

Nutrition

A close-up photograph of a light-colored wooden bowl overflowing with fresh, dark purple blackberries. The bowl sits on a rustic wooden surface. Several individual blackberries are scattered on the table in the foreground, and a few green leaves are visible at the bottom right corner. The background is softly blurred, showing more of the wooden surface.

An Applied Approach

**FOURTH
EDITION**

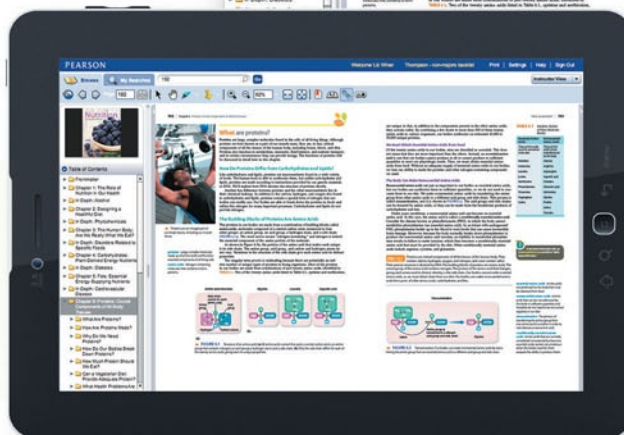
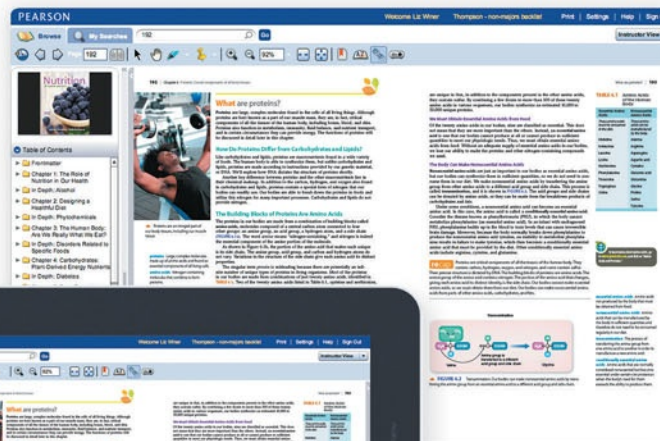
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Nutrition

An Applied Approach

FOURTH EDITION

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University of Birmingham

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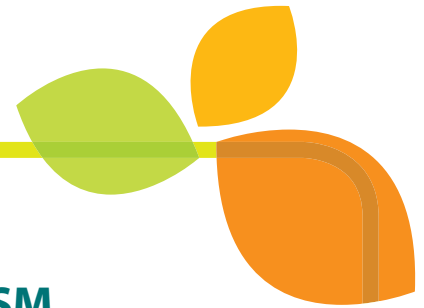
“To our Moms—your consistent love and support are the keys to our happiness and success. You have been incredible role models.”

“To our Dads—you raised us to be independent, intelligent, and resourceful. We miss you and wish you were here to be proud of, and to brag about, our accomplishments.”



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about the authors



Janice Thompson, Ph.D., FACSM

University of Birmingham

Janice Thompson earned her Ph.D. at Arizona State University in exercise science with an emphasis in exercise physiology and nutrition. She is currently a professor in the School of Sports and Exercise Sciences at The University of Birmingham, U.K. Her work in the United Kingdom focuses on developing nutrition and physical activity interventions to reduce the risk for cardiovascular disease and type 2 diabetes in high-risk populations. Janice has retained her U.S. affiliation as a nutrition and exercise research consultant with the Office of Native American Diabetes Programs at the University of New Mexico Health Sciences Center.

Janice is a fellow of the American College of Sports Medicine (ACSM) and a member of the American Society for Nutrition (ASN), the British Association of Sport and Exercise Science (BASES), and The Nutrition Society. Janice won an undergraduate teaching award while a faculty member at the University of North Carolina, Charlotte.

Janice publishes two other nutrition books with Pearson: the higher-level majors text, *The Science of Nutrition* (just published in its 3rd edition), and the consumer-level book, *Nutrition for Life*, 3rd edition. In addition, Janice co-authored *Sport Nutrition for Health and Performance*, with Melinda Manore (published by Human Kinetics).



Melinda Manore, Ph.D., RD, CSSD, FACSM

Oregon State University

Melinda Manore earned a doctorate in human nutrition with a minor in exercise physiology at Oregon State University, and a master's degree in health education from the University of Oregon. She is currently a professor in the Department of Nutrition and Exercise Sciences at Oregon State University, where she teaches and conducts research in the area of nutrition and exercise. She served as Chair and Professor in the nutrition department until late 2004, when it combined with the exercise sciences department and she stepped down from her Chair position. Before coming to Oregon State, she taught at Arizona State University for 17 years. Melinda's areas of specialization include nutritional requirements and issues for active women, nutrition assessment, and the role that nutrition and exercise play in health, energy balance, obesity, and disordered eating.

A registered dietitian, Melinda is an active member of the American Dietetic Association (ADA). She is Past Chair of the ADA Research Committee and the Research DPG (Dietetic Practice Group). Melinda is a member of the American Society of Nutritional Sciences (ASNS), the American Society for Clinical Nutrition (ASCN), the North American Association for the Study of Obesity (NAASO), the National Academy of Sciences Committee on Military Nutrition Research, and a Fellow of the American College of Sports Medicine (ACSM).

Melinda writes a nutrition column for and is an associate editor for ACSM's *Health and Fitness Journal*, and she has won numerous awards for excellence in research and teaching. While at Arizona State University, she was nominated for the Distinguished Mentor of Women Award (1996), and the College of Liberal Arts & Sciences Alumni Association Outstanding Teaching Award (1998, 2000). In 2001, she received the SCAN Excellence in Practice Award.

Melinda co-authored *The Science of Nutrition*, 3rd edition with Janice Thompson and Linda Vaughan; *Nutrition for Life*, 3rd edition with Janice Thompson; and co-authored the Human Kinetics title *Sport Nutrition for Health and Performance* with Janice.

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Welcome to *Nutrition: An Applied Approach*, Fourth Edition!

Why We Wrote This Book

Nutrition gets a lot of press. Go online or pick up a magazine and you'll read the latest debate over which weight-loss diet is best; turn on the TV or stream a video and you'll hear a celebrity describe how she lost 50 pounds without exercising; scan the headlines or read some blogs and you'll come upon the politics surrounding the creation of new, enhanced "designer" foods. How can you evaluate these sources of nutrition information and find out whether the advice they provide is reliable? How do you navigate through seemingly endless recommendations and arrive at a way of eating that's right for *you*—one that supports your physical activity, allows you to maintain a healthful weight, and helps you avoid chronic diseases?

