NUTRITION

SCIENCE AND APPLICATIONS

Lori Smolin | Mary Grosvenor

4th EDITION

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Dietary Reference Intakes: Recommended Intakes for Individuals: Vitamins

Life Stage Group	Vitamin A (μg/day)[a]	Vitamin C (mg/day)	Vitamin D (μg/day)[b,c]	Vitamin E (mg/day)[d]	Vitamin K (μg/day)	Thiamin (mg/day)	Riboflavin (mg/day)	Niacin (mg/day)[e]	Vitamin B_6 (mg/day)	Folate (μg/day)[f]	Vitamin B_{12} (μg/day)	Pantothenic Acid (mg/day)	Biotin (μg/day)	Choline (mg/day)[g]
Infants														
0–6 mo	400*	40*	10*	4*	2.0*	0.2*	0.3*	2*	0.1*	65*	0.4*	1.7*	5*	125*
6–12 mo	500*	50*	10*	5*	2.5*	0.3*	0.4*	4*	0.3*	80*	0.5*	1.8*	6*	150*
Children														
1–3 y	**300**	**15**	**15**	**6**	30*	**0.5**	**0.5**	**6**	**0.5**	**150**	**0.9**	2*	8*	200*
4–8 y	**400**	**25**	**15**	**7**	55*	**0.6**	**0.6**	**8**	**0.6**	**200**	**1.2**	3*	12*	250*
Males														
9–13 y	**600**	**45**	**15**	**11**	60*	**0.9**	**0.9**	**12**	**1.0**	**300**	**1.8**	4*	20*	375*
14–18 y	**900**	**75**	**15**	**15**	75*	**1.2**	**1.3**	**16**	**1.3**	**400**	**2.4**	5*	25*	550*
19–30 y	**900**	**90**	**15**	**15**	120*	**1.2**	**1.3**	**16**	**1.3**	**400**	**2.4**	5*	30*	550*
31–50 y	**900**	**90**	**15**	**15**	120*	**1.2**	**1.3**	**16**	**1.3**	**400**	**2.4**	5*	30*	550*
51–70 y	**900**	**90**	**15**	**15**	120*	**1.2**	**1.3**	**16**	**1.7**	**400**	**2.4**[h]	5*	30*	550*
>70 y	**900**	**90**	**20**	**15**	120*	**1.2**	**1.3**	**16**	**1.7**	**400**	**2.4**[h]	5*	30*	550*
Females														
9–13 y	**600**	**45**	**15**	**11**	60*	**0.9**	**0.9**	**12**	**1.0**	**300**	**1.8**	4*	20*	375*
14–18 y	**700**	**65**	**15**	**15**	75*	**1.0**	**1.0**	**14**	**1.2**	**400**[i]	**2.4**	5*	25*	400*
19–30 y	**700**	**75**	**15**	**15**	90*	**1.1**	**1.1**	**14**	**1.3**	**400**[i]	**2.4**	5*	30*	425*
31–50 y	**700**	**75**	**15**	**15**	90*	**1.1**	**1.1**	**14**	**1.3**	**400**[i]	**2.4**	5*	30*	425*
51–70 y	**700**	**75**	**15**	**15**	90*	**1.1**	**1.1**	**14**	**1.5**	**400**	**2.4**[h]	5*	30*	425*
>70 y	**700**	**75**	**20**	**15**	90*	**1.1**	**1.1**	**14**	**1.5**	**400**	**2.4**[h]	5*	30*	425*
Pregnancy														
14–18 y	**750**	**80**	**15**	**15**	75*	**1.4**	**1.4**	**18**	**1.9**	**600**[j]	**2.6**	6*	30*	450*
19–30 y	**770**	**85**	**15**	**15**	90*	**1.4**	**1.4**	**18**	**1.9**	**600**[j]	**2.6**	6*	30*	450*
31–50 y	**770**	**85**	**15**	**15**	90*	**1.4**	**1.4**	**18**	**1.9**	**600**[j]	**2.6**	6*	30*	450*
Lactation														
14–18 y	**1200**	**115**	**15**	**19**	75*	**1.4**	**1.6**	**17**	**2.0**	**500**	**2.8**	7*	35*	550*
19–30 y	**1300**	**120**	**15**	**19**	90*	**1.4**	**1.6**	**17**	**2.0**	**500**	**2.8**	7*	35*	550*
31–50 y	**1300**	**120**	**15**	**19**	90*	**1.4**	**1.6**	**17**	**2.0**	**500**	**2.8**	7*	35*	550*

Note: This table (taken from the DRI reports, see www.nap.edu) presents Recommended Dietary Allowances (RDAs) in **bold** type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intakes. RDAs are set to meet the needs of almost all (97 to 98 percent) healthy individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for all other life stage and gender groups is believed to cover the needs of all healthy individuals in the groups, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

[a]As retinol activity equivalents (RAEs). 1 RAE = 1 μg retinol, 12 μg β-carotene, 24 μg α-carotene, or 24 μg β-cryptoxanthin. The RAE for dietary provitamin A carotenoids is two-fold greater than retinol equivalents (REs), whereas the RAE for preformed vitamin A is the same as the RE.

[b]As cholecalciferol. 1 μg cholecalciferol = 40 IU vitamin D.

[c]Under the assumption of minimal sunlight.

[d]As α-tocopherol, which includes RRR-α-tocopherol, the only form of α-tocopherol that occurs naturally in foods, and the 2R-stereoisomeric forms of α-tocopherol (RRR-, RSR-, RRS, and RSS-α-tocopherol) that occur in fortified foods and supplements. It does not include the 2S-stereoisomeric forms of α-tocopherol (SRR-, SSR-, SRS-, and SSS-α-tocopherol), also found in fortified foods and supplements.

[e]As niacin equivalents (NEs), 1 mg niacin = 60 mg tryptophan; 0–6 months = preformed niacin (not NE).

[f]As dietary folate equivalents (DFE). 1 DFE = 1 μg food folate = 0.6 μg folic acid from fortified food or as a supplement consumed with food = 0.5 μg of a supplement taken on an empty stomach.

[g]Although AIs have been set for choline, there are few data to assess whether a dietary supply of choline is needed at all stages of the lifecycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages.

[h]Because 10–30% of older people may malabsorb food-bound B_{12} it is advisable for those older than 50 years to meet their RDA mainly by consuming foods fortified with B_{12} or a supplement containing B_{12}.

[i]In view of evidence linking folate intake with neural tube defects in the fetus, it is recommended that all women capable of becoming pregnant consume 400 μg from supplements or fortified foods in addition to intake of food folate from a varied diet.

[j]It is assumed that women will consume 400 μg from supplements or fortified foods until their pregnancy is confirmed and they enter prenatal care, which ordinarily occurs after the end of the periconceptional period—the critical time for neural tube formation.

Source: Dietary Reference Intake Tables: The Complete Set. Institute of Medicine, National Academy of Sciences available online at www.nap.edu. Reprinted with permission from *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements* , 2006, by the National Academy of Sciences, Washington, D.C. Institute of Medicine, Food and Nutrition Board Dietary Reference Intakes for Calcium and Vitamin D (2011), National Academies Press, Washington DC, 2011.

Dietary Reference Intakes: Recommended Intakes for Individuals: Minerals

Life Stage Group	*Calcium (mg/day)*	*Chromium (μg/day)*	*Copper (μg/day)*	*Fluoride (mg/day)*	*Iodine (μg/day)*	*Iron (mg/day)*	*Magnesium (mg/day)*	*Manganese (mg/day)*	*Molybdenum (μg/day)*	*Phosphorous (mg/day)*	*Selenium (μg/day)*	*Zinc (mg/day)*	*Sodium (g/day)*	*Chloride (g/day)*	*Potassium (g/day)*
Infants															
0–6 mo	200*	0.2*	200*	0.01*	110*	0.27*	30*	0.003*	2*	100*	15*	2*	0.12*	0.18*	0.4*
6–12 mo	260*	5.5*	220*	0.5*	130*	**11**	75*	0.6*	3*	275*	20*	**3**	0.37*	0.57*	0.7*
Children															
1–3 y	**700**	11*	**340**	0.7*	**90**	**7**	**80**	1.2*	**17**	**460**	**20**	**3**	1.0*	1.5*	3.0*
4–8 y	**1000**	15*	**440**	1*	**90**	**10**	**130**	1.5*	**22**	**500**	**30**	**5**	1.2*	1.9*	3.8*
Males															
9–13 y	**1,300**	25*	**700**	2*	**120**	**8**	**240**	1.9*	**34**	**1,250**	**40**	**8**	1.5*	2.3*	4.5*
14–18 y	**1,300**	35*	**890**	3*	**150**	**11**	**410**	2.2*	**43**	**1,250**	**55**	**11**	1.5*	2.3*	4.7*
19–30 y	**1,000**	35*	**900**	4*	**150**	**8†**	**400**	2.3*	**45**	**700**	**55**	**11**	1.5*	2.3*	4.7*
31–50 y	**1,000**	35*	**900**	4*	**150**	**8†**	**420**	2.3*	**45**	**700**	**55**	**11**	1.5*	2.3*	4.7*
51–70 y	**1,000**	30*	**900**	4*	**150**	**8†**	**420**	2.3*	**45**	**700**	**55**	**11**	1.3*	2.0*	4.7*
> 70 y	**1,200**	30*	**900**	4*	**150**	**8†**	**420**	2.3*	**45**	**700**	**55**	**11**	1.2*	1.8*	4.7*
Females															
9–13 y	**1,300**	21*	**700**	2*	**120**	**8**	**240**	1.6*	**34**	**1,250**	**40**	**8**	1.5*	2.3*	4.5*
14–18 y	**1,300**	24*	**890**	3*	**150**	**15†‡**	**360**	1.6*	**43**	**1,250**	**55**	**9**	1.5*	2.3*	4.7*
19–30 y	**1,000**	25*	**900**	3*	**150**	**18†‡**	**310**	1.8*	**45**	**700**	**55**	**8**	1.5*	2.3*	4.7*
31–50 y	**1,000**	25*	**900**	3*	**150**	**18†‡**	**320**	1.8*	**45**	**700**	**55**	**8**	1.5*	2.3*	4.7*
51–70 y	**1,200**	20*	**900**	3*	**150**	**8†**	**320**	1.8*	**45**	**700**	**55**	**8**	1.3*	2.0*	4.7*
> 70 y	**1,200**	20*	**900**	3*	**150**	**8†**	**320**	1.8*	**45**	**700**	**55**	**8**	1.2*	1.8*	4.7*
Pregnancy															
14–18 y	**1,300**	29*	**1,000**	3*	**220**	**27**	**400**	2.0*	**50**	**1,250**	**60**	**12**	1.5*	2.3*	4.7*
19–30 y	**1,000**	30*	**1,000**	3*	**220**	**27**	**350**	2.0*	**50**	**700**	**60**	**11**	1.5*	2.3*	4.7*
31–50 y	**1,000**	30*	**1,000**	3*	**220**	**27**	**360**	2.0*	**50**	**700**	**60**	**11**	1.5*	2.3*	4.7*
Lactation															
14–18 y	**1,300**	44*	**1,300**	3*	**290**	**10**	**360**	2.6*	**50**	**1,250**	**70**	**13**	1.5*	2.3*	5.1*
19–30 y	**1,000**	45*	**1,300**	3*	**290**	**9**	**310**	2.6*	**50**	**700**	**70**	**12**	1.5*	2.3*	5.1*
31–50 y	**1,000**	45*	**1,300**	3*	**290**	**9**	**320**	2.6*	**50**	**700**	**70**	**12**	1.5*	2.3*	5.1*

Note: This table (taken from the DRI reports, see www.nap.edu) presents Recommended Dietary Allowances (RDAs) in **bold** type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intakes. RDAs are set up to meet the needs of almost all (97–98%) healthy individuals in a group. It is calculated from an EAR. If sufficient scientific evidence is not available to establish an EAR, and thus calculate an RDA, an AI is usually developed. For healthy breastfed infants, the AI is the mean intake. The AI for all other life stage and gender groups is believed to cover the needs of all healthy individuals in the groups, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

† The RDA is increased for vegetarians. Value = RDA × 1.8

‡ The RDA is increased for women taking oral contraceptives for 14–18 years = 11.4 mg/day, for 19–50 years = 10.9 mg/day.

Source: Dietary Reference Intake Tables: The Complete Set. Institute of Medicine, National Academy of Sciences. Available online at www.nap.edu. Reprinted with permission from *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements,* 2006, by the National Academy of Sciences, Washington, D.C. Institute of Medicine, Food and Nutrition Board Dietary Reference Intakes for Calcium and Vitamin D (2011), National Academies Press, Washington DC, 2011.

Acceptable Macronutrient Distribution Ranges (AMDR) for Healthy Diets as a Percent of Energy

Age	*Carbohydrate*	*Added Sugars*	*Total Fat*	*Linoleic Acid*	*α-Linolenic Acid*	*Protein*
1–3 y	45–65	≤25	30–40	5–10	0.6–1.2	5–20
4–18 y	45–65	≤25	25–35	5–10	0.6–1.2	10–30
≥19 y	45–65	≤25	20–35	5–10	0.6–1.2	10–35

Source: Institute of Medicine, Food and Nutrition Board. "Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids." Washington, D.C.: National Academies Press, 2002, 2005.

