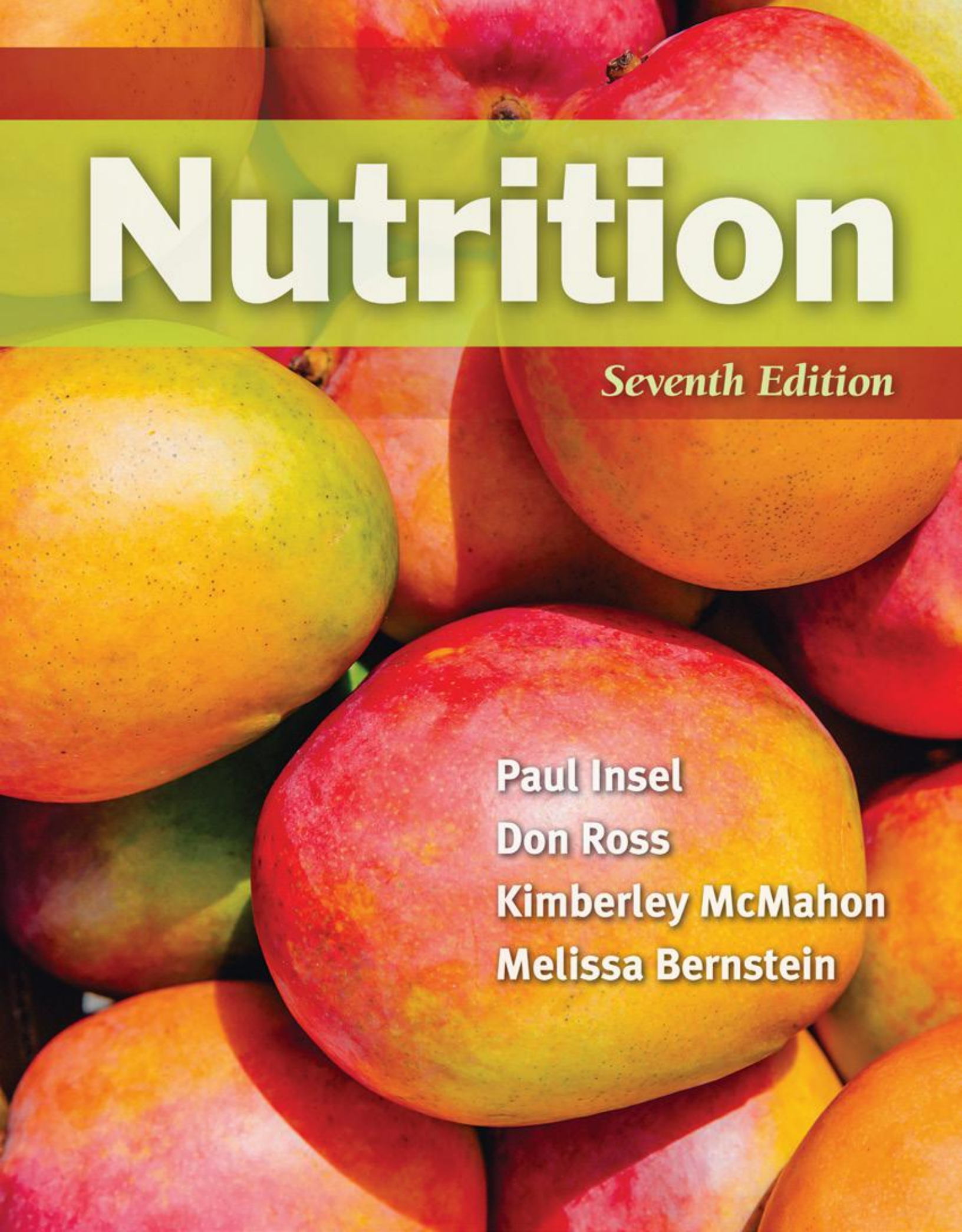
Nutrition
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