Second Edition

HUMAN NUTRITION

Science For Healthy Living

Tammy J. Stephenson | Wendy J. Schiff

Mc Graw Hill Education

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HUMAN NUTRITION: SCIENCE FOR HEALTHY LIVING, SECOND EDITION

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Brief Contents

About the Authors

©Tammy Stephenson

Tammy J. Stephenson, PhD, received her BS in Food Science and Human Nutrition and PhD in Nutritional Sciences from the University of Kentucky. She has taught a wide variety of food, nutrition, and wellness courses, including introductory nutrition, to majors and nonmajors in the Department of Dietetics and Human Nutrition at the University of Kentucky for the past 20 years. Dr. Stephenson is an active member of the Academy of Nutrition and Dietetics, having served as Chair of the Nutrition Educators of Health Professionals practice group. She has published and presented on service learning, technology in teaching, student–centered learning, and other related topics. Dr. Stephenson has a passion for teaching engaging, interesting, and relevant nutrition courses that has been recognized through multiple teaching and mentoring awards at the university, state, and national levels. At the University of Kentucky, she has been recognized with both the Alumni Association's Great Teacher Award (2016) and the Provost Office's Outstanding Teacher Award (2015). Outside of the classroom, she enjoys running, yoga, gardening, cooking, watching her daughters play sports, and spending time with her family.

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Wendy J. Schiff, MS, RDN, received her BS in Biological Health/Medical Dietetics and MS in Human Nutrition from The Pennsylvania State University. She has taught introductory foods and nutrition courses at the University of Missouri–Columbia as well as nutrition, biology, and personal health courses at St. Louis Community College–Meramec. She has worked as a public health nutritionist at the Allegheny County Health Department (Pittsburgh, Pennsylvania) and State Food and Nutrition Specialist for Missouri Extension at Lincoln University in Jefferson City, Missouri. In addition to coauthoring *Human Nutrition*: *Science for Healthy Living*, Wendy has authored *Nutrition for Healthy Living* and *Nutrition Essentials*: *A Personal Approach*. She is a registered dietitian nutritionist and member of the Academy of Nutrition and Dietetics.

To Brian, Bailey, Kylie Mae, and Ansley

–Tammy Stephenson

To Bill and Kevin

–Wendy Schiff

Welcome to Human Nutrition: Science for Healthy Living

Dear Students,

Welcome to the study of human nutrition! Before you begin your studies, it is important to understand that nutrition is a science that draws upon knowledge from other sciences, particularly biology, human anatomy and physiology, general chemistry, and biological chemistry. The science of human nutrition also involves learning scientific information about foods and nutrition, and how this information is used to develop dietary recommendations for healthy people and nutritional therapies for those who are not healthy. By understanding the contents of this introductory nutrition textbook, you will recognize the effects that peoples' food choices can have on their health. In addition, you will appreciate the valuable role that registered dietitian nutritionists (RDNs) play as members of the health care team and be well prepared to take more advanced human nutrition courses, if you decide to become a dietitian.

Human Nutrition: *Science for Healthy Living* has been developed by a team of nutrition educators who have extensive college teaching experience and a passion for teaching relevant, student−centered nutrition, foods, health, and wellness courses. Our goals with this textbook are to teach students the science of nutrition, while also preparing future health care professionals, and to make the study of introductory human nutrition enjoyable. Learning about any science can be challenging if the information is not presented in an appealing, interesting manner. We've made a distinct effort to write the content of this book in an understandable way and to provide clear descriptions of concepts that can be difficult to convey, such as the processes of digestion, absorption, and energy metabolism. To enhance your learning, numerous meaningful illustrations and photographs accompany the narrative. Such graphics facilitate learning for all students, but especially for those who are "visual learners." By reviewing this Preface, you will learn about the features of this book and how to use them to facilitate your study of human nutrition.

We hope you will enjoy using this textbook!

Tammy J. Stephenson

Kendy J. Schiff

About the Cover: The cover of this edition reflects the "farm−to−table" theme that we used for the cover of the first edition of *Human Nutrition*. Farm−to−table can be broadly defined as selecting and eating foods grown or produced by local farmers, whenever it is possible. By doing so, consumers can follow a more nutrient−rich diet by increasing their intake of healthy food options, especially fresh fruits and vegetables. Such actions also enable consumers to support their local economy and contribute to a sustainable community.

The mixed greens' salad on this cover includes fresh leafy greens that are garnished with some pale purple flowers of salvia (*Salvia officinalis*). Salvia flowers are safe to eat occasionally and in small amounts. The leaves of salvia are also edible, but they are generally used in food preparation as a seasoning after they have been dried ("sage").

Preface

Tammy Stephenson and Wendy Schiff had a vision of writing an interesting, engaging, and evidence−based introductory nutrition textbook that has a wide variety of pedagogical features to promote active learning. To that end, this second edition of *Human Nutrition*: *Science for Healthy Living* is learner−centered, easy to read, and richly illustrated with figures and images that clearly show physiological processes. Furthermore, the author team felt students and faculty would appreciate a textbook that was clinically oriented and provided ample opportunities for students to practice using their nutrition knowledge and critical thinking skills. *Human Nutrition*: *Science for Healthy Living* is the result of Tammy and Wendy's efforts.

The clinical emphasis of the textbook is of particular relevance to those studying nutrition, dietetics, or other health science professions, including nursing. Specific real−life examples, current statistics, and scientific evidence from professional resources are provided to support nutrition concepts. Features designed to attract students' interest, such as *Did You Know?* and *Fresh Tips* boxes, provide up−to−date information on current and sometimes controversial topics, as well as practical recommendations for everyday healthy living.

Human Nutrition: *Science for Healthy Living* provides the framework for students to *learn* how nutrition information is often interrelated and to *apply* the science of nutrition to clinical situations. Furthermore, students can use their foods and nutrition knowledge throughout their lives.

Features Designed Around Student-Centered Learning

Human Nutrition: *Science for Healthy Living* was written by authors who have extensive experience teaching introductory nutrition classes to both majors and nonmajors. The authors recognize the diverse learning needs of today's students and how the modern learning environment in higher education—large lecture classes, online classes, and flipped/hybrid classrooms—often challenge even the most experienced nutrition educators. The textbook and its supportive interactive materials are designed to help instructors create a learner−centered teaching environment that maximizes student engagement and knowledge acquisition. This current, evidence−based introductory textbook has a wide variety of pedagogical features to promote active learning among students.

What's New in This Edition?

This edition of *Human Nutrition*: *Science for Healthy Living* has been updated with the most current research and incorporates information from the *2015–2020 Dietary Guidelines for Americans*.

This list provides highlights of some of the additions and updates for the second edition of the textbook:

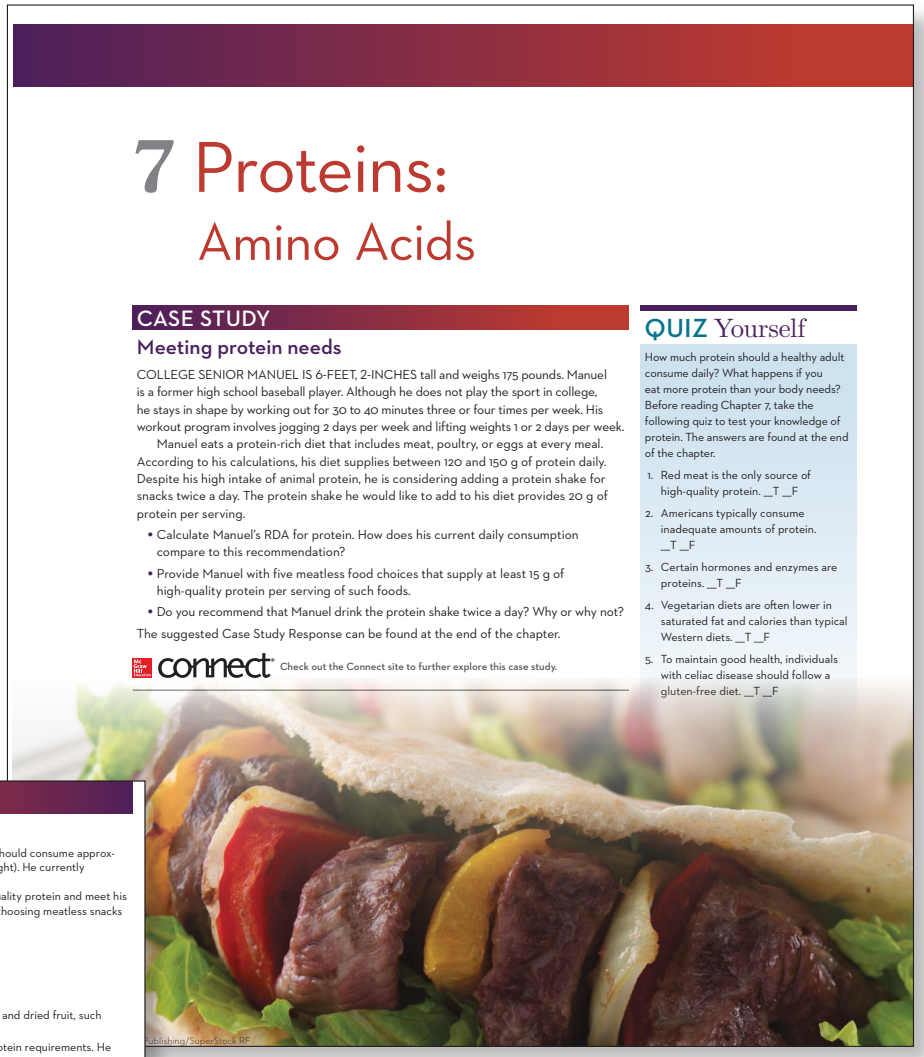
- Numerous new and modern photos have been included to engage the reader.
- References have been updated for all chapters to include the most current research and evidence−based practice recommendations.
- The Dietary Reference Intake tables are now included as Appendix J.
- Chapter 1 includes revised Figure 1.10, "Beverage Comparison," and a new *Did You Know?* about seals of approval for dietary supplement labels.
- Chapter 2 includes new *Did You Know?* features on diet−related apps, as well as the sugar industry's role in influencing scientific opinions about diet and cardiovascular health in the mid−1960s. In addition, Figure 2.5, "Cohort Studies," has been revised to make its content easier for students to understand.
- Chapter 3 has a figure that displays the new Nutrition Facts panel, and discusses how the new panel differs from the original panel, which is still in use.
- Chapter 4 has expanded content on gut microbiota, including information about probiotics, prebiotics, and gut microbiota ("fecal") transplantation.
- Chapter 5 includes the latest research on diabetes, including updated Figure 5.14, "Regulating Blood Glucose," and a new *Did You Know?* about diabetic alert service dogs that are trained to detect hyper− and hypoglycemia in humans.
- Chapter 6 provides updated information on trans fats and the Food and Drug Administration ban of partially hydrogenated oils. New recommendations for dietary cholesterol intake ("as low as possible") are also summarized.
- Chapter 7 includes updates concerning food allergies, celiac disease, and phenylketonuria.
- Chapter 8 includes revised Figures 8.28, "Amino Acids and Energy Metabolism," and 8.40, "Effects of Alcohol Metabolism on the Liver." Tables 8.9, "Typical Effects of Alcohol at Various BAC Levels (Adults)," and 8.10, "Classifying Drinkers," have also been updated.