Nutrition: An Applied Approach began with our conviction that students and instructors would both benefit from an accurate and clear textbook that links nutrients to their functional benefits. As authors and instructors, we know that students have a natural interest in their bodies, their health, their weight, and their success in sports and other activities. By demonstrating how nutrition relates to these interests, this text empowers students to reach their personal health and fitness goals. Throughout the text, material is presented in a lively narrative that continually links the facts to students' circumstances, lifestyles, and goals. Information on current events and research keeps the inquisitive spark alive, illustrating that nutrition is truly a "living" science, and a source of considerable debate. The content of *Nutrition: An Applied Approach* is appropriate for non-nutrition majors, but also includes information that will challenge students who have a more advanced understanding of chemistry and math. We present the "science side" in a contemporary narrative style that's easy to read and understand, with engaging features that reduce students' apprehensions and encourage them to apply the material to their lives. Also, because this book is not a derivative of a majors text, the writing and the figures are cohesive and always level-appropriate.

As teachers, we are familiar with the myriad challenges of presenting nutrition information in the classroom, and we have included the most comprehensive ancillary package available to assist instructors in successfully meeting these challenges. We hope to contribute to the excitement of teaching and learning about nutrition: a subject that affects all of us, a subject so important and relevant that correct and timely information can make the difference between health and disease.

New to the Fourth Edition

In this edition we are pleased to introduce all-new, colorful **Focus Figures**. Appearing in bold displays covering fifteen critical topics, these full-page visual displays help instructors to more easily teach, and students to better understand, some of the toughest topics in nutrition, with clear, easy-to-follow graphics and text. These dramatic visual spreads also appear as tutorials within MasteringNutrition™, with hints and wrong answer feedback that can be assigned and graded.

This Fourth Edition of *Nutrition: An Applied Approach* also now features the **MasteringNutrition**™ online homework, tutorial, and assessment system which delivers self-paced tutorials and activities that provide individualized coaching, a focus on course objectives, and tools enabling instructors to respond individually to each student's progress. The proven Mastering system provides instructors with customizable,

easy-to-assign, automatically graded assessments that motivate students to learn outside of class and arrive prepared for lecture. Key MasteringNutrition™ features include:

- **Personalized learning** to help students quickly master key concepts using self-paced tutorials that include wrong-answer feedback and hints
- **Focus Figure Coaching Activities** that guide students through key nutrition concepts with interactive mini-lessons that supply hints and feedback.
- **NutriTools Build-A-Meal Coaching Activities** that enable students to apply nutrition concepts through interactive mini-lessons that supply hints and feedback.
- **Math Activities** that provide hands-on practice for important calculations along with helpful wrong-answer feedback.
- **ABC News Videos** that bring nutrition to life with up-to-date topics in the nutrition field, and include multiple choice questions with wrong-answer feedback.
- **Nutrition Animations** that elucidate big-picture concepts and provide a helpful visual overview of complex topics in nutrition.
- An online **Study Area** that is broken out into learning areas and which includes videos, animations, MP3s, and other resources.
- Additional graded activities include chapter-based **Reading Quizzes, MP3s, Math Review, and MyDietAnalysis Case Study Activities.**

Other exciting new features include a new **Behavior Change** feature box, appearing near the end of every main chapter, that provides a personalized and useful tool for improving students' nutritional awareness and their ability to incorporate positive nutritional changes into their lives. We have also updated and expanded the chapter-opening **Learning Objectives** throughout the text, in addition to adding them to each In Depth feature. **Critical Thinking Questions** have been added to every main chapter Nutrition Debate box, and new topic areas have been added. **Hot Topics** is an engaging new feature appearing throughout the text that provides snapshots of important and trending topics in nutrition.

We have also reorganized and enhanced numerous chapter topics and treatments, including expanding coverage of Functional Foods; reorganizing and expanding content in Chapter 10 on Nutrients Involved in Energy Metabolism and Blood Health; revising, updating, and reorganizing the content in Chapter 13 and In Depth 13.5, covering Food Safety and Technology and issues related to Food Ethics; and added a new In Depth (Chapter 2.5) on Eating Wisely that focuses on recent developments in the areas of mindful eating and the practical aspects of eating well. Note that the Find the Quack feature from previous editions can now be found in the MasteringNutrition Study Area.

The Visual Walkthrough located at the front of this text provides an overview of these and other important features in the Fourth Edition. For specific changes to each chapter, please see below.

Chapter 1 and In Depth 1.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Changed the title of chapter to more accurately reflect revised content.
- Added new Focus Figure 1.9 on Dietary Reference Intakes (replaces previous Figures 1.9–1.11).
- Added new section on *Healthy People 2020*.
- Added new Nutrition Debate, “Are There Such Things as Good Foods and Bad Foods?”
- Added Nutrition Online links.
- Revised text to include more references to the Internet.
- Revised section title and added new information within section, “How Can You Interpret the Results of Research Studies?”
- Revised and tightened the Quick Tips on detecting media hype.
- Updated Figures 1.3 and 1.4 with more recent statistics on causes of death and obesity rates, respectively.

- Simplified the You Do The Math box context.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added new In Depth, “New Frontiers in Nutrition and Health.”
- Added new Learning Objectives to the In Depth.

Chapter 2 and In Depth 2.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Added additional information on cultural influences on food choices.
- Updated discussion related to proposed changes to food labels and the Nutrition Facts panel.
- Updated information on the Dietary Guidelines for Americans, the USDA Food Patterns, and MyPlate.
- Deleted the Nutrition Label Activity related to Health Claims on Food Labels.
- Dropped the figures of Latin American, Asian, and Mediterranean food pyramids.
- Added new Figures 2.5 (MyPlate), 2.6 (MyPlate can be easily used to design a Mediterranean-style diet), and 2.11 (MiPlato).
- Developed a new Hot Topic, “Does Calorie-Labeling Influence Food Choice?”
- Wrote a new Nutrition Debate, “Will MyPlate Promote America’s Health?”
- Added in a brief section discussing healthy eating plans (DASH diet and the exchange system).
- Added Nutrition Online links.
- Added a second You Do The Math box on determining the healthiest food choices when eating out.
- Added the new Behavior Change feature.
- Developed an entirely new In Depth on Eating Wisely.
- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Chapter 3 and In Depth 3.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Moved content on appetite and eating cues from the section “Why Do We Want to Eat What We Want to Eat?” to In Depth 2.5.
- Expanded the discussion of hormones involved in hunger and satiation.
- Added two new Focus Figures (Figures 3.4 and 3.12) to provide a more comprehensive overview of digestion and of the absorption of nutrients at the enterocytes.
- Moved the figure of the role of enzymes in the human body from Chapter 6 to this chapter.
- Discussed and added a math box (You Do The Math) on the pH scale, with a figure.
- In the disorders section, added discussions of vomiting and of GI cancers. We also added a new figure of a colonoscopy.
- Added a new Hot Topic on digestion simulators, removing the old one on prescription appetite suppressants.
- Also in the disorders section, we completely updated the discussion of GERD.
- Replaced a previous Nutrition: Myth or Fact? feature on ulcers with a more comprehensive Nutrition Debate on ulcers, “*H. pylori*: Could the Same Germ Make Us Sick and Keep Us Well?”, which discusses research into the helpful role of *H. pylori* in childhood as well as its role in ulcers and stomach cancer.
- Deleted the previous Nutrition Debate on colon cleansing.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Chapter 4 and In Depth 4.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Introduced the terms *glycogenesis* and *glycogenolysis*.

