

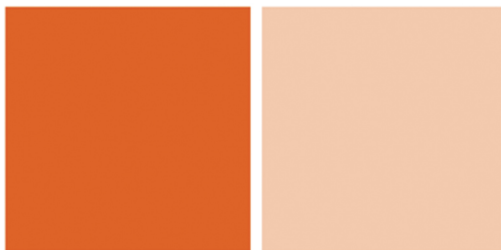


VISUALIZING

Nutrition: Everyday Choices

THIRD EDITION

MARY B. GROSVENOR • LORI A. SMOLIN



WILEY

Third Edition

VISUALIZING
NUTRITION
EVERYDAY CHOICES



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VISUALIZING NUTRITION EVERYDAY CHOICES

Third Edition

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How Is Wiley Visualizing Different?

Wiley Visualizing is based on decades of research on the use of visuals in learning.¹ The visuals teach key concepts and are pedagogically designed to **explain, present, and organize** new information. The figures are tightly integrated with accompanying text; the visuals are conceived with the text in ways that clarify and reinforce major concepts, while allowing students to understand the details. This commitment to distinctive and consistent visual pedagogy sets Wiley Visualizing apart from other textbooks.

Wiley Visualizing texts offer an array of remarkable photographs, maps, media, and film from photo collections around the world, including that of National Geographic. Visualizing images are not decorative, which can often be distracting to students, but purposeful and the primary driver of the content. These authentic materials immerse the student in real-life issues and experiences and support thinking, comprehension, and application.

Together these elements deliver a level of rigor in ways that maximize student learning and involvement. Wiley Visualizing has proven to increase student learning through its unique combination of text, photographs, and illustrations, with online video, animations, simulations, and assessments.

1. Visual Pedagogy. Using the Cognitive Theory of Multimedia Learning, which is backed up by hundreds of empirical research studies, Wiley's authors create

visualizations for their texts that specifically support students' thinking and learning. For example, visuals help students identify important topics, organize new information, and integrate new material with prior knowledge.

2. Authentic Situations and Problems. *Visualizing Nutrition: Everyday Choices, 3e* benefits from National Geographic's more than century-long recording of the world. Through this resource, it offers an array of remarkable photographs, maps, and media. These materials immerse the student in real-life issues related to nutrition and thereby enhance interest, learning, and retention.²

3. Designed with Interactive Multimedia. *Visualizing Nutrition: Everyday Choices, 3e* is tightly integrated with WileyPLUS *Learning Space*, our online learning environment that provides interactive multimedia activities in which learners can actively engage with the materials. The combination of textbook and *WileyPLUS Learning Space* 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 course. *WileyPLUS Learning Space* is a key component of the Wiley Visualizing learning and problem-solving experience. This sets Wiley Visualizing apart from other textbooks whose online component is mere drill-and-practice.

Wiley Visualizing and WileyPLUS Learning Space 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.

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.

¹ Mayer, R.E. (Ed) (2005). *The Cambridge Handbook of Multimedia Learning*. Cambridge University Press.

² Donovan, M.S., & Bransford, J. (Eds.) (2005). *How Students Learn: Science in the Classroom*.

The National Academy Press. Available at http://www.nap.edu/openbook.php?record_id=11102&page=1

Wiley Visualizing is designed for engaging and effective learning

The visuals and text in *Visualizing Nutrition: Everyday Choices, 3e* are integrated to present complex processes in clear steps, organize information, and integrate related pieces of information with one another. This approach minimizes unproductive cognitive load and helps students engage with the content. When students are engaged, they are reading and learning; this leads to both greater acquisition of knowledge and academic success. Examples of this integration of textual concepts with visual elements include the following:

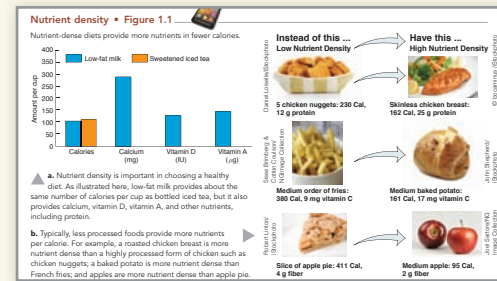


Figure 1: Nutrient density To augment the definition of nutrient density, which appears in the text, this 2-part figure integrates a graphical depiction of the concept of nutrient density with a photographic illustration. The arrows visually guide students to the more nutrient dense choice while captions add specific information about the nutrient density of each food.