- Chapters 9 and 10 have been updated to include the most current research on the effects of fat− and water−soluble vitamin intake on human health. A new *Did You Know?* on farmer's markets has been added to Chapter 9.
- Chapters 11 and 12 summarize fluid balance and provide evidence−based recommendations for optimal mineral consumption. Tables 11.3, "Common Signs of Dehydration," and 12.5, "Signs and Symptoms of Iron Deficiency Anemia," have been revised.
- Chapter 13 includes revised Figure 13.1, "Prevalence of Self−Reported Obesity among U.S. Adults," and new *Did You Know?* features about obesity, the risk of polycystic ovary syndrome, and weight−loss methods that are unreliable. The section on bariatric surgical methods has also been expanded.
- Chapter 14 provides updates on the link between genetics and eating disorders and a new *Did You Know?* concerning the role of social media in glamorizing and spreading misinformation about eating disorders.
- Chapter 15 has been revised based on the latest recommendations from the sports nutrition position paper of the Academy of Nutrition and Dietetics. Updates include Table 15.7, "Popular Energy Bars and Gels," as well as revisions to the sections on vitamin D status/needs of athletes and summary of the current research on popular ergogenic aids.
- The life cycle chapters, Chapters 16, 17, and 18, have also been updated based on the most current research. Examples of updates from these chapters include revised Figure 16.6, "Signs of Preeclampsia," recent recommendations concerning the introduction of peanuts and other hyperallergenic foods to a baby's diet, and new content on diabetic eye diseases.
- Chapter 19 provides updated recommendations for preventing foodborne illness, including revised Tables 19.4, "USDA Recommended Safe Minimum Internal Temperatures," and 19.5, "Cold Storage Time Limits for Perishable Foods."
- Chapter 20 includes a revised case study on a child experiencing malnutrition in a developing country. Tables 20.1, "Prevalence of Undernutrition Among Selected Countries," and 20.2, "Under−5 Mortal− ity Rates for Selected Countries," have both been updated. Furthermore, a new *Did You Know?* on the Campus Kitchens Project has been added.

Features

Case Study—Each chapter begins with a case study addressing a realistic scenario. These high–interest scenarios engage the student by showing how the chapter's content is relevant to their future professions and can be utilized in a practical or clinical situation. Students are encouraged to consider the case study as they study the chapter. A suggested ***Case Study Response*** is provided at the end of the chapter to allow students to self–assess their understanding of the chapter's material and its applications.

Quiz Yourself—This pretest, which is next to the *Case Study*, stimulates interest in reading the chapter. By taking the quiz, students may be surprised to learn how little or how much they know about the chapter's contents.



7 Proteins:
Amino Acids

CASE STUDY

Meeting protein needs

COLLEGE SENIOR MANUEL IS 6-FEET, 2-INCHES tall and weighs 175 pounds. Manuel is a former high school baseball player. Although he does not play the sport in college, he stays in shape by working out for 30 to 40 minutes three or four times per week. His workout program involves jogging 2 days per week and lifting weights 1 or 2 days per week.

Manuel eats a protein-rich diet that includes meat, poultry, or eggs at every meal. According to his calculations, his diet supplies between 120 and 150 g of protein daily. Despite his high intake of animal protein, he is considering adding a protein shake for snacks twice a day. The protein shake he would like to add to his diet provides 20 g of protein per serving.

- Calculate Manuel's RDA for protein. How does his current daily consumption compare to this recommendation?
- Provide Manuel with five meatless food choices that supply at least 15 g of high-quality protein per serving of such foods.
- Do you recommend that Manuel drink the protein shake twice a day? Why or why not?

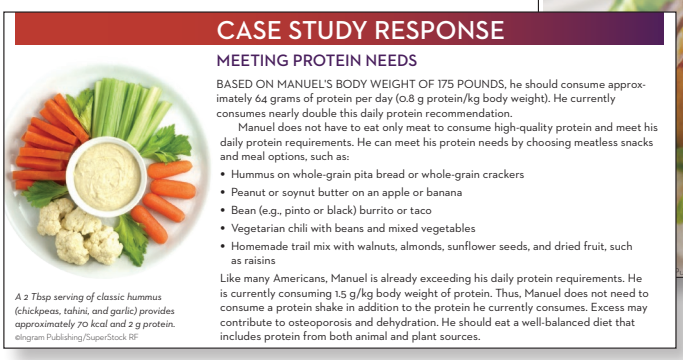
The suggested Case Study Response can be found at the end of the chapter.

connect Check out the Connect site to further explore this case study.

QUIZ Yourself

How much protein should a healthy adult consume daily? What happens if you eat more protein than your body needs? Before reading Chapter 7, take the following quiz to test your knowledge of protein. The answers are found at the end of the chapter.

1. Red meat is the only source of high-quality protein. __T __F
2. Americans typically consume inadequate amounts of protein. __T __F
3. Certain hormones and enzymes are proteins. __T __F
4. Vegetarian diets are often lower in saturated fat and calories than typical Western diets. __T __F
5. To maintain good health, individuals with celiac disease should follow a gluten-free diet. __T __F



CASE STUDY RESPONSE

MEETING PROTEIN NEEDS

A 2 Tbsp serving of classic hummus (chickpeas, tahini, and garlic) provides approximately 70 kcal and 2 g protein.

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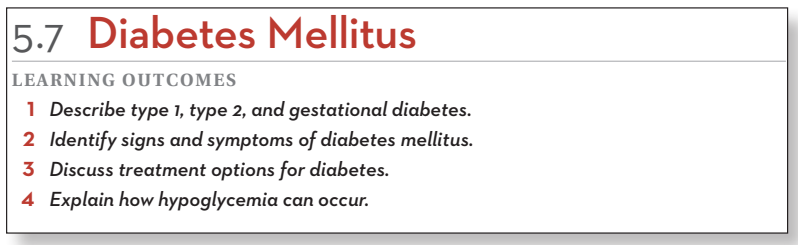
BASED ON MANUEL'S BODY WEIGHT OF 175 POUNDS, he should consume approximately 64 grams of protein per day (0.8 g protein/kg body weight). He currently consumes nearly double this daily protein recommendation.

Manuel does not have to eat only meat to consume high-quality protein and meet his daily protein requirements. He can meet his protein needs by choosing meatless snacks and meal options, such as:

- Hummus on whole-grain pita bread or whole-grain crackers
- Peanut or soynut butter on an apple or banana
- Bean (e.g., pinto or black) burrito or taco
- Vegetarian chili with beans and mixed vegetables
- Homemade trail mix with walnuts, almonds, sunflower seeds, and dried fruit, such as raisins

Like many Americans, Manuel is already exceeding his daily protein requirements. He is currently consuming 1.5 g/kg body weight of protein. Thus, Manuel does not need to consume a protein shake in addition to the protein he currently consumes. Excess may contribute to osteoporosis and dehydration. He should eat a well-balanced diet that includes protein from both animal and plant sources.

Learning Outcomes—Each major section of a chapter opens with a list of learning outcomes. The *Learning Outcomes* help students prepare for reading the section and also clarify major concepts they are expected to learn. These measurable outcomes are further supported by assessment methods and study aids found within the chapters and within McGraw–Hill Education's Connect®.