Dietary Reference Intakes: Recommended Intakes for Individuals: Carbohydrates, Fiber, Fat, Fatty Acids, Protein, and Water

Life Stage Group	*Carbohydrate (g/day)*	*Fiber (g/day)*	*Fat (g/day)*	*Linoleic Acid (g/day)*	*α-Linolenic Acid (g/day)*	*Protein*		*Water*[b] *(L/day)*
						(g/kg/day)[a]	*(g/day)*	
Infants								
0–6 mo	60*	ND	31*	4.4*†	0.5*‡	1.52*	9.1*	0.7*
6–12 mo	95*	ND	30*	4.6*†	0.5*‡	1.50	11.0	0.8*
Children								
1–3 y	130	19*	ND	7*	0.7*	1.10	13	1.3*
4–8 y	130	25*	ND	10*	0.9*	0.95	19	1.7*
Males								
9–13 y	130	31*	ND	12*	1.2*	0.95	34	2.4*
14–18 y	130	38*	ND	16*	1.6*	0.85	52	3.3*
19–30 y	130	38*	ND	17*	1.6*	0.80	56	3.7*
31–50 y	130	38*	ND	17*	1.6*	0.80	56	3.7*
51–70 y	130	30*	ND	14*	1.6*	0.80	56	3.7*
>70 y	130	30*	ND	14*	1.6*	0.80	56	3.7*
Females								
9–13 y	130	26*	ND	10*	1.0*	0.95	34	
14–18 y	130	26*	ND	11*	1.1*	0.85	46	2.1*
19–30 y	130	25*	ND	12*	1.1*	0.80	46	2.3*
31–50 y	130	25*	ND	12*	1.1*	0.80	46	2.7*
51–70 y	130	21*	ND	11*	1.1*	0.80	46	2.7*
>70 y	130	21*	ND	11*	1.1*	0.80	46	2.7*
Pregnancy	175	28*	ND	13*	1.4*	1.10	71	3.0*
Lactation	210	29*	ND	13*	1.3*	1.10	71	3.8*

ND = not determined. *Values are AI (Adequate Intakes), † Refers to all ω-6 polyunsaturated fatty acids, ‡ Refers to all ω-3 polyunsaturated fatty acids.

[a] Based on g protein per kg of body weight for the reference body weight, e.g., for adults 0.8 g/kg body weight for the reference body weight.

[b] Total water includes all water contained in food, beverages, and drinking water.

Source: Institute of Medicine, Food and Nutrition Board. "Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids" (2002/2005); "Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate" (2005). Washington, D.C.: National Academies Press.

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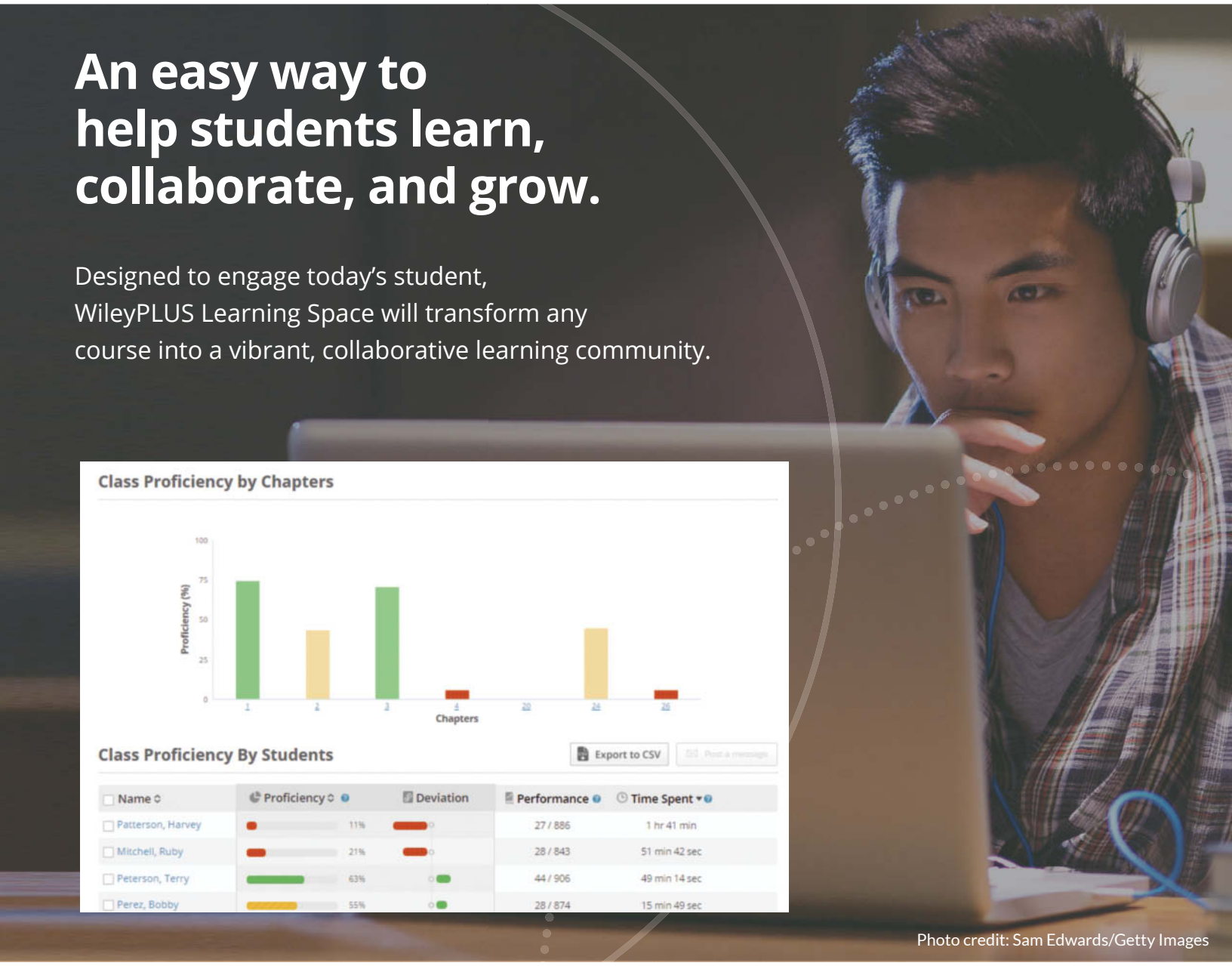

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About the Authors

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. In her spare time Dr. Smolin enjoys bicycling and watercolor painting.

Mary B. Grosvenor holds a bachelor of arts in English from Georgetown University and a master of science in Nutrition Science from the University of California at Davis. This combination provides 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.

Dedication

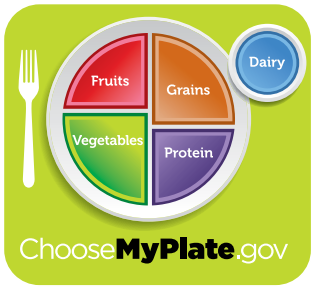
To my sons, Zachary and Max, and my husband David, for their love, support, and humorous outlook on life. To my mother, Shirlee Smolin, who is a testament to the health benefits of eating well and staying physically and mentally active.

LAS

To Peter, David, and John for their advice, patience, and editorial services, but most of all for continuing to remind me what is important in life.

MBG

Preface



Courtesy USDA

2011

Nutrition: Science and Applications, Fourth Edition, is intended as an introductory text for a science-oriented nutrition course. The material is appropriate for a college student at any level, freshman to senior, taking this course to fulfill a science requirement. The clear, concise writing style—reinforced visually with colorful, engaging illustrations and photographs—makes the science accessible. The strong metabolism coverage, clinical flavor, and critical-thinking approach to understanding science and nutrition research make this a text that will also prepare nutrition majors and other science majors for their future studies and careers. These students will discover that this text ties together information that they have studied in chemistry, physiology, biology, and biochemistry courses.

This up-to-date text includes the most recent recommendations from the DRIs, Dietary Guidelines, and MyPlate, as well as the food label changes proposed by the FDA. The text is extensively referenced from current literature. Recent concerns in nutrition science, such as nutritional genomics, the dual epidemics of obesity and diabetes, controlling world hunger, the risks and benefits of genetically modified foods, and the nutritional impact of dietary supplements, are discussed. The examples used throughout the text reflect the diverse ethnic and cultural mix of the American population.

Jeffrey Coolidge/Getty Images, Inc.

Critical Thinking Enhances Problem-Solving Skills

Charles D. Winters/Photo Researchers, Inc.

Nutrition: Science and Applications takes a critical-thinking approach to understanding and applying human nutrition. Like other introductory texts, it offers students the basics of nutrition by exploring the nutrients, their functions in the body, and sources in the diet. But its unique critical-thinking approach gives students an understanding of the "whys" and "hows" behind nutrition processes and explores the issues that surround nutrition controversies. Within each chapter, separate Critical Thinking exercises introduce nutrition-related problems. They then walk students through the process of first finding the facts, and then applying the logic needed to find solutions to the problems and to make healthy food and nutrition decisions. Application exercises, found online, ask students to use this same process of logical scientific inquiry, along with the information in the chapter, to analyze, modify and/or plan diets that promote health and reduce the risk of nutrient deficiencies and nutrition-related chronic diseases. "Think Critically" and "Analyze the Data" questions accompany many of the illustrations and photographs in the text and appear at the end of special features such as Debate, Off the Label, and Science Applied. These are designed to promote critical thought and focus student attention on the information in visuals or discussed in the features. This critical-thinking approach gives students the tools they need to bring nutrition out of the classroom and apply the logic of science to their own nutrition concerns—both as consumers and as future scientists and health professionals.

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Integrated Metabolism Reinforces Understanding

Nutrition: Science and Applications is distinctive in its integrated approach to the presentation of nutrient metabolism. Metabolism is one of the most challenging topics for students, but a knowledge of metabolism is critical for understanding how nutrients function and impact human health. The text includes a comprehensive discussion of metabolism as it applies to each of the energy-yielding nutrients, shows how the micronutrients are involved, and then ties it all together in discussions of energy balance and fueling physical activity. The presentation differs from that in other texts, however, in integrating discussions of metabolism throughout appropriate chapters. This approach makes metabolism more manageable and

memorable for students because it presents material in smaller segments and highlights its relevance to the nutrient being discussed. It also reinforces understanding of metabolic processes by revisiting key concepts with each nutrient and adding relevant new information. *Nutrition: Science and Applications* introduces a simple overview of metabolism in Chapter 3 and then builds on this base with more complex discussions in Chapters 4 through 10. For example, the discussion of carbohydrate metabolism in Chapter 4 presents the basics of glucose metabolism. This information is reviewed and augmented in chapters on lipids, proteins, micronutrients, energy balance, and exercise. Each discussion of metabolism is highlighted by the metabolism icon. To tie the concepts together, the illustrations use the same basic diagram with new information superimposed over familiar portions to demonstrate how each nutrient fits into the process. The nutrients and steps of metabolism are also color coded for easier recognition. Students or instructors who want to cover metabolism as a separate topic will find a slightly more in-depth summary online in Focus on Metabolism.

Integration of Health and Disease Relationships Holds Interest

Can I help my mom manage her blood cholesterol?

Why have I gained 10 pounds?

What should I eat to reduce my risk of cancer?

How can I change my diet to better support my athletic training?

These are some of the questions students want answered when they enroll in nutrition classes. To answer these and other health-related questions and to fuel student interest continuously, discussions of the relationships among nutrition, health, and disease are integrated throughout the text. The integration helps students recognize that a nutrient's function in the body is related to its role in health and disease. For example, just as discussing goiters in the section on iodine is logical and piques interest, so is discussing diabetes with carbohydrates, osteoporosis with calcium, and hypertension with sodium. Covering nutrition-related chronic conditions with the topic or nutrient most related to the issue continuously reinforces the applicability of nutrition science to the students' lives, and also helps them appreciate how and why their diet affects their health.

The Dietary Pattern, Not Individual Foods, Is the Focus

Nutrition: Science and Applications presents the message that each food choice makes up only a small part of your total diet and that it is the overall dietary pattern that determines the healthfulness of your diet. Each of the macronutrient chapters begins with a section that discusses the role of that nutrient in the diet—factors that affect our intake and how different food sources of each nutrient may make very different contributions to the diet. For example, a less-processed choice, such as whole-wheat bread, provides a more nutrient-dense source of carbohydrate than a slice of chocolate cake. However, this does not mean you can never have chocolate cake. The text emphasizes that there are no "bad" foods as long as the sum of food choices over a period of days or weeks makes up a healthy overall dietary pattern. To reinforce this, these chapters end with a discussion of how to meet your need for that specific nutrient while taking into consideration other dietary recommendations that promote health.

Distinctive Features

This text includes a number of features that both spark student interest and help them learn the basics of nutrition.

Chapter Outline

This brief outline of the chapter's content gives students and instructors an overview of the major topics presented in the chapter.

Case Study

Each chapter begins with a short case study. These health- and disease-oriented vignettes help spur student curiosity and provide a taste of some of the concepts to be explained in the chapter. For example, the case study for Chapter 6 describes the challenges a college student faces in choosing and meeting his nutrient needs with a vegan diet. The Chapter 10 case study recounts the story of an athlete who experienced dehydration during an Olympic marathon. The case study in Chapter 9 discusses a baby diagnosed with vitamin D deficiency. These intriguing and entertaining stories link the material in the chapter with everyday health and disease issues. The chapter content then helps students understand the issues associated with each case.

lucamanieri/iStockphoto

Proteins and Amino Acids

6

CHAPTER OUTLINE

(©iStockphoto)

CASE STUDY

Elliot thinks that it will be better for his health if he stops eating animal products. He is a college student who eats some of his meals at the dining halls and cooks his other meals. He doesn't know much about nutrition, but he knows that the dining halls offer vegetarian choices at every meal. What he doesn't realize is that, although their vegetarian meals don't contain meat, many contain eggs and dairy products. He had planned to eliminate these from his diet as well as meat.