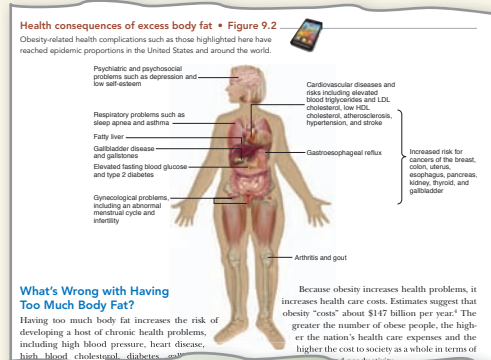


Figure 2: Health consequences of excess body fat This visual overview enhances learning by visually relating the health conditions associated with obesity to the area of the body affected. Organizing the list of health conditions and their effects reduces cognitive load.

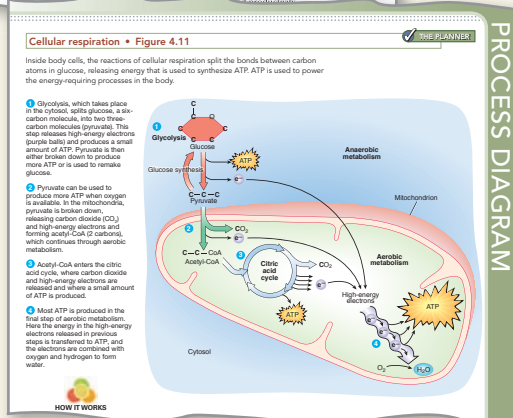


Figure 3: Cellular respiration (process diagram) Visually ordering the steps in this process diagram makes metabolism easier to understand. Analogous metabolism process illustrations appear throughout the book to review, reinforce, and build student's metabolism knowledge.

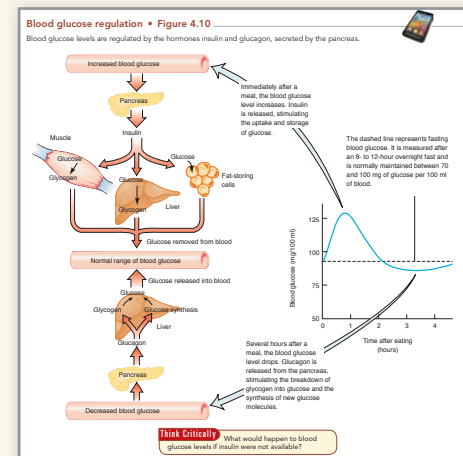


Figure 4: Blood glucose regulation Physically integrating textual elements with the visual elements, as shown here, eliminates split attention (when we must divide our attention between several sources of different information).

Research shows that well-designed visuals, integrated with comprehensive text, can improve the efficiency with which a learner processes information. In this regard, SEG Research, an independent research firm, conducted a national, multisite study evaluating the effectiveness of Wiley Visualizing. Its findings indicate that students using Wiley Visualizing products (both print and multimedia) were more engaged in the course, exhibited greater retention throughout the course, and made significantly greater gains in content area knowledge and skills, as compared to students in similar classes that did not use Wiley Visualizing.³

The use of *WileyPLUS Learning Space* can also increase learning. According to a white paper titled "Leveraging Blended Learning for More Effective Course Management and Enhanced Student Outcomes" by Peggy Wyllie of

Evince Market Research & Communications, studies show that effective use of online resources can increase learning outcomes. Pairing supportive online resources with face-to-face instruction can help students to learn and reflect on material, and deploying multimodal learning methods can help students to engage with the material and retain their acquired knowledge. *WileyPLUS Learning Space* provides students with an environment that stimulates active learning and enables them to optimize the time they spend on their coursework. Continual assessment/remediation is also key to helping students stay on track. The *WileyPLUS Learning Space* system facilitates instructors' course planning, organization, and delivery and provides a range of flexible tools for easy design and deployment of activities and tracking of student progress for each learning objective.

³ SEG Research (2009). Improving Student-Learning with Graphically-Enhanced Textbooks: A Study of the Effectiveness of the Wiley Visualizing Series

New To This Edition

This third edition of *Visualizing Nutrition: Everyday Choices* includes the most recent nutrition information and recommendations along with improved illustrations and critical thinking pedagogy.