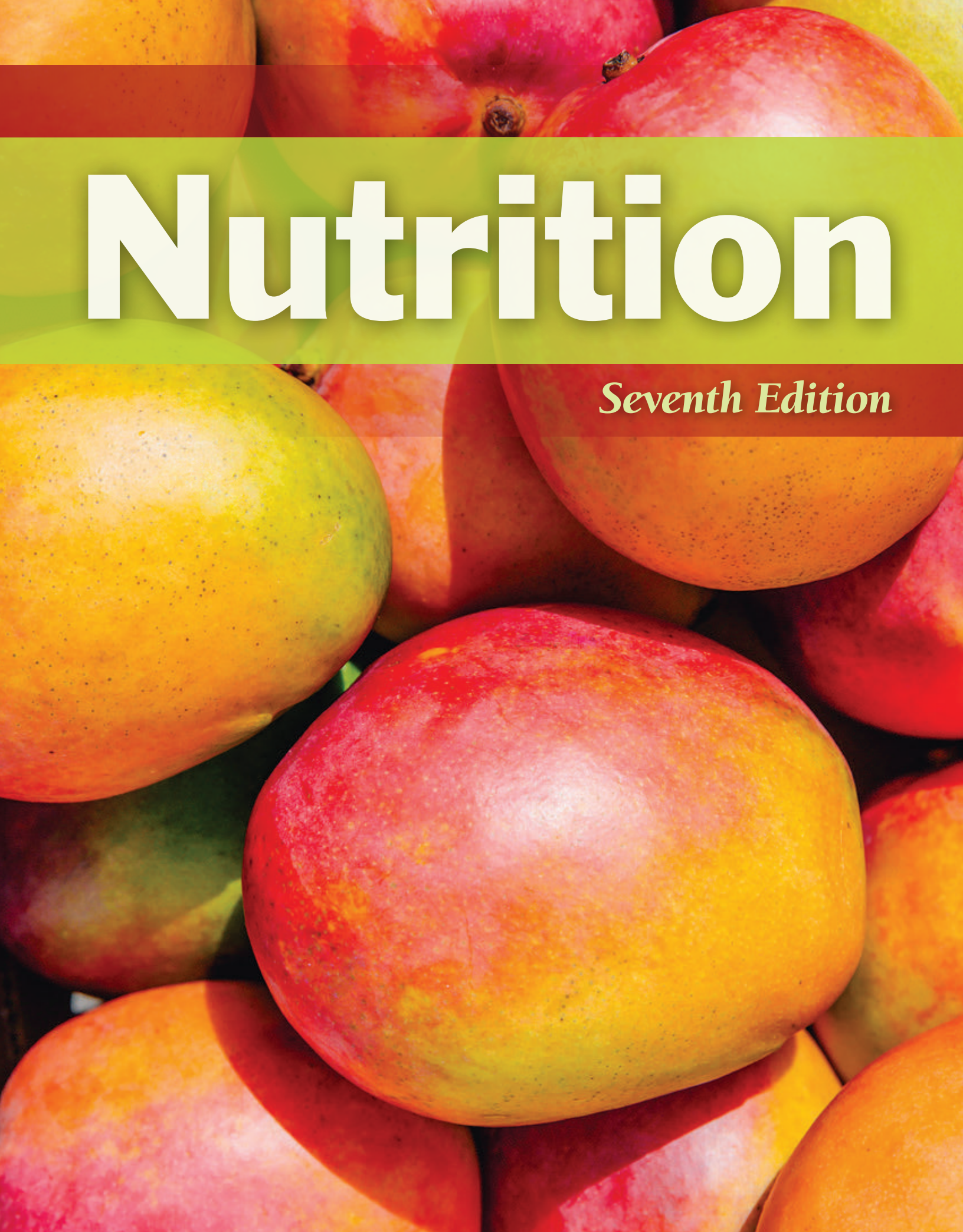