- Added two new Focus Figures—one on carbohydrate digestion (Figure 4.8) and one on regulation of blood glucose (Figure 4.10).
- Added new Focus Figure 2 on Diabetes in In Depth.
- Added a new section on “What Makes a Whole Grain Whole,” which includes new Figure 4.13.
- Added a new Quick Tips feature on reducing added sugar intake, “Slashing Your Sugar Intake.”
- Enhanced the section on diabetes by adding *prediabetes* as a key term, adding the blood glucose range values for diagnoses of normal, prediabetes, and diabetes, and expanding information on the management of diabetes.
- Expanded the information on high-fructose corn syrup by adding it as a boldfaced term and discussing it in more detail in the section on sugar and obesity.
- Updated and revised the Nutrition Debate to encompass the role of all added sugars in the obesity epidemic.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Chapter 5 and In Depth 5.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Added three new Focus Figures: Figure 5.10 on lipid digestion, Figure 1 on atherosclerosis in In Depth 5.5 and Figure 3 on lipoprotein transport and distribution in In Depth 5.5.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Chapter 6 and In Depth 6.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Moved the figure on proteins acting as enzymes to Chapter 3 (it is now Figure 3.6) where the concept is first introduced.
- Expanded the section on how genes regulate amino acid binding and protein synthesis.
- Added two new Focus Figures—one on protein synthesis (Figure 6.4) and one on protein digestion (Figure 6.11).
- Expanded the information on the functions of proteins, including their role in the transport and storage of nutrients, as neurotransmitters, and in blood clotting.
- Updated and expanded the section examining whether eating too much protein is harmful.
- Deleted the figure of the Vegetarian Food Pyramid, and added a new section on using MyPlate to design a vegetarian diet.
- Updated the section on kwashiorkor, highlighting recent research implicating the role of dysfunctional GI bacteria in this disorder.
- Added a new section addressing disorders related to genetic abnormalities, including PKU, sickle cell anemia, and cystic fibrosis.
- Updated and revised the Nutrition Debate to focus on climate change and the current controversies surrounding meat consumption and livestock production.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Updated the In Depth on vitamins and minerals.
- Added a Quick Tips feature on “Retaining the Vitamins in Foods.”
- Added new Learning Objectives to the In Depth.

Chapter 7 and In Depth 7.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Added the new Behavior Change feature.
- Added a new Focus Figure (Figure 7.4) on fluid and electrolyte balance in the cell membrane.

- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Chapter 8 and In Depth 8.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Enhanced the matching of examples of foods high in specific nutrients in the written text with examples provided in the figures (specifically Figures 8.6, 8.7, 8.10, 8.12, and 8.16).
- Added a new figure on selenium and glutathione peroxidase (now Figure 8.9).
- Expanded information related to antioxidant supplementation and risk for various cancers and cardiovascular disease.
- Added additional information on the conversion of units of beta-carotene and vitamin A in both food and supplement forms.
- Updated, revised, and reorganized the content on vitamin A.
- Added a new Focus Figure on vitamin A's role in vision (Figure 8.14).
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Updated the In Depth on cancer, and enhanced information on the role of diet in cancer prevention.
- Added new Learning Objectives to the In Depth.

Chapter 9 and In Depth 9.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Revised and updated content on parathyroid hormone and its role in increasing blood calcium.
- Revised Figure 9.5 to illustrate the mechanism and action of parathyroid hormone in increasing blood calcium.
- Updated the new RDA information for calcium and vitamin D.
- Updated the Hot Topic feature on the role of calcium in weight loss.
- Revised the latitude line (from 40° to 37°) at which sun exposure is/is not adequate for vitamin D conversion during the winter in Figure 9.9.
- Updated content on the link between soft drink intake and bone mineral density.
- Provided recent recommendations on vitamin D supplementation to prevent vitamin D insufficiency and deficiency in children and adults.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Updated and revised current recommendations and associated risks for the use of calcium and vitamin D supplements to prevent and treat osteoporosis.
- Updated the latest research into the risks and benefits of medications used to treat osteoporosis, including bisphosphonates and hormone replacement therapy.
- Added new Learning Objectives to the In Depth.

Chapter 10 and In Depth 10.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Chapter 11 and In Depth 11.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Updated research on possible protective effects of having a body mass index in the overweight category, and included a new Hot Topic on this issue.
- Expanded information on energy balance and introduced the concept of dynamic (versus static) energy balance and its role in body weight regulation.
- Added a new Focus Figure (Figure 11.5) illustrating energy balance.

- Added a section describing Non-Activity Thermogenesis (NEAT).
- Added information on the FTO gene and obesity.
- Expanded the information describing metabolic and physiologic factors that influence weight loss and gain.
- Added a section on cultural and economic factors that influence food choice and body weight.
- Expanded the information on how to design a healthy weight loss plan.
- Added a section on underweight and how to healthfully gain weight.
- Added a section on obesity and its related health risks.
- Added a new figure on abdominal obesity (Figure 11.10).
- Updated information on current medications used to treat obesity, and on the sleeve gastrectomy surgical procedure.
- Revised and updated the Nutrition Debate on High Carbohydrate, Moderate-Fat Diets.
- Added the new Behavior Change feature.
- Added two new end of chapter Math Review questions.
- Added new Learning Objectives to the In Depth.

Chapter 12 and In Depth 12.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Added new Figure 12.1 highlighting benefits of physical activity.
- Added a new section describing how to assess your current level of fitness.
- New What About You? feature on “Taking the President’s Challenge Adult Fitness Test.”
- Expanded information on the factors that influence a person’s motivations to be physically active.
- Updated and expanded content on the FITT principle (frequency, intensity, time, and type) for appropriately overloading the body to achieve fitness gains.
- Added new Figure 12.4—heart rate training chart to estimate heart rate training range for goal setting.
- Added new Focus Figure (Figure 12.7) on What Fuels Our Activities?
- Expanded information on the intensity of exercise needed to decrease body fat.
- Added a new Hot Topic feature, “Should Athletes ‘Train Low’ with Carbohydrate?”
- Revised and updated the Nutrition Debate, “How Much Physical Activity Is Enough?”
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added a new In Depth chapter on Ergogenic Aids, which includes a new table providing an overview of commonly used ergogenic aids, their claimed mechanism of action, whether or not they are effective, and side effects.
- Added new Learning Objectives to the In Depth.