- **Metabolism: Energy for Life:** Metabolism topics have always been integrated through the *Visualizing Nutrition* texts. For those who require slightly more in-depth coverage of metabolism, want to cover it as a single topic, or who want help integrating the metabolic roles of macro- and micronutrients, a new separate chapter called *Metabolism: Energy for Life* is available online. This chapter consolidates material presented in the text and expands on topics such as oxidation-reduction reactions, the coenzyme roles of vitamins, and biochemical adaptations that occur between the fed and fasted states.
- **Food Label Legislation:** The Food Labeling Modernization Act of 2013 is currently before Congress. Coverage of this topic in Chapter 2 compares the current food label to the one proposed by this act. The relevance of these proposed changes are also addressed in all applicable subsequent chapters. Although these labels have not been adopted, they offer a launching pad for student discussion and critical thinking regarding the purpose of food labels, the effectiveness of current and proposed labels in providing consumer guidance, and how best to present nutrition information about individual foods to consumers.
- **Chapter introductions:** New chapter introductions have been written for the core chapters. These intriguing narratives, which are accompanied by vivid photographs, are designed to draw readers into the nutrition topics that will be addressed in the chapter. These capture student interest by relating nutrition concepts covered in the chapter to health, history, and culture.
- **New health management guidelines:** Recently published guidelines for the management of cardiovascular disease and overweight and obesity have been integrated into Chapters 5 and 9, respectively. New diagnostic criteria for eating disorders are included in Chapter 9. The World Health Organization's infant growth charts, which are now recommended for infants in the United States, are included in Chapter 11.
- **Choice (Exchange) Lists:** The Choice Lists, which update and replace the Exchange Lists, are discussed in Chapter 2 and provided in the online appendices.
- **Thinking it Through:** These critical thinking case study exercises have been redesigned and updated to more effectively promote critical thinking. The questions have been refined to make them more specific and to better emphasize current nutrition goals such as increasing consumption of whole grains and fresh fruits and vegetables and eating more whole foods and fewer processed foods.
- **Most current information:** The entire text has been updated and re-referenced to reflect the most current nutrition science and guidelines. For example, the Debate boxes have been updated and a new Debate, *Is Personalized Nutrition the Best Approach to Reducing Chronic Disease?*, has been included in Chapter 6 to reflect expanding study and interest in the topic of nutritional genomics. A new illustration and a more in-depth explanation of nutritional genomics have also been added to Chapter 1.
- **Improved art and labeling of illustrations:** Many illustrations have been replaced or revised to be more visually appealing or better illustrate concepts. For example, all digestion figures have been replaced with art that is more anatomically accurate. Figure layout, labels, arrow placement, color, and font size have been improved to make figures easier to understand and more informative. To help organize information and interconnect related pieces of information all multipart figures now include a unifying legend.
- **Online Features:** Critical and Creative Thinking Questions, gradable Self-Test questions, and links to Additional Resources for each chapter have been moved to an online format. This puts Additional Resources a click away and allows students to quickly check to see if they have answered all Self-Test questions correctly. Gradable Concept Check questions are also new online for this edition. Concept Questions apply to every learning objective and provide students with instant feedback on their understanding of the content.

How Does Wiley Visualizing Support Instructors?

Wiley Visualizing Site

The Wiley Visualizing site hosts a wealth of information for instructors using Wiley Visualizing, including ways to maximize the visual approach in the classroom and a white paper titled “How Visuals Can Help Students Learn,” by Matt Leavitt, instructional design consultant. Visit Wiley Visualizing at www.wiley.com/college/visualizing.



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>.



PowerPoint Presentations

(available in *WileyPLUS Learning Space* and on the book companion site)

A complete set of highly visual PowerPoint presentations—one per chapter—by Jennifer Zimmerman, Tallahassee Community College, is available online and in *WileyPLUS Learning Space* 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 *WileyPLUS Learning Space* and on the book companion site)

The visuals from the textbook are also included in the Test Bank by Melanie Burns, Eastern Illinois University. The Test Bank has approximately 75 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 Respondus Test Bank, and within *WileyPLUS Learning Space*. 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 *WileyPLUS Learning Space* and on the book companion site)

The Instructor’s Manual includes a lecture outline and chapter summary.