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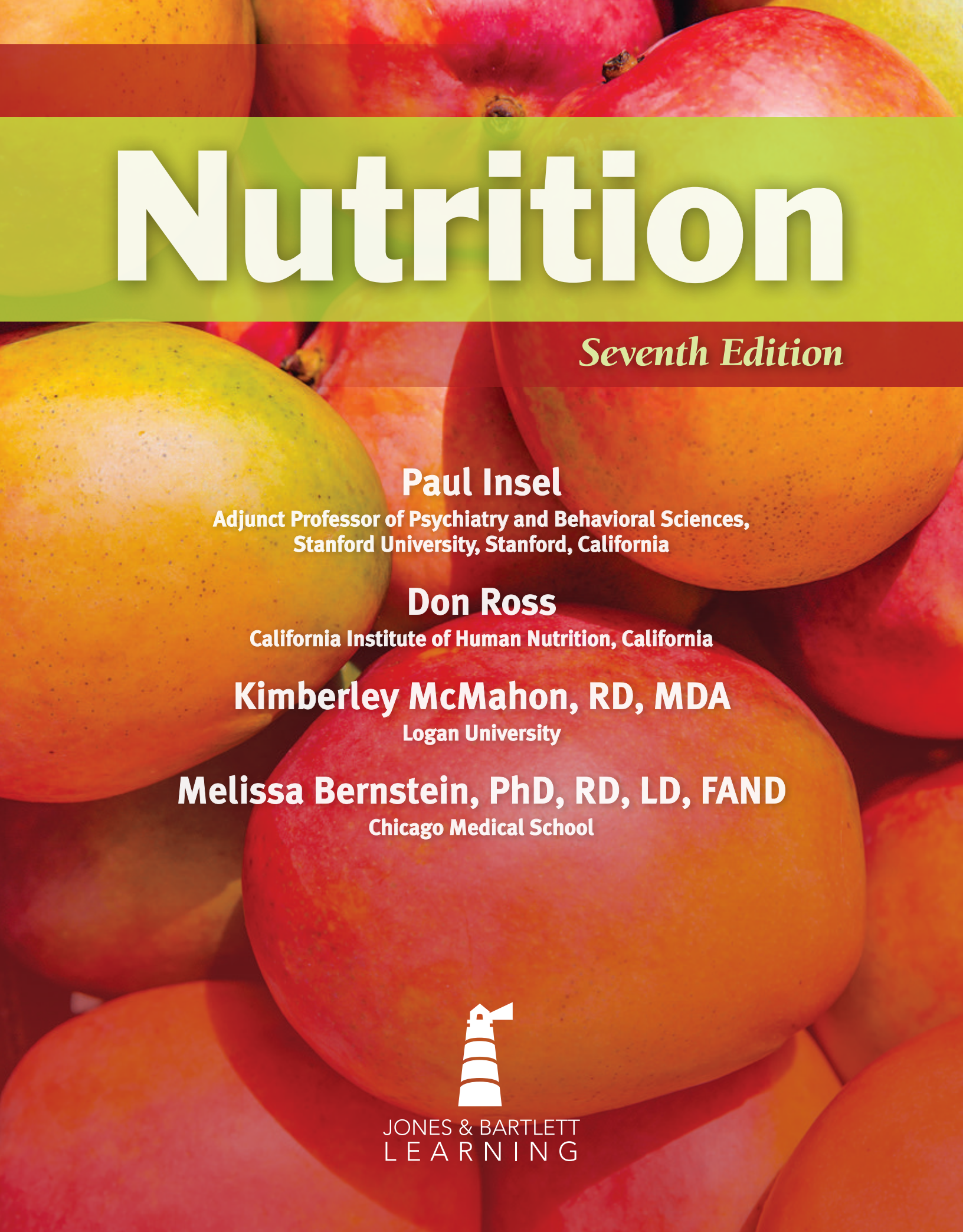

