Requirements (EERs)** (**Figure 2.5a**), provides an estimate of how many

FIGURE 2.5 Meeting energy needs The DRIs recommend amounts of energy (calories) and proportions of carbohydrate, fat, and protein that provide a healthy diet.

Raul Touzon / National Geographic Creative

a. The EER represents the amount of energy required to maintain weight. Based on the EER calculation, a 19-year-old girl who is 5′4″ tall, weighs 127 pounds, and gets no exercise needs about 1940 Calories a day. If she adds an hour of tennis or other moderate activity to her daily routine, her EER will increase to about 2400 Calories; she would need to eat an additional 460 Calories more per day to maintain her current weight.[13]

Think Critically

Why would gaining 20 pounds affect this 19-year-old's EER?

(continues)

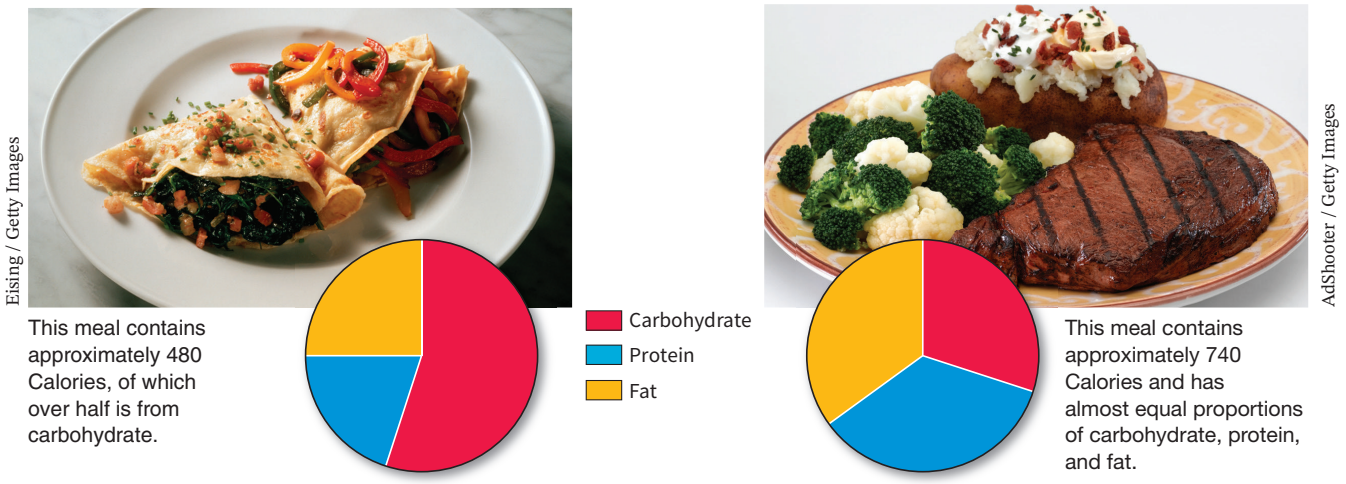
Tolerable Upper Intake Levels (ULs) Maximum daily intake levels that are unlikely to pose risks of adverse health effects to almost all individuals in a given gender and life-stage group.

Chronic Disease Risk Reduction Intake (CDRR) The amount of a nutrient above which reducing intake is expected to lower chronic disease risk within a healthy population.

Estimated Energy Requirements (EERs) Energy intakes that are predicted to maintain body weight in healthy individuals.

57 Short
58 Normal
59 long

FIGURE 2.5 *(continued)*



b. The AMDRs are a guide for selecting healthy proportions of carbohydrate, protein, and fat. As shown by these two meals, many different food combinations can provide a healthy diet. Although only the meal on the left provides proportions of carbohydrate, protein, and fat that fall within the AMDRs, the meal on the right can still be part of a diet that meets the AMDRs if other meals that day are lower in protein and fat and higher in carbohydrate.

calories are needed to keep body weight stable. EER calculations take into account a person's age, gender, weight, height, and level of physical activity (see Appendix A). A change in any of these variables changes the person's energy needs.

The second type of energy recommendation, called **Acceptable Macronutrient Distribution Ranges (AMDRs)**, makes recommendations about the proportions of calories from carbohydrate, fat, and protein in a healthy diet. AMDRs are ranges—10 to 35% of calories from protein, 45 to 65% of calories from carbohydrate, and 20 to 35% of calories from fat—not exact values. This is because a wide range of macronutrient distributions is associated with health. AMDRs are intended to promote diets that minimize disease risk and allow flexibility in food intake patterns (**Figure 2.5b**).

Concept Check

1. **What** are RDAs and AIs used for?
2. **How** might you use ULs?
3. **What** happens to a person's EER as they increase their activity level?
4. **Why** are AMDR values given as ranges rather than as single numbers?

2.3 The Dietary Guidelines for Americans

LEARNING OBJECTIVES

1. **Explain** the purpose of the Dietary Guidelines.
2. **List** four characteristics of a healthy eating pattern.
3. **Name** three foods or food components that the Dietary Guidelines recommend we increase and three that we should decrease in our diets.
4. **Describe** how different segments of society can be involved in promoting a healthy lifestyle.

The DRIs tell you how much of each nutrient you need, but they do not help you choose foods that will meet these needs. To help consumers choose diets that will meet their needs, the U.S. government has developed the **Dietary Guidelines for Americans**. The *2015–2020 Dietary Guidelines for Americans* include five overarching evidence-based guidelines that encourage healthy eating patterns, recognize that most Americans need to make shifts in their food and beverage choices to achieve a healthy pattern, and urge all segments of society to play a role in supporting healthy eating and activity choices.[2] **Table 2.1** lists the five guidelines and the key recommendations of the 2015–2020 Dietary Guidelines. Adopting these recommendations will help support a healthy body weight, meet nutrient needs, and reduce the risk of chronic disease throughout all stages of life. The guidelines target Americans 2 years and older.

57 Short
58 Normal
59 long

Acceptable Macronutrient Distribution Ranges (AMDRs)
Healthy ranges of intake for carbohydrate, fat, and protein, expressed as percentages of total energy intake.

TABLE 2.1 Dietary Guidelines for Americans, 2015–2020[2]

The guidelines	
1. **Follow a healthy eating pattern across the life span.** All food and beverage choices matter. Choose a healthy eating pattern at an appropriate calorie level to help achieve and maintain a healthy body weight, support nutrient adequacy, and reduce the risk of chronic disease.	4. **Shift to healthier food and beverage choices.** Choose nutrient-dense foods and beverages across and within all food groups in place of less healthy choices. Consider cultural and personal preferences to make these shifts easier to accomplish and maintain.
2. **Focus on variety, nutrient density, and amount.** To meet nutrient needs within calorie limits, choose a variety of nutrient-dense foods across and within all food groups in recommended amounts.	5. **Support healthy eating patterns for all.** Everyone has a role in helping to create and support healthy eating patterns in multiple settings nationwide, from home to school to work to communities.
3. **Limit calories from added sugars and saturated fats and reduce sodium intake.** Consume an eating pattern low in added sugars, saturated fats, and sodium. Cut back on foods and beverages higher in these components to amounts that fit within healthy eating patterns.	