Chapter 13 and In Depth 13.5:

- All Learning Objectives are matched to main (A level) sections of the chapter.
- Replaced the chapter-opening discussion with a discussion of norovirus specifically, because of the many recent outbreaks.
- Updated information on the Food Safety Modernization Act.
- Expanded and separated with subheadings the discussions of the microorganisms involved in foodborne illness.
- Expanded and separated with subheadings the discussions of toxins involved in foodborne illness.
- Added Figure 13.7 on the “danger zone” of temperature within which microorganisms readily multiply in food.
- Removed previous Table 13.3 (A Guide to Thawing Poultry) and Figure 13.8 (“Thermy”).
- Condensed the information on food preservation.
- Expanded the discussion of genetically modified foods.
- Expanded the discussion of organic foods.

- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Replaced the prior In Depth on Global Nutrition with a new In Depth called Food Ethics: Sustainability, Equity, and the New Food Movement, which covers the impact of corporate farming on the environment and on food diversity; various initiatives such as CSAs and school gardens; food insecurity; fair trade; and what consumers can do to help.
- Added new Learning Objectives to the In Depth.

Chapter 14 and In Depth 14.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Chapter 15 and In Depth 15.5:

- Added new Learning Objectives matched to main (A-level) sections of the chapter.
- Added the new Behavior Change feature.
- Added an end of chapter Math Review question.
- Added new Learning Objectives to the In Depth.

Appendices and Back Matter:

- Moved the USDA Food Guide Evolution to Appendix A.
- Data for Appendix C—“Foods Containing Caffeine”—has been revised and updated.
- References for all chapters and In Depth features are now located and centralized at the back of the text.
- Answers to Review Questions and Math Review have been revised and updated to reflect the new edition’s changes.
- Glossary terms have been revised and expanded as needed.

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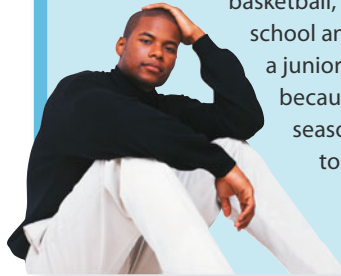
Our Nutri-Case scenarios enable students to evaluate the nutrition-related beliefs and behaviors of five people representing a range of backgrounds and nutritional challenges. Take a moment to get acquainted with our Nutri-Case characters here.

HANNAH



Hi, I’m Hannah. I’m 18 years old and in my first year at Valley Community College. I’m 5’6” and right now I weigh 171 lbs. I haven’t made up my mind yet about my major. All I know for sure is that I don’t want to work in a hospital like my mom! I got good grades in high school, but I’m a little freaked out by college so far. There’s so much homework, plus one of my courses has a lab, plus I have to work part-time because my mom doesn’t have the money to put me through school. . . . Sometimes I feel like I just can’t handle it all. And when I get stressed out, I eat. I’ve already gained 10 pounds and I haven’t even finished my first semester!

THEO



Hi, I'm Theo. Let's see, I'm 21, and my parents moved to the Midwest from Nigeria 11 years ago. I'm 6'8" tall and weigh-in at 200 lbs. The first time I ever played basketball, in middle school, I was hooked. I won lots of awards in high school and then got a full scholarship to the state university, where I'm a junior studying political science. I decided to take a nutrition course because, last year, I had a hard time making it through the playing season, plus keeping up with my classes and homework. I want to have more energy, so I thought maybe I'm not eating right. Anyway, I want to figure out this food thing before basketball season starts again.

LIZ



I'm Liz, I'm 20, and I'm a dance major at the School for Performing Arts. I'm 5'4" and currently weigh about 103 lbs. Last year, two other dancers from my class and I won a state championship and got to dance in the New Year's Eve celebration at the governor's mansion. This spring, I'm going to audition for the City Ballet, so I have to be in top condition. I wish I had time to take a nutrition course, but I'm too busy with dance classes, rehearsals, and teaching a dance class for kids. But it's okay, because I get lots of tips from other dancers and from the Internet. Like last week, I found a website especially for dancers that explained how to get rid of bloating before an audition. I'm going to try it for my audition with the City Ballet!

JUDY



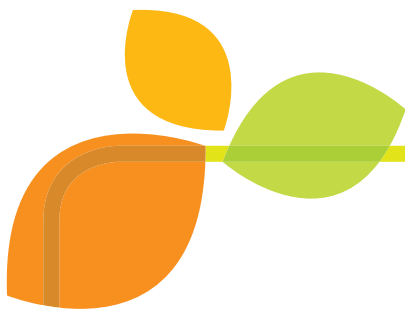
I'm Judy, Hannah's mother. I'm 38 years old and a nurse's aide at Valley Hospital. I'm 5'5" and weigh 200 lbs. Back when Hannah was a baby, I dreamed of going to college so I could be a registered nurse. But then my ex and I split up, and Hannah and me, we've been in survival mode ever since. I'm proud to have raised my daughter without any handouts, and I do good work, but the pay never goes far enough and it's exhausting. I guess that's partly because I'm out of shape, and my blood sugar's high. Most nights, I'm so tired at the end of my shift that I just pick up some fast food for supper. I know I should be making home-cooked meals, but like I said, I'm in survival mode.

GUSTAVO



Hello. My name is Gustavo. I'm 69 years young at the moment, but when I was 13 years old I came to the United States from Mexico with my parents and three sisters to pick crops in California. Now I manage a large vineyard. They ask me when I'm going to retire, but I can still work as hard as a man half my age. Health problems? None. Well, maybe my doctor tells me my blood pressure is high, but that's normal for my age! I guess what keeps me going is thinking about how my father died 6 months after he retired. He had colon cancer, but he never knew it until it was too late. Anyway, I watch the nightly news and read the papers, so I keep up on what's good for me, "Eat less salt" and all that stuff. I'm doing great! I'm 5'5" tall and weigh 166 lbs.

Throughout this text, students will follow these five characters as they grapple with various nutrition-related challenges. As they do, the characters might remind students of themselves, or of people they may know. Our hope is that by applying the information learned in this course to their own circumstances, students will deepen their understanding of the importance of nutrition in achieving a healthful life.