In starting his new eating plan, Elliot thought breakfast would be easy, but as he poured himself a bowl of cereal, he realized that milk was an animal product so he made a note to pick up some soymilk. He decided on toast instead, and since the butter he had in the refrigerator was an animal product, he had peanut butter on his toast. He likes cream in his coffee, but when he read the label on his nondairy creamer he was astonished to find that it contained milk protein. Tomorrow he will use soymilk in his coffee. For lunch he has a veggie and cheese sub, without the cheese. This meal wasn't very filling, so on the way home he bought a big bag of chips—at least these didn't contain any animal products.

For dinner that night the dining hall had vegetarian lasagna, but it was full of cheese. So he just had some pasta with marinara sauce and a salad. Ice cream for dessert was out so he opted for a slice of apple pie once he was assured it didn't contain any animal products. **By the end of the day, he was frustrated and hungry and wondered whether his vegan diet would provide enough protein and other nutrients to keep him healthy.**

© Chris Schmidt/iStockphoto

Outcome

Outcome, appearing at the end of each chapter, completes the case study stories begun in the chapter introduction. For example, the outcome at the end of Chapter 6 describes how the student is able to find more varied vegan choices once he understands complementary proteins and recognizes the variety of healthy ethnic vegan choices that are available to him. The outcome in Chapter 9 describes how the vitamin D deficiency is treated and can be prevented. These "outcomes" review concepts covered in the chapter and illustrate the application of nutrition knowledge to clinical situations.

OUTCOME

Elliot did some reading about vegan diets that helped him understand the plant food combinations that would give him enough protein and other nutrients to meet his needs. He now knows that his peanut butter and toast breakfast is an inexpensive source of complementary proteins. He continues to explore the variety of vegan options offered at ethnic restaurants. The Chinese take-out place near campus has a tasty tofu and vegetable stir-fry and the Indian restaurant offers a number of vegan options that contain lentils or chickpeas with rice or naan (a type of Indian bread). At home he eats lots of salads and vegetables with rice. After spending a little extra time at the grocery store, he discovers almond and rice milks in addition to soymilk that are options for his cereal and coffee. He also discovers vegan prepared foods such as veggie burgers and frozen enchiladas. All these choices give him a varied diet that provides plenty of protein, vitamins, and minerals, and has less saturated fat and more fiber than his former diet. **He now knows how to easily find foods that fit in with his vegan diet. He is enjoying his meals and feels good about the health benefits of his diet.**

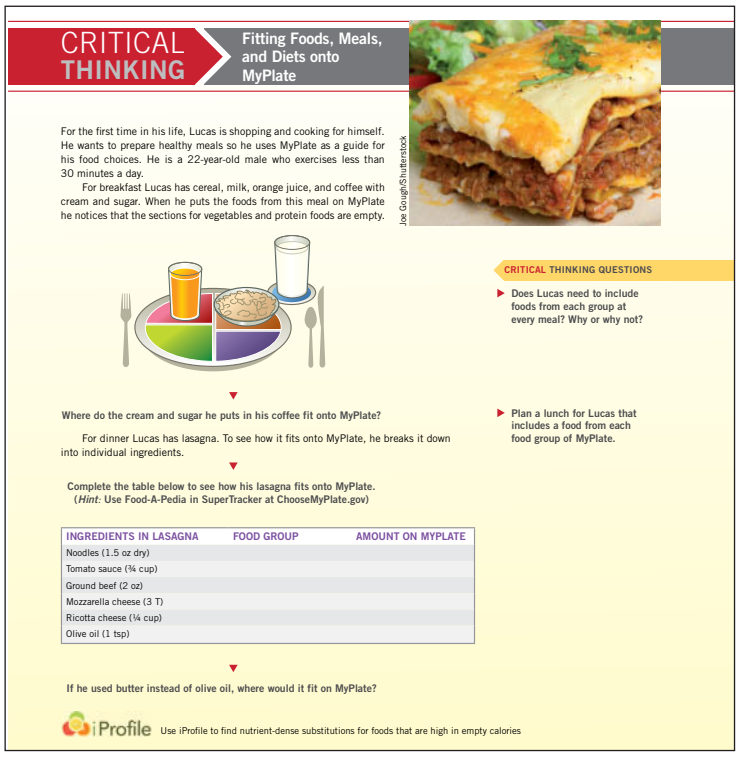
Learning Objectives

Each chapter section begins with one or more learning objectives that indicate, in behavioral terms, what the student must be able to do to demonstrate mastery of the material in the chapter.

4.4 Carbohydrates in the Body

LEARNING OBJECTIVES

- Name the main function of glucose in the body.
- Discuss factors that affect blood glucose levels after eating and when fasting.
- Describe the steps involved in metabolizing glucose to produce ATP.
- Explain how metabolism changes when carbohydrate is limited.



CRITICAL THINKING

Fitting Foods, Meals, and Diets onto MyPlate

For the first time in his life, Lucas is shopping and cooking for himself. He wants to prepare healthy meals so he uses MyPlate as a guide for his food choices. He is a 22-year-old male who exercises less than 30 minutes a day.

For breakfast Lucas has cereal, milk, orange juice, and coffee with cream and sugar. When he puts the foods from this meal on MyPlate he notices that the sections for vegetables and protein foods are empty.

Joe Gough/Shutterstock

Where do the cream and sugar he puts in his coffee fit onto MyPlate?

For dinner Lucas has lasagna. To see how it fits onto MyPlate, he breaks it down into individual ingredients.

Complete the table below to see how his lasagna fits onto MyPlate. (*Hint:* Use Food-A-Pedia in SuperTracker at ChooseMyPlate.gov)

INGREDIENTS IN LASAGNA	FOOD GROUP	AMOUNT ON MYPLATE
Noodles (1.5 oz dry)		
Tomato sauce (¾ cup)		
Ground beef (2 oz)		
Mozzarella cheese (3 T)		
Ricotta cheese (¼ cup)		
Olive oil (1 tsp)		

If he used butter instead of olive oil, where would it fit on MyPlate?

CRITICAL THINKING QUESTIONS

- Does Lucas need to include foods from each group at every meal? Why or why not?
- Plan a lunch for Lucas that includes a food from each food group of MyPlate.

iProfile Use iProfile to find nutrient-dense substitutions for foods that are high in empty calories

Critical-Thinking

These exercises, which appear in each chapter, ask students to use critical thinking to make decisions and solve problems regarding nutrition. They help students apply their nutrition knowledge to everyday situations by presenting a nutrition-related problem and then asking a series of fact-finding and critical thinking questions that lead the student through the logical progression of thought needed to collect information and solve the problem. Many of these exercises focus on modifying a diet to reduce disease risk or maintain health. For example, the exercise in Chapter 2 focuses on how the food choices of a 22-year-old man can fit on MyPlate and how to use this tool to plan a healthy diet. In Chapter 11, Critical-Thinking takes students through the process of assessing the risk of osteoporosis and modifying a diet to increase calcium intake.

OFF THE LABEL

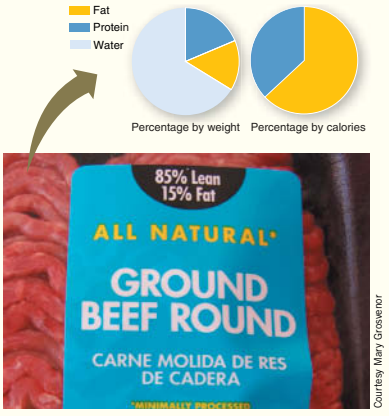
Making Sure Your Meat Is Lean

Looking for lean meat? Most fresh meats (whole cuts and ground and chopped products) are required to have a Nutrition Facts label on the package or have the equivalent nutrition information displayed nearby, but the information related to fat content can still be misleading.[73] Understanding the terminology can help you choose meats that will fit into your diet plan.

The terms "lean" and "extra lean" describe the fat content of packaged meats such as hot dogs and lunch meat, as well as fresh meats such as pork chops and steaks. "Lean" means the meat contains less than 10% fat by weight, and "extra lean" means it contains no more than 5% fat by weight. Ground beef is an exception to these labeling rules. The USDA allows ground beef to be labeled "lean" even if as much as 22% of its weight is fat. To further complicate your shopping, the amount of fat in ground beef labeled "lean" and "extra lean" can vary from store to store.

You can still figure out how much fat is in lean ground beef because ground meats labeled "lean" or "extra lean" must indicate the actual percentage of fat versus lean by stating that it is a certain "% lean" and "% fat" (see figure). So a package of ground beef like this one that is 85% lean and only 15% fat looks like a good choice. But these percentage claims can be misleading. "Percent lean" and "percent fat" refer to the weight of the meat that is lean or fat. So in a meat that is 85% lean, 85% of the weight is lean tissue and 15% of the weight of the meat is fat, so there are 15 g of fat in 100 g (3.5 oz) of raw hamburger. This is a relatively small percentage by weight, but because fat contains 9 kcal/g, the fat contributes 63% of the calories in the meat (see pie charts).

Should you pass on the ground beef and select ground turkey instead? Check the label. If the package is labeled "ground turkey," it may contain skin and leg meat and actually have more fat (about 15 to 20% by weight) than lean ground beef. Only poultry labeled "ground turkey (or chicken) breast" is made with just the lean breast meat and contains only about 3% fat by weight.



THINK CRITICALLY: If you want to purchase ground beef that fits the definition of "lean" meat, what "% lean" should you look for on the label?

Off the Label

"Off the Label" boxes present in-depth information on food, supplement, and even drug labels. Off the Label is designed to show students how to use labels to make wise choices. For example, the Off the Label in Chapter 4 shows how to use the ingredient list to choose whole-grain products and avoid foods that are high in added sugars. The one in Chapter 9 helps students use the information on Supplement Facts labels to make safe supplement decisions, and in Chapter 10, the Off the Label box discusses the sodium and potassium content of packaged foods and shows students how to use food labels to select foods that are low in sodium and high in potassium.

Science Applied

These boxed features included in every chapter focus on research studies that are key to our current knowledge of nutrition and our understanding of nutrition-related diseases. These help students appreciate how science is done and how the results apply to our understanding of nutrition and medicine. For example, the Science Applied in Chapter 8 discusses how studying the niacin-deficiency disease pellagra led to the enrichment of grains, and in Chapter 9 it describes how studying a bleeding disorder in cattle led scientists to a better understanding of vitamin K and coagulation. Other Science Applied topics include how weightlessness in space contributes to our grasp of osteoporosis, how the discovery of the leptin gene enhanced our understanding of the genetics of body weight regulation, and how the discovery of LDL receptors, which help remove LDL cholesterol from the blood, led to medications to treat high blood cholesterol.

SCIENCE APPLIED

Bone: Lost in Space



When John Glenn became the first American to orbit the Earth in 1962, there was little concern about the effect his five-hour flight would have on his bones. But by 1997, when Shannon Lucid spent 188 days aboard the Russian *Mir* space station, the effect of weightlessness on bone health had become a serious concern. Weight-bearing activities such as walking, jogging, and weight training are important for the maintenance of bone health. Under the force of Earth's gravity, these activities mechanically stress the bones, and this stimulates the deposition of calcium. When an astronaut goes into space, weightlessness eliminates this stimulus, calcium no longer accumulates in bone, and that present in bone upon leaving Earth's gravitational field begins to dissipate, elevating calcium levels in the rest of the body. This may lead to kidney stones and calcification of the soft tissues.[23] Unless bone loss in space can be prevented, prolonged space flights may not be possible.

NASA astronaut Dan Burbank exercises using the advanced Resistive Exercise Device (aRED) in the *Tranquility* node of the International Space Station.

THE SCIENCE

Information on bone loss in space has been accumulating for 60 years. Studies done in the 1960s and early 1970s during the *Gemini* and *Apollo* space missions first showed that astronauts lost calcium from their bones during space travel. *Skylab* missions then offered an opportunity to study the effects of more extended periods in zero gravity. In one study, nine astronauts maintained a constant dietary intake and made continuous urine and fecal collections for 21 to 31 days before their flight, during their *Skylab* missions, and for 17 to 18 days after returning to Earth. The results showed that urinary calcium losses were increased during the flight. These losses occurred despite vigorous exercise regimens while in flight and were comparable to losses seen in normal adults subjected to prolonged bed rest.[24]

In the 1990s, the *Mir* space station provided an opportunity for long-duration studies of bone metabolism in space.[25] The use of dual-energy X-ray absorptiometry (DXA) scans of astronauts and cosmonauts revealed that bone mineral density was decreasing at a rate of about 1.0 to 1.5% per month.[26] The most significant bone loss was found in weight-bearing parts of the skeleton: the lower vertebrae, hips, and upper femur—the same areas at risk for fracture in osteoporosis.[27] Once the astronauts returned to Earth, calcium loss slowed, but even after six months, bone mass in most subjects had not completely recovered.[28] Biochemical measures indicate that the bone loss that occurs during space flight is due to an increase in bone resorption and decreased intestinal calcium absorption.[23,25] The decrease in calcium absorption is likely due to low levels of vitamin D from insufficient dietary intake and lack of ultraviolet light exposure during space flight.[25]

In 2000, the first crews occupied the International Space Station, which was equipped with special resistance exercise equipment. The diet aboard the station provides 1000 to 1200 mg of calcium/day, as is recommended on Earth. Crews on *Skylab* consumed only about 900 mg/day.[29] It has also been determined that supplements of 800 IU/day of vitamin D maintain vitamin D levels during a six-month space mission.[30]

THE APPLICATION

By combining good nutritional intakes with heavy resistance exercise using a treadmill, cycle, and high-load resistance exercise devices (see photo), astronauts aboard the International Space Station were able to maintain their bone mineral density at preflight levels.[30] This occurred because the regimen increased bone formation. It failed, however, to decrease the space flight–induced bone resorption, leaving concerns about bone strength. Studies on astronauts continue to investigate other nutritional factors that affect bone metabolism such as omega-3 fatty acid intakes and appropriate levels of vitamin K, sodium, and protein.[29] What is optimal for bone health in space may be different from what is best for a healthy person living on Earth, but may be applicable to special populations at increased risk of bone loss. Understanding how to optimize nutrient intake and exercise patterns for bone mineral retention during long space flights will not only enhance our potential for space exploration, but also help people who are at risk of bone loss due to prolonged bed rest because of surgery, serious illness, or complications of pregnancy and those who are experiencing immobilization of some part of the body because of stroke, fracture, spinal cord injury, or other chronic conditions.