Key recommendations	
The *Dietary Guidelines'* Key Recommendations for healthy eating patterns should be applied in their entirety, given the interconnected relationship that each dietary component can have with others.	
Consume a healthy eating pattern that accounts for all foods and beverages within an appropriate calorie level.	
A healthy eating pattern includes:	
• A variety of vegetables from all of the subgroups—dark green, red and orange, legumes (beans and peas), starchy, and other	• Fat-free or low-fat dairy, including milk, yogurt, cheese, and/or fortified soy beverages
• Fruits, especially whole fruits	• A variety of protein foods, including seafood, lean meats and poultry, eggs, legumes (beans and peas), and nuts, seeds, and soy products
• Grains, at least half of which are whole grains	• Oils
A healthy eating pattern limits:	
Saturated fats and *trans* fats, added sugars, and sodium	
Key Recommendations that are quantitative are provided for several components of the diet that should be limited. These components are of particular public health concern in the United States, and the specified limits can help individuals achieve healthy eating patterns within calorie limits:	
• Consume less than 10% of calories per day from added sugars.	• Consume less than 2300 milligrams (mg) per day of sodium.
• Consume less than 10% of calories per day from saturated fats.	• If alcohol is consumed, it should be consumed in moderation—up to one drink per day for women and up to two drinks per day for men—and only by adults of legal drinking age.
In tandem with the recommendations above, Americans of all ages—children, adolescents, adults, and older adults—should meet the *Physical Activity Guidelines for Americans* to help promote health and reduce the risk of chronic disease. Americans should aim to achieve and maintain a healthy body weight. The relationship between diet and physical activity contributes to calorie balance and managing body weight. As such, the *Dietary Guidelines* includes a Key Recommendation to	
Meet the *Physical Activity Guidelines for Americans*.[a]	

[a] U.S. Department of Health and Human Services. *2008 Physical Activity Guidelines for Americans*. ODPHP Publication No. U0036. Washington, DC, 2008. Available at www.health.gov/paguidelines. Accessed October 15, 2016.

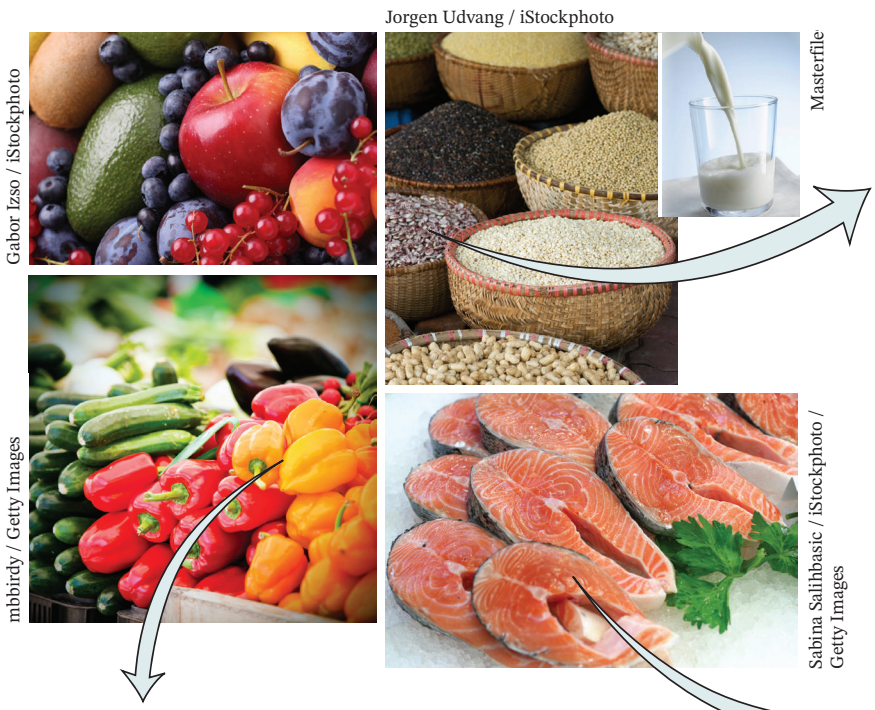
57 Short
58 Normal
59 long

Follow a Healthy Eating Pattern

An eating pattern, or *dietary pattern*, is the combination of foods and beverages that make up an individual's intake over time. In recommending patterns rather than specific foods, the Dietary Guidelines recognize that the components of an eating pattern have interactive and potentially cumulative effects on health that are greater than that of any individual food component in isolation. Many different dietary patterns can promote health; those recommended by the guidelines include the USDA Food Patterns, which reflect the U.S.-style eating pattern, as well as a Mediterranean-Style Eating Pattern, Vegetarian Patterns, and the DASH Eating Plan (**Figure 2.6**).[2] Healthy eating patterns provide an adaptable framework within which

NUTRITION INSIGHT

FIGURE 2.6 Healthy eating patterns The *Dietary Guidelines for Americans* suggest that there are many ways to choose a healthy diet (see Appendix B and C). Healthy dietary patterns are high in fruits, vegetables, and whole grains and include low-fat dairy products; varied protein sources such as fish, legumes, and nuts and seeds; and healthy oils. They are low in added sugars, saturated fat, and sodium.



Gabor Izso / iStockphoto

Jorgen Udvang / iStockphoto

Masterfile

mbbirdy / Getty Images

Sabina Salihbasic / iStockphoto / Getty Images

The DASH Eating Plan

Food group	Servings
Grains	6–8/day
Vegetables	4–5/day
Fruits	4–5/day
Fat-free or low-fat milk and milk products	2–3/day
Lean meats, poultry, and fish	6 or less/day
Nuts, seeds, and legumes	4–5/week
Fat and oils	2–3/day
Sweets and added sugars	5 or less/week

The DASH Eating Plan focuses on increasing foods rich in potassium, calcium, magnesium, and fiber. It is plentiful in fruits and vegetables, whole grains, low-fat dairy, fish, poultry, beans, nuts, and seeds. It was first developed for lowering blood pressure and is discussed further in Chapter 8.

Mediterranean Eating Pattern

Foods	How often
Fruits, vegetables, grains (mostly whole), olive oil, nuts, legumes and seeds, herbs, and spices	Every meal
Fish and seafood	At least twice a week
Cheese and yogurt	Moderate portions daily or weekly
Poultry and eggs	Moderate portions every 2 days or weekly
Meats and sweets	Less often

The traditional Mediterranean-Style Eating Pattern is based on fruits, vegetables, grains, olive oil, legumes, nuts, and seeds. It includes moderate portions of cheese and yogurt. Fish and seafood are consumed at least twice a week; poultry and eggs every few days; and red meat and sweets less often. The incidence of chronic diseases such as heart disease is low in populations consuming this diet (see Chapter 5).