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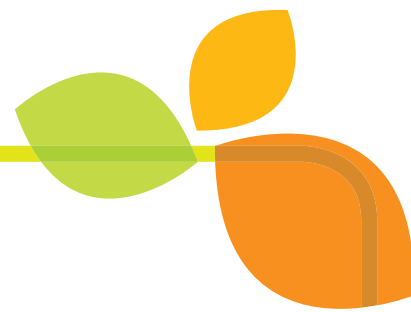
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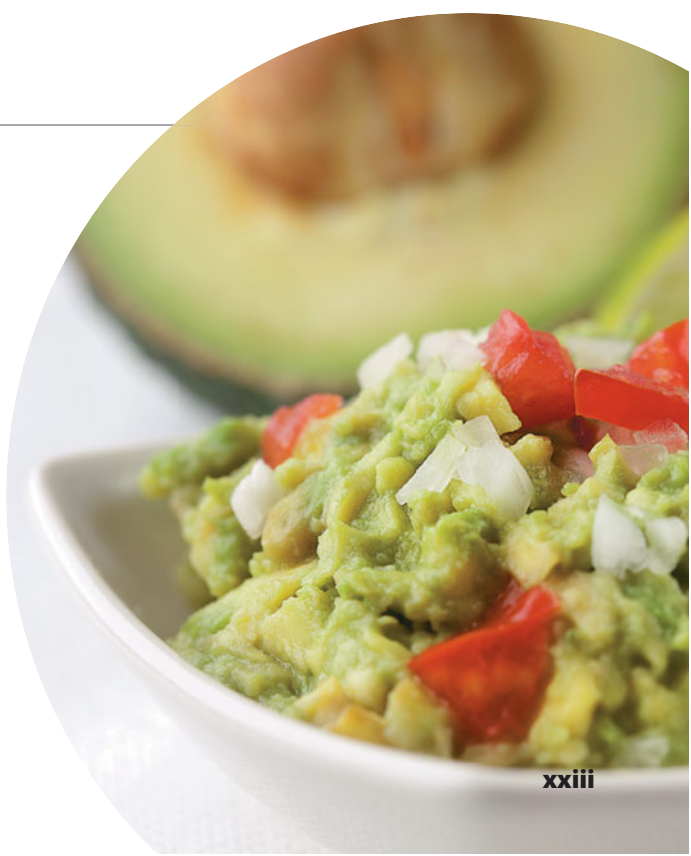


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test yourself

1. **T** **F** A Calorie is a measure of the amount of fat in a food.
2. **T** **F** Proteins are not the primary source of energy for our body.
3. **T** **F** The Recommended Dietary Allowance is the maximum amount of a vitamin or other food component that people should consume to support normal body functions.

Test Yourself answers are located at the end of the chapter.

Nutrition

Linking food, function, and health

1

Learning objectives

After studying this chapter you should be able to:

- 1 Define the term *nutrition* and describe its evolution as a science, p. 4.
- 2 Discuss why nutrition is important to health, pp. 4–8.
- 3 Identify the six classes of nutrients essential for health, pp. 8–13.
- 4 Identify the Dietary Reference Intakes for nutrients, pp. 14–17.
- 5 Describe the steps of the scientific method used in research studies, pp. 17–23.
- 6 List at least four sources of reliable and accurate nutrition information, pp. 24–26.

Miguel hadn't expected college life to make him

feel so tired. After classes, he just wanted to go back to his dorm and sleep. Plus, he'd been having trouble concentrating and was worried that his first-semester grades would be far below those he'd achieved in high school. Scott, his roommate, had little sympathy. "It's all that junk food you eat!" he insisted. "Let's go down to the organic market for some real food." Miguel dragged himself to the market with Scott. A woman wearing a white lab coat approached him and introduced herself as the market's staff nutritionist. "You're looking a little pale," she said. "Anything wrong?" Miguel explained that he had been feeling tired lately. "I don't doubt it," the woman answered. "I can see from your skin tone that you're anemic. You need to start taking an iron supplement." She took a bottle of pills from a shelf and handed it to him. "This one is the easiest for you to absorb, and it's on special this week. Take it twice a day, and you should start feeling better in a day or two." Miguel bought the supplement and began taking it that night with the meal his roommate had prepared. He took it twice the next day as well, just as the nutritionist had recommended, but didn't feel any better. After 2 more days, he visited the university health clinic, where a nurse drew some blood for testing. When the results came in, the doctor told him that his thyroid gland wasn't making enough of the hormone he needed to keep his body functioning properly. She prescribed a medication and congratulated Miguel for catching the problem early. "If you had waited," she said, "it would only have gotten worse, and you could have become seriously ill." Miguel asked if he should continue taking his iron supplements. The doctor looked puzzled. "Where did you get the idea that you needed iron supplements?"

Continued next page

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Continued—

Like Miguel, you've probably been offered nutrition-related advice from well-meaning friends and self-professed "experts." Perhaps you found the advice helpful, or maybe, as in Miguel's case, it turned out to be all wrong. Where can you go for reliable advice about nutrition? What exactly *is* nutrition, and why does what we eat have such an influence on our health? In this chapter, we'll begin to answer these questions, and you'll gain a deeper understanding as you work through the rest of this book. You'll also learn how to evaluate nutrition-related research studies, as well as how to distinguish science from scams. Our goal is that, by the time you finish this course, you'll be the expert on your own nutritional needs!



What is nutrition?

Although many people think that *food* and *nutrition* mean the same thing, they don't. **Food** refers to the plants and animals we consume. It provides the chemicals our body needs to maintain life and support growth and health. **Nutrition**, in contrast, is the science that studies food and how food nourishes our body and influences our health. It encompasses how we consume, digest, absorb, and store the chemicals in food, and how these chemicals affect our body. Nutrition also involves studying the factors that influence our eating patterns, making recommendations about the amount we should eat of each type of food, attempting to maintain food safety, and addressing issues related to the global food supply. You can think of nutrition, then, as the discipline that encompasses everything about food.

When compared with other scientific disciplines such as chemistry, biology, and physics, nutrition is a relative newcomer. Although food has played a defining role in the lives of humans since the evolution of our species, an appreciation of the importance of nutrition to our health has developed slowly only during the past 400 years. Early research in nutrition focused on making the link between dietary deficiencies and illness. For instance, the cause of scurvy, which is a vitamin C deficiency, was discovered in the mid-1700s. At that time, however, vitamin C had not been identified—what was known was that some ingredient found in citrus fruits could prevent scurvy. Another early discovery in nutrition is discussed in the accompanying **Nutrition Myth or Fact?** box about a disease called pellagra.

Nutrition research continued to focus on identifying and preventing deficiency diseases through the first half of the 20th century. Then, as the higher standard of living after World War II led to an improvement in the American diet, nutrition research began pursuing a new objective: supporting health and preventing and treating **chronic diseases**—that is, diseases that come on slowly and can persist for years, often despite treatment. Chronic diseases of particular interest to nutrition researchers include obesity, heart disease, type 2 diabetes, and various cancers. This new research has raised as many questions as it has answered, and we still have a great deal to learn about the relationship between nutrition and chronic disease.