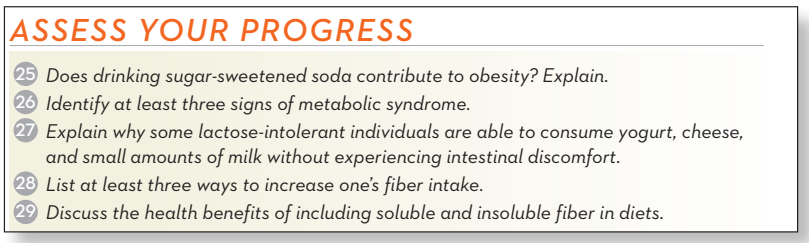


5.7 Diabetes Mellitus

LEARNING OUTCOMES

1 *Describe type 1, type 2, and gestational diabetes.*
2 *Identify signs and symptoms of diabetes mellitus.*
3 *Discuss treatment options for diabetes.*
4 *Explain how hypoglycemia can occur.*

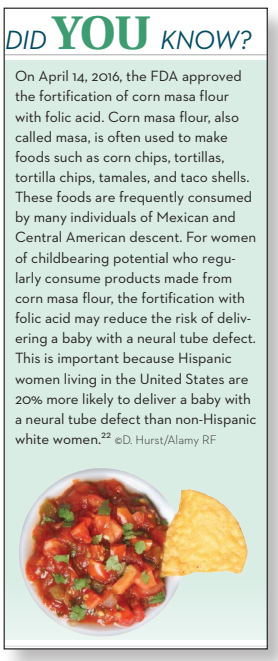
Assess Your Progress—These review questions, which appear at the end of each major section within a chapter, apply to the section's learning outcomes and often involve critical thinking skills. Such questions enable students to test their knowledge and understanding of information provided within that section.



ASSESS YOUR PROGRESS

25 *Does drinking sugar-sweetened soda contribute to obesity? Explain.*
26 *Identify at least three signs of metabolic syndrome.*
27 *Explain why some lactose-intolerant individuals are able to consume yogurt, cheese, and small amounts of milk without experiencing intestinal discomfort.*
28 *List at least three ways to increase one's fiber intake.*
29 *Discuss the health benefits of including soluble and insoluble fiber in diets.*

Fresh Tips—These practical suggestions help students apply the chapter's content to their current situations. The *Fresh Tips* are also valuable for future health care professionals who want to provide useful health, food, and nutrition advice to their clients. Such features include tips for including more fruits and vegetables in diets, maintaining a healthy body weight, preventing choking in children, and keeping foods safe to eat.



Did You Know?—This feature presents bits of information concerning topics that support the chapter's content and are of interest to introductory nutrition students. Some of these features dispel beliefs about food and nutrition that are commonly held but inaccurate, such as "stick" margarine being more fattening than butter. Other *Did You Know* features report results of current and unusual areas of research or nutrition–related news, such as the fortification of corn masa flour with folic acid.

Real People, Real Stories—This unique feature provides information about real people, some of whom have recovered from or are currently living with nutrition–related conditions. Such conditions include PKU, celiac disease, type 1 diabetes, smell disorders, and hypertension. This feature is designed to help students recognize the daily challenges faced by people with such conditions and the roles that diet and physical activity play in managing one's health.

Each chapter ends with the Case Study Response and the following features.

Summary

SUMMARY

SECTION 15.1 Physical Activity and Health

- Physical fitness refers to the ability of an individual to perform moderate- to vigorous-intensity physical activity without becoming excessively fatigued. Regular physical activity has numerous health benefits, including weight control and prevention of heart disease.
- Aerobic exercises raise heart rate, and resistance exercises build muscle mass, muscle strength, and bone density.

SECTION 15.2 Physical Activity Guidelines

- Adults under 65 years of age should perform moderate-intensity aerobic activity for at least 150 minutes per week. For moderate-intensity physical activity, an individual should exercise at 50 to 70% of their age-related maximum heart rate.
- At least 2 days per week, adults should engage in strength-training exercises, neuromotor exercises, and flexibility exercises.
- Physical fitness plans should be individualized and include three stages: initiation, improvement, and maintenance.

SECTION 15.3 Energy Systems for Exercising Muscles

- The PCr-ATP energy system does not require oxygen and provides energy for quick bursts of physical activity. The lactic acid energy system does not require oxygen. The degradation of glucose to lactic acid provides energy during high-intensity physical activity that lasts up to 180 seconds.
- The oxygen energy system is the primary source of energy for most exercising muscles. The aerobic system enables cells to produce significantly more ATP energy than the PCr-ATP or lactic acid energy systems.
- The rate of intensity and duration of physical activity determine the fuel source for that activity. Muscle cells rely on a balance of carbohydrate and fat for fuel.

Critical Thinking—These questions involve higher–level cognition skills, including applying, analyzing, synthesizing, and evaluating information.

Critical Thinking

1. Using the recommendations provided in this chapter, analyze your weekly physical activity habits. Does your participation in various activities meet the minimum recommendations? If not, which physical activities are you willing to include in your weekly routine to improve your fitness level?
2. Why is protein not a major source of energy for the body during physical activity?
3. Describe how taking a creatine supplement may improve performance in activities requiring short bursts of intense energy.
4. Develop a chart summarizing the fluid needs of a 170-pound male endurance runner before, during, and after a 3-hour race. Assume the runner lost 2 pounds of body weight during the race.
5. Explain why low-fat chocolate milk is considered a good recovery drink for athletes.

Practice Test—This series of multiple–choice questions assess students' comprehension and recall of information presented in the chapter.

Practice Test

Select the best answer.

1. Miranda is physically fit. She has
   a. an increased risk of osteoporosis.
   b. the strength, endurance, and flexibility to meet the demands of daily living.
   c. a greater need for vitamins and minerals than other women.
   d. the endurance to run an ultramarathon.

2. A ____ physical activity generally requires a high degree of exertion.
   a. vigorous
   b. basic
   c. moderate
   d. precise

10. According to recommendations, a healthy adult who participates in regular high-intensity interval training should consume ____ of body weight of protein per day.
    a. 0.8 g/kg
    b. 1.0 to 1.4 g/kg
    c. 1.2 to 2.0 g/kg
    d. 1.8 to 2.4 g/kg

11. Drinking at least 6 L of water daily
    a. is recommended by the National Academies of Sciences.
    b. is necessary for healthy persons, even if they are not thirsty.
    c. can result in water intoxication.
    d. improves athletic performance.

12. Sports drinks
    a. are the best source of fluid for most athletes.
    b. contain a mix of complex carbohydrates.

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The end of chapters may also include:

- Test Kitchen and
- Personal Dietary Analysis.

TEST KITCHEN

Modifying Recipes for Healthy Living

You are working with a client who has recently been diagnosed with type 2 diabetes. Your client is concerned about the high amounts of sugar that are in many of her favorite desserts. She would like to know how to reduce the sugar content of this strawberry cobbler recipe. Indicate how to modify the recipe so that it is more "diabetes-friendly" and does not contain as much sucrose.

STRAWBERRY COBBLER

©Wendy Schiff

INGREDIENTS

3 Tbsp melted butter
½ cup white sugar
¼ cup brown sugar
¾ cup all-purpose flour
¾ cup whole milk
1 tsp baking powder
Pinch of salt
2 cups frozen or fresh hulled strawberries, sliced into halves
1 Tbsp white sugar

PREPARATION STEPS

1. Preheat oven to 375° F.
2. Grease the inside of an 8" square baking dish with melted butter.
3. Combine sugars, flour, baking powder, and salt in a small bowl. Add milk and blend well to form a batter.
4. Pour batter into the baking dish and add strawberries to the top of the batter. Sprinkle with tablespoon of white sugar.
5. Bake for 50 to 55 minutes; batter will be golden brown and a toothpick will come out of the batter clean when the cobbler is done.
6. Serve warm with whipped cream or a scoop of vanilla ice cream.

STEP 1 Brainstorm

Examine the recipe. What ingredients can you use to reduce the added sugar content of the recipe? What ingredients can you add or substitute to boost the recipe's soluble fiber content? (Refer to Table 1.7 for substitutions.)

STEP 2 Develop a modified version of this recipe

List ingredients and amounts needed.