USDA Food Patterns

Food group	Amount/day
Vegetables	2.5 cups
Fruit and juices	2.0 cups
Grains	6.0 ounces
Dairy products	3.0 cups
Protein foods	5.5 ounces
Oils	27 grams
Solid fats	16 grams
Added sugars	32 grams

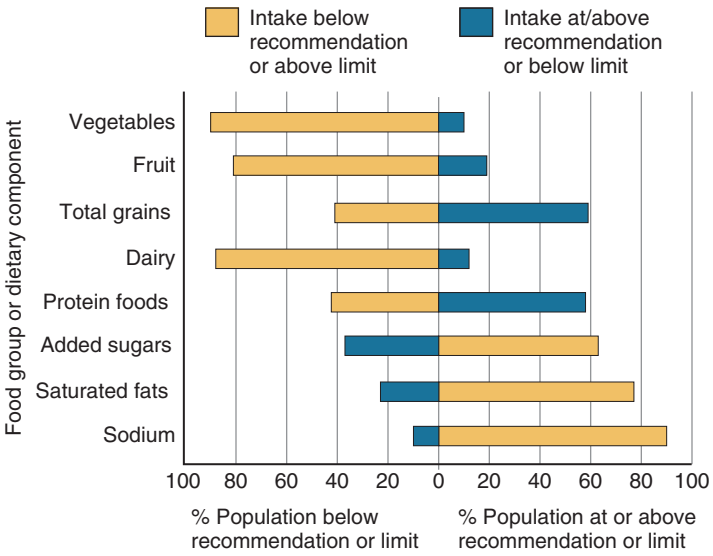
Healthy Vegetarian Pattern

Food group	Amount/day	
	Lacto-Ovo	Vegan
Dairy products or dairy substitutes	3 cups milk, calcium fortified soymilk, or yogurt, 4½ oz. hard cheese	3 cups calcium fortified soymilk or other plant-based milks or yogurts
Protein foods		
Eggs	4 per week	
Beans and peas	⅓ cup	½ cup
Soy products	½ cup tofu, 2 oz. tempeh, ½ cup soybeans	½ cup tofu, 2 oz. tempeh, ½ cup soybeans
Nuts and seeds	¼ cup	¼ cup

The USDA Food Patterns and their vegetarian adaptations suggest amounts of foods from different food groups and subgroups for different calorie levels (2000 Calories shown here) (see Chapter 6). These were developed to help individuals follow the Dietary Guidelines recommendations and are the basis for the MyPlate recommendations.

57 Short
58 Normal
59 long

FIGURE 2.7 How healthy is the American diet? The current U.S diet needs improvement. The graph shown here illustrates how the typical American diet compares with recommendations for various food groups and dietary components.



Interpret the Data

What percentage of the population consumes fewer vegetables than recommended? What percentage consumes more sodium than recommended?

individuals can enjoy foods that meet their personal and sociocultural preferences, fit within their budgets, and meet their nutritional and medical needs.

Shift to Healthier Choices

The Dietary Guidelines suggest that most Americans do not consume a healthy eating pattern (Figure 2.7). To maintain a healthy weight and meet current recommendations for a nutrient-dense diet, most people need to shift food choices both within and across food groups. These shifts can occur slowly, beginning with small changes over the course of a week, a day, or even an individual meal (see *What Should I Eat?*).

Shift to balance calories with activity

The Dietary Guidelines emphasize balancing the calories consumed in foods and beverages with the calories expended through physical activity in order to achieve and maintain a healthy weight. Weight maintenance requires consuming the same number of calories as you burn; this means that if you eat more, you need to be more active (see Chapter 9). Most Americans would benefit from increasing their physical activity to a minimum of 150 minutes of moderate-intensity activity each week and from limiting their screen time and sedentary leisure activity. This, along with attention to portion sizes and a shift to more nutrient-dense choices from both foods and beverages, will promote a healthy weight (Figure 2.8).

What Should I Eat?

To Follow the Dietary Guidelines

Shift to Balance Calories with Activity

- If you stop for an ice cream cone go for a walk while eating it.
- Walk an extra 1000 steps; the more you exercise, the easier it is to keep your weight at a healthy level.
- Ride your bike to work or when running errands.
- Measure out your portions rather than snacking right out of the bag.

Shift to Meet Food Group Recommendations

- Have berries for dessert.
- Make sure your breakfast cereal is a whole-grain cereal.
- Be colorful by adding some red and orange vegetables to your salad.
- Toss some salmon on the grill to increase your seafood intake.

Shift to Limit Added Sugars, Saturated Fat, and Sodium

- Choose lean meat, fish, and low-fat dairy products in order to limit saturated fat.
- Have water and skip sugary soft drinks.
- Pass on the salt; instead, try lemon juice or some basil and oregano.
- Snack on baby carrots and apple slices; they are low in added sugars, saturated fat, and sodium.

Use iProfile to look up the sugar and calorie content of your favorite dessert.

57 Short
58 Normal
59 long

FIGURE 2.8 Healthy weight and exercise recommendations The Dietary Guidelines suggest that most Americans consume more calories than they expend. To achieve calorie balance, adults should decrease calorie intake and increase physical activity gradually over time to achieve a healthy weight.

Blend Images / Getty Images

a. Limiting portion sizes and reducing consumption of added sugars, solid fats, and alcohol, which provide calories but few essential nutrients, can help promote a healthy weight. There is no optimal proportion of macronutrients that can facilitate weight management; the critical issue is the right number of calories needed to maintain or lose weight over time.

Radius Images / Design Pics / Alamy Stock Photo

b. To promote health and reduce disease risk, a minimum of 150 minutes of moderate-intensity aerobic exercise is recommended each week. Some adults need a higher level of physical activity than others to achieve and maintain a healthy body weight.

Shift to meet food group recommendations

Most Americans do not meet recommendations for the amounts and variety of food from the various food groups (see Figure 2.7). Selecting more whole fruits and eating a variety of vegetables, especially dark-green and red and orange vegetables and beans and peas, and eating more whole grains will help align intake with recommendations. The guidelines also suggest that Americans increase their intake of fat-free or low-fat milk and milk products while limiting consumption of high-fat dairy products such as cheese. This pattern of fruit, vegetable, grain, and dairy consumption will increase intakes of potassium, dietary fiber, calcium, and vitamin D, which are nutrients of concern in American diets. Most Americans consume enough protein foods but need to shift their choices to include more seafood along with a variety of other protein choices, such as lean meat, poultry, eggs, beans and peas, soy products, and unsalted nuts and seeds.

57 Short
58 Normal
59 long

Shift to limit added sugars, saturated fat, and sodium

The Dietary Guidelines set specific limits on the amounts of added sugars, saturated fat, and sodium that can be included in a healthy dietary pattern (see Figure 2.7). Added sugars are sugars and syrups that are added to foods or beverages during processing or preparation. The Dietary Guidelines recommend that we reduce added sugars intake to less than 10% of calories (see Chapter 4). Currently, added sugars account for more than 13% of the calories Americans consume; most of this comes from sweetened beverages such as soft drinks, fruit drinks, sweetened coffee and tea, and sport and energy drinks (**Figure 2.9**).[2] Too much saturated fat increases the risk of heart disease (see Chapter 5), yet only about one-third of Americans meet the recommendation to limit saturated fat to less than 10% of calories. The Dietary Guidelines recommend shifting to oils in place of solid fats to reduce saturated fat intake. The American diet is also too high in sodium. The Dietary Guidelines recommend limiting sodium intake to less than 2300 mg/day (see Chapter 8).[2] This can be done by choosing whole foods instead of processed, packaged foods, which are the major source of sodium in the American diet.