Nutrition Bytes Blog

The Nutrition Bytes Blog provides an ongoing dialogue of trending topics and controversies in nutrition that spark discussion, highlight the relevance of nutrition in our lives, and encourage critical thinking. Nutrition Bytes is accessible on mobile devices and available from both the student and instructor companion sites, as well as within *WileyPLUS Learning Space*. The blog is written by Katie Ferraro, University of California, San Francisco, and updated on a weekly basis, ensuring that discussions focus on the most current and relevant issues in nutrition. Blogs are searchable for topics of interest and students and instructors can join the discussion by posting their own comments. Users can subscribe to the newsfeed, which will automatically add it to their Favorites Center and be kept up to date.

Nutrition Visual Library

Visuals from the text are online and in *WileyPLUS Learning Space* and can be used as you wish in the classroom. These online electronic files allow you to easily incorporate images into your PowerPoint presentations as you choose, or to create your own handouts. Images are available labeled, with leader lines only, or unlabeled.

Book Companion Site

All instructor resources (the Test Bank, Instructor’s Manual, PowerPoint presentations, and all textbook illustrations and photos in jpeg format) are housed on the book companion site (www.wiley.com/college/grosvenor). Student resources include self-quizzes and flashcards.

Wiley Faculty Network

The Wiley Faculty Network (WFN) is a global community of faculty, connected by a passion for teaching and a drive to learn, share, and collaborate. Their mission is to promote the effective use of technology and enrich the teaching experience.

Connect with the Wiley Faculty Network to collaborate with your colleagues, find a mentor, attend virtual and live events, and view a wealth of resources all designed to help you grow as an educator. Visit the Wiley Faculty Network at www.wherefacultyconnect.com.



How Does WileyPLUS Learning Space Support Instructors and Students?

WileyPLUS Learning Space is designed for personalized, active learning. Several new resources are available for instructors and students within WileyPLUS Learning Space.

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. Figures with audio tutorials are indicated in the text with an audio player icon. All audio files are accompanied by downloadable scripts of the narration.

Nutrition Interactivities

The third edition of *Visualizing Nutrition* includes 15 new activities for student practice. Each activity is embedded within the e-book so that students can practice as they are learning the content. Activities include food source identification drag-n-drop exercises for the macro- and micro-nutrient chapters and calculating and critical thinking activities that ask students to compute caloric intake and percent RDA. These types of exercises include informative feedback about the health consequences of specific nutrient toxicities or deficiencies. New activities are available in most chapters, including the online chapter Metabolism: Energy for Life.

Create-a-Plate and Revise-a-Recipe Activities

New to this edition, each chapter includes an activity that asks students to create a balanced meal or snack to meet specific nutrient recommendations, incorporating MyPlate guidelines. Students can also practice altering meals by substituting foods with healthier choices.

Videos

New videos focus on topics that pique student interest. Videos address current topics and discussions in nutrition, such as gluten allergies and increasing portion sizes in the American diet. These videos can be used as part of lecture presentations, as discussion tools, or can be assigned through WileyPLUS Learning Space with gradable accompanying assessments. All videos have closed captioning for the hearing-impaired.

iProfile Mobile

The iProfile dietary analysis program now contains a database of over 50,000 foods and is available as a mobile-enabled

website. Students can enter their food intakes and activities into their journal on the go via their smartphones and tablets. iProfile is also available, with additional functionality, fully integrated with WileyPLUS Learning Space. WileyPLUS Learning Space includes a few types of assessments around iProfile, including computer graded iProfile Dietary Analysis Exercises in Chapters 4 through 9, written by Lori A. Smolin and Mary B. Grosvenor. These exercises ask students to analyze and modify a diet in relation to the specific nutrients discussed in the chapter. iProfile Case Study Assignments are also available in every chapter, which have students focus on a specific nutritional concept related to that chapter's content. Students can analyze the impact of different food and activity choices using iProfile reports.

Personalized Practice

ORION adaptive practice exercises meet students at just above their level in order to keep them challenged, but not frustrated. ORION adaptive practice assesses student understanding at the objective level. All students begin with a unique, short diagnostic quiz that establishes a baseline from which each student develops his own unique path. Adaptive practice includes extensive actionable reports that focus student study in key areas individual to each learner. Our rich question database contains nearly 6000 questions at every level of difficulty and all Bloom's levels.