In recent decades, advances in technology have contributed to the emergence of several exciting new areas of nutrition research. For example, reflecting our growing understanding of genetics, *nutrigenomics* seeks to uncover links between our genes, our environment, and our diet. The **In Depth** following this chapter describes this and other new frontiers in nutrition and health.



➤ Nutrition is the science that studies all aspects of food and its influence on our body and health.

food The plants and animals we consume.

nutrition The science that studies food and how food nourishes our body and influences our health.

chronic diseases Diseases that come on slowly and can persist for years, often despite treatment.

How does nutrition contribute to health?

Think about it: If you eat three meals a day, by this time next year, you'll have had more than a thousand chances to influence your body's makeup! As you'll learn in

nutrition myth or fact?



Is Pellagra an Infectious Disease?

In the first few years of the 20th century, Dr. Joseph Goldberger successfully controlled outbreaks of several fatal infectious diseases, from yellow fever in Louisiana to typhus in Mexico. So it wasn't surprising that, in 1914, the U.S. Surgeon General chose him to tackle another disease, thought to be infectious, that was raging throughout the South. Called *pellagra*, the disease was characterized by a skin rash, diarrhea, and mental impairment. At the time, it afflicted more than 50,000 people each year, and in about 10% of cases it resulted in death.¹



▲ Pellagra is characterized by a scaly skin rash.

Goldberger began studying the disease by carefully observing its occurrence in groups of people. He asked, if it is infectious, then why would it strike children in orphanages and prison inmates yet leave their nurses and guards unaffected? Why did it overwhelmingly affect impoverished millworkers and sharecroppers while leaving their affluent (and well-fed) neighbors healthy? Could a dietary deficiency cause pellagra?

To confirm his hunch, he conducted a series of trials in which he fed afflicted orphans and prisoners—who had been consuming a limited, corn-based diet—a variety of nutritious foods, including meats. They recovered. Moreover, orphans and inmates who did not have pellagra and ate the new diet did not develop the disease. Finally, Goldberger recruited eleven healthy prison inmates, who, in return for a pardon of their sentence, agreed to consume a limited, corn-based diet. After

5 months, six of the eleven developed pellagra.

Still, many skeptics were unable to give up the idea that pellagra was an infectious disease. To prove that pellagra was not spread by germs, Goldberger and his colleagues deliberately injected themselves with and ingested patients' scabs, nasal secretions, and other body fluids. He and his team remained healthy.

Although Goldberger could not identify the precise component in the new diet that cured pellagra, he

eventually found an inexpensive and widely available substance, brewer's yeast, that when added to the diet prevented or reversed the disease. Shortly after Goldberger's death in 1937, scientists identified the component that is deficient in the diet of pellagra patients: niacin, one of the B-vitamins, which is plentiful in brewer's yeast.¹

CRITICAL THINKING QUESTIONS

1. What issues arise from the research done by Dr. Goldberger and his colleagues?
2. Do you think that this research would be considered ethical and acceptable by today's standards? Why or why not?
3. Identify a disease linked to nutrition that you feel deserves substantial attention from researchers. What makes you choose this disease?

this text, you really are what you eat: the substances you take into your body are broken down and reassembled into your brain cells, bones, muscles—all of your tissues and organs. The foods you eat also provide your body with the energy it needs to function properly. In addition, proper nutrition can improve your health, prevent certain diseases, achieve and maintain a desirable weight, and maintain your energy and vitality. Let's take a closer look at how nutrition supports health and wellness.

Nutrition Is One of Several Factors Supporting Wellness

Wellness can be defined in many ways. Traditionally considered simply the absence of disease, wellness has been redefined as we have learned more about our body and what it means to live a healthful lifestyle. Wellness is now considered to be *multidimensional*, including physical, emotional, social, occupational, and spiritual health (FIGURE 1.1, page 6). Wellness is not an endpoint in our lives, but an active process we work on every day.

In this book, we focus on two critical aspects of physical health: nutrition and physical activity. The two are so closely related that you can think of them as two sides of the same coin: our overall state of nutrition is influenced by how much energy we expend doing daily activities, and our level of physical activity has a major impact on how we use the food we eat. We can perform more strenuous activities for

wellness A multidimensional, life-long process that includes physical, emotional, social, occupational, and spiritual health.



▲ **FIGURE 1.1** Many factors contribute to our wellness. Primary among these are a nutritious diet and regular physical activity.

longer periods when we eat a nutritious diet, whereas an inadequate or excessive food intake can make us lethargic. A poor diet, inadequate or excessive physical activity, or a combination of these also can lead to serious health problems. Finally, several studies have suggested that healthful nutrition and regular physical activity can increase feelings of well-being and reduce feelings of anxiety and depression. In other words, wholesome food and physical activity just plain feel good!

A Healthful Diet Can Prevent Some Diseases and Reduce Your Risk for Others

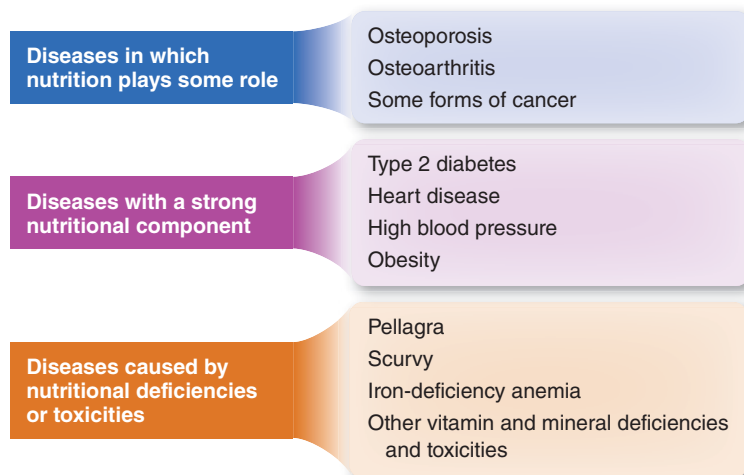
Nutrition appears to play a role—from a direct cause to a mild influence—in the development of many diseases (**FIGURE 1.2**). As we noted earlier, poor nutrition is a direct cause of deficiency diseases, such as scurvy and pellagra. Early nutrition research focused on identifying the missing vitamin or other food substance behind such diseases and on developing guidelines for intake levels that are high enough to prevent them. Over the years, nutrition scientists successfully lobbied for the fortification of foods with the substances of greatest concern. These measures, along with a more abundant and reliable food supply, have almost completely wiped out the majority of nutritional deficiency diseases in developed countries. However, they are still major problems in many developing nations.