FIGURE 2.9 **Beverages count** Beverages contribute an average of about 400 Calories per day to the diets of American adults. Most of these calories come from sugar-sweetened sodas, fruit drinks, and alcoholic beverages, which are high in empty calories. The Dietary Guidelines recommend replacing sugar-sweetened drinks with water.[2]

Matthew Chattle / Alamy Stock Photo

Support from All Segments of Society

Americans consume too many calories, don't meet food group and nutrient recommendations, and don't get enough physical activity. Changing this pattern requires a new paradigm in which healthy lifestyle choices at home, at school, at work, and in the community are easy, accessible, and affordable. The Dietary Guidelines suggest that changes at all levels of society can help individuals embrace and maintain healthy eating and physical activity patterns. Policymakers can implement strategies and programs that provide nutrition education and access to affordable, healthy food. Business and industry can modify products and menus to align with the Dietary Guidelines. Communities can increase opportunities for physical activity by designing safe and accessible parks, recreation facilities, and sports programs. Individuals are encouraged to find their healthy eating and activity pattern by starting with small changes.

Concept Check

1. **How** do the Dietary Guidelines recommendations differ from the DRIs?
2. **What** do healthy eating patterns have in common?
3. **Why** do the Dietary Guidelines recommend we decrease the amount of added sugars in our diet?
4. **What** could your community do to promote an increase in physical activity?

2.4 MyPlate: Putting the Guidelines into Practice

LEARNING OBJECTIVES

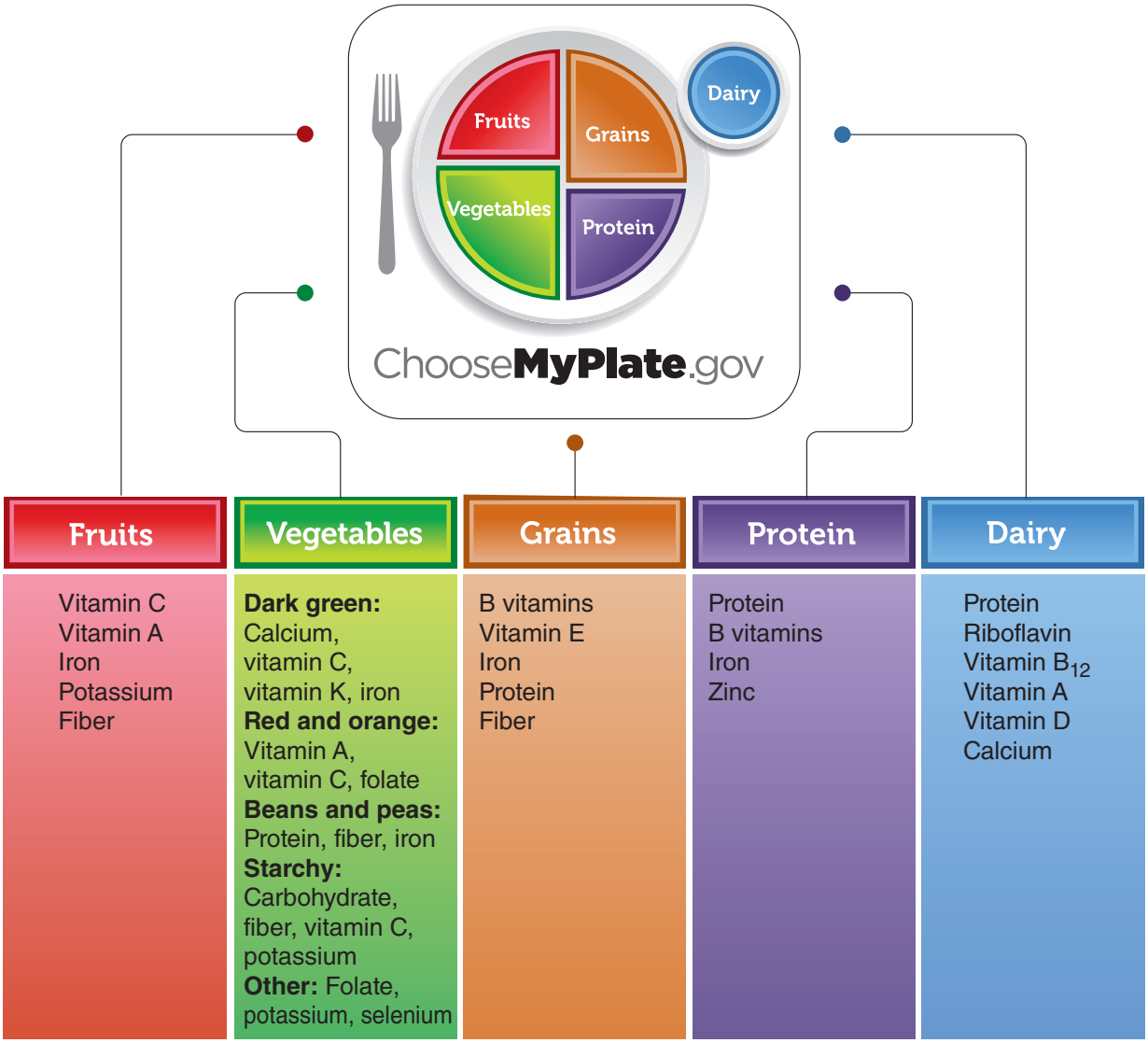
1. **Explain** the purpose of MyPlate.
2. **Describe** the food group recommendations of MyPlate.
3. **Use** the MyPlate recommendations to plan your healthy eating style.
4. **Distinguish** MyPlate food groups from the Choice Lists.

To help individuals apply the recommendations of the Dietary Guidelines to their own food choices, the USDA has developed **MyPlate**. This educational tool translates the recommendation of the Dietary Guidelines into the food choices that make up a healthy eating pattern. It divides foods into groups, based on the nutrients they supply most abundantly, and illustrates the appropriate proportions of foods from each food group that make up a healthy diet (**Figure 2.10**).

The recommendations of MyPlate are designed to help consumers build a healthy eating style. They focus on the amount, variety, and nutrient density of food and beverage choices and aim to meet but not exceed calorie needs. This healthy eating style also limits added sugars, saturated fat, and sodium, and the guidelines encourage physical activity. A healthy eating style can be achieved by making small changes over time that reflect personal preferences, culture, and tradition. You can determine your calorie needs, and find the MyPlate Plan

57 Short
58 Normal
59 long

FIGURE 2.10 Key nutrients in MyPlate food groups Foods in MyPlate are grouped by the amounts of key nutrients they provide. The MyPlate icon illustrates the proportions of food recommended from each of five food groups to meet nutrient needs. Half of your plate should be fruits and vegetables; grains and proteins should each make up about a quarter of your plate. Dairy should accompany meals as shown by the small circle to the right of the plate.



specific to your age, gender, height, weight, and activity level at www.ChooseMyPlate.gov or in Appendix B (**Figure 2.11**).