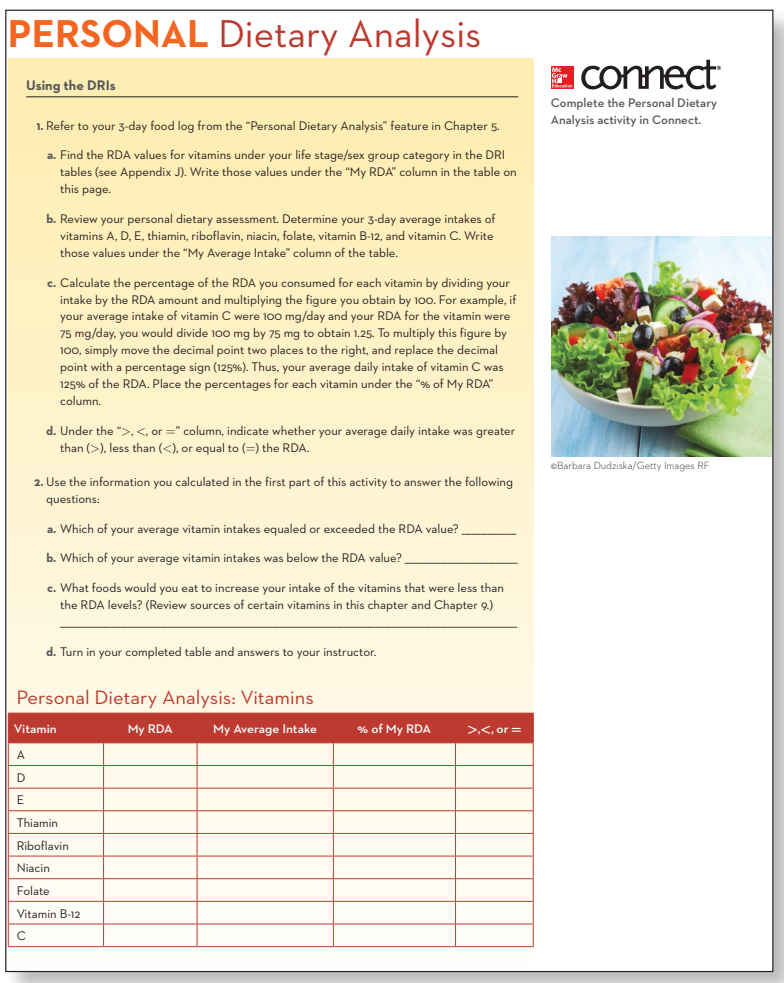
List the preparation steps.

STEP 3 Analyze nutrient contents of the original and modified recipes by using a computer software program

Develop a table that compares the number of kcal and amounts of total carbohydrate, saturated fat, protein, fiber, and sugar in each strawberry cobbler recipe.

How did your modifications change the nutrient composition of the cobbler?

Test Kitchen: Modifying Recipes for Healthy Living—This unique feature provides students with the opportunity to apply nutrition and food information to situations that commonly arise in clinical settings. Students modify an existing recipe to make it healthier, using information they have learned in the chapter. This feature allows students to experiment with recipe modifications, such as substituting "healthy" fats for "unhealthy" ones and using less sugar and salt in recipes.



PERSONAL Dietary Analysis

Using the DRIs

1. Refer to your 3-day food log from the "Personal Dietary Analysis" feature in Chapter 5.
   a. Find the RDA values for vitamins under your life stage/sex group category in the DRI tables (see Appendix J). Write those values under the "My RDA" column in the table on this page.
   b. Review your personal dietary assessment. Determine your 3-day average intakes of vitamins A, D, E, thiamin, riboflavin, niacin, folate, vitamin B-12, and vitamin C. Write those values under the "My Average Intake" column of the table.
   c. Calculate the percentage of the RDA you consumed for each vitamin by dividing your intake by the RDA amount and multiplying the figure you obtain by 100. For example, if your average intake of vitamin C were 100 mg/day and your RDA for the vitamin were 75 mg/day, you would divide 100 mg by 75 mg to obtain 1.25. To multiply this figure by 100, simply move the decimal point two places to the right, and replace the decimal point with a percentage sign (125%). Thus, your average daily intake of vitamin C was 125% of the RDA. Place the percentages for each vitamin under the "% of My RDA" column.
   d. Under the ">, <, or =" column, indicate whether your average daily intake was greater than (>), less than (<), or equal to (=) the RDA.
2. Use the information you calculated in the first part of this activity to answer the following questions:
   a. Which of your average vitamin intakes equaled or exceeded the RDA value? _____
   b. Which of your average vitamin intakes was below the RDA value? _____
   c. What foods would you eat to increase your intake of the vitamins that were less than the RDA levels? (Review sources of certain vitamins in this chapter and Chapter 9.)
   _____
   d. Turn in your completed table and answers to your instructor.

connect

Complete the Personal Dietary Analysis activity in Connect.

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Personal Dietary Analysis: Vitamins

Vitamin	My RDA	My Average Intake	% of My RDA	>,<, or =
A				
D				
E				
Thiamin				
Riboflavin				
Niacin				
Folate				
Vitamin B-12				
C				

Personal Dietary Analysis—Students can gain insight into their eating habits by completing this activity. Many of these activities can be completed with the use of a dietary analysis software program, such as NutritionCalc Plus.

Artwork and Photographs That Enhance Learning

Dimensional, full–color illustrations, some with num–bered labels and explanatory text, help teach and/or show the progression of a complicated concept.

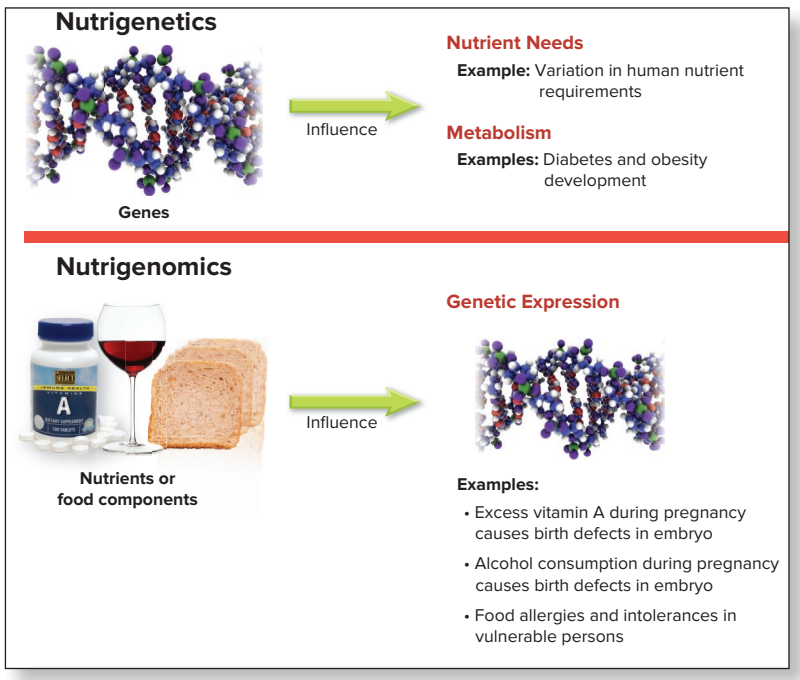

FIGURE 7.22 Nutritional genomics.

Double helix: ©Digital Vision/Getty Images RF; Vitamin bottle: ©McGraw-Hill Education/John Flournoy, photographer; Red wine: ©FoodCollection/StockFood RF; Bread: ©Ingram Publishing RF

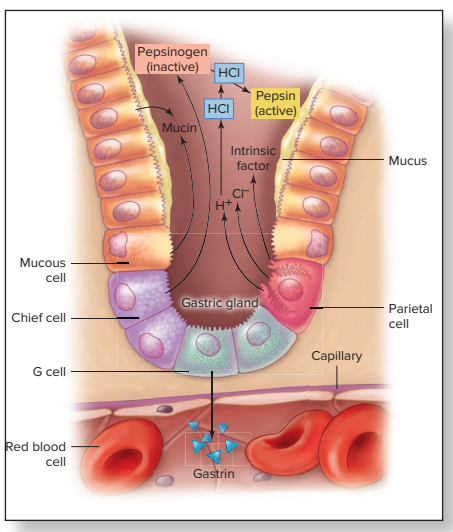

FIGURE 4.11 Gastric gland and its secretory cells.

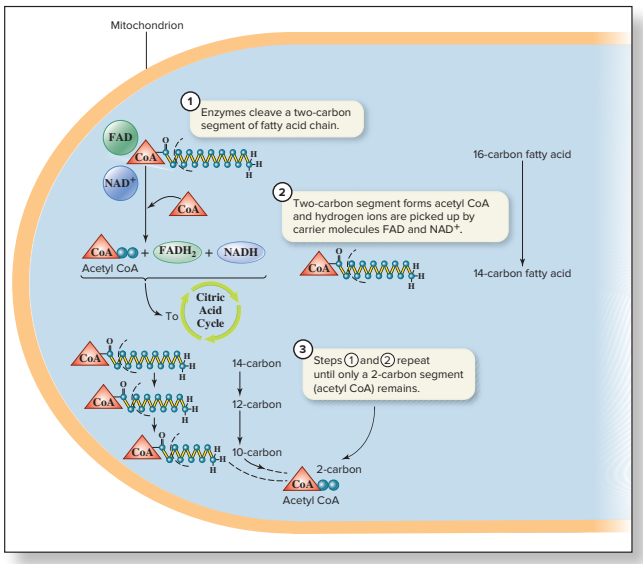

FIGURE 8.24 Beta-oxidation.

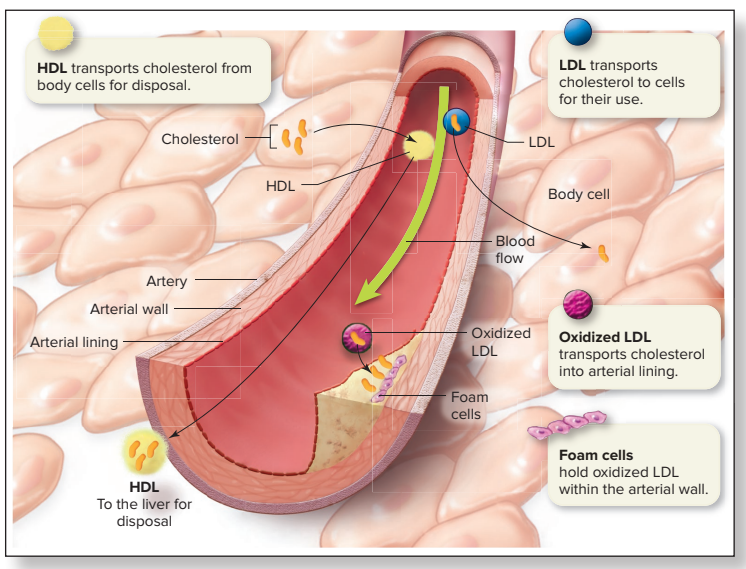

FIGURE 6.21 HDL, LDL, and oxidized LDL.