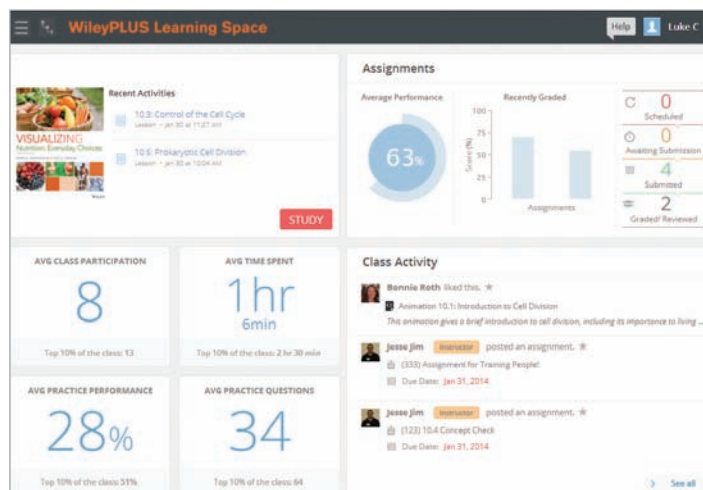
Mobile Enabled Assets

All of the key resources students need to succeed in their nutrition course are now accessible on mobile devices. These include the How It Works, Estimating Portion Sizes, and MyPlate animations. Also mobile are the new Nutrition Interactivities, Create-a-Plate and Revise-a-Recipe activities, and Interactive Process Diagrams.

The screenshot shows the 'Comparing Mineral Content in Foods' interface. At the top, it says 'WILEY Comparing Mineral Content in Foods'. Below that, it asks to 'Select a type of mineral to compare foods.' with radio buttons for Calcium, Iron, Sodium, Potassium (selected), and Zinc. A note says 'Click the information icon for instructions.' The main area is a grid of food items. On the left, there are four items: 3 oz Beef, lean; 3 oz Chicken, breast; 3 oz Tuna; and 2 lg Eggs. In the center, there are four items: 1 med Banana; 1 c Filled yogurt; 1 c Lentils; and 1.5 oz Cheese, cheddar. On the right, there are four items: 1 c Bran Bakes; 2 sl Bread, whole wheat; 1 med Apple; 1 c Orange juice; 1 c Milk, soy; 1 c Milk, nondairy; 1 med French Fries; 1 med Potato, baked; 1 c Rice, white; 1 c Spaghetti; 1 c Cantaloupe; 1 c Spinach, fresh; and 1 c Tomato. Each item has a small image and a text box with its potassium content. For example, the Banana box says 'Of foods being compared, the highest in Potassium is'. The Almonds box says 'Of foods being compared, the lowest in Potassium is'. There are 'Try Again' and 'Good job!' buttons for the highest and lowest items respectively. At the bottom, there are 'Submit', 'Show Me', and 'Reset' buttons.

WileyPLUS Learning Space

An easy way to help your students **learn, collaborate,** and **grow.**



Personalized Experience

Students create their own study guide while they interact with course content and work on learning activities.



Flexible Course Design

Educators can quickly organize learning activities, manage student collaboration, and customize their course—giving them full control over content as well as the amount of interactivity between students.



Clear Path to Action

With visual reports, it's easy for both students and educators to gauge problem areas and act on what's most important.

Instructor Benefits

- Assign activities and add your own materials
- Guide students through what's important in the interactive e-textbook by easily assigning specific content
- Set up and monitor collaborative learning groups
- Assess learner engagement
- Gain immediate insights to help inform teaching

Student Benefits

- Instantly know what you need to work on
- Create a personal study plan
- Assess progress along the way
- Participate in class discussions
- Remember what you have learned because you have made deeper connections to the content

We are dedicated to supporting you from idea to outcome.

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How Has Wiley Visualizing Been Shaped by Contributors?

Instructor Contributions

Throughout the process of developing this edition, 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:

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Priya Venkatesan, Pasadena City College
Shahla Wunderlich, Montclair State University

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Special thanks to Peter Ambrose for providing a fresh eye by writing the chapter introductions for this project. We appreciate his “non-nutritionist” view of the science we know too well. His ability to help us organize and articulate our thoughts throughout the text is greatly appreciated.

Our sincere appreciation goes to Rose Martin, Iowa State University, for helping us develop the new nutrition interactivities for this edition. We are grateful for her vision and hands-on involvement throughout the development process.