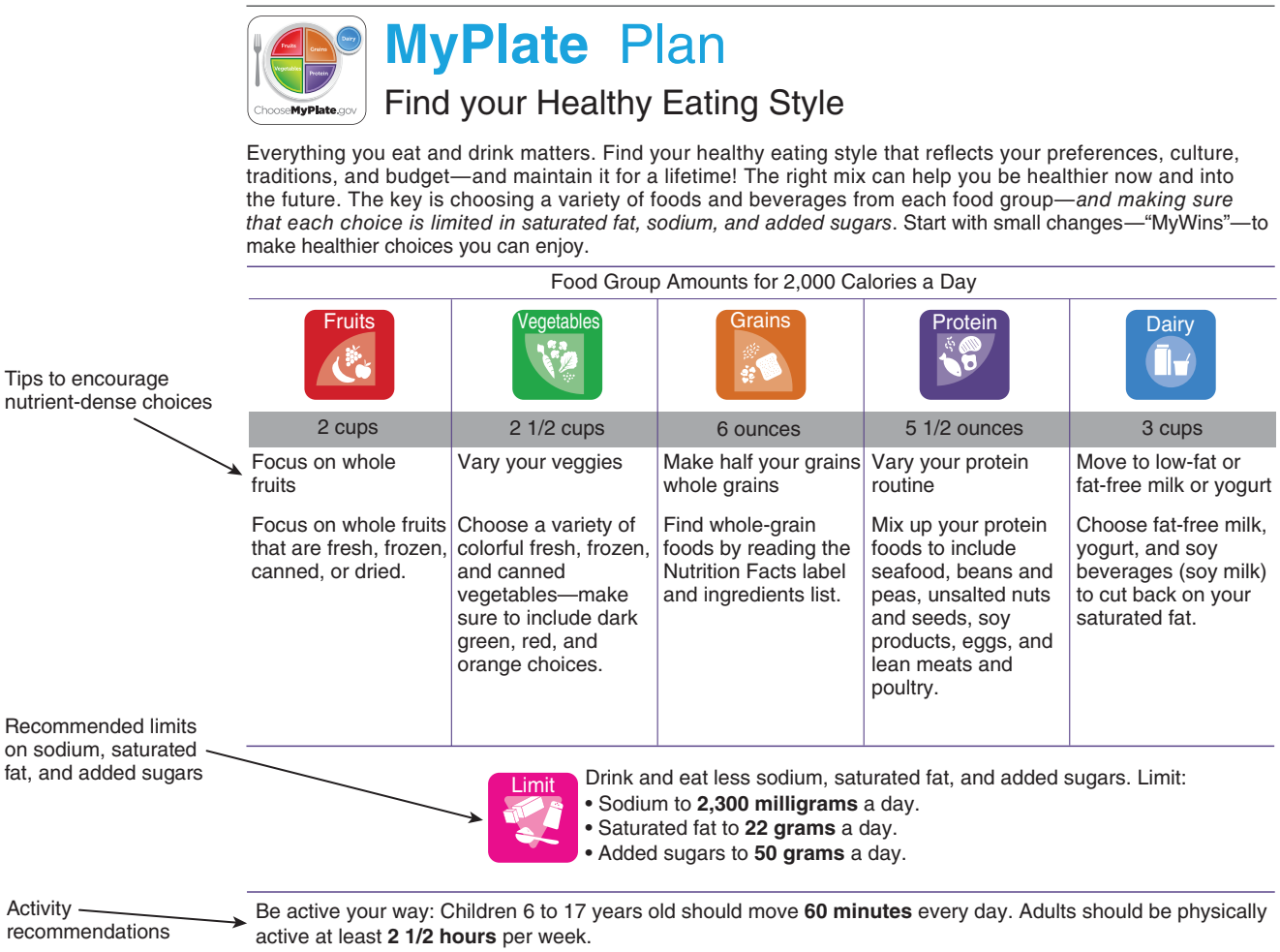
Choose the Right Amount from Each Food Group

The MyPlate recommendations tell you how much to choose from each of five food groups: fruits, vegetables, grains, protein foods, and dairy. The amounts recommended for fruits, vegetables, and dairy are given in cups. The amounts from the grains group are expressed in ounces. An ounce of grains is 1 cup of cold cereal, ½ cup of cooked cereal or grains, or a slice of bread. So if you have 2 cups of cereal and 2 slices of toast at breakfast, you have already consumed 4 ounces of grains for the day (two-thirds of the total for a 2000-Calorie diet). The amounts recommended for protein foods are also expressed in ounces. One ounce is equivalent to 1 ounce of cooked meat, poultry, or fish; one egg; 1 tablespoon of peanut butter; ¼ cup of cooked dry beans; or ¼ cup of nuts or seeds. The amounts recommended per day from each food group depend on your energy needs (see Figure 2.11). The amount of food chosen is important because how much you eat and drink affects your nutrient intake as well as your weight and your risk of chronic disease. Choosing wisely from each food group and watching portion sizes can help meet nutrient recommendations and ensure that calories consumed are balanced with calories burned.

It is easy to see where some foods in your diet fit on MyPlate. For example, a chicken breast is 3 ounces from the protein group; a scoop of rice is 2 ounces from the grains group.

57 Short
58 Normal
59 long

FIGURE 2.11 Building a healthy eating style A MyPlate Plan includes serving recommendations for each food group, along with activity recommendations and specific limits on the amounts of added sugars, saturated fat, and sodium in a healthy eating pattern. The serving recommendations shown are for someone who needs 2000 Calories per day.



It is more difficult to see how much mixed foods such as pizza, stews, and casseroles contribute to each food group. To fit these on your plate, consider the individual ingredients. For example, a slice of pizza provides 1 ounce of grains from the crust, ⅛ cup of vegetables from the sauce, and ½ cup of dairy from the cheese. Having meat on your pizza adds about ¼ ounce from the protein group. Another example of how to break down meals into food groups is shown in **Figure 2.12**.