Nutrition

Seventh Edition

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Dedication

To Michelle with love.
— Paul Insel

To Donna and Mackinnon for their sustenance of love, support, and patience.
— Don Ross

To Tom, Dawson, Emmett, and Quincy with gratitude and love.
— Kimberley McMahon

To my family with all my love.
— Melissa Bernstein

Brief Contents

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Contents

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Preface

Welcome to the seventh edition of *Nutrition.* Changes in nutrition-related information have never been more exciting or important than they are today. *Nutrition* takes students on a fascinating journey, beginning with curiosity and ending with a solid knowledge base and a healthy dose of skepticism for the endless ads and infomercials promoting "new" diets and food products. We want students to learn enough about their nutritional and health status to use this new knowledge in their everyday lives.

The new standards emerging in the science of nutrition inspire us to provide comprehensive, current, and accurate information on the most pressing issues. For example, you will find a focus on the "obesity epidemic" and the challenges the nutrition community is taking on to help resolve this chronic problem. Overall,you should find the content, organization, and features remain, but, within this framework, key topics and issues have been updated with new features and the most recent information available. Our goals in writing this book can be stated simply as follows:

- To present science-based, accurate, up-to-date information in an accessible format
- To involve students in taking responsibility for their nutrition, health, and well-being
- To instill a sense of competence and personal power in students

The first of these goals means making expert knowledge about nutrition available to the individual. *Nutrition* presents current information to students about topics and issues that concern them—a balanced diet, nutritional supplements, weight management, exercise, and a multitude of others. Current, complete, and straightforward coverage is balanced with user-friendly features designed to make the text appealing.

Our second goal is to involve students in taking responsibility for their nutrition and health. To encourage students to think about the material they are reading and how it relates to their own lives, *Nutrition* uses innovative pedagogy and unique interactive features. We invite students to examine the issues and to analyze their own nutrition-related behaviors.

Our third goal in writing *Nutrition* is the most important: to stimulate a sense of competence and personal power in the students who read this book. Everyone has the ability to monitor, understand, and affect their own nutritional behaviors.

Accessible Science

Nutrition makes use of the latest in learning theory and balances the behavioral aspects of nutrition with an accessible approach to scientific concepts. You will find this book to be a comprehensive resource that communicates nutrition both graphically and personally.

We present technical concepts in an engaging, non-intimidating manner,with an appealing parallel development of text and annotated illustrations. Illustrations in all chapters use consistent representations. For example, each type of nutrient has a distinct color and shape. Icons of an amino acid, a protein, a triglyceride, and a glucose molecule represent "characters" in the nutrition story and are instantly recognizable as they appear throughout the book.

This book is unique in the field of nutrition and leads the way in depicting important biological and physiological phenomena, such as emulsification, glucose regulation, digestion and absorption, and fetal development. Extensive graphic presentations make nutrition and physiological principles come alive.

Dietary Guidelines for Americans, 2020–2025

The *Dietary Guidelines for Americans, 2020–2025* recognizes that people consume nutrients and foods in various combinations over time and that these foods and beverages act synergistically to affect health, a concept referred to as a person's dietary pattern. Just as eating healthy and exercising produces an effect on health that is greater than either can yield alone, each part of a person's dietary pattern acts synergistically to affect health and serve as a possible predictor of individual overall health status and disease risk. The *Dietary Guidelines for American, 2020-2025* features a call to action, which encourages people to focus on choosing healthy foods and beverages rich in nutrients, while staying within individual calorie needs. In addition, these guidelines encourage individuals to follow a healthy dietary pattern at every life stage. As you read this text,

look for key recommendations of the *Dietary Guidelines* highlighted in the margins.