Numerous high–quality photos support the text and provide examples of nutrition–related medical conditions as well as microscopic views of clinical cases from the human body.

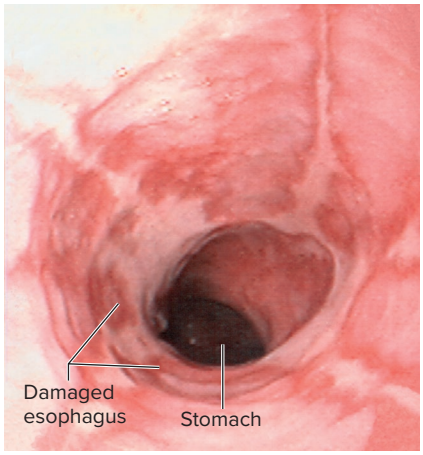

FIGURE 4.23 Acid reflux damage.
©David M. Martin, M.D./Science Source

FIGURE 6.16 Gallstones.
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FIGURE 7.19 Skin patch testing for allergies.
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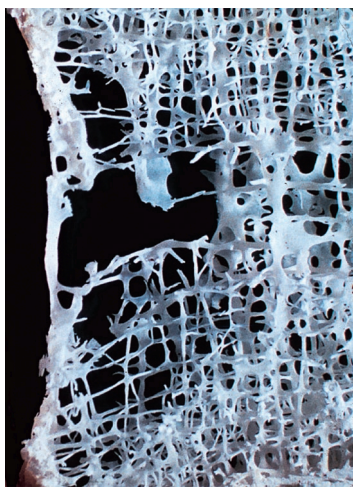

FIGURE 11.14 Bone tissue.
©Michael Klein/Photolibrary/Getty Images

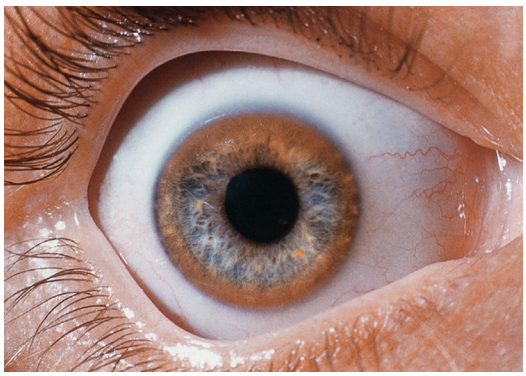

FIGURE 12.11 Kayser-Fleischer ring.
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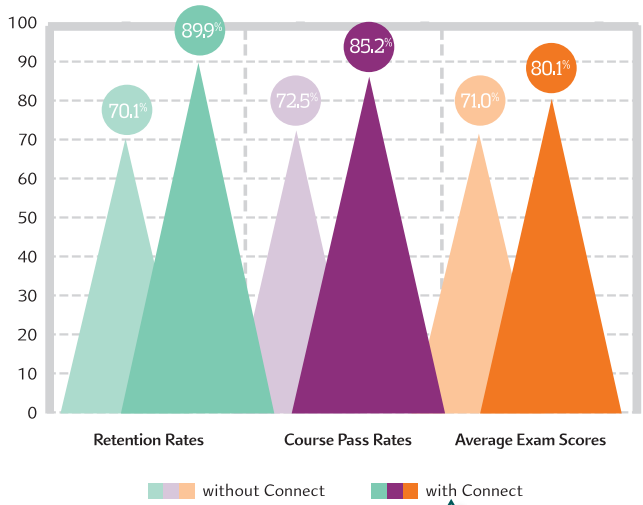

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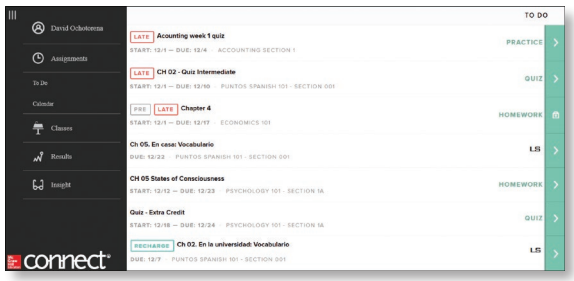

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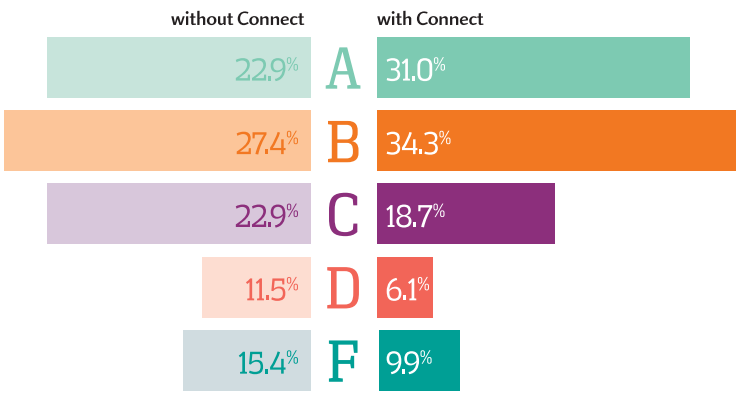

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Acknowledgments

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Tammy J. Stephenson

Wendy J. Schiff

Contents

1 Introduction to Nutrition

CASE STUDY

Healthy eating while on campus

EACH CHAPTER IN THE TEXTBOOK is introduced with a real-life application "Case Study" that describes a person's background, including his or her health and food choices. Begin by reviewing the case study and writing down potential responses to the case study questions. Then, after reading and studying the chapter, review your initial answers and make changes, if necessary. Compare your responses with the suggested responses to the case study that are provided at the end of each chapter.

Jorge has become concerned about his eating practices since he started college last month. He lives in a residence hall that has an all-you-can-eat dining facility in the basement and the Student Union is nearby. Several fast-food chain restaurants are in the Student Union, including burger, sandwich, and smoothie shops.

After moving in, Jorge began a daily routine of eating a fast-food breakfast sandwich, large chocolate chip muffin, and sugar-sweetened coffee at the Student Union before his 10 A.M. class. Between classes he would drink sugary soft drinks and then eat three slices of pizza or a couple of hamburgers and a large portion of French fries in the dining facility at night. He knows he should eat more nutritious foods, but he thinks he does not have enough time to eat fresh salads or fresh fruit. Jorge wants your advice concerning how he can improve his food choices.

- Consider Jorge's current eating practices. Do his food choices reflect a nutritionally adequate pattern?
- What steps can Jorge take to improve his eating practices?

The suggested Case Study Response can be found at the end of the chapter.

connect® Check out the Connect site to further explore this case study.

QUIZ Yourself

Each chapter of this textbook begins with "Quiz Yourself," a brief true-or-false quiz to test your knowledge of the material covered in the chapter. Before reading Chapter 1, test your basic nutrition knowledge by taking the following quiz. The answers are found at the end of this chapter.

1. There are six classes of nutrients: carbohydrates, lipids, proteins, vitamins, minerals, and water. __T __F
2. Vitamins and minerals are sources of energy. __T __F
3. A healthy diet is one that contains no carbohydrate or fat. __T __F
4. Heart disease is the leading cause of death in the United States. __T __F
5. The Food and Drug Administration regulates the safety and effectiveness of dietary supplements that are sold in the United States. __T __F

1.1 The Importance of Nutrition

LEARNING OUTCOMES

1. *Explain why it is important to study nutrition.*
2. *Describe Americans' current food-buying practices and how they compare to dietary recommendations.*

Many college students do not pay much attention to the foods they consume regularly, possibly because they are healthy now and they think poor health is unlikely to affect them until they are much older. Why should young adults focus more on what and how much they eat? What is nutrition? In this textbook, we will provide a framework of understanding nutrition and making healthy food choices.

Why Study Nutrition?

nutrients life-sustaining substances in food

nutrition scientific study of nutrients and how the body uses them

diet a person's usual pattern of food choices

Food is a basic human need for survival: people become hungry and search for something to eat when their body needs **nutrients**, the life-sustaining substances in food. Nutrients are necessary for the growth, maintenance, and repair of the body's cells. **Nutrition** is the scientific study of nutrients and how the body uses them.

Humans have no instinctive ability to select the appropriate mix of nutrients their bodies require for proper functioning. To eat well, people need to learn about the nutritional value of foods and the effects that their **diet**, their usual pattern of food choices, can have on health.

Simply having information about nutrients and their importance to good health may not be enough for people to change ingrained food-related behaviors and purchase healthier foods: a person must be motivated to make such changes. Some people strive to improve their diets because they want to lose or gain weight. Others are so concerned about their health, they are motivated to change their eating habits in specific ways, such as by eating fewer salty foods or more whole-grain products.