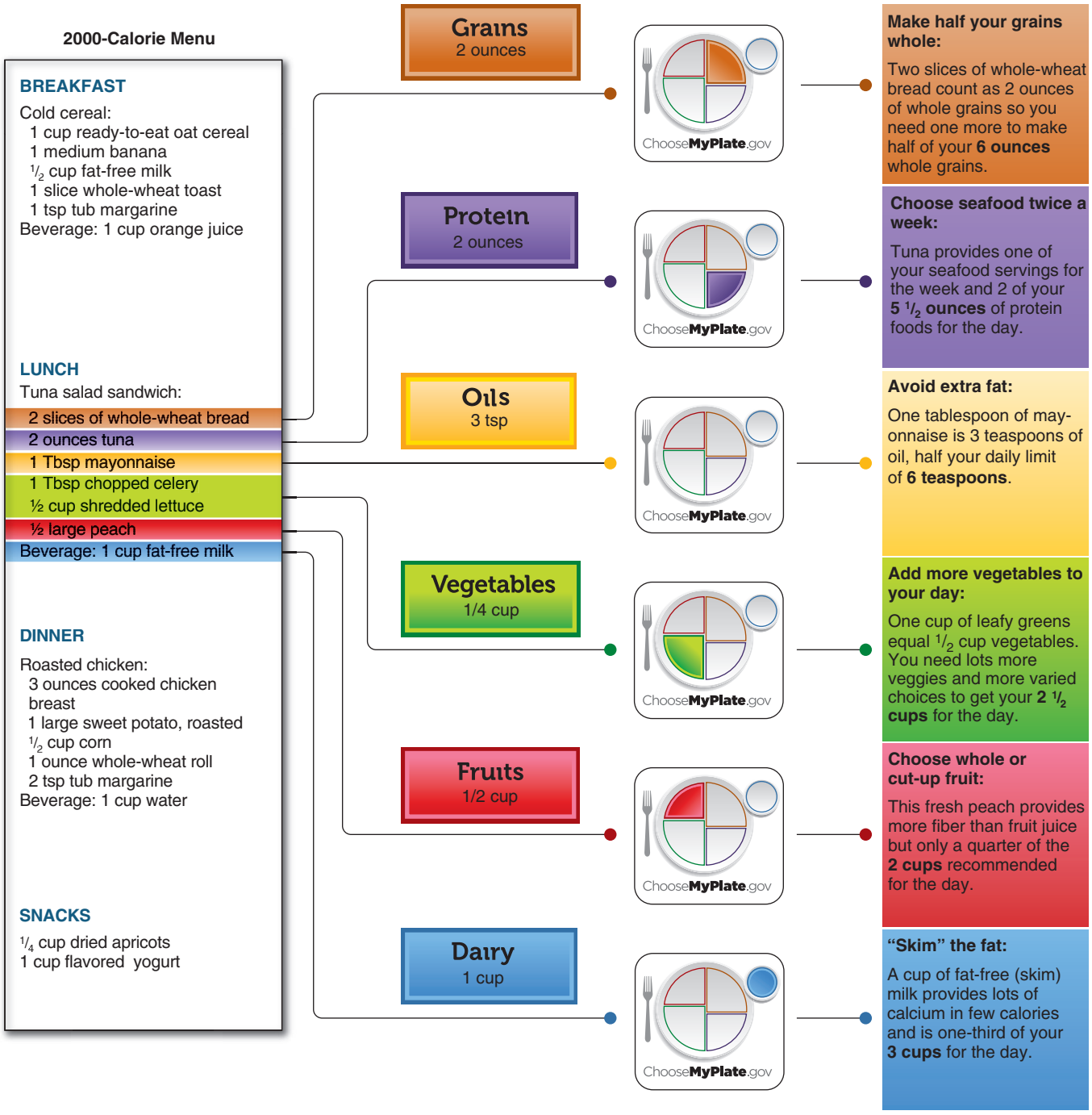
Choose a Variety of Nutrient-Dense Foods

Variety is important for a healthy diet because no one food or food group provides all the nutrients and food components the body needs (see Figure 2.10). Choosing foods from all the food groups provides variety, but a variety of foods should also be selected from within each food group. The vegetables food group includes choices from five subgroups: dark-green vegetables such as broccoli, collard greens, and kale; red and orange vegetables such as carrots, sweet potatoes, and red peppers; starchy vegetables such as corn, green peas, and potatoes; other vegetables such as cabbage, asparagus, and artichokes; and beans and peas such as lentils, chickpeas, and black beans. Beans and peas are good sources of the nutrients found in both vegetables and protein foods, so they can be counted in either food group. The protein foods group includes animal sources of protein such as meat, poultry, seafood, and eggs, and plant sources of protein such as beans and peas, soy products, nuts, and seeds. Grains include whole grains such as whole-wheat bread, oatmeal, and brown rice as well as refined grains such as white bread, white rice, and white pasta (see Chapter 4). Fruits include fresh, canned, or dried fruit and 100% fruit juice. Dairy includes all fluid milk products and many foods made from milk, such as cheese, yogurt, and pudding, as well as calcium-fortified soy products.

A MyPlate Plan provides tips to help you make nutrient-dense choices within each food group (see Figure 2.11). Choosing nutrient-dense foods allows you to maximize the vitamins, minerals, fiber, and other healthful nutrients you consume while minimizing empty calories. This pattern helps manage weight and reduce the risk of chronic disease. Many of the foods Americans currently choose are low in nutrient

57 Short
58 Normal
59 long

FIGURE 2.12 How meals fit The lunch that is part of this 2000-Calorie menu includes about a third of the amounts of grains, protein foods, and dairy recommended for the day, a quarter of the recommended fruit, and half the recommended oils but only a small proportion of the vegetables recommended. The lettuce and celery fit into the "other vegetables" subgroup, so choices at other meals should come from dark-green, red and orange, and starchy vegetables as well as beans and peas. To find out what counts as an ounce or a cup, go to each food group at www.ChooseMyPlate.gov.



density and high in empty calories. Some, such as butter, table sugar, soft drinks, and candy, don't belong in any food group because all their calories are empty calories from solid fats and added sugars. Other foods low in nutrient density do belong to a food group because they are still a source of essential nutrients despite being high in empty calories. For example, cookies are in the grains group, but about half of their calories are empty calories (**Table 2.2**).

57 Short
58 Normal
59 long

Limit Saturated Fat, Sodium, and Added Sugars

MyPlate also reinforces the recommendations of the Dietary Guidelines to keep saturated fat to less than 10% of calories, sodium to 2300 mg or less, and added sugars to 50 g/day or less. Specific recommendations based on calorie level are given on

TABLE 2.2 Food group choices and nutrient density

Food group	Nutrient-dense choices	Less nutrient-dense choices
Grains	Whole-grain bagel	Donut
	Oatmeal	Oatmeal chocolate chip cookies
	Brown rice	Fried rice
Vegetables	Steamed broccoli	Broccoli with cheese sauce
	Sweet potatoes	Candied sweet potatoes
	Green beans	Green bean casserole
Fruits	Fresh cherries	Cherry pie
	Fresh strawberries	Frozen sweetened strawberries
	Fresh peach	Peach canned in heavy syrup
Dairy	Low-fat milk	Whole milk
	Plain nonfat yogurt	Fruit on the bottom low-fat yogurt
Protein	Extra lean ground beef	Pork sausage
	Roasted skinless chicken breast	Fried chicken breast with skin
	Grilled salmon	Fried breaded cod
	Pinto beans	Refried beans made with lard and cheese

your MyPlate Plan (see Figure 2.11). Choosing nutrient-dense foods helps you meet these goals. Saturated fat can be reduced by limiting solid fats such as butter and lard and consuming fewer high-fat meats and whole-fat dairy products and more liquid oils such as olive and corn oil, which are low in saturated fat. Sodium and added sugars can be limited by choosing fewer processed foods such as snack foods, baked goods, and sweetened beverages (see Table 2.2).

MyPlate Compared with Choice (Exchange) Lists

The **Choice Lists** are a set of food-group recommendations developed as the **Exchange Lists** in the 1950s to plan diets for people with diabetes. Since then, their use has been expanded to planning diets for anyone monitoring calorie intake. The most recent version, published as *Choose Your Foods*, has replaced the term "exchange" with "choice." The Choice Lists group foods based on their energy and macronutrient composition. Foods in the same list each contain approximately the same amounts of calories, carbohydrate, protein, and fat. The food groupings of the Choice Lists differ from the MyPlate food groups because the lists are designed to meet energy and macronutrient criteria, whereas the MyPlate groups are designed to be good sources of nutrients regardless of their energy content (see Figure 2.10). For example, a potato is included in the starch food list because it contains about the same amount of energy, carbohydrate, protein, and fat as breads and grains, but in MyPlate a potato is in the vegetable group because it is a starchy vegetable that is a good source of vitamins, minerals, and fiber. The Choice Lists are a useful tool whether you are controlling calorie intake for purposes of weight loss or carbohydrate intake for purposes of diabetes management (see Appendix G).