In addition to causing disease directly, poor nutrition can have a subtle influence on our health. For instance, it can contribute to the development of brittle bones (a disease called *osteoporosis*) as well as to the progression of some forms of cancer. These associations are considered mild; however, poor nutrition is also strongly associated with three chronic diseases—heart disease, stroke, and diabetes—which are among the top ten causes of death in the United States (**FIGURE 1.3**).

It probably won't surprise you to learn that the primary link between poor nutrition and mortality is obesity. Fundamentally, obesity is a consequence of eating more Calories than are expended. At the same time, obesity is a well-established risk factor for heart disease, stroke, type 2 diabetes, and some forms of cancer. Unfortunately, the prevalence of obesity has dramatically increased throughout the United States during the past 25 years (**FIGURE 1.4**). Throughout this text, we will discuss in detail how nutrition and physical activity affect the development of obesity.



▲ Our level of physical activity has a major impact on how we use the foods we eat.



▲ **FIGURE 1.2** The relationship between nutrition and human disease. Notice that, whereas nutritional factors are only marginally implicated in the diseases of the top row, they are strongly linked to the development of the diseases in the middle row and truly causative of those in the bottom row.

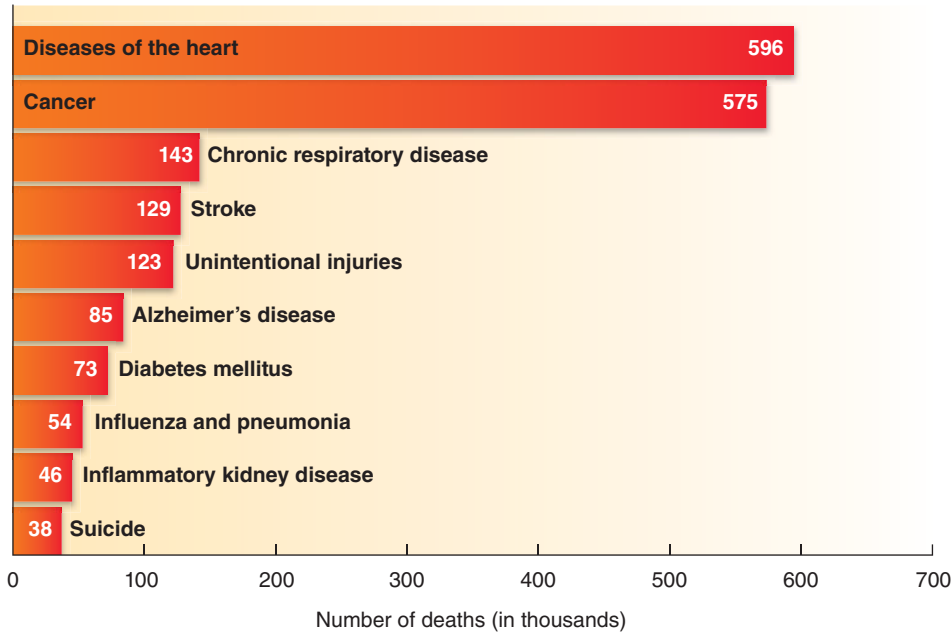


FIGURE 1.3 Of the ten leading causes of death in the United States in 2011, three—heart disease, stroke, and diabetes—are strongly associated with poor nutrition. In addition, nutrition plays a limited role in the development of some forms of cancer.
Data from: “Deaths: Preliminary Data for 2011” (U.S. Department of Health and Human Services).

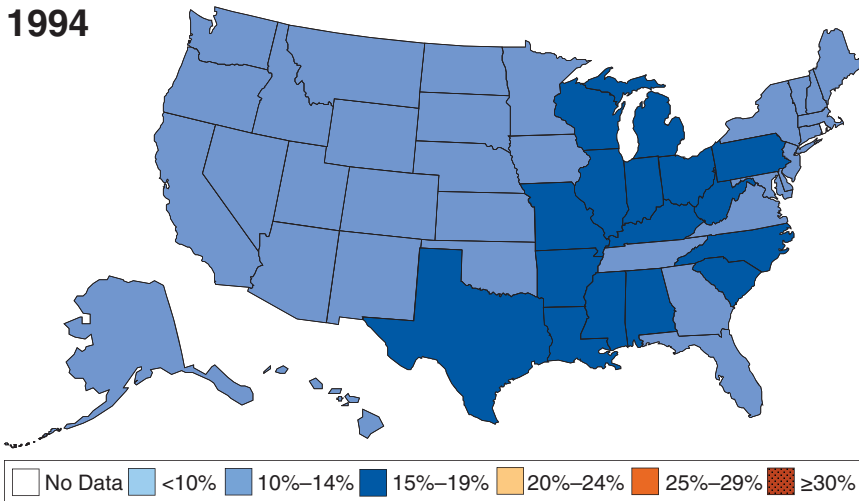


FIGURE 1.4 These diagrams illustrate the increase in obesity rates across the United States from 1994 to 2011 as documented in the Behavioral Risk Factor Surveillance System. Obesity is defined as a body mass index greater than or equal to 30, or approximately 30 lb overweight for a 5'4" woman.
Graphics and data from: “Prevalence of Self-Reported Obesity among U.S. Adults” and “Percent of Obese (BMI=30) in U.S. Adults: 1994” (Centers for Disease Control and Prevention).