What People Eat in America

According to a recent analysis of food spending patterns, most Americans do not purchase recommended amounts of fruits, vegetables, whole grains, fish, and low-fat dairy products.[1] Americans, however, tend to buy more than recommended amounts of red meats; candies; cheese; sugary beverages, such as sugar-sweetened fruit and soft drinks; and *refined* grain products. Raw foods often undergo some form of processing, such as refining, canning, freezing, or cooking, before they are eaten. Processing can make a food more nutritious, safer to eat, and less likely to spoil. However, some forms of processing remove nutrients that were naturally in the food and/or add unhealthy amounts of sodium, sugar, and "solid" fat to foods.[2]

Public health experts are concerned with Americans' eating habits, because many serious diseases, including obesity and type 2 diabetes, are associated with certain dietary practices. Over the past 30 years, these disorders have become increasingly more common, not only among Americans, but also among populations of other countries. People may be able to live longer, healthier lives by improving the nutritional quality of their diets.

How to Use This Textbook

Every major section of a chapter begins with a set of "Learning Outcomes" and ends with "Assess Your Progress" questions for you to evaluate your knowledge of the material. Key terms that you need to know when learning about nutrition are displayed in bold type within the narrative. The terms and their definitions are in the margins, but you can also look up the definitions in the Glossary.

At the end of each chapter, you will find a summary of key points; a set of "Critical Thinking" questions; and "Practice Test," a group of multiple–choice questions that check your understanding of the material in the chapter. Answers to the "Practice Test" questions are provided at the end of the test. Many chapters also have a "Personal Dietary Analysis" activity and "Test Kitchen," a case study in which you modify a recipe to accommodate a client's special dietary needs.

ASSESS YOUR PROGRESS

1. *Why is it important to learn about nutrition?*
2. *Which foods do Americans tend to buy in amounts that are higher than recommended?*

1.2 The Nutrients

LEARNING OUTCOMES

1. ***List the six classes of nutrients, and identify major roles of each class of nutrient in the body.***
2. ***Identify the key features of an essential nutrient.***
3. ***Categorize nutrients based on whether they are essential and their designation as a micronutrient or macronutrient.***
4. ***Identify rich food sources of phytochemicals.***

To understand nutrition, students need to learn about and use information from biology, anat–omy, physiology, and chemistry. This chap–ter introduces the nutrients and their general functions. Chapter 4 focuses on the struc–tures and functions of the human digestive system. Appendices B and C provide brief reviews of basic chemistry and physiol–ogy concepts that form the foundation for understanding the science of nutrition.

The Six Classes of Nutrients

There are six classes of nutrients: carbohy–drates, lipids (such as fats and oils), proteins, vitamins, minerals, and water. Both food and the human body are comprised of these nutrients. Although the percentage varies with age and sex, about 50 to 70% of the body's total weight is water. On average, healthy young men and women have similar amounts of vitamins, minerals, and car–bohydrates in their bodies, but the young women have less water and protein, and considerably more fat (Fig. 1.1). Bodies with high fat content tend to have less water in them than bodies with less fat.

Each nutrient typically has more than one physiological role, that is, function in the body (Table 1.1). In general, the body uses cer–tain nutrients for energy, growth and development, and regulation of processes, including the repair and maintenance of cells. Cells do not need food to survive, but they need the nutrients *in* food to

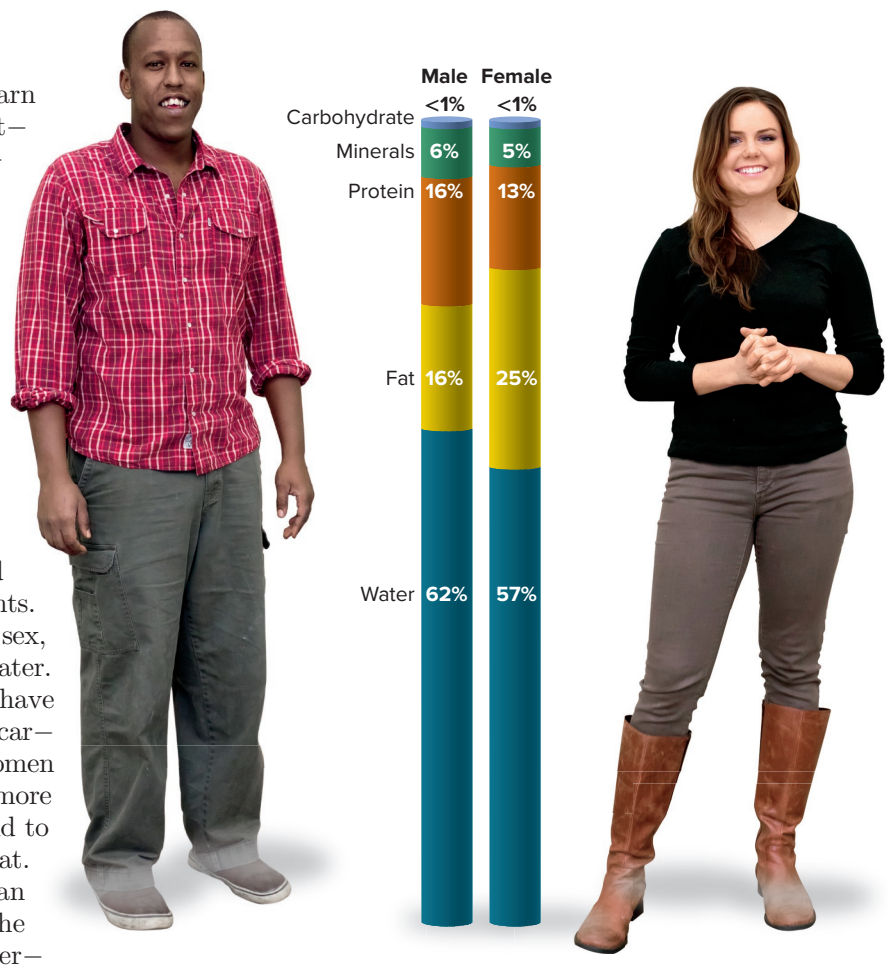

FIGURE 1.1 Comparing body composition. These illustrations present the approximate percentages of nutrients that comprise the bodies of a healthy man and woman. Note that the amount of vitamins in the human body is so small, it is not shown.

Man, woman: ©McGraw-Hill Education. Aaron Roeth Photography

TABLE 1.1 Nutrients

Nutrient Class	Major Functions
Carbohydrates	• Major source of energy (most forms) • Maintenance of normal blood glucose levels • Elimination of solid waste from gastrointestinal tract (fiber)
Lipids	• Major source of energy (fat) • Cellular development, physical growth and development • Regulation of body processes (certain hormones, for example) • Growth and development of the brain • Absorption of fat-soluble vitamins
Proteins	• Production of structural components, such as cell membranes, and functional components, such as enzymes • Cellular development, growth, and maintenance • Regulation of body processes (certain hormones, for example) • Transportation of substances within the blood • Energy (normally a minor source)
Vitamins	• Regulation of body processes • Immune function • Production and maintenance of cells • Protection against agents that can damage cellular components
Minerals	• Regulation of body processes, including fluid balance and energy metabolism • Formation of certain chemical messengers • Formation of structural and functional components of various substances and tissues • Cellular development, growth, and maintenance
Water	• Maintenance of fluid balance • Regulation of body temperature • Elimination of wastes • Transportation of substances • Participation in many chemical reactions

metabolism total of all chemical processes that occur in living cells

carry out their metabolic activities. **Metabolism** is the total of all chemical processes that occur in living cells, including chemical reactions involved in supplying energy, making proteins, and eliminating waste products.

Nutrients: Elements

element substance that cannot be separated into simpler substances by ordinary chemical or physical means

Nutrients are sources of elements that the body needs to carry out its activities (Table 1.2). An **element** is a substance, such as carbon and oxygen, that cannot be separated into simpler substances by ordinary chemical or physical means.

TABLE 1.2 Elements in Nutrients

Nutrient Class	Elements*
Carbohydrates	Carbon, hydrogen, and oxygen
Lipids	Carbon, hydrogen, and oxygen; phosphorus (phospholipids); nitrogen (certain phospholipids)
Proteins	Carbon, hydrogen, oxygen, nitrogen Sulfur (methionine and cysteine)
Vitamins	Carbon, hydrogen, oxygen Nitrogen, sulfur, phosphorus, cobalt
Minerals	Sodium, magnesium, potassium, calcium, chromium, manganese, iron, cobalt, copper, zinc, molybdenum, phosphorus, sulfur, chlorine, selenium, iodine, fluorine
Water	Hydrogen, oxygen

* Not every element listed may be a component of a particular nutrient in each class.

Elements are the basic substances that make up all things, including life forms such as human beings. Note that almost 98% of the human body (by weight) is composed of only five elements: oxygen, carbon, hydrogen, nitrogen, and calcium (Fig. 1.2).[3] Several elements, such as calcium, are minerals that the body needs for a variety of functions. In Figure 1.2, the mineral elements are highlighted in green.

In chemistry, the term **organic** refers to compounds that contain carbon. Carbohydrates, lipids, proteins, and vitamins are organic nutrients, because they contain carbon. **Inorganic** nutrients, such as minerals and water, are substances that do not contain carbon.