Concept Check

1. **What** does the MyPlate graphic show you about a healthy diet?
2. **How** many ounces from the grains group does MyPlate recommend for you?
3. **Why** is variety important in a healthy eating style?
4. **Where** does a baked potato fit on MyPlate? In Choice Lists?

2.5 Food and Supplement Labels

LEARNING OBJECTIVES

1. **Discuss** how the information on food labels can help you choose a healthy diet.
2. **Determine** whether a food is high or low in fiber, sodium, or saturated fat.
3. **Explain** how the order of ingredients on a food label is determined.
4. **Explain** the types of claims that are common on food and dietary supplement labels.

The Dietary Guidelines and MyPlate recommend appropriate amounts of nutritious foods, but sometimes it is difficult to tell how nutritious a particular food is. How do you know whether your frozen entrée is a good source of iron, how much fiber your breakfast cereal provides, or how much calcium is in your daily vitamin/mineral supplement? You can find this information on food and supplement labels.

Food Labels

Standardized food labels are designed to help consumers make informed food choices by providing information about the

57 Short
58 Normal
59 long

nutrient composition of a food and how that food fits into the overall diet.[14] They are required on all packaged foods, except those produced by small businesses and those in packages too small to accommodate the information. Raw fruits, vegetables, and seafood are not required to carry individual food labels. However, grocery stores are asked to provide nutrition information voluntarily for the raw fruits, vegetables, and seafood most frequently purchased in the United States. The information can appear on large placards or in consumer pamphlets or brochures. Most fresh meat and poultry (whole cuts and ground and chopped products) are required to have a Nutrition Facts label on the package. Those that are not packaged must have the equivalent information displayed nearby.[15] Food served in restaurants, delicatessens, and bakeries is not required to carry labels unless the food is from an establishment that has 20 or more locations. These food chains must list calorie content information for standard menu items and provide other nutrient information upon request.[16]

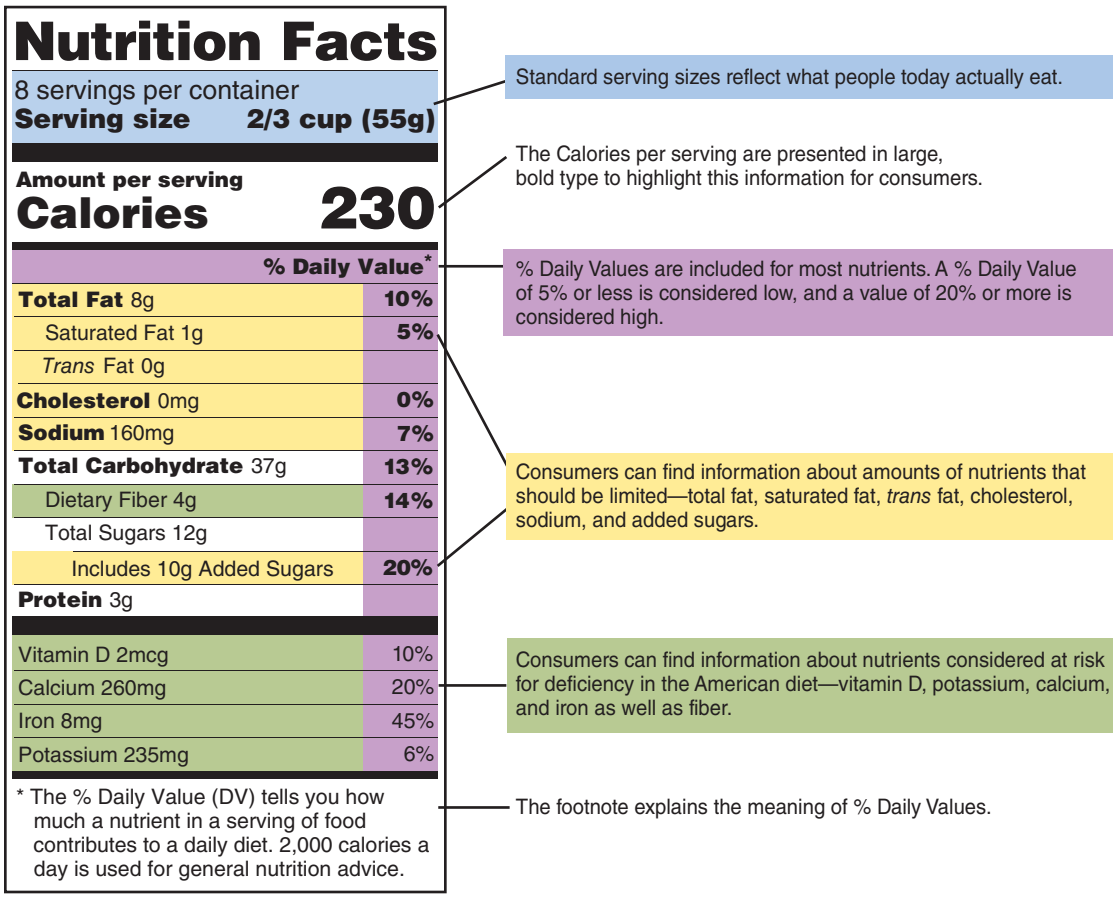
Since 1990, food labels have included a **Nutrition Facts** panel and an ingredient list. In 2016, the Food and Drug Administration (FDA) updated the Nutrition Facts panel. This revision reflects new scientific information and makes it easier for consumers to make informed food choices (**Figure 2.13**).[17]

Nutrition Facts

All food labels must contain a Nutrition Facts panel that lists the number of servings per container and the serving size. The number of Calories per serving and the serving size are shown in a large, bold type (see Figure 2.13a).[14,18] This information is important for choosing a diet that meets but does not exceed needs; if a person eats twice the standard serving, he or she consumes twice the number of calories listed (see *Thinking It Through*).

The Nutrition Facts panel list the amounts of nutrients contained in a serving by weight and as a percentage of the **Daily Value**. The % Daily Value is the amount of a nutrient in a food as a percentage of the amount recommended

FIGURE 2.13 Food labels Knowing how to interpret the information on food labels can help you choose foods that fit into a healthy eating pattern.



a. The Nutrition Facts panel highlights the serving size and the number of Calories per serving and provides amounts and % Daily Values for nutrients of interest or concern in the American diet.

(continues)

Think Critically

How much sodium would you consume if you ate 2 cups of this product? What percentage of the Daily Value would that represent?

57 Short
58 Normal
59 long

Daily Value A reference value for the intake of nutrients used on food labels to help consumers see how a given food fits into their overall diet.

FIGURE 2.13 *(continued)*

b. The ingredient list shows the exact contents of a food. This information can be useful for those who are curious about what is in their food, those who have food allergies, and those who restrict certain ingredients, such as animal products.

INGREDIENTS:
Enriched macaroni product (wheat flour, niacin, ferrous sulfate [iron], thiamine mononitrate, riboflavin, folic acid); cheese sauce mix (whey, modified food starch, milk fat, salt, milk protein concentrate, contains less than 2% of sodium tripolyphosphate, cellulose gel, cellulose gum, citric acid, sodium phosphate, lactic acid, calcium phosphate, milk, yellow 5, yellow 6, enzymes, cheese culture)

Labels must contain basic product information, such as the name of the product, the weight or volume of the contents, and the name and place of business of the manufacturer, packager, or distributor.