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 book. Their tireless enthusiasm, professional assistance, and endless patience smoothed the path as we found our way. We thank in particular Associate Publisher, Kevin Witt, who continually works to provide support and guidance and develop new ways to ensure the book’s success; and Trish McFadden, Senior Production Editor, who guided the production process. Our sincere thanks also go to Kaye Pace, Vice President and Executive Publisher, who oversaw the entire project; Clay Stone, Executive Marketing Manager, who adeptly represents the Visualizing imprint. We appreciate the expertise of Mary Ann Price, Senior Photo Editor, in managing and researching our photo program. We also wish to thank Media Specialist, Svetlana Barskaya, who worked on the wide assortment of media resources. We are grateful to Emma Townsend-Merino, Senior Editorial Assistant for helping to bring this project to fruition. And thanks to Senior Associate Editor, Lauren Elfers, for her support through developing and writing this text and its ancillary materials.

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 and has worked in clinical as well as research nutrition, in hospitals and communities large and small in the western United States. She teaches at the community college level and 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.



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 postdoctoral 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 sons, David and John, and my husband, Peter. In the beginning, their contribution was support and patience with my long hours but over the years it has grown to include editing and writing as well. Thanks for keeping my projects, and me, on track.

(from Mary Grosvenor)

To my sons, Zachary and Max, who have grown up along with my textbooks, helping me to keep a healthy perspective 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 the computer and technological issues that arise when writing in the electronic age.

(from Lori Smolin)

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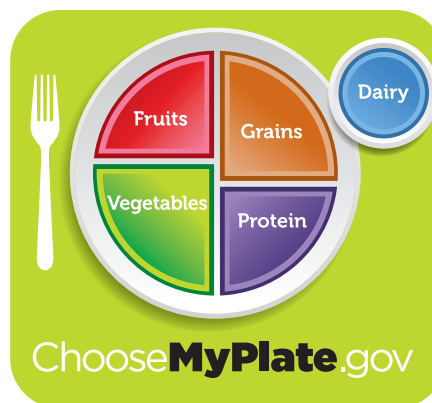
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Third Edition

VISUALIZING
NUTRITION
EVERYDAY CHOICES

1 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. Fundamentally, 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 agriculture and food production became more sophisticated,

a greater array of food choices became available. Colonization and exploitation of native peoples introduced new foods to the colonizers: Corn became part of the diet of European settlers in North America, for instance, and the potato was brought to the Old World from the New. Today, in a cosmopolitan, global society, one may literally choose from the world's dinner table.



The implications of food choices are significant not only because what you eat affects your health but also because what you like affects what you choose to eat. Hundreds of millions of people enjoy eating insects, raw fish, horses, and even dogs, while hundreds of millions of others abhor pork, beef, shellfish, dairy products, and even chocolate! Most of us enjoy the sweet and avoid the bitter, yet some of us choose the zip of the bitter or the bite of the zesty.

Because the nutrients in the food we eat form and maintain the structure of our bodies, we really are what we eat. The challenge is to find a satisfying balance between what we like and what optimizes our health. The choice is ours.



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CHAPTER OUTLINE

Food Choices and Nutrient Intake 4

- Nutrients from Foods, Fortified Foods, and Supplements
- Food Provides More Than Nutrients
- What Determines Food Choices?

Nutrients and Their Functions 8

- The Six Classes of Nutrients
- What Nutrients Do
- DEBATE: Super-Fortified Foods: Are They a Healthy Addition to Your Diet?

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- Eat a Variety of Foods
- Balance Your Choices
- Practice Moderation
- What Should I Eat? A Healthy Diet
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- Judging for Yourself

CHAPTER PLANNER

- Stimulate your interest by reading the opening story and looking at the visual.
- Scan the Learning Objectives in each section: p. 4 p. 8 p. 12 p. 15 p. 18
- Read the text and study all figures and visuals. Answer any questions.

Analyze key features:

- Nutrition InSight, p. 6 p. 11
- Debate, p. 10
- Thinking it Through, p. 17
- Process Diagram, p. 18
- What a Scientist Sees, p. 21
- Stop: Answer the Concept Checks before you go on: p. 7 p. 12 p. 14 p. 17 p. 24

End of chapter and online review:

- Review the Summary, Key Terms, and online links to Additional Resources.
- Answer the online Critical and Creative Thinking Questions.
- Answer What is happening in this picture?
- Complete the online Self-Test and check your answers.

1.1 Food Choices and Nutrient Intake

LEARNING OBJECTIVES

1. **Define** nutrient density.
2. **Compare** fortified foods and dietary supplements.
3. **Distinguish** essential nutrients from phytochemicals.
4. **Identify** factors that determine 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 turkey sandwich? 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.

nutrient A
A substance in food that provides energy and structure to the body and regulates body processes.