New to this Edition

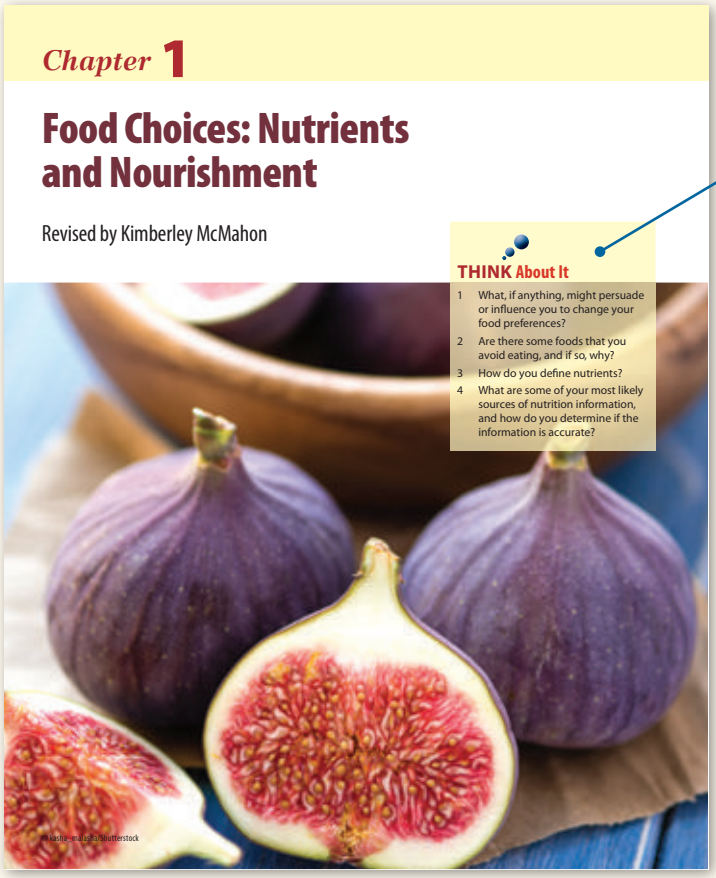
For this edition, the latest scientific evidence, recommendations, and national standards have been incorporated throughout each chapter.

Key Highlights

- Updated content reflects the *Dietary Guidelines for Americans, 2020–2025* released in December 2020.
- Updated Getting Personal feature, found in most of the end-of-chapter Learning Portfolios, encourages students to apply their nutritional knowledge to understanding their own diets.
- Revised statistics and data incorporated throughout the text reflect the current state of nutrition in America and the world.
- Revised food source charts in the vitamins and minerals chapters more clearly convey common sources for vitamins and minerals.
- Updated Position Statements from the Academy of Nutrition and Dietetics, the American Heart Association, and other organizations appear throughout the text.
- Updated references utilize the latest science in the field.
- New and updated FYI, Going Green, and Quick Bite features provide in-depth discussions of controversial issues and topics for classroom discussion.

The Pedagogy

Nutrition focuses on teaching behavioral change, personal decision making, and up-to-date scientific concepts in a number of novel ways. This interactive approach addresses different learning styles, making it the ideal text to ensure mastery of key concepts. Beginning with Chapter 1, the material engages students in considering their own behavior in light of the knowledge they are gaining. The pedagogical aids that appear in most chapters include the following:


Chapter 1

Food Choices: Nutrients and Nourishment

Revised by Kimberley McMahon

THINK About It

1 What, if anything, might persuade or influence you to change your food preferences?
2 Are there some foods that you avoid eating, and if so, why?
3 How do you define nutrients?
4 What are some of your most likely sources of nutrition information, and how do you determine if the information is accurate?

Think About It questions at the beginning of each chapter present realistic nutrition-related situations and ask students to consider how they would behave in such circumstances.

The **Chapter Outline** at the beginning of each chapter gives students a preview of topics that will be covered.

Learning Objectives focus students on the key concepts of each chapter and the material they will learn.

CHAPTER Outline

- Why Do We Eat the Way We Do?
- Introducing the Nutrients
- Applying the Scientific Process to Nutrition
- From Research Study to Headline
- Key Terms
- Study Points
- Study Questions
- Try This
- Getting Personal
- References

LEARNING Objectives

- Define *nutrition*.
- List factors that influence food choices.
- Describe the standard American diet.
- List the six classes of nutrients essential for health.
- Determine the kilocalorie content of various foods.
- Outline the basic steps in the nutrition research process.
- Recognize credible scientific research and reliable sources of nutrition information.

Consider these scenarios. A group of friends goes out for pizza every Thursday night. A young man greets his girlfriend with a box of chocolates. A 5-year-old shakes salt on her meal after watching her parents do this. A man says hot dogs are his favorite food because they remind him of going to baseball games with his father. A parent punishes a misbehaving child by withholding dessert. What do all of these people have in common? They are all using food for something other than its nutrient value. Can you think of a holiday that is not celebrated with food? For most of us, food is more than a collection of nutrients. Many factors affect what we choose to eat. Many of the foods people choose are nourishing and contribute to good health. The same, of course, may be true of the foods we reject.