The ingredients are listed in descending order by weight, from the most abundant to the least abundant. The wheat flour in the macaroni is the most abundant ingredient in this product.

for a 2000-Calorie diet. For example, if a food provides 10% of the Daily Value for calcium, it provides 10% of the recommended daily intake for calcium in a 2000-Calorie diet (see Appendix H). These percentages help consumers see how a given food fits into their overall diet. Because a Daily Value is a single standard for all consumers, it may overestimate the amount of a nutrient needed for some population groups, but it does not underestimate the requirement for any group except pregnant and lactating women. Daily Values have not been established for *trans* fat or total sugars but are available for added sugars and most other nutrients. The Daily Values used on the Nutrition Facts panel were updated in 2016 based on the most recent information on nutrient needs.[19]

Ingredient list Do you want to know exactly what is in your food? The ingredient list is the place to look (see Figure 2.13b). The ingredient list presents the contents of the product, in order of their prominence by weight. An ingredient list is required on all products containing more than one ingredient and optional on products that contain a single ingredient. Food additives, including food colors and flavorings, must be listed among the ingredients.

Nutrient content and health claims Looking for low-fat or high-fiber foods? You may not even need to look at the Nutrition Facts panel. Food labels often contain **nutrient content claims**. These are statements that highlight specific characteristics of a product that might be of interest to consumers, such as "high fiber" or "low sodium." Standard definitions for these descriptors have been established by the FDA (see Appendix H). For example, foods that claim to be "sugar free" or "fat free" must contain less than 0.5 grams per serving of sugar or fat, respectively, and a food that is "high" in a particular nutrient must contain 20% or more of the Daily Value for that nutrient. These definitions also apply to food sold in restaurants. When a claim is made about a menu item's nutritional content or health benefits, such as "low-fat" or "heart healthy," nutrition information must be available upon request."[20]

Some of these standard definitions are outdated, and some of the descriptors we see on labels, such as "natural," have not been defined (**Figure 2.14**). The term "healthy" can currently be used on products that are low in fat, saturated fat, cholesterol, and sodium and also contain 10% of the Daily Value for vitamins A or C, iron, calcium, protein, or fiber. Based on this definition, almonds could not be labeled "healthy" because of their fat content, but sugary breakfast cereals could be labeled "healthy" despite their high added sugar content. The FDA is currently in the process of reviewing the use of the term "natural" on food labels and redefining the term "healthy" so it is more consistent with current dietary recommendations.

57 Short
58 Normal
59 long

Thinking It Through

A Case Study on Using Food Labels to Guide Food Choices

Frieda is trying to improve her diet. She needs to eat about 2000 Calories per day to maintain her weight. She has looked up her MyPlate recommendations and knows that she needs to make some changes.

Based on the MyPlate recommendations in Figure 2.11, how many cups of fruits and of vegetables should Frieda eat each day?

Your answer:

Frieda eats lots of fruits but eats only about a cup of vegetables each day. While shopping she notices vegetable chips. The bag says she will get a serving (½ cup) of vegetables in every ounce.

Vegetable Chips

Nutrition Facts

7 servings per container
Serving size **1 oz (28g)**

Amount per serving
Calories **150**

	% Daily Value*
Total Fat 9g	**12%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 150mg	**7%**
Total Carbohydrate 16g	**6%**
Dietary Fiber 3g	**11%**
Total Sugars 3g	
Includes 1g Added Sugars	**2%**
Protein 1g	**2%**

Not a significant source of vitamin D, calcium, iron, and potassium

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

How many servings of chips would she have to eat to get the 1½ cups of vegetables she is lacking?

Your answer:

Based on the label shown here, how many Calories and how much sodium would this contribute? What percentage of her recommended intake would this be?

Your answer:

Use iProfile to compare the Calories and fiber in 2 servings of chips to the amounts in a cup of baby carrots (12 baby carrots).

Your answer:

Another easy option that Frieda notices is a 100% fruit and vegetable juice blend. The bottle says that it provides ½ cup of fruit and ½ cup of vegetables in 8 ounces.

Juice Blend

Nutrition Facts

1 servings per container
Serving size **8 fl oz (240g)**

Amount per serving
Calories **110**

	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 70mg	**3%**
Total Carbohydrate 28g	**10%**
Dietary Fiber 0g	**0%**
Total Sugars 24g	
Includes 12g Added Sugars	**24%**
Protein 1g	**2%**

Not a significant source of vitamin D, calcium, iron, and potassium

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

If Frieda wants to get all her fruits and vegetables from the juice, how much would she have to drink?

Your answer:

Based on the label shown here, how many Calories and how much fiber and added sugar would this provide?

Your answer:

What are the advantages and disadvantages of the juice versus whole fruits and vegetables?

Your answer:

(Check your answers in Appendix L.)

57 Short
58 Normal
59 long

FIGURE 2.14 Consider the entire label People often choose foods labeled "natural" because they think these products are good for them. It turns out that the term "natural" was not defined by the FDA, and its use is only restricted on foods that contain added colors, artificial flavors, or synthetic substances. As a result it currently appears on a wide variety of foods, some of which should be limited in a healthy diet.

Mary Ann Price / Wiley

Keeping labeling regulations consistent with current scientific knowledge and dietary recommendations is challenging because food label updates impact the packaging on all foods that carry a label, so changes can't be made often.

Because of the importance of certain types of foods and dietary components in disease prevention, food labels are permitted to include a number of **health claims**. Health claims refer to a relationship between a nutrient, food, food component, or dietary supplement and reduced risk of a disease or health-related condition. All health claims are reviewed by the FDA. To carry a health claim, a food must be a naturally good source of one of six nutrients (vitamin A, vitamin C, protein, calcium, iron, or fiber) and must not contain more than 20% of the Daily Value for fat, saturated fat, cholesterol, or sodium. Authorized health claims are supported by strong scientific evidence (**Figure 2.15** and Appendix H). Health claims for which there is emerging but not well-established evidence are called **qualified health claims**; such a claim must be accompanied by an explanatory statement to avoid misleading consumers.

FIGURE 2.15 Health claims Oatmeal contains enough soluble fiber to be permitted to include this health claim about the relationship between soluble fiber and the risk of heart disease. Some other authorized health claims you may see on food labels are listed below and all authorized and qualified health claims are included in Appendix H.[18]

Michael Neelon(misc) / Alamy Stock Photo

4 g of soluble fiber from oatmeal daily in a diet low in saturated fat and cholesterol may reduce the risk of heart disease

- Calcium intake and calcium and vitamin D intake and the risk of osteoporosis
- Sodium intake and the risk of high blood pressure
- Saturated fat and cholesterol intake and the risk of heart disease
- Fiber-containing fruit, vegetable, and grain intake and the risk of heart disease and cancer
- Fruit and vegetable intake and the risk of cancer
- Dietary fat and the risk of cancer
- Whole-grain foods and the risk of heart disease and certain cancers

57 Short
58 Normal
59 long