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 (**Figure 1.1**). If a large proportion of your diet consists of foods that are low in nutrient density, 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.

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.

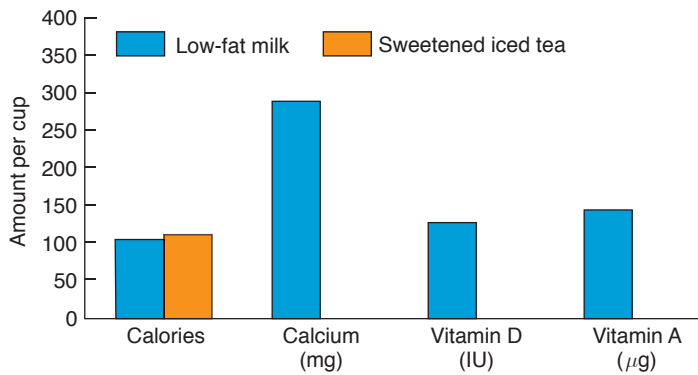
calorie
A unit of measure used to express the amount of energy provided by food.

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

Nutrient density • Figure 1.1



Nutrient-dense diets provide more nutrients in fewer calories.



a. Nutrient density is important in choosing a healthy diet. As illustrated here, low-fat milk provides about the same number of calories per cup as bottled iced tea, but it also provides calcium, vitamin D, vitamin A, and other nutrients, including protein.

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

<p>Instead of this ... Low Nutrient Density</p> <p>5 chicken nuggets: 230 Cal, 12 g protein</p>	<p>Have this ... High Nutrient Density</p> <p>Skinless chicken breast: 162 Cal, 25 g protein</p>
<p>Medium order of fries: 380 Cal, 9 mg vitamin C</p>	<p>Medium baked potato: 161 Cal, 17 mg vitamin C</p>
<p>Slice of apple pie: 411 Cal, 4 g fiber</p>	<p>Medium apple: 95 Cal, 2 g fiber</p>

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 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.

Recently, however, voluntary fortification of foods has become common practice. Vitamins and minerals are routinely added to breakfast cereals and a variety of 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.

fortification The addition of nutrients to foods.

dietary supplement A product sold to supplement the diet; may include nutrients (vitamins, minerals, amino acids, fatty acids), enzymes, herbs, or other substances.

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

Dietary supplements are another source of nutrients; about half of U.S. adults take some sort of daily dietary supplement. Supplements provide nutrients but do not offer all the benefits of food (see Chapters 2 and 7).¹

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, these health-promoting substances are called **phytochemicals** (Figure 1.2). 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

Foods that are high in phytochemicals • Figure 1.2

Fruits, vegetables, and whole grains provide a variety of phytochemicals, such as those highlighted here. Supplements of individual phytochemicals are available, but there is little evidence that they provide the health benefits obtained from foods that are high in phytochemicals.¹

Todd Gipstein/NG Image Collection

Garlic, broccoli, and onions provide sulfur-containing phytochemicals that help protect us from some forms of cancer by inactivating carcinogens or stimulating the body's natural defenses.^{4,5}

Yellow–orange fruits and vegetables, such as peaches, apricots, carrots, and cantaloupe, as well as leafy greens, are rich in carotenoids, which are phytochemicals that may prevent oxygen from damaging our cells.⁸



Soybeans are a source of phytoestrogens, hormone-like compounds found in plants that may affect the risk of certain types of cancer and delay the progression of heart disease.^{6,7}

Purple grapes, berries, and onions provide red, purple, and pale yellow pigments called flavonoids, which prevent oxygen damage and may reduce the risk of cancer and heart disease.^{9,10}

Functional foods provide benefits beyond their nutrients Table 1.1

Food	Potential health benefit
Blueberries	May reduce the risk of heart disease and cancer. ^{10,11}
Breakfast cereal with added flaxseed	Helps reduce blood cholesterol levels and the overall risk of heart disease. ¹²
Chocolate	May help reduce blood pressure and other risk factors for heart disease. ¹³
Garlic	Helps reduce blood cholesterol levels and the overall risk of heart disease. ¹⁴
Kale	May reduce the risk of age-related blindness (macular degeneration). ¹⁵
Margarine with added plant sterols	Reduces blood cholesterol levels. ¹⁶
Nuts	May reduce the risk of heart disease. ¹⁷
Oatmeal	Helps reduce blood cholesterol. ¹⁸
Orange juice with added calcium	Helps prevent osteoporosis.
Salmon	Reduces the risk of heart disease. ¹⁹
Green tea	May reduce the risk of certain types of cancer. ²⁰
Whole-grain bread	Helps reduce the risk of cancer, heart disease, obesity, and diabetes. ²¹

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

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, but some foods fortified with nutrients or enhanced with phytochemicals or other substances are also classified as functional foods (**Table 1.1**).²²

Nutrition InSight

Food choices • Figure 1.3

The food choices we make are influenced by society, culture, attitudes, and emotions as well as by food availability.