Essential Nutrients

All nutrients are important for health, but the body can use the "raw materials" from food to synthesize (make) many nutrients, such as cholesterol and fats (types of lipids). The remaining nutrients, about 50 of them, are dietary essentials. An **essential nutrient** must be supplied by food, because the body does not synthesize the nutrient or make enough to meet its needs. Water is the most essential nutrient, because the body can survive for only a few days without it.

Nutrition scientists use the following factors to help determine whether a nutrient is essential:

- If the nutrient is missing from the diet, a deficiency disease occurs as a result. A **deficiency disease** is a state of health characterized by certain abnormal physiological changes. Changes that are observable or measurable are **signs** of disease. Disease signs include rashes, failure to grow properly, and elevated blood pressure. **Symptoms** are subjective complaints of ill health that are difficult to observe and measure, such as dizziness, fatigue, and headache.
- When the missing nutrient is added to the diet, the abnormal physiological changes are corrected. As a result, signs and symptoms of the deficiency disorder resolve as normal functioning is restored and the condition is cured.
- After scientists identify the nutrient's specific roles in the body, they can explain why the abnormalities occurred when the substance was missing from the diet.

To test an adult male human's need for vitamin C, for example, scientists would have the subject avoid consuming foods or vitamin supplements that contain the vitamin. When the amount of vitamin C in the subject's white blood cells (leukocytes) became too low for them to function normally, the person would develop physical signs of scurvy, the vitamin C deficiency disease. When the person brushed his teeth, his gums would bleed from the pressure of the toothbrush (Fig. 1.3). If he cut himself, the wound would heal slowly or not at all.

If the scientists began to feed foods that contain vitamin C to the subject again, the man's deficiency signs and symptoms would disappear within a few days, because his body was recovering. Chapter 10 provides information about the physiological roles of vitamin C. One of those roles is maintaining *collagen*, the protein in the body that holds cells together, including the cells that form tiny blood vessels in skin. Collagen is also needed to produce scar tissue for wound healing. When the vitamin is lacking, the tiniest blood vessels in the gums begin to leak blood where they are compressed, and even minor cuts have difficulty healing. Thus, vitamin C meets all the required features of an essential nutrient. Table 1.3 lists nutrients that are generally considered to be essential.

Some nutrients that are normally nonessential can become essential under certain conditions, such as in metabolic disorders or serious diseases, and during prenatal (before birth) development. In these conditions, **conditionally essential nutrients** may be made by the body but in amounts that are inadequate and must be supplemented by the diet. Chapter 7 discusses some amino acids that are

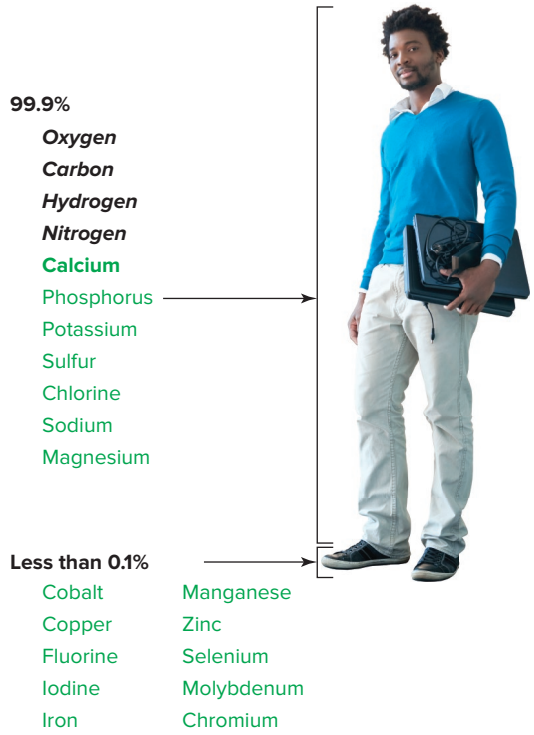

FIGURE 1.2 **Nutrient-related elements in the human body. Minerals are highlighted in green; calcium is the most plentiful mineral element in the body.**

©Eric Audras/Getty Images RF

organic (chemistry) refers to compounds that contain carbon

inorganic refers to substances that do not contain carbon

essential nutrient nutrient that must be supplied by food

deficiency disease state of health characterized by certain abnormal physiological changes that occur when the body lacks a nutrient

signs physical changes associated with a disease state that are observable or measurable

symptoms subjective complaints of ill health that are difficult to observe and measure

conditionally essential nutrients nutrients that are normally not essential but become essential under certain conditions, such as during a serious illness

FIGURE 1.3 **Sign of scurvy.**

Source: Centers for Disease Control and Prevention

TABLE 1.3 Essential Nutrients for Humans

Carbohydrates	Proteins (Amino Acids*)	Lipids	Vitamins	Minerals	Water
Glucose	The following amino acids are generally recognized as essential: Histidine Leucine Isoleucine Lysine Methionine Phenylalanine Threonine Tryptophan Valine	Fats that contain: Linoleic acid Alpha-linolenic acid	A Thiamin Riboflavin Niacin Pantothenic acid Biotin Folate B-6 B-12 C D† E K Choline‡	**Major minerals:** Calcium Chloride Magnesium Phosphorus Potassium Sodium Sulfur **Trace minerals:** Chromium Copper Iodine Iron Manganese Molybdenum Selenium Zinc	Water

* Amino acids are the basic units that make up proteins.
† The body makes vitamin D after exposure to sunlight, but a dietary source of the nutrient is often necessary.
‡ The body makes choline but may not make enough to meet needs. Choline is classified as a *vitamin-like* compound.

conditionally essential. Amino acids are the nitrogen–containing compounds that make up protein molecules.

Macronutrients and Micronutrients

macronutrients nutrients that the body needs in large amounts

micronutrients nutrients that the body needs in very small amounts

So far, we have organized nutrients based on their chemical composition and essentiality. A third way to classify nutrients is based on amounts that the body needs. Carbohydrates, fats, and proteins are **macronutrients**, because the body requires relatively large amounts of these nutrients daily (*macro* = large). Vitamins and minerals are **micronutrients**, because the body needs very small amounts of them to function properly (*micro* = small).

In general, a serving of food supplies grams (g) of carbohydrate, fat, and protein, and milligram (mg) or microgram (µg or mcg) quantities of vitamins and minerals. For example, a serving of a commercially prepared pumpkin pie (⅛ of a 9″ pie) provides about 54 g of carbohydrate, 15 g of fat, 6 g of protein, 514 µg of vitamin A, and 1.4 mg of iron.

Macronutrients supply energy for cells, whereas micronutrients are not sources of energy. Although the body requires large amounts of water, this nutrient does not provide energy and is not usually classified as a macronutrient.

phytochemicals substances in plants that are not nutrients but may have healthful benefits

Phytochemicals

Plants make hundreds of substances called **phytochemicals** (*phyto* = plant), which are not nutrients (nonnutrients), yet they may have healthful benefits. The stimulant caffeine, for example, is a phytochemical made by coffee plants. Beta–carotene is a phytochemical in many fruits and vegetables that the body can convert to vitamin A. Table 1.4 identifies rich food sources of several phy–tochemicals that scientists are studying. The table indicates some effects of the chemicals of the body, including possible health benefits.

Not all phytochemicals have beneficial effects on the body. Some phyto–chemicals, such as nicotine in tobacco leaves, ricin in castor beans, and oxalic acid in rhubarb leaves, are toxic or can interfere with the absorption of nutrients. Information about several phytochemicals that have known effects on human health is woven into chapters of this textbook where it is appropriate.

Most foods are mixtures of nutrients. Pumpkin pie is a rich source of carbohydrate and fat, but the dessert also contributes some protein, vitamin A, and iron to diets.

TABLE 1.4 Phytochemicals That Are of Scientific Interest

Classification and Examples	Biological Effects/Possible Health Benefits	Rich Food Sources
Carotenoids Alpha-carotene, beta-carotene, lutein, lycopene, zeaxanthin	May reduce risk of certain cancers and macular degeneration (a major cause of blindness in the United States)	Orange, red, yellow fruits and vegetables; egg yolks
Phenolics	Antioxidant activity; may inhibit cancer growth and reduce risk of heart disease	
Quercetin		Apples, tea, red wine, onions, olives, raspberries, cocoa
Catechins		Green and black tea, chocolate, plums, apples, berries, pecans
Anthocyanins		Red, blue, or purple fruits and vegetables
Resveratrol		Red wine, purple grapes and grape juice, dark chocolate, cocoa
Isoflavonoids		Soybeans and other legumes
Tannins		Tea, coffee, chocolate, blueberries, grapes, persimmons
Monterpenes		Oranges, lemons, grapefruit, cherries
Organosulfides Isothiocyanates, indoles, allylic sulfur compounds	Antioxidant effects; may improve immune system functioning and reduce the risk of heart disease	Garlic, onions, leeks, cruciferous vegetables (broccoli, cauliflower, cabbage, kale, bok choy, collard and mustard greens)
Alkaloids Caffeine	Stimulant effects	Coffee, tea, "energy drinks," kola nuts, cocoa
Capsaicinoids Capsaicin	May provide some pain relief	Chili peppers

ASSESS YOUR PROGRESS

3. *List the six major classes of nutrients, and identify at least one physiological role for each class.*
4. *Explain the meaning of* organic *in the context of chemical compounds.*
5. *What are three key factors that determine whether a substance is an essential nutrient?*
6. *Distinguish between macronutrients and micronutrients, and provide examples of each.*
7. *List at least seven foods that are rich sources of phytochemicals.*

1.3 Food as Fuel

LEARNING OUTCOMES

1. ***Distinguish between calorie and kilocalorie.***
2. ***Estimate the amount of energy (kcal) in a serving of food based on the grams of carbohydrate, protein, fat, and alcohol present.***

Most foods are sources of biological fuels, because they provide energy for cells. The human body uses energy while running, sitting, studying, and even sleeping. Every cell in the body needs energy to carry out its various activities. Therefore, people need to consume energy–containing foods and beverages to survive.

A **calorie** is the amount of heat (a form of energy) necessary to raise the temperature of 1 g (1 mL) of water 1° Celsius (C). A calorie is such a small unit of measurement that the amount of energy in food is reported in 1000–calorie units called kilocalories or Calories. Thus, a **kilocalorie (kcal)** or **Calorie** is the heat energy needed to raise the temperature of 1000 g (1 liter) of water 1° Celsius (C).

calorie amount of heat necessary to raise the temperature of 1 g (1 mL) of water 1° Celsius (C)

kilocalorie (kcal) or **Calorie** the heat energy needed to raise the temperature of 1000 g (a liter) of water 1° Celsius (C)

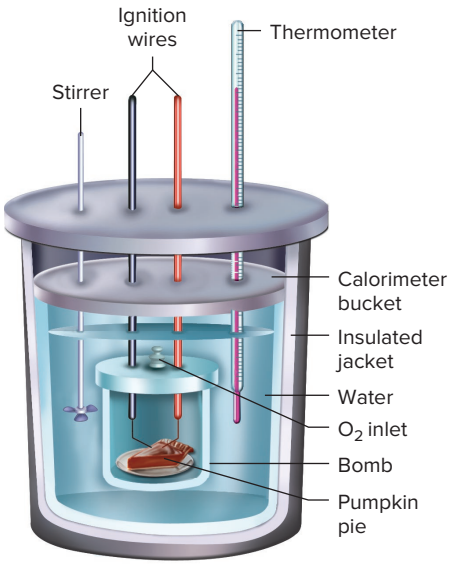

FIGURE 1.4 Bomb calorimeter.

bomb calorimeter device used to measure the calories in a sample of food

A small apple, for example, supplies 40,000 calories or 40 kcal or 40 Calories. If no number of kilocalories is specified, it is appropriate to use *calories*. In this textbook, the term *calories* is interchangeable with *food energy* or simply *energy*. Appendix I is a food composition table that lists energy and nutrient contents of many commonly consumed foods and beverages.

Direct Calorimetry

The calorie content of a food or beverage can be determined through direct calorimetry, which involves placing a specific amount of food in a **bomb calorimeter** (*kal–oh–rim′–eh–ter*). As shown in Figure 1.4, the "bomb" is a small chamber surrounded by a jacket of water. An electrical spark ignites the food and, under the conditions inside the bomb, the food burns completely. As the food burns, it releases heat, which raises the temperature of the water in the surrounding chamber. A thermometer measures the increased water temperature, and scientists use this information to determine the number of calories in the food.

Compared to the human body, a bomb calorimeter is much more efficient at using the energy-yielding nutrients in foods as fuel. Therefore, scientists must correct for this difference in efficiency when developing food composition tables, such as the one in Appendix I.

Calculating Food Energy

Consumers can calculate the number of kcal in their diets by knowing amounts of macronutrients and the nonnutrient alcohol in their foods and beverages. A gram of carbohydrate and a gram of protein each supply about 4 kcal; a gram of fat provides about 9 kcal (Fig. 1.5). Alcohol is not a nutrient, because the

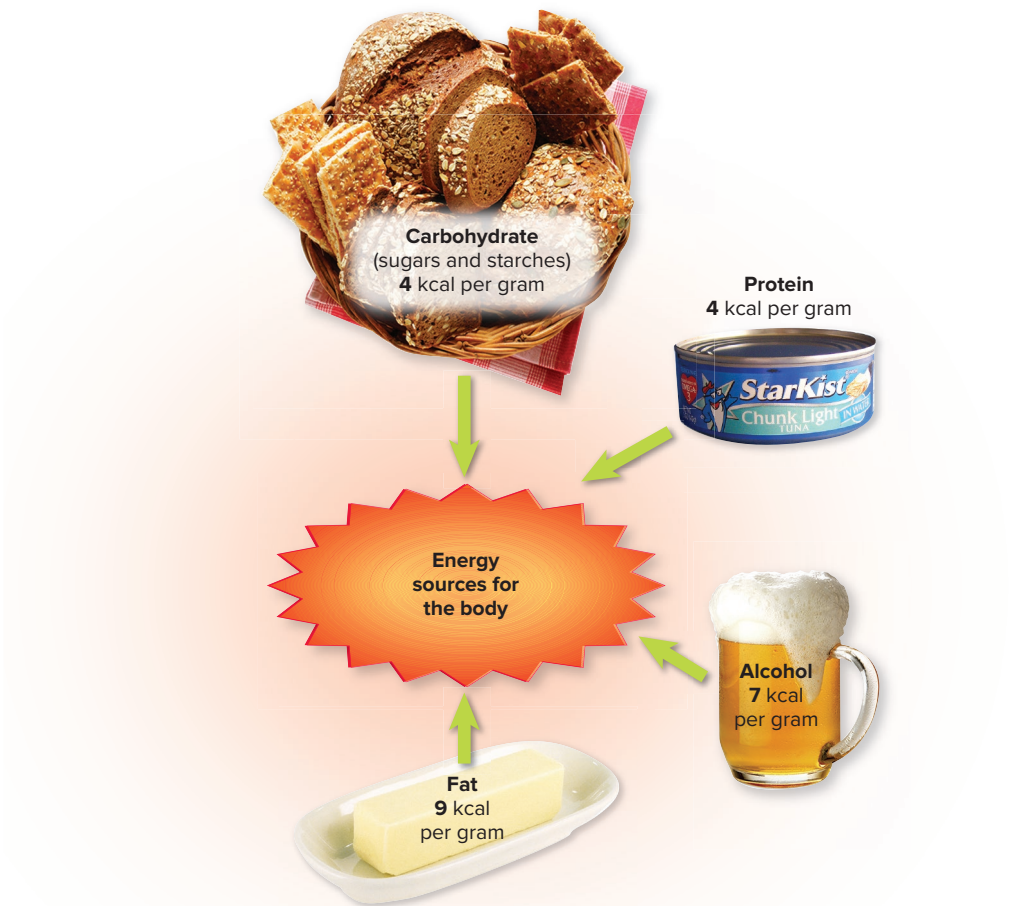

FIGURE 1.5 Energy sources for the body.

Bread, beer: ©FoodCollection/StockFood RF;
Can of tuna: ©McGraw-Hill Education;
Butter: ©Comstock/Jupiter Images RF

human body does not need the chemical to survive. Alcohol, however, is a source of energy; a gram of pure alcohol supplies 7 kcal. Chapter 8 discusses alcohol, including its effects on health.

Let us use the serving of pumpkin pie that we mentioned earlier as an example for estimating the caloric content of a food. The piece of pie contains about 54 g of carbohydrate, 15 g of fat, and 6 g of protein. To estimate the number of kcal provided in a serving of this food:

STEP 1: Determine how many kcal are provided by each type of macronutrient.

54 g carbohydrate	×	4 kcal/g carbohydrate	=	216 kcal
15 g fat	×	9 kcal/g fat	=	135 kcal
6 g protein	×	4 kcal/g protein	=	24 kcal

STEP 2: Add the individual kcal from carbohydrate, fat, and protein together to estimate the total kcal per serving of the food.

Total kcal = 216 kcal (carbohydrate) + 135 kcal (fat) + 24 kcal (protein) = 375 kcal

This food provides approximately 375 kcal per serving.

ASSESS YOUR PROGRESS

8 *What is the difference between a calorie and a kilocalorie?*

9 *A slice of whole-wheat bread supplies approximately 13 g of carbohydrate, 1 g of fat, 3 g of protein, and 11 g of water. Based on this information, estimate the number of kilocalories this serving of food provides.*

10 *An alcoholic beverage contains 4 g of carbohydrate and 10 g of alcohol. In this drink, how many kilocalories are provided by the alcohol?*

1.4 Does Diet Matter?

LEARNING OUTCOMES

1 ***Identify the 10 leading causes of death in the United States.***

2 ***Describe lifestyle factors that contribute to many of the leading causes of death in the United States.***

3 ***Identify two nutrition-related objectives of* Healthy People 2020.**

In the beginning of this chapter, we mentioned that public health officials are concerned about the impact that poor food choices can have on the health of Americans. The graph shown in Figure 1.6 indicates the 10 leading causes of deaths in the United States and the approximate percentages of deaths that were attributed to each of them in 2015. Note that heart disease was the leading cause of death and cancer was the second leading cause of death. In 2015, these two diseases accounted for almost half of all deaths.[4] Also note that several of the leading causes of death are diet–related and responsible for the premature (early) deaths of thousands of adult Americans.

Risk Factors

Heart disease, diabetes, and cancer are chronic diseases. **Chronic** diseases are long–term conditions that usually take many years to develop and have complex causes.

chronic long-term