The National Institutes of Health (NIH) define **nutrition** as the field of study focused on foods and substances in foods that help people and animals (and plants) to grow and stay healthy.[1]

The science of nutrition helps us improve our food choices by identifying the amounts of nutrients we need, the best food sources of those nutrients, and the other components in foods that may be helpful or harmful.

Learning about nutrition will help us to be informed and more likely to make good nutrition choices, which in turn may not only improve our health, but also reduce our risk of some diseases and may even help us to live longer. Keep in mind, though, that no matter how much you know about nutrition, you are still likely to choose some foods regardless of the nutrients they provide, simply for their taste or just because it makes you feel good to eat them.

Why Do We Eat the Way We Do?

Do you "eat to live" or "live to eat"? For all of us, the first is certainly true—you must eat to live. But there may be times when our enjoyment of food is more important to us than the nourishment we get from it. We use food to project a desired image, forge relationships, express friendship, show creativity, and disclose our feelings. We cope with anxiety or stress by eating or not eating; we reward ourselves with food for a good grade or a job well done; or, in extreme cases, we punish failures by denying ourselves the benefit and comfort of eating. Factors such as age, gender, genetic makeup, occupation, lifestyle, family, and cultural background can all affect our daily and habitual food choices, or diet. In this book we use the term "diet" to refer to a person's daily and habitual food choices rather than a regimen of eating and drinking for the purpose of weight loss such as "dieting to lose weight."

nutrition The science of foods and their components (nutrients and other substances), including the relationships to health and disease (actions, interactions, and balances); processes within the body (ingestion, digestion, absorption, transport, functions, and disposal of end products); and the social, economic, cultural, and psychological implications of eating.

Quick Bite

An Expanded Definition of Nutrition

Nutrition science includes behaviors and social factors related to food choices, and the foods we eat provide energy (calories) and nutrients such as protein, fat, carbohydrate, vitamins, minerals, and water. Eating healthy food in the right amounts gives your body energy to perform daily activities, helps to maintain a healthy body weight, and can lower your risk for certain diseases such as diabetes and heart disease.

Quick Bite

Try It Again, You Just Might Like It

Studies have found that children between the ages of 2 and 6 years commonly dislike things that are new or unfamiliar. This is also the time when kids are most likely to reject vegetables. Kids have a better chance to overcome this tendency if they are repeatedly exposed to the food they initially reject—somewhere between 5 and 15 exposures should do it.

Position Statements from distinguished organizations such as the Academy of Nutrition and Dietetics, the American College of Sports Medicine, and the American Heart Association relate to the chapter topics and bolster the assertions made by the authors by showcasing concurrent opinions held by some of the leading organizations in nutrition and health.

Position Statement: Academy of Nutrition and Dietetics

Food and Nutrition for Older Adults: Promoting Health and Wellness

It is the position of the Academy of Nutrition and Dietetics that all Americans age 60 years and older receive appropriate nutrition care; have access to coordinated, comprehensive food and nutrition services; and receive the benefits of ongoing research to identify the most effective food and nutrition programs, interventions, and therapies.

Reproduced from Position of the Academy of Nutrition and Dietetics Food and Nutrition for Older Adults: Promoting Health and Wellness. *J Acad Nutr Diet.* 2012;112(8):1255-1277. Copyright 2012. Reprinted with permission from Elsevier.

to home-bound people as well as those in congregate (group) settings. Most programs provide meals at least five times per week. The Older Americans Act Nutrition Program is supported primarily with federal funds; volunteer time, in-kind donations, and participant contributions make up the remainder. The **Supplemental Nutrition Assistance Program (SNAP)**, formerly the Food Stamp Program, is another option that provides low-income older adults with the means to purchase food. Unfortunately, because SNAP carries a "welfare" stigma, some older adults are reluctant to participate. In addition, many people who need some help buying food do not meet the eligibility requirements.