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◀ We use food as reward and punishment. A well-behaved child may be rewarded with an ice cream cone, while a child who misbehaves may be sent to bed without dessert. We also use food to commemorate milestones such as birthdays and anniversaries.

Food can provide comfort and security. “Comfort foods” such as hot tea, chicken soup, and chocolate help us to feel better when we are sick, cold, tired, or lonely. ▶



Justin Guariglia/NG Image Collection



◀ We can choose only from foods that are available to us. What is available is affected by season, geography, economics, health, and living conditions. In many parts of the world, food choices are limited to foods produced locally, but in more developed regions, many nonnative and seasonal foods, such as these grapes, are available year-round because they can be stored and shipped from distant locations.

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These modified foods, such as water with added vitamins, oatmeal with added soy protein, and orange juice with added calcium, have also been called **designer foods**. The term **nutraceutical** refers to any food or supplement that delivers a health benefit. As food manufacturers fortify foods to cash in on the concept that “health sells,” the line between what is a dietary supplement and what is a food has become blurred.

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. Sometimes we choose a food simply because it is put in front of us; often our choices also depend on what we have learned to eat, what is socially acceptable in our cultural heritage or religion, what we think is healthy, or what our personal convictions—such as environmental

consciousness or vegetarianism—demand. Tradition and values may dictate what foods we consider appropriate, but individual preferences for taste, smell, appearance, and texture affect which foods we actually consume. All these factors are involved in food choices because food does more than meet our physiological requirements. It also provides sensory pleasure and helps meet our social and emotional needs (**Figure 1.3**).

CONCEPT CHECK



1. **Which** has a higher nutrient density: a soda or a glass of 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 the foods you eat at a family picnic?

✓ THE PLANNER



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◀ Food preferences and eating habits are learned as part of an individual’s family, cultural, national, and social background. In many parts of the world, insects, such as these cicadas and grasshoppers, are considered a treat, but in U.S. culture, insects are considered food contaminants, and most people would refuse to eat them.



David Hoffman/Alamy

◀ Often people’s attitudes about what foods they think are good for them or are good for the environment affect what they choose. For example, you may choose green tea to increase your intake of cancer-fighting antioxidants or organic produce because you are concerned about the environmental impact of pesticides.



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▲ For an adolescent, stopping for pizza after school may be part of being accepted by his or her peers. Food is the centerpiece of everyday social interactions. We meet friends for dinner or a cup of coffee. The family dinner table is a focal point for communication, where experiences of the day are shared.

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, and proteins are all **organic compounds** that provide energy to the body. Although we

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 (H₂O).

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 1.4a). Several types of **lipids** play important roles in nutrition (Figure 1.4b). 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 called **amino acids** that are linked

together in different combinations to form different proteins (Figure 1.4c).

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. In the body, water acts as a lubricant, a transport fluid, and a regulator of body temperature.

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 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 (see *Debate: Super-Fortified Foods: Are They a Healthy Addition to Your Diet?* on page 10). Dietary supplements are another source of vitamins and minerals for some people.

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.

What Nutrients Do

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 listed on food labels are actually **kilocalories** (abbreviated kilocalorie 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

Carbohydrates, lipids, and proteins • Figure 1.4

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 added sugar. High-fiber, low-sugar foods have a higher nutrient density than do low-fiber, high-sugar foods.



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b. High-fat plant foods such as vegetable oils, avocados, olives, and nuts have no cholesterol and are high in unsaturated fat, so they don't increase the risk of heart disease. High-fat animal foods such as cream, butter, meat, and whole milk are high in saturated fat and cholesterol; a diet high in these increases the risk of heart disease.



Charles D. Winters/Science Source



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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 found in grains, nuts, and beans. However, when plant sources of protein are combined, they can provide all the amino acids we need.