Debate

The "Debate" features are essays that explore controversial nutrition issues and ask students to think critically about them. Both sides of the issues are presented and then Think Critically questions at the end ask students to integrate and evaluate the information presented. Debates address topics such as "How Involved Should the Government Be in Your Food Choices?" "Is There a 'Best' Diet for You?" "Should You Be Gluten Free?" "Should You Avoid High-Fructose Corn Syrup?" "Is Surgery a Good Solution to Obesity?" and "The Highs and Lows of High-Protein Diets."

DEBATE

How Involved Should the Government Be in Your Food Choices?

The typical U.S. diet is not as healthy as it could be. Poor dietary habits in the United States have resulted in an unfit, unhealthy nation. Our overindulgence has contributed to our high rates of obesity, diabetes, high blood pressure, and heart disease.[4] This is the concern not only of the individuals whose lives it affects but also of the government. The dollar cost to our health-care system is huge; half of the $147 billion per year the United States spends on obesity comes from government-funded Medicare and Medicaid.[5] Government concern is not just financial. The fact that almost one in four applicants to the military is rejected for being overweight is suggested as a threat to national security and military readiness.[6] So, who is responsible for our unhealthy diet, and who should be responsible for changing what we eat?

Joe Raedle/Getty Images

New York City officials tried unsuccessfully to prohibit restaurants, sports stadiums, movie theatres, and food carts from selling sugar-sweetened beverages larger than 16 oz.

Because of the financial and societal costs of an unfit nation, some argue that the government should be more involved in directing our dietary choices. Proponents of more government involvement in our food choices suggest that our food environment is the cause of our unhealthy eating habits. Obesity expert Kelly Brownell believes that environment plays a more powerful role in determining food choices than does personal irresponsibility.[7] Brownell and other proponents of government intervention argue that the government should treat our noxious food environment like any other public health threat and develop programs to keep us safe and healthy. Just as government regulations help to ensure that our food is not contaminated with harmful bacteria, laws could ensure that what you order at a restaurant will not contribute to heart disease or cancer. Unfortunately, unlike bacteria, individual foods are difficult to classify as healthy or unhealthy. Almost all food has some nutritional benefits, and arguments are ongoing as to what is a "junk food" and what we should add or subtract from our diets. However, many people believe there are things that could be done to ensure healthier choices.

One option to encourage healthier choices suggested by proponents of government intervention is to tax junk food, making it more expensive, and increase subsidies for fruits and vegetables, making them less expensive. Another is to control what can be sold. For example, in 2013 New York City's Board of Health attempted to prohibit the sale of sugar-sweetened drinks in cups larger than 16 ounces (oz) (see photo). The courts overturned the ban on the grounds that it exceeded the Board of Health's regulatory authority. Other suggestions to change the food environment include zoning restrictions to keep fast-food restaurants away from schools and limitations on the types of foods advertised on children's television. All these ideas have pros and cons, and none will absolve individuals of the responsibility for getting more exercise and making healthier food choices.

Opponents of government involvement believe such regulation is an infringement on personal freedom and suggest that individuals need to take responsibility for their actions. They propose that the food industry work with the public to make healthier food more available and affordable. Many food companies have already responded to the need for a better diet; General Mills and Kellogg's offer whole-grain cereals. And the giant food retailer Wal-Mart is working with suppliers to reduce the amount of sodium and added sugar and eliminate *trans* fat from packaged foods.

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

THINK CRITICALLY: Do you think restricting the size of sodas sold will help curb obesity? Why or why not?

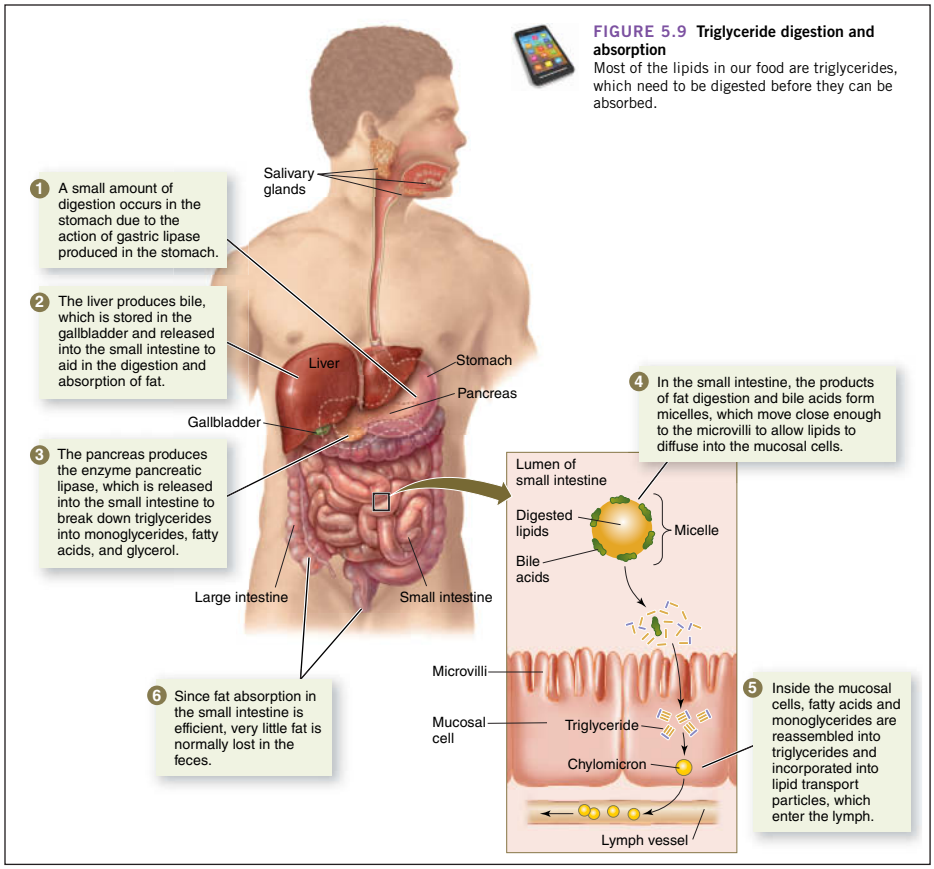


FIGURE 5.9 Triglyceride digestion and absorption
Most of the lipids in our food are triglycerides, which need to be digested before they can be absorbed.

Process Diagrams

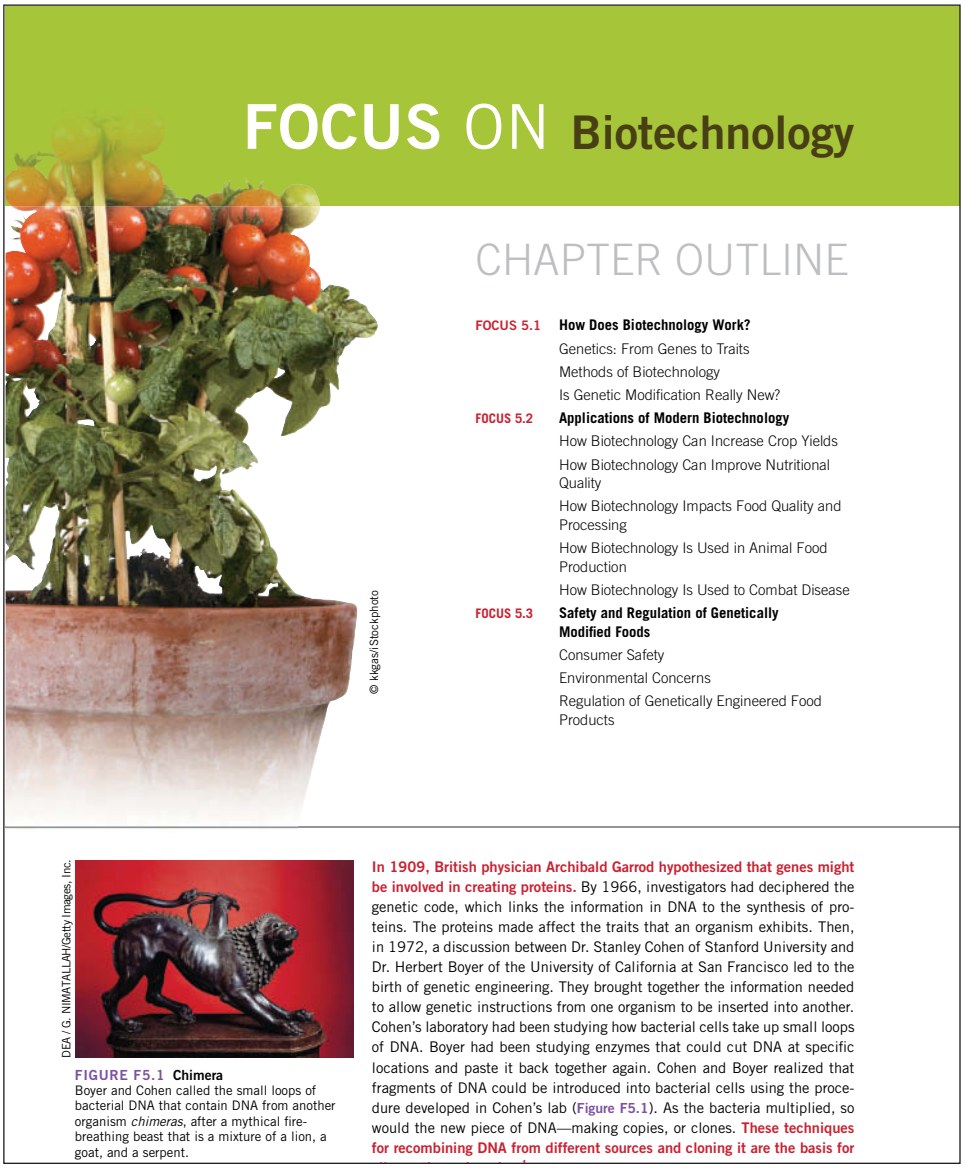
Sometimes the hardest part of understanding a graphic is knowing where to start. To help students comprehend the more complex illustrations, each step in the process depicted is numbered and includes a narrative describing what happens. Process diagrams help students reduce intimidating topics such as digestion and absorption, metabolism, and lipid transport to a series of easy-to-follow steps.

Chapter Summary

Each chapter ends with a summary that highlights important concepts addressed in each section of the chapter.

Focus On

The text includes six Focus On "mini-chapters": Focus on Alcohol, Focus on Eating Disorders, Focus on Phytochemicals, Focus on Dietary Supplements, and Focus on Biotechnology are in the printed text, and Focus on Metabolism is available online. Those in the text discuss topics of great interest to students that are not necessarily part of the core curriculum in nutrition. For example, eating disorders have nutritional symptoms but are really psychological disorders; alcohol is consumed in the diet and affects nutrient metabolism, but is not itself a nutrient; and herbal supplements are not nutrients but may affect health and are sold alongside vitamin and mineral supplements. To provide adequate coverage of these fascinating topics, they are discussed in separate Focus On sections. These sections allow instructors to cover this material or skip it if they feel it is not pertinent to their curriculum. The online Focus on Metabolism is provided for those who want to cover nutrition and metabolism in one chapter rather than, or in addition to, integrating it throughout the text.



FOCUS ON Biotechnology

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CHAPTER OUTLINE

DEA / G. NIMATALLAH/Getty Images, Inc.

FIGURE F5.1 **Chimera**
Boyer and Cohen called the small loops of bacterial DNA that contain DNA from another organism *chimeras*, after a mythical fire-breathing beast that is a mixture of a lion, a goat, and a serpent.

In 1909, British physician Archibald Garrod hypothesized that genes might be involved in creating proteins. By 1966, investigators had deciphered the genetic code, which links the information in DNA to the synthesis of proteins. The proteins made affect the traits that an organism exhibits. Then, in 1972, a discussion between Dr. Stanley Cohen of Stanford University and Dr. Herbert Boyer of the University of California at San Francisco led to the birth of genetic engineering. They brought together the information needed to allow genetic instructions from one organism to be inserted into another. Cohen's laboratory had been studying how bacterial cells take up small loops of DNA. Boyer had been studying enzymes that could cut DNA at specific locations and paste it back together again. Cohen and Boyer realized that fragments of DNA could be introduced into bacterial cells using the procedure developed in Cohen's lab (Figure F5.1). As the bacteria multiplied, so would the new piece of DNA—making copies, or clones. **These techniques for recombining DNA from different sources and cloning it are the basis for**

Margin Features

The text includes a number of features that are placed in the margin. These aid comprehension, enhance interest, and point out where particular types of information can be found.

Definitions of New Terms

New terms are highlighted in bold in the text and defined in the margin, providing easy access to new terms as they appear. These and other terms are included in an extensive glossary at the back of the text.