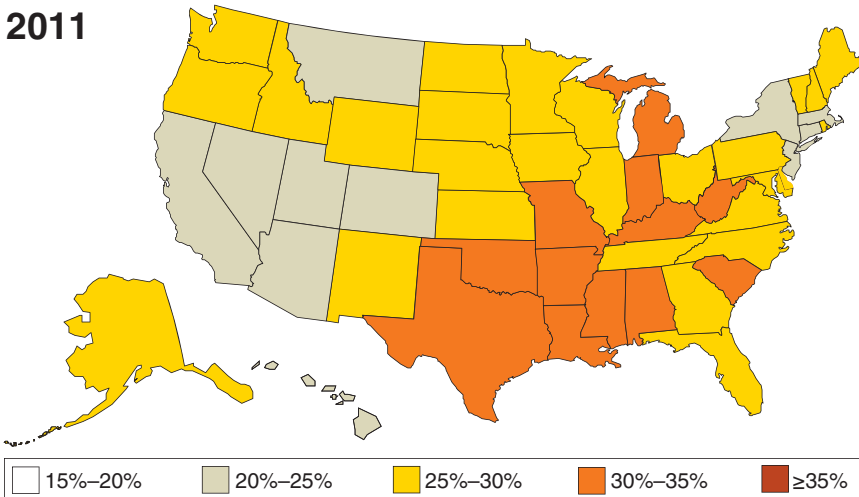


TABLE 1.1 Nutrition and Physical Activity Objectives from *Healthy People 2020*

Topic	Objective Number and Description
Weight status	NWS-8. Increase the proportion of adults who are at a healthy weight from 30.8% to 33.9%. NWS-9. Reduce the proportion of adults who are obese from 34.0% to 30.6%. NWS-10.2. Reduce the proportion of children aged 6 to 11 years who are considered obese from 17.4% to 15.7%.
Food and nutrient composition	NWS-14. Increase the contribution of fruits to the diets of the population aged 2 years and older. NWS-15. Increase the variety and contribution of vegetables to the diets of the population aged 2 years and older.
Physical activity	PA-1. Reduce the proportion of adults who engage in no leisure-time physical activity from 36.2% to 32.6%. PA-2.1. Increase the proportion of adults who engage in aerobic physical activity of at least moderate intensity for at least 150 minutes per week, or 75 minutes per week of vigorous intensity, or an equivalent combination from 43.5% to 47.9%. PA-2.3. Increase the proportion of adults who perform muscle-strengthening activities on 2 or more days of the week from 21.9% to 24.1%.

Data adapted from: "Healthy People 2020" (U.S. Department of Health and Human Services).



Want to see how the prevalence of obesity has changed in the United States over the past 25 years? Go to www.cdc.gov and enter "obesity data trend maps" into the search bar.

Healthy People 2020 Identifies Nutrition-Related Goals for the United States

Because of its importance to the wellness of all Americans, nutrition has been included in the national health promotion and disease prevention plan of the United States. Called *Healthy People*, the plan is revised every decade. *Healthy People 2020*, launched in January 2010, identifies a set of goals and objectives (as an agenda) that we hope to reach as a nation by the year 2020.² This agenda was developed by a team of experts from a variety of federal agencies under the direction of the Department of Health and Human Services. Input was gathered from a large number of independent experts and national and state health organizations, and the general public was invited to share ideas.

The four overarching goals of *Healthy People* are to "1) attain high-quality, longer lives free of preventable disease, disability, injury, and premature death; 2) achieve health equity, eliminate disparities, and improve the health of all groups; 3) create social and physical environments that promote good health for all; and 4) promote quality of life, healthy development, and healthy behaviors across all life stages." These broad goals are supported by hundreds of specific goals and objectives, including many related to nutrition. Other objectives address physical activity and the problem with overweight and obesity, both of which are, of course, influenced by nutrition. **TABLE 1.1** identifies some of the specific goals and objectives related to nutrition and physical activity from *Healthy People 2020*.

recap *Food* refers to the plants and animals we consume, whereas *nutrition* is the scientific study of food and how food affects our body and our health. Nutrition is an important component of wellness and is strongly associated with physical activity. One goal of a healthful diet is to prevent deficiency diseases, such as scurvy and pellagra; a second goal is to lower the risk for chronic diseases, such as type 2 diabetes and heart disease. *Healthy People 2020* is a health promotion and disease prevention plan for the United States.

What are nutrients?

We enjoy eating food because of its taste, its smell, and the pleasure and comfort it gives us. However, we rarely stop to think about what our food actually contains. Foods are composed of many chemical substances, some of which are not useful to the body

SIX GROUPS OF ESSENTIAL NUTRIENTS

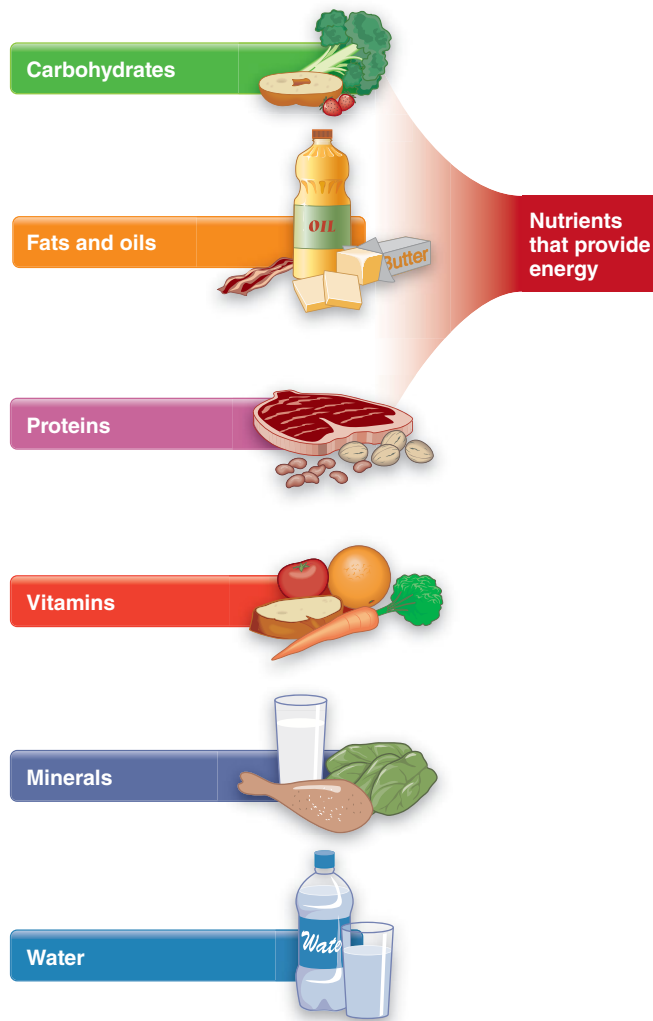


FIGURE 1.5 The six groups of nutrients found in the foods we consume.

and others of which are critical to our growth and function. These latter chemicals are referred to as **nutrients**. The six groups of nutrients found in foods are (FIGURE 1.5):

- carbohydrates
- fats and oils (two types of lipids)
- proteins
- vitamins
- minerals
- water

The term *organic* is commonly used to describe foods that are grown with little or no use of synthetic chemicals. But when scientists describe individual nutrients as **organic**, they mean that these nutrients contain both carbon and hydrogen, fundamental units of matter that are common to all living organisms. Carbohydrates, lipids, proteins, and vitamins are organic. Minerals and water are **inorganic**. Organic and inorganic nutrients are equally important for sustaining life but differ in their structures, functions, and basic chemistry. You will learn more about these nutrients in subsequent chapters; a brief review is provided here.

Macronutrients Provide Energy

Carbohydrates, fats, and proteins are the only nutrients that provide energy. By this we mean that our body breaks down these nutrients and reassembles their

nutrients Chemicals found in foods that are critical to human growth and function.

organic A substance or nutrient that contains the elements carbon and hydrogen.

inorganic A substance or nutrient that does not contain carbon and hydrogen.