An evaluation of the Older Americans Act Nutrition Program showed that program participants had higher nutrient intake levels than nonparticipants and had a higher number of regular social contacts—another important factor in eating well.[112] Participation in food assistance programs can reduce the incidence of depression and overweight associated with food insecurity.[113]

Wise Eating for One or Two

Preparing meals that are healthful and tasty is a challenge for those living alone or in small households. As discussed earlier in this chapter, our nutrition needs—with the exception of calories—do not decrease as we age, but our ability to meet them does. Reliance on convenience foods, fast foods, and eating out can adversely affect the nutritional status of older adults. Men who live alone are especially likely to eat out or skip meals rather than prepare food for themselves. For both men and women, physical disability or illness can diminish the desire to prepare and eat meals.

Some simple changes in appliances and foodpreparation techniques can help older adults overcome common obstacles to food preparation. Those who cannot or will notcook can use microwaves, toaster ovens, and small appliances to prepare simple meals. A meal based on a lower-sodium, low-fat convenience entrée can meet nutritional needs if accompanied by vegetables, whole-grain bread, milk, and fruit.

THINK About It 4

Finding Community Resources

An older person's need for community support typically changes from decade to decade. Sometimes, identifying community resources can be challenging, and financial considerations might further limit access to resources that can assist older adults in their own homes. Within local communities, area agencies on aging, social and rehabilitation services, cooperative extension services, churches, and extended-care facilities might have lists of resources and educational programs for older adults. **TABLE 17.13** lists important resources for older adults.

TABLE 17.13
Important Resources for Older Adults

The Eldercare Locator: www.eldercare.gov and (800) 677-1116 (toll free)
The National Association of Area Agencies on Aging and the National Association of State Units on Aging administer the Eldercare Locator, a public service of the Administration on Aging, U.S. Department of Health and Human Services. The Eldercare Locator is a nationwide directory-assistance service that helps older persons and their families identify resources for aging Americans.

Supplemental Nutrition Assistance Program (SNAP) A USDA program that helps single people and families with little or no income to buy food. Formerly known as the Food Stamp Program.

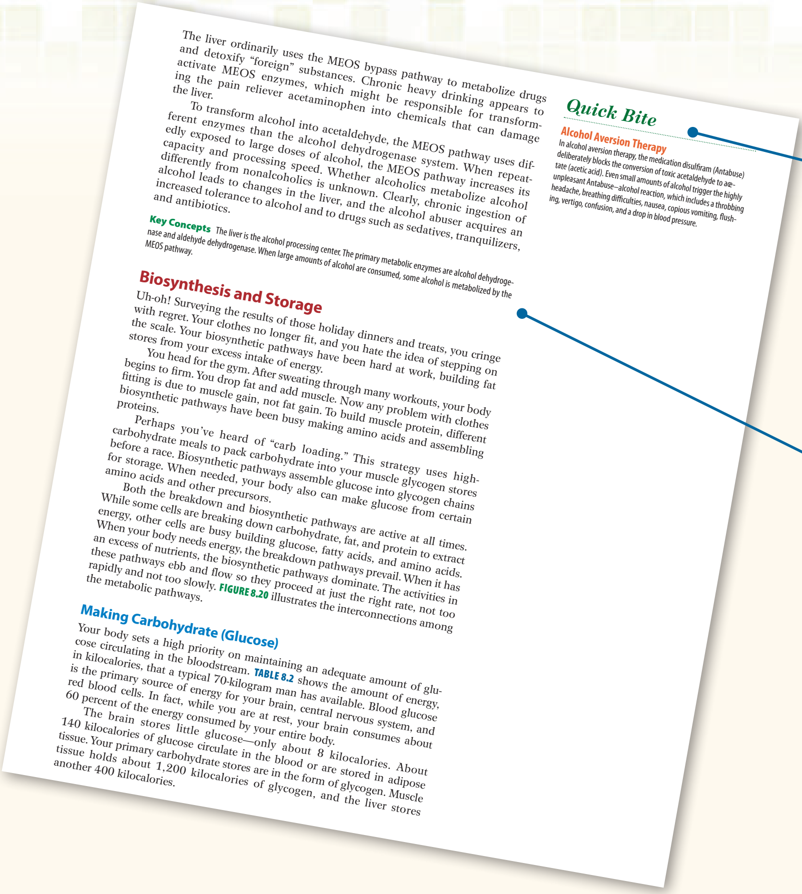
Position Statement: Academy of Nutrition and Dietetics