Carbohydrate Digestion and Absorption

Digestion of carbohydrate begins in the mouth, where the enzyme salivary amylase starts breaking starch into shorter polysaccharides. The majority of starch and disaccharide digestion occurs in the small intestine. Here, pancreatic amylases complete the job of breaking down starch into disaccharides and oligosaccharides. The digestion of disaccharides and oligosaccharides is completed by enzymes attached to the microvilli in the small intestine (Figure 4.9). Here maltose is broken down into two glucose molecules by the enzyme maltase, sucrose is broken down by sucrase to yield glucose and fructose, and lactose is broken down by **lactase** to form glucose and galactose. The resulting monosaccharides—glucose, galactose, and fructose—are then absorbed and transported to the liver via the hepatic portal vein.

lactase An enzyme located in the microvilli of the small intestine that breaks the disaccharide lactose into glucose and galactose.

iProfile Icons These show students where they can use the iProfile software to answer a nutrition-related question.

Video Icons These icons appear by topics that students can explore further by watching a BBC, **New York Times**, CBS, or Voice of America video in WileyPLUS Learning Space.

Metabolism Icons These highlight discussions of how each nutrient fits into the metabolic processes of nutrition.

Life cycle Icons These highlight discussions of the differences in nutritional requirements, concerns, and effects at different life stages. This information helps students understand how nutrient requirements are affected by life stage as well as offering information relevant to students in all phases of life. **Life cycle** nutrition is also covered in depth in Chapters 14, 15, and 16.

Hear This Illustration Icons These indicate important figures with accompanying audio files within WileyPLUS Learning Space. Narrated tutorials help students understand more complex topics while they review these figures.

New to This Edition

Most Current Information

As the science of nutrition continues to evolve *Nutrition Science and Applications* evolves with it, to include the most up-to-date information, terminology, and ways of thinking about nutrition. The entire text has been updated and re-referenced to reflect the most current nutrition science and guidelines. More information on the emerging science of nutritional genomics, nutritional programming, the recognition of non-celiac gluten sensitivities, and the role of the intestinal microbiota in human health has been added. Current recommendations in nutrition, such choosing a plant-based diet and reducing added refined sugars have been integrated into discussions of diet and health and advances in our understanding of biotechnology and the effect of our food environment on the incidence of non-communicable nutrition-related diseases has been addressed. The most recent information is included on the prevalence of obesity and undernutrition as well as programs such as Healthy People 2020 and the United Nations 2015 Sustainable Development Goals that target improving health and nutrition.

2015–2020 Dietary Guidelines

This up-to-date text includes the recommendations of the *2015–2020 Dietary Guidelines for Americans*, which are described in Chapter 2 and addressed in all applicable subsequent chapters.

FIGURE 2.7 Healthy eating patterns
The Dietary Guidelines for Americans suggest that there are many ways to choose a healthy diet. Healthy dietary patterns all focus on similar types of foods, but choices can be tailored to suit an individual's preferences and meet their medical needs (see Appendices B and C for more information).

The DASH Eating Plan

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

The DASH Eating Plan is plentiful in fruits and vegetables, whole grains, low-fat dairy products, fish, poultry, seeds, and nuts. It was first developed for lowering blood pressure (see Chapter 10).

USDA Food Patterns

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

Mediterranean Eating Pattern

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

Traditional Mediterranean eating patterns are based on fruits, vegetables, grains, olive oil, fish, beans, nuts, legumes, and seeds. They include smaller amounts of red meat and sweets. The incidence of chronic diseases such as heart disease is low in populations consuming these diets (see Chapter 5).

USDA Vegetarian Adaptations

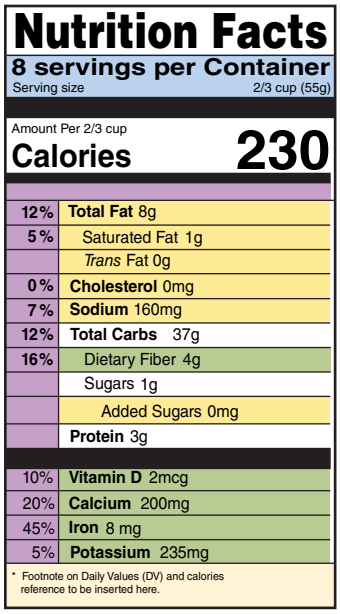
Food group	Amount/day	
	Lacto-Ovo	Vegan
Dairy products or dairy substitutes	3 cups milk, calcium fortified soymilk, or yogurt, 4½ oz. hard cheese	3 cups calcium fortified soymilk or other plant-based milks or yogurts
Protein foods		
Eggs	4 per week	
Beans and Peas	⅓ cup	½ cup
Soy products	½ cup tofu,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

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

Food Labeling

The FDA has proposed updates to the Nutrition Facts labels we see on most packaged foods. Coverage of this topic in Chapter 2 compares the current food label to the proposed Nutrition Facts label. The relevance of these proposed changes is 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 and the effectiveness of current food labels in providing consumer guidance, and how best to present nutrition information about individual foods to consumers.

In addition to this information on the labeling of packaged foods, the most up-to-date information on the calorie labeling of foods sold at restaurants and in vending machines is included.



Nutrition Facts

8 servings per Container

Serving size 2/3 cup (55g)

Amount Per 2/3 cup

Calories 230

12%	**Total Fat** 8g
5%	Saturated Fat 1g
	Trans Fat 0g
0%	**Cholesterol** 0mg
7%	**Sodium** 160mg
12%	**Total Carbs** 37g
16%	Dietary Fiber 4g
	Sugars 1g
	Added Sugars 0mg
	Protein 3g
10%	**Vitamin D** 2mcg
20%	**Calcium** 200mg
45%	**Iron** 8 mg
5%	**Potassium** 235mg

* Footnote on Daily Values (DV) and calories reference to be inserted here.

New Health Management Guidelines

Recently published guidelines for the management of cardiovascular disease, blood pressure, and overweight and obesity have been integrated into Chapters 5, 10, and 7, respectively. New diagnostic criteria for eating disorders are included in Focus on Eating Disorders and new diagnostic criteria for alcohol use disorder, commonly known as alcoholism, are included in Focus on Alcohol. The World Health Organization's infant growth charts, which are now recommended for infants in the United States, are included in Chapter 14. The recommendations of the Healthy Hunger-Free Kids Act regarding school lunch standards are discussed in Chapter 15, and new recommendations on protein intake in older adults to minimize lean tissue loss are included in Chapter 16. Updated guidelines for fish consumption for children and pregnant women are discussed in Chapter 17.

Choice (Exchange) Lists

The Choice Lists, which update and replace the Exchange Lists, are discussed in Chapter 2, and revisited in Chapters 4, 5, and 6, which address the energy-yielding nutrients, and with energy balance in Chapter 7. The complete Food (Exchange) Lists are provided in the online appendices.

New and Updated Features

Many of the Debate, Off the Label, and Science Applied features in the Fourth Edition, have been amended and updated and new topics have been introduced. The chapter Case Study introductions and Outcome stories have been gently edited to make them more student friendly.

A few new Debate topics have been introduced and all have been revised to include the most up-to-date science. The Chapter 1 Debate, "Is There a 'Best' Diet for You?" which focuses on the new science of nutritional genomics, has been rewritten and new art added to enhance student understanding of this topic. The Chapter 3 Debate, "Should You Be Gluten Free?" has been updated to include a discussion of non-celiac gluten sensitivity. A new Debate on coconut oil, "Coconut Oil: Does a Tablespoon a Day Keep the Doctor Away?" has been included in Chapter 5 to highlight the conflicting information about this type of lipid. The Chapter 12 Debate, "Antioxidant Supplements: Helpful or Harmful?" has been rewritten and new art added to explain the concept of oxidative stress. The Chapter 6 Debate, "The Highs and Lows of High-Protein Diets," has been revised to provide the most current information on the risks and benefits of high-protein diets.

A few of the Off the Label features are new, and most have been updated to include the proposed label changes. In Chapter 1, a new Off the Label "Beware of Misleading Claims"

focuses on how manufacturers use label claims to promote product sales. In Chapter 7, the Off the Label has been revised to highlight the proposed changes in serving sizes and how the number of calories is presented on the label and in Chapter 11, a new Off the Label, "How Much Calcium Is in Your Yogurt?" shows changes in the presentation of micronutrients on the proposed label.

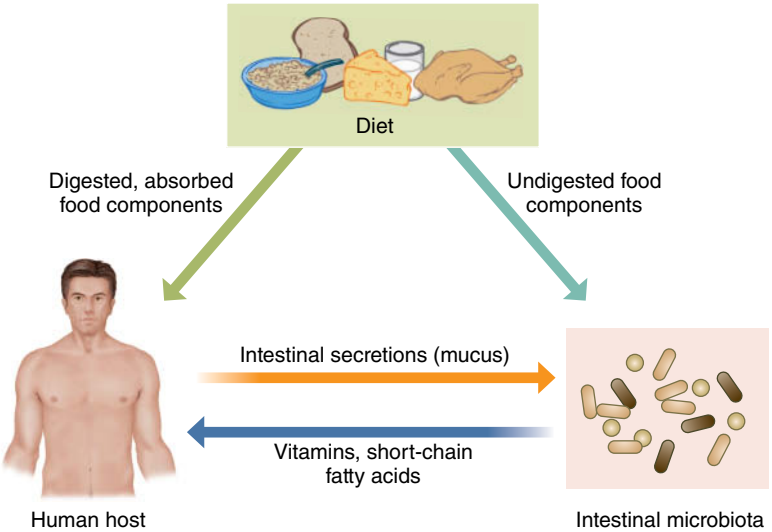
Where appropriate, the Science Applied features have been revised to include continued advances in science. For example, in Chapter 16, "Eat Less–Live Longer" has been updated to include the most recent research on calorie restriction. In Chapter 11, "Bones: Lost in Space" includes information on advances in nutrition and exercise regimens for astronauts aboard the International Space Station.

Improved Critical Thinking Exercises

Critical Thinking topics have been refined and the design modified slightly to distinguish fact-gathering questions from those that require true critical thinking. Critical thinking is a process that challenges an individual to use reflective, reasonable, rational thinking to gather, interpret, and evaluate information in order to derive a judgment. These exercises start by giving students background information and identifying a nutritional problem. Students then use the clinical data provided, such as blood cholesterol values, body weight, or diet records, to first gather information and then answer a series of critical-thinking questions to explore and solve the problem.

In addition to refining the critical thinking in these exercises, many of the Think Critically questions linked to art and special features have been refined and Analyze the Data questions have been added to enhance students' ability to analyze the information presented in graphs and charts.

New and Improved Art



In *Nutrition: Science and Applications,* Fourth Edition, the new art program introduced in the previous edition continues to be improved and refined to enhance clarity, understanding, and visual appeal. New illustrations and photographs have been added to enhance student understanding and make important visual points. For example, Chapter 1 includes two new graphs: one showing how the amount of time we spend cooking has changed since 1965 and another showing how eating breakfast away from home impacts overall diet quality. Additional new art in Chapter 1 helps illustrate the science of nutritional genomics. In Chapter 2, the figure on healthy dietary patterns has been updated to include vegetarian dietary patterns and the proposed Nutrition Facts label has been added so it can be compared to the current label. In Chapter 3, new art helps students understand the role of the intestinal microbiota in overall health. Chapter 6 introduces an illustrated table to distinguish different types of vegetarian diets and a new illustration to show how to use MyPlate to plan vegetarian and vegan diets. Chapter 7 includes the most recent obesity map, a new figure to illustrate the role of nonexercise activity thermogenesis (NEAT) in regulating body weight, and a new decision tree illustration for determining who should lose weight based on the most recent guidelines for the treatment of overweight and obesity. Chapter 12 has new art in the Debate to illustrate oxidative stress. New art in Chapter 13 highlights the relationship between nutrition, physical activity, and health and new art in Chapter 18 illustrates the impact of infectious disease on child deaths and the impact of noncommunicable diseases on a population's productivity.

Chapter-by-Chapter Overview

CHAPTER 1—"Nutrition: Food for Health," begins by discussing why we eat what we do, how the American diet has changed, and how healthy it is. It emphasizes that food choices affect current and future health. This chapter provides an overview of the nutrients and their roles in the body, and defines the basic principles of balance, variety, and moderation that are key to a healthy diet. It also introduces the scientific method and the steps students need to follow to sort accurate from inaccurate nutrition information.

CHAPTER 2—"Nutrition Guidelines: Applying the Science of Nutrition," takes the science out of the laboratory and shows how advances in nutrition knowledge have been used to develop the Dietary Reference Intakes (DRIs), the *Dietary Guidelines for Americans*, and tools for diet planning, including MyPlate, food labels, and Choice (Exchange) Lists. The final section of this chapter discusses how these and other tools can be used to assess the nutritional health of populations and individuals.

CHAPTER 3—"Digestion, Absorption, and Metabolism," discusses how food is digested, how nutrients from foods are absorbed into the body and transported to the cells where they are broken down to provide energy or used to synthesize structural or regulatory molecules, and finally how wastes are removed. This chapter provides an overview of metabolism that serves as a launching pad for the more detailed metabolism information presented in subsequent chapters.

CHAPTER 4—"Carbohydrates: Sugars, Starches, and Fiber," begins with a discussion of the sources and types of carbohydrates in our food. The chapter discusses carbohydrate digestion, absorption, and metabolism and the functions of carbohydrates in the body. The health impact of refined grains and added sugar versus whole grains and unrefined sources of sugars are discussed. The role of dietary carbohydrate in the management of health conditions such as diabetes, dental caries, obesity, heart disease, diverticulosis, and colon cancer are discussed. The chapter ends with a discussion of how to choose a diet that meets carbohydrate recommendations.

CHAPTER 5—"Lipids: Triglycerides, Phospholipids, and Cholesterol," discusses the basics of lipid digestion, absorption, transport, and metabolism, and explains how lipids function in the body. The discussion on fats in our food addresses the sources of fat in our diet and points out that Americans are not eating too much fat, but are typically choosing the wrong types of fat for a healthy diet. The chapter also explains the steps involved in the development of cardiovascular disease and discusses the relationship between fat intake and the risk of cardiovascular disease, obesity, and cancer. The chapter ends with a discussion of how to choose a diet that meets lipid recommendations.

FOCUS ON ALCOHOL discusses alcohol metabolism, the health risks associated with excessive alcohol consumption, and the health benefits associated with moderate intake.

CHAPTER 6—"Proteins and Amino Acids," discusses animal and plant sources of protein and points out that either plant or animal proteins can meet protein needs, but these protein sources bring with them different combinations of nutrients. In addition to discussing protein digestion, absorption, and metabolism, the chapter explains how amino acids are

used for protein synthesis and the functions of the proteins synthesized in the body. The chapter includes information on protein deficiency and excess and recommendations on meeting protein needs and planning healthy vegetarian diets.

CHAPTER 7—"Energy Balance and Weight Management," discusses the obesity epidemic and its causes, and the effects of excess body fat on health. The chapter explains energy balance and shows how small changes in diet and behavior can alter long-term energy balance. The most up-to-date information on how body weight is regulated and the role of genetic versus environmental factors in determining body fatness is covered. The chapter includes recommendations for healthy body weight and composition and equations for determining energy needs. It also discusses weight-loss options that range from simple energy restriction to the most common surgical approaches.

FOCUS ON EATING DISORDERS includes a comprehensive discussion of the different types of eating disorders, their causes, consequences, and treatment. This Focus also addresses the sociocultural factors that influence body ideal as well as what to do to help a friend or relative that you suspect has an eating disorder.

CHAPTER 8—"The Water-Soluble Vitamins," begins with a general overview of the vitamins—where they are found in the diet, factors affecting their bioavailability, and how they function. Each of the B vitamins and vitamin C is then discussed individually, providing information on sources in the diet, functions in the body, impact on health, recommended intakes, use as dietary supplements, and potential for toxicity. This chapter also discusses choline, a substance that is not currently classified as a vitamin but one for which DRIs have been established.

CHAPTER 9—"The Fat-Soluble Vitamins," introduces the fat-soluble vitamins within the context of the modern diet and then presents each one with a discussion of its sources in the diet, functions in the body, impact on health, recommended intake, use as a dietary supplement, and potential for toxicity. The chapter ends with a discussion of who needs vitamin and mineral supplements and how to choose them.

FOCUS ON PHYTOCHEMICALS discusses the role of phytochemicals in nutrition and health. These substances are not dietary essentials but can positively impact health. Different categories of phytochemicals are presented, along with a discussion of how to maximize their intake.

CHAPTER 10—"Water and the Electrolytes," addresses water, a nutrient often overlooked, and sodium, potassium, and chloride, because they help regulate the distribution of body fluids. This chapter presents information on where these nutrients are found in the diet and describes their functions in the body and their relationship to health and disease. A discussion of hypertension illustrates the importance of sodium, potassium, and other minerals and dietary components in blood pressure regulation. Advances in our understanding of how dietary patterns affect hypertension are stressed in a discussion of the DASH diet, a dietary pattern that has been shown to lower blood pressure.

CHAPTER 11—"Major Minerals and Bone Health," provides an overview of the minerals and discusses the remaining major minerals, calcium, phosphorus, magnesium, and sulfur. Their functions in the body and availability in the diet as well as their relationship to health and disease are addressed. Because most of these play an important role in bone health, this chapter also includes a section on the relationship between nutrition, bone health, and the development of osteoporosis.

CHAPTER 12—"The Trace Minerals," discusses the trace minerals in a format similar to that used for other micronutrients. Emphasis is placed on the unique roles of some minerals as well as the similarities that some have in their functions and the interactions among them. Discussions of the health issues related to these nutrients help create interest, as do discussions of the pros and cons of trace mineral supplements.

FOCUS ON DIETARY SUPPLEMENTS targets dietary supplements that contain substances other than micronutrients. Micronutrient supplements are discussed in depth in Chapters 8 through 12 with the appropriate nutrient, but many of the supplements Americans are taking include ingredients that are not vitamins or minerals. This Focus will help students evaluate the benefits and risks associated with supplements containing substances such as coenzyme Q and glucosamine that are found naturally in the body, as well as herbal ingredients such as echinacea.

CHAPTER 13—"Nutrition and Physical Activity," begins by discussing the relationships among physical activity, nutrition, and health. It emphasizes the importance of exercise for health maintenance as well as the impact nutrition can have on exercise performance. Because nutrients fuel activity, this chapter serves as a review of energy metabolism. By this point in the text, students have studied all the essential nutrients, so a complete discussion of the macronutrients and micronutrients needed to generate ATP for various types of activity can be included. An expanded discussion of ergogenic aids for more competitive athletes directs students to use a risk-benefit analysis of these products before deciding whether or not to use them.

CHAPTER 14—"Nutrition During Pregnancy and Lactation," addresses the role of nutrition in human development by discussing the nutritional needs of women during pregnancy and lactation as well as the nutritional needs of infants. The benefits of breastfeeding versus formula feeding are discussed.

CHAPTER 15—"Nutrition from Infancy to Adolescence," begins with a discussion of what American children are eating and how it relates to the rising rates of childhood obesity and other chronic diseases. The chapter discusses the nutrient needs and nutrition-related health concerns of children, from infancy through adolescence.

CHAPTER 16—"Nutrition and Aging: The Adult Years," addresses how nutrition affects health and how the physiological changes that occur with aging affect nutritional needs and the ability to meet them. The impact that chronic disease, medications, and socioeconomic changes have on the risk of malnutrition is discussed.

CHAPTER 17—"Food Safety," discusses the risks and benefits associated with the U.S. food supply and includes information on different types of microbial hazards, chemical toxins, food additives, irradiation, and food packaging. This chapter discusses the use of HACCP (Hazard Analysis Critical Control Point) to ensure safe food and the role of the consumer in selecting, storing, and preparing food to reduce the risk of food-borne illness.

FOCUS ON BIOTECHNOLOGY explains how genetic engineering is used to modify the characteristics of organisms and create new products. It addresses the potential benefits and risks associated with this expanding technology.

CHAPTER 18—"World Hunger and Malnutrition," discusses the coexistence of undernutrition with obesity and other non-communicable diseases due to overnutrition in both developed and developing nations around the world. It examines the causes of world hunger and solutions that can impact the amounts and types of food and nutrients that are available.

Teaching and Learning Resources

WileyPLUS Learning Space

WileyPLUS Learning Space is a new dynamic teaching and personalized learning environment that features your course content intuitively organized—all in one place.

With WileyPLUS Learning Space, students have the opportunity to practice, ask questions, share insights and see how they are doing through self-assessment. Students feel more invested in their learning experience as they participate with course topics and each other in meaningful new ways.

What can students do with WileyPLUS Learning Space?

- Access the complete digital textbook and integrated multimedia resources
- Instantly know what they need to work on from their visual dashboard
- Create a personal study plan
- Assess their progress throughout the course with informative reports
- Participate in class discussions
- Remember what they have learned because they have made deeper connections to the content

What can instructors do with WileyPLUS Learning Space?

- Assign activities and add their 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 with visual reports

Student Resources in WileyPLUS Learning Space

ORION Personalized Practice

ORION asks practice questions to assess student understanding at the objective level and identify areas where more study is needed. This adaptive practice meets students at just above their level in order to keep them challenged, but not frustrated. Adaptive practice includes extensive actionable reports that focus student study in key areas individual to each learner. ORION features a rich question database with nearly 6,000 questions at every level of difficulty on a 100-point, nationally-set difficulty level and all Bloom's levels. All students begin with a unique, short diagnostic quiz that establishes a baseline from which each student develops his own unique path.

Videos

Videos produced by the BBC, CBS, and Voice of America spark discussion and allow students to explore current and relevant topics in nutrition. These videos help students discover relevant and topical issues like diabetes, the local food movement, and gastric bypass surgery.

Video Bites

This new video series features student-focused sketches that explore the impact of day-to-day nutrition choices using real life scenarios. Each video examines a topic germane to one or more chapters and blends up-to-date information with humor to pique student interest, address misconceptions, and spark discussion.

How It Works Animations

Wiley has developed a new set of animations for nutrition students and professors. We surveyed professors across North America to find out what topics were the most difficult to teach and learn and what processes were most essential to the introductory nutrition course. After much research and review, we developed animations on these topics, to make these difficult processes easier for students to understand and bring the process diagrams from the book to life.

- Absorption of Nutrients
- Flow of Blood During Absorption
- Digestion and Absorption of Carbohydrates
- Glucose Metabolism
- Regulation of Glucose Metabolism
- Maintaining Normal Blood Glucose Levels
- Blood Glucose Regulation
- Digestion and Absorption of Lipids
- Lipid Transport
- Metabolism of Lipids
- Digestion and Absorption of Proteins
- Metabolism of Proteins
- Role of B Vitamins in Metabolism
- Action of Antioxidants Against Free Radicals
- How Vitamin C Supports Immune Function
- Acid-Base Balance

Other Animations

In addition to the How It Works animations, many other animations exist to aid student comprehension. These include: MyPlate, Biology Basics, Visualizing Serving Sizes, and Estimating Portion Sizes.

iProfile 3.0: Assessing Your Diet and Energy Balance

The iProfile dietary analysis program now features improved food searches and is available as a mobile-enabled website. Students can access the new **mobile version** on their phone or tablet to conveniently add items to their food journal throughout the day. This dynamic diet assessment software includes nutrient values for over 50,000 foods, inclusive of many of the most popular food choices of students today, as well as ethnic and cultural choices. It includes a feature that allows users to add foods to the database to keep pace with the ever-growing market of available products. Since exercise is such an important part of energy balance, the software also allows students to track and analyze their physical activity. In addition to the ability to track and analyze food intake and exercise, some distinctive features include serving-size animations, a quick self-quiz, single nutrient reports, recipe builder, and an easy-to-use design.

Games and Activities

New to this edition and embedded in the e-textbook, are activities that require mathematical calculations and critical thinking. Some ask students to compute calories and percentages of the RDA and others are drag-and drop games to identify food sources of macro- and micronutrients. Developed by Rose Martin at Iowa State University, these include informative feedback about the health consequences of specific nutrient toxicities or deficiencies. Each activity allows for multiple attempts for continued practice. Additional activities are available at the chapter level and allow students to modify meals and recipes to make healthier choices.

Nutrition Bytes Blog

The Nutrition Bytes Blog provides an ongoing dialogue of current topics and controversies in nutrition. These provide up-to-the-minute discussions on the latest hot topics in nutrition and encourage critical thinking around these. 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 of The University of San Diego and updated on a biweekly 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.

Hear This Illustration

Audio tutorials accompany key figures for improved understanding of important topics and are available with downloadable transcripts.

Interactive Process Diagrams and Graphics

Select interactive figures within WileyPLUS Learning Space allow students to learn the concepts presented and then have an opportunity to build the processes themselves.

Applications

These exercises, which are included for each chapter, contain three sets of application questions. The "Assessing Your Diet" applications focus on the student's personal diet and nutrition concerns "Consumer Issues" applications address more general consumer nutrition issues such as reading food labels. The "Clinical Concerns" applications ask about more clinical nutrition and health issues as they relate to the chapter material. All require the student to think critically and apply key nutrition concepts, and all help reinforce the importance of nutrition in health promotion and disease prevention. Some of these can be done as collaborative learning exercises, which encourage students to work together and learn from one another to solve a problem.

Review Questions

A set of questions is available for each chapter to test students' understanding of the key points covered. Students can use them as a study tool to test their comprehension of the important information in the chapter.

Teaching Materials Available to *Instructors*

- **Test Bank**—Available online, the Test Bank includes multiple-choice questions as well as short case studies with questions. Many other question banks are available including pre-populated assignments and the ability to customize your own assignments.
- **Respondus Test Bank**—This computerized version of the Test Bank makes preparing clear, concise tests quick and easy.
- **Nutrition Visual Library**—This resource includes all of the illustrations from the textbook in labeled, unlabeled, and unlabeled with leader line formats. Search for images by chapter, or by using keywords. It is also available through WileyPLUS Learning Space.

iProfile Mobile and iProfile Assignments

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 smart phones 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 gradable **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 available in every chapter. These focus on a specific nutritional concept or dietary pattern related to that chapter's content. Students are asked to enter the food choices of the case study subject and then analyze the impact of these choices. Each case study topic includes a question to generate discussion as well as gradable multiple-choice and true-false questions.

Companion Websites

- **Student Companion Website** [www.wiley.com/college/smolin] A dynamic website rich with many activities for review and exploration includes: Quizzes for each chapter, Flash Cards for learning concepts and terminology, Hear This Illustration podcasts, and the Nutrition Bytes Blog.
- **Instructor Companion Website** [www.wiley.com/college/smolin]—A dedicated companion website for instructors provides many resources for preparing and presenting lectures. Also available are all of the illustrations and tables in the text already placed within PowerPoint Slides, as well as a set of Lecture PowerPoints that combine important images with major concepts from each chapter. Questions for use with Clicker Systems are also provided.

To the Student

Nutrition is a subject that all of you have a personal interest in, whether you are concerned about your own nutritional health, a parent with diabetes, or a friend with an eating disorder. You may enroll in a nutrition course to learn what to eat and how to choose healthy foods and then be surprised when the course talks about protein synthesis, lipid transport, and anaerobic metabolism. A good course and textbook should do both.

As authors, our goal is to provide you with tools that can be used throughout your life. We could tell you what to eat for breakfast, but if you didn't understand why these foods were healthy choices you would not be able to make your own healthy choices from a different set of breakfast foods, or use the same principles to choose a healthy dinner. On the other hand, for example, if you understand how your saturated fat intake can affect your risk for heart disease or your sodium intake affects your blood pressure, you will have the tools you need to choose a healthy dietary pattern.

The critical-thinking approach we have used in this text will help you understand the science of nutrition and give you the decision-making skills you need to navigate the scores of choices you face when deciding what to eat and which of the latest nutrition headlines to believe. By becoming a knowledgeable consumer, you will be able to make informed choices about diet and lifestyle, whether you use this information to improve your own health or to pursue a career in nutrition.

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We would like to add a special thank you to John Ambrose, who worked tirelessly to write, direct, and produce Video Bites, a unique set of short videos that help students relate to key topics covered in the text.

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Brief Contents

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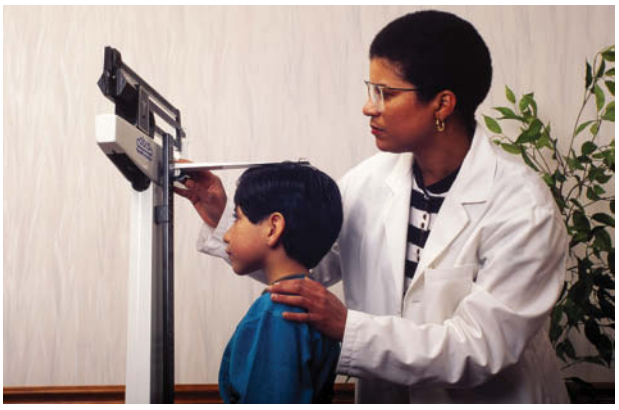

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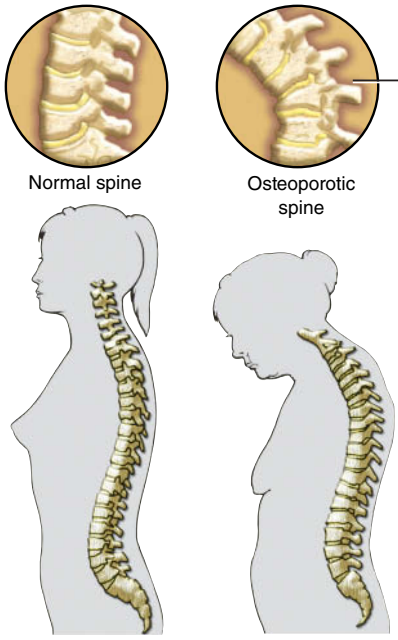

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NUTRITION

SCIENCE AND APPLICATIONS

4th EDITION

WILEY

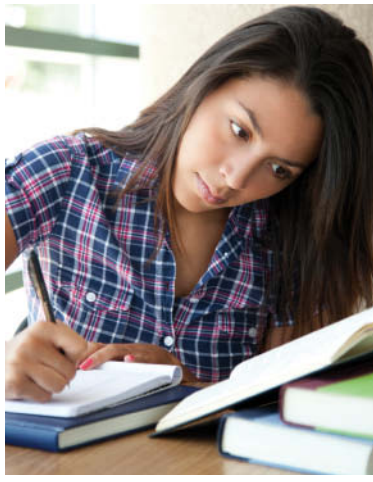
CHAPTER OUTLINE

Mauritius Images/Age Fotostock America, Inc.

Nutrition: Food for Health

1

CASE STUDY



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Kaitlyn peered into the minifridge in her dorm room looking for something to eat. The only thing she had was some leftover pizza and a couple of cookies. Kaitlyn had been in classes and then at work until late in the evening, so when she finally sat down to study, she realized that she had completely forgotten to eat dinner. She needed to eat something to keep her going until she finished that chapter in her nutrition book, but her dorm offered few food choices late at night. After finishing the pizza, Kaitlyn headed down the hall to get a bag of potato chips and an energy drink from the vending machine. She knew that they weren't a good choice, but they were her only option.

As a college freshman away from home for the first time, Kaitlyn has gained a few pounds and is beginning to be concerned about her weight. Her father recently suffered heart problems, and her mother takes medication for high blood pressure. Kaitlyn knows that because of this family history, her diet is particularly important for her future health. Though the dorm cafeteria offers a variety of choices, Kaitlyn never learned how to choose a healthy diet. She wants to keep healthy foods in her refrigerator, but never takes time to go to the store.

Several of Kaitlyn's friends have started taking supplements like Mega B to give them more energy and ginkgo biloba to improve their memories. She is tempted to start taking them but she's not sure the claims about them are true. **To optimize her health, Kaitlyn needs to learn the basics of nutrition science and perfect the art of making nutritionally sound decisions and healthy food choices—a goal that is a little overwhelming at first.**

1.1 Nutrition, Food Choices, and the American Diet

LEARNING OBJECTIVES

- Identify factors that affect our food choices.
- Describe two ways in which our food and eating patterns have changed during the past 50 years.
- Name two foods or nutrients that Americans over- or underconsume.

nutrition A science that studies the interactions between living organisms and food.

nutrients Substances in foods that provide energy and structure and help regulate body processes.

Nutrition is a science that studies all the interactions that occur between living organisms and food. Food provides **nutrients** and energy, which are needed to keep us alive and healthy, to support growth, and to allow reproduction. Which foods we choose determine the nutrients we get, which in turn affects how healthy we are. Many factors affect our food choices, and despite an abundant food supply Americans today don't always choose the right combination of foods to optimize nutritional health.

Why We Eat What We Eat

Our food choices are affected by more than our nutrient needs. We choose what we eat based on what is available to us, what we have learned to eat from our family and cultural traditions, what foods appeal to us for emotional reasons, and what our personal preferences are, whether based on what we enjoy or what we think we should eat.

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

Availability The food available to an individual or a population is affected by the **food environment**, which includes factors such as access to grocery stores and restaurants, the products available in these stores and restaurants, food pricing, and food advertising. Economic status and health also affect what foods are available.

In developing parts of the world, dietary choices are often limited to foods produced locally. Nutrients that are lacking in local foods will be lacking in the population's diet. This is less of a factor in more-developed countries because the ability to store, transport, and process food allows year-round access to seasonal foods and foods grown and produced at distant locations (Figure 1.1).

iStock/Getty Images

FIGURE 1.1 Food from around the word
In the United States, seasonal fruits and vegetables are available all year long because they can be stored and shipped from around the globe.

Even if foods are available in the store, it doesn't mean that they are available to all individuals. Socioeconomic factors such as income level, living conditions, and education affect the types and amounts of foods to which people have access. Individuals with limited incomes can choose only the types and amounts of foods that they can afford. Individuals who don't own cars can purchase only what they can carry home. Those without refrigerators or stoves are limited in what foods can be prepared at home. And those who can't or don't have time to cook are limited to raw foods, prepared foods, and restaurant meals.

Health status also affects the availability of food. People who cannot carry heavy packages are limited in what they can purchase. People with food allergies, digestive problems, and dental disease are limited in the foods that are safe and comfortable for them to eat. People consuming special diets to manage disease conditions are limited to foods that meet their dietary prescriptions.

AFP/Getty Images

FIGURE 1.2 Culture dictates food acceptability If you grew up in Asia or Africa, you might consider grasshoppers, termites, or the silkworms in this Vietnamese market to be an acceptable food choice. Most Americans would not be willing to include insects as part of a meal.

Social and Cultural Considerations Food preferences and eating habits are learned as part of each individual's family, cultural, national, and social background (Figure 1.2). They are among the oldest and most entrenched features of every culture. In Japan rice is the focus of the meal, whereas in Italy, pasta is included with every meal. Curries characterize Indian cuisine, and we expect refried beans and tortillas when we go out for Mexican food.

Social, religious, and cultural traditions also affect what foods we choose. Each of us associates holidays such as Christmas, Easter, Passover, New Year's Day, and Kwanzaa with specific foods that are traditional in our family, religion, and culture. Seventh-Day Adventists espouse vegetarianism; Jews and Muslims do not eat pork; Sikhs and Hindus do not eat beef.

In addition to being part of our cultural heritage, food is the centerpiece of our everyday social interactions. We get together with friends for a meal or for a cup of coffee and dessert. The dinner table is often the focal point for communication within the family—a place where the experiences of the day are shared. Social events dictate our food choices in a number of ways. When invited to a friend's house for dinner, we may eat foods we don't like out of politeness to our hosts. We also sometimes alter our food choices because of peer pressure (Figure 1.3).

Psychological and Emotional Factors Food represents comfort, love, and security. Comfort foods such as hot tea and chicken soup help us to feel better when we are sick, sad, tired, or lonely. We use food as a reward when we are good—A's on a report card are celebrated with an ice cream cone. We sometimes take away food as punishment—a child who misbehaves is sent to bed without dessert. We celebrate milestones and reward life's accomplishments with food. Food may also be an expression and a moderator of mood and emotional states. When we are upset, some of us turn to chocolate or overeat in general, while others eat less or stop eating altogether.

Blend Images/Moxie Productions/Getty Images

FIGURE 1.3 Peer pressure affects food intake For an adolescent, having pizza after school may be an important part of being accepted by his or her peers.

Personal Preference We eat what we like. Tradition, religion, and social values may dictate what foods we consider appropriate, but personal preferences for taste, smell, appearance, and texture affect which foods we actually consume. How would you feel about giving up your favorite foods? Probably not too good, and you are not alone. Even though most Americans understand that nutrition is important to their health, many do not choose a healthy diet because they don't want to give up their favorite foods and they don't want to eat foods they don't like.[1] Personal convictions also affect food choices; a vegetarian would not choose a

meal that contains meat, and a person concerned about the environment may not buy foods packaged in nonrecyclable containers.

Individuals' perceptions about food and health also affect their food and nutrition choices. Some people may choose low-carbohydrate foods because they think these choices will help them lose weight. Others may limit red meat intake to reduce their risk of heart disease, or may purchase organically produced foods if they believe that reducing pesticide exposure will prevent illness.

Food in 21st-Century America

food processing The practices used by the food industry to transform raw plant and animal materials, such as grains, produce, meat, and milk, into products for consumers. Nearly all our food has been processed in some way.

For much of human history, people needed to spend most of their day obtaining food and preparing meals in order to get enough to eat. Even a generation ago, the time spent for meal preparation was measured in hours—hours spent peeling, chopping, baking, roasting, stewing, and then cleaning. Today, our homes are stocked with an endless assortment of foods available at a moment's notice. Many of these choices are foods that have been part of the human diet for centuries—fresh fruits and vegetables, milk, breads, and cereals. But others are newer additions created through **food processing**: frozen vegetables complete with sauce, dried soups and noodle bowls, pre-cooked packaged meats, frozen prepared meals, and an endless array of sweet and savory snack foods.

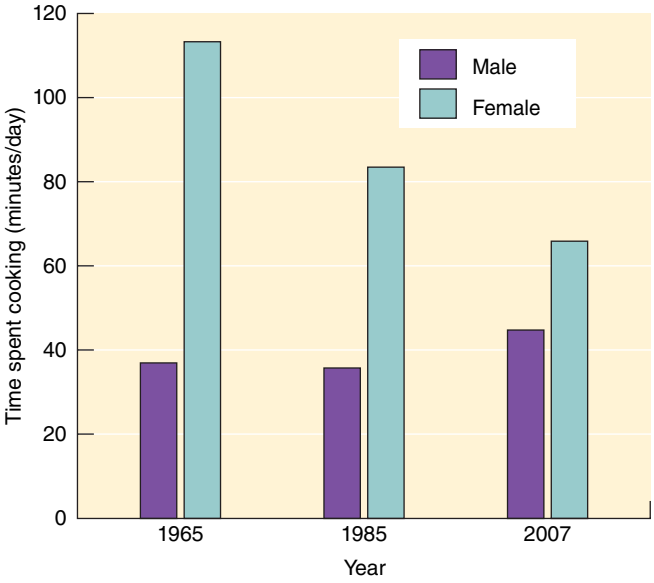


FIGURE 1.4 Time spent cooking
Since the 1960s the amount of time women spend cooking has decreased significantly. Due to other social changes, the amount of time men spend cooking has increased slightly.[2]

In addition to our food choices, our eating patterns have changed. Fifty years ago people ate most of their meals at home, with their families, at a leisurely pace. Today, more single-parent households and families with both parents working mean no one is home in the afternoon to prepare an evening meal. Dinner is a rush because busy after-school schedules impinge on family mealtimes. Fewer people today even know how to prepare a full meal, so shoppers of all ages are choosing to buy more convenient, processed foods that can be boiled or heated in the microwave rather than raw ingredients that need to be chopped, seasoned, and cooked (Figure 1.4).[2] These convenience foods have expanded our choices for meals at home and Americans are replacing more and more home-cooked meals with take-out food and meals eaten away from home. These meals tend to be higher in calories than foods prepared at home; almost a third of our calories currently come from meals eaten away from home.[3]

These changes in our food environment have made it easier and faster to obtain a meal or snack on the run, but the foods we choose are lower in whole grains, milk, fruits, and vegetables and higher in unhealthy saturated fat than the choices we make at home (Figure 1.5).[4] Over the past century, the major nutrition concerns in the United States have shifted from providing enough nutrients to meet people's needs to limiting overconsumption and reducing the incidence of chronic diseases related to excesses of energy and certain nutrients.

How Healthy Is the American Diet?

The American diet isn't as healthy as it could be. As it has become easier to obtain and prepare food, the amount of food we eat has increased. American adults eat more calories than they did 50 years ago primarily due to larger portion sizes, especially from fast foods, and an increase in the frequency of snacking and calories consumed from those snacks.[5,6] As a result, over two-thirds of American adults weigh more than they should.[7]

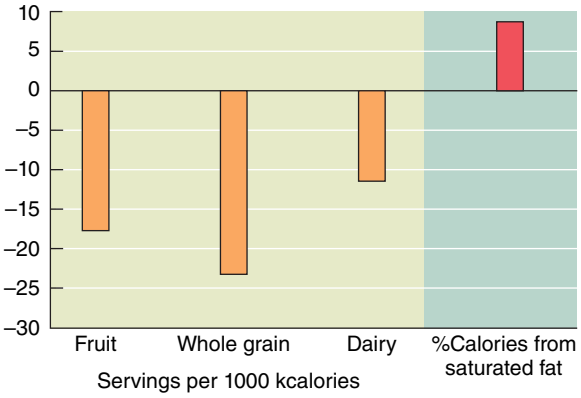
In addition to eating more calories than we need, we are not eating enough of the foods that make up a healthy diet. Recommendations suggest a diet based on whole grains, vegetables, and

Breakfast at home
A cup of coffee with whole milk and sugar and a cup of whole grain cereal with low-fat milk and a half a banana would cost about $1.00 and provide about 350 kcalories.

P. Langen/Getty Images

Breakfast out
A 16-ounce caramel mocha and a blueberry muffin at Dunkin' Donuts or the corner coffee bar would cost about $4 and provide about 770 kcalories.

P. Mittongtare/FoodPix/Getty Images



Dietary impact of eating breakfast away from home

On average, breakfast away from home decreases the number of servings of whole grains, fruit, and dairy consumed per 1000 kcalories and increases the percentage of calories from saturated fat.[4]

FIGURE 1.5 The costs of convenience
If you stop for a muffin and coffee on your way to work or school, you can save a couple of minutes, but you may pay a higher price than you think in terms of both dollars and nutrient intake. The impact of stopping for coffee and a muffin once in a while when you are running late is minimal, but making this an everyday habit can break your dollar and calorie budget and affect the quality of your overall diet.

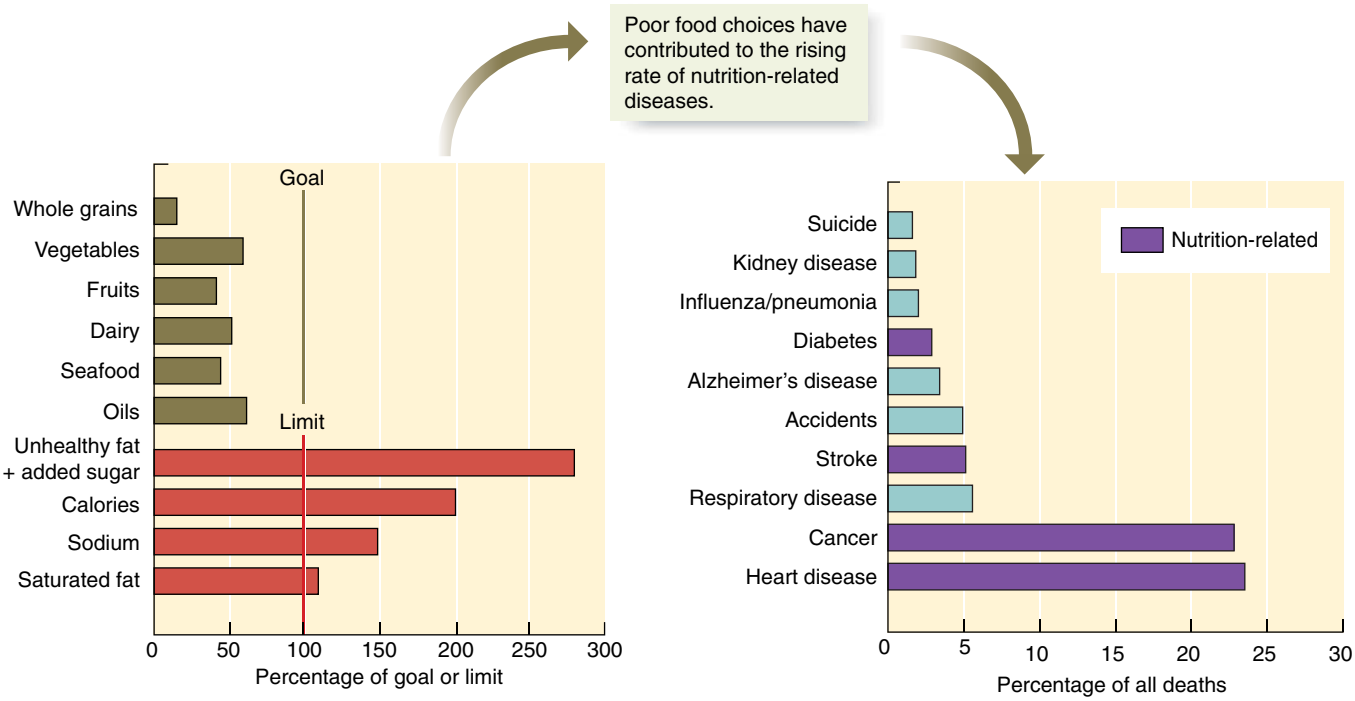
THINK CRITICALLY

iProfile Use iProfile to plan a 500-kcal lunch that you can prepare at home. How does the amount of food compare with 500 kcalories of food from a typical fast-food restaurant?

fruits, with smaller amounts of low-fat dairy products and lean meats and limited amounts of sweets and certain types of fats, such as saturated fat.[5] As a population, we don't eat enough whole grains, vegetables, fruits, seafood, or dairy products. We frequently choose French fries for a vegetable and consume few nutrient-rich dark green and deep yellow vegetables. Our diets are high in snack foods and desserts that supply us with more salt (sodium) and sugar than is recommended (Figure 1.6A).[5] Instead of milk, we are choosing sweetened beverages, especially carbonated soft drinks and fruit drinks.[8] This dietary pattern, along with a lack of physical activity, increases the risk of developing chronic diseases such as diabetes, obesity, heart disease, and cancer, which are the most common, costly, and preventable of all health problems in the United States (Figure 1.6B).[9–11] Recommendations for reducing disease risk focus on changes in the foods we choose and the amount of exercise we get.[5,12]

A healthy diet does not need to exclude processed convenience foods, but it must involve wise choices. To choose a healthy diet that provides the right amounts of energy and each nutrient, we need to understand how our bodies obtain nutrients from food, which nutrients are essential, how much we need, and which foods provide healthy sources of nutrients. We also need to recognize which nutrition information to believe.

FIGURE 1.6 Our current diet increases our health risks



A. The current U.S. dietary pattern is not as healthy as it could be. The graph shows the usual U.S. intake of selected foods and nutrients as a percentage of the recommended goal or limit.

B. The graph shows the leading causes of death in the United States; those shown in purple are nutrition related.[9]

1.2 Food Provides Nutrients

LEARNING OBJECTIVES

- Define the term *essential nutrient* and list the six classes of nutrients.
- Describe the three general functions of nutrients.
- Discuss how nutrition can affect your health in the short term and in the long term.

essential nutrient A nutrient that must be provided in the diet because the body either cannot make it or cannot make it in sufficient quantities to satisfy its needs.

fortified food Food to which one or more nutrients have been added.

enriched grains Grain products to which specific amounts of thiamin, riboflavin, niacin, and iron have been added. Since 1998 folic acid has also been added to enriched grains.

dietary supplement A product intended for ingestion in the diet that contains one or more of the following: vitamins, minerals, plant-derived substances, amino acids, and concentrates or extracts.

To date, approximately 45 nutrients have been determined to be essential to human life. **Essential nutrients** must be supplied in the diet to support life; they either cannot be made by the body or cannot be made in large enough quantities to meet needs. For example, our bodies cannot synthesize vitamin C, but we need it to stay healthy. If we do not consume vitamin C in the foods we eat, we will begin to show signs of a vitamin C deficiency. If vitamin C is not added back into the diet, the vitamin C deficiency will eventually be fatal.

Our intake of essential nutrients is determined by our food choices. Some foods are naturally high in nutrients, and some contain nutrients added during processing. Foods to which nutrients have been added are called **fortified foods**. Some fortified foods, such as milk with added vitamin A and **enriched grains**, have been a part of our food supply for decades. The government mandated the fortification of these foods to eliminate nutrient deficiencies in the population, and the amounts and types of nutrients added are specified. Other foods, such as orange juice with added calcium and flavored water with added vitamins and minerals, are not part of mandated fortification programs. These foods are fortified with nutrients to increase sales by meeting consumer demand for nutrient-rich foods. The amounts and types of nutrients added to these foods are at the discretion of the manufacturer. **Dietary supplements** are another source of nutrients in the American food supply. National surveys indicate that 68% of adults in the United States take dietary supplements, and vitamin and mineral supplements are the most popular category.[13]

In addition to nutrients, food contains substances that are needed by the body but are not essential in the diet. Lecithin, for example, is a substance found in egg yolks that is needed for nerve function. It is not considered an essential nutrient because it can be manufactured in the body in adequate amounts. The diet also contains substances that are not made by the body and are not necessary for life, but that have health-promoting properties. Those that come from plants are called **phytochemicals**; those that come from animal foods are called *zoochemicals*. For example, a phytochemical found in broccoli called sulforaphane is not essential in the diet but has effects in the body that may help reduce the risk of cancer.

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

energy-yielding nutrient A nutrient that can be metabolized to provide energy in the body.

macronutrient A nutrient needed by the body in large amounts. These include water and the energy-yielding nutrients: carbohydrates, lipids, and proteins.

micronutrient A nutrient needed by the body in small amounts. These include vitamins and minerals.

organic molecule A molecule that contains carbon bonded to hydrogen.

inorganic molecule A molecule that contains no carbon–hydrogen bonds.

kilocalorie (kcal, kcalorie) The unit of heat used to express the amount of energy provided by foods. It is the amount of heat required to raise the temperature of 1 kg of water 1 degree Celsius (1 kcal = 4.18 kJ).

kilojoule (kJ, kjoule) A unit of work that can be used to express energy intake and energy output. It is the amount of work required to move an object weighing 1 kg a distance of 1 meter under the force of gravity (1 kJ = 0.24 kcal).

The Six Classes of Nutrients

Chemically, there are six classes of nutrients: carbohydrates, lipids, proteins, water, vitamins, and minerals. These classes can be grouped in a variety of ways—by whether they provide energy to the body, by how much is needed in the diet, and by their chemical structure. Carbohydrates, lipids, and proteins provide energy and thus are referred to as **energy-yielding nutrients**. Alcohol also provides energy but is not considered a nutrient because it is not needed to support life (see Focus on Alcohol). Along with water, the energy-yielding nutrients constitute the major portion of most foods and are required in relatively large amounts by the body. Therefore, they are referred to as **macronutrients** (*macro-* means large). Their requirements are measured in kilograms (kg) or grams (g). Vitamins and minerals are classified as **micronutrients** because they are needed in small amounts in the diet (*micro-* means small). The amounts required are expressed in milligrams (1 mg = 1/1000 g) or micrograms (1 μg = 1/1,000,000 g) (see online Appendix I). Structurally, carbohydrates, proteins, lipids, and vitamins are **organic molecules**, so they are referred to as *organic nutrients*. Minerals and water are **inorganic molecules**, so they are referred to as *inorganic nutrients*.

The Energy-Yielding Nutrients The energy provided by carbohydrates, lipids (fats), and proteins is measured in **kilocalories** (abbreviated kcal or kcalories) or in **kilojoules** (abbreviated kJ or kjoules). The more common term, calorie (lowercase *c*), is technically 1/1000 of a kilocalorie, but when spelled with a capital *C*, Calorie means a kilocalorie (Figure 1.7). In the popular press, calorie (small *c*) is often used to express the kilocalorie content of a food or diet.

The grams of carbohydrate, fat, and protein determine the number of kcalories in a food.

Nutrition Facts
Serving Size 1 cup (236ml)
Servings Per Container 1

Amount Per Serving

Calories 121	Calories from Fat 45
	% Daily Value*
Total Fat 5g	**8%**
Saturated Fat 3g	**15%**
Trans Fat 0g	
Cholesterol 20mg	**7%**
Sodium 160mg	**7%**
Total Carbohydrate 11g	**4%**
Dietary Fiber 0g	**0%**
Sugars 5g	
Protein 8g	

Energy Provided by Macronutrients and Alcohol

	Kcalories/gram	Kjoules/gram
Carbohydrate	4	16.7
Protein	4	16.7
Fat	9	37.6
Alcohol	7	29.3

FIGURE 1.7 Calories in foods
The term "Calories" listed near the top of the Nutrition Facts panel on a food label technically refers to the number of kilocalories in a serving of the food. It is equal to the total number of kilocalories provided by the grams of carbohydrate, fat, and protein in a serving. Alcohol also provides calories but currently nutrition information is not required on the labels of alcoholic beverages. The number of kilocalories in a serving of the food from the label shown here can be calculated as follows: (5 g fat × 9 kcal/g) + (11 g carbohydrate × 4 kcal/g) + (8 g protein × 4 kcal/g) = 121 kcal per serving.