Individualized Nutrition Approaches for Older Adults: Long-Term Care, Post-Acute Care, and Other Settings

It is the position of the Academy of Nutrition and Dietetics that the quality of life and nutritional status of older adults in long-term care, post-acute care, and other settings can be enhanced by individualized nutrition approaches. The Academy advocates that as part of the interprofessional team, registered dietitian nutritionists assess, evaluate, and recommend appropriate nutrition interventions according to each individual's medical condition, desires, and rights to make healthcare choices. Nutrition and dietetic technicians assist registered dietitian nutritionists in the implementation of individualized nutrition care.

Reproduced from Dorner B, Friedrich EK. Position of the Academy of Nutrition and Dietetics: Individualized Nutrition Approaches for Older Adults: Long-Term Care, Post-Acute Care, and Other Settings. *J Acad Nutr Diet.* 2018;118(4):724-735. doi: 10.1016/j.jand.2018.01.022.

Key Terms are in boldface type the first time they are mentioned. Their definitions appear in the margins near the relevant textual discussion, making it easy for students to review material.


The liver ordinarily uses the MEOS bypass pathway to metabolize drugs and detoxify "foreign" substances. Chronic heavy drinking appears to activate MEOS enzymes, which might be responsible for transforming the pain reliever acetaminophen into chemicals that can damage the liver.

To transform alcohol into acetaldehyde, the MEOS pathway uses different enzymes than the alcohol dehydrogenase system. When repeatedly exposed to large doses of alcohol, the MEOS pathway increases its capacity and processing speed. Whether alcoholics metabolize alcohol differently from nonalcoholics is unknown. Clearly, chronic ingestion of alcohol leads to changes in the liver, and the alcohol abuser acquires an increased tolerance to alcohol and to drugs such as sedatives, tranquilizers, and antibiotics.

Key Concepts The liver is the alcohol processing center. The primary metabolic enzymes are alcohol dehydrogenase and aldehyde dehydrogenase. When large amounts of alcohol are consumed, some alcohol is metabolized by the MEOS pathway.

Quick Bite

Alcohol Aversion Therapy

In alcohol aversion therapy, the medication disulfiram (Antabuse) deliberately blocks the conversion of toxic acetaldehyde to acetate (acetic acid). Even small amounts of alcohol trigger the highly unpleasant Antabuse–alcohol reaction, which includes a throbbing headache, breathing difficulties, nausea, copious vomiting, flushing, vertigo, confusion, and a drop in blood pressure.

Biosynthesis and Storage

Uh-oh! Surveying the results of those holiday dinners and treats, you cringe with regret. Your clothes no longer fit, and you hate the idea of stepping on the scale. Your biosynthetic pathways have been hard at work, building fat stores from your excess intake of energy.

You head for the gym. After sweating through many workouts, your body begins to firm. You drop fat and add muscle. Now any problem with clothes fitting is due to muscle gain, not fat gain. To build muscle protein, different biosynthetic pathways have been busy making amino acids and assembling proteins.

Perhaps you've heard of "carb loading." This strategy uses high-carbohydrate meals to pack carbohydrate into your muscle glycogen stores before a race. Biosynthetic pathways assemble glucose into glycogen chains for storage. When needed, your body also can make glucose from certain amino acids and other precursors.

Both the breakdown and biosynthetic pathways are active at all times. While some cells are breaking down carbohydrate, fat, and protein to extract energy, other cells are busy building glucose, fatty acids, and amino acids. When your body needs energy, the breakdown pathways prevail. When it has an excess of nutrients, the biosynthetic pathways dominate. The activities in these pathways ebb and flow so they proceed at just the right rate, not too rapidly and not too slowly. **FIGURE 8.20** illustrates the interconnections among the metabolic pathways.

Making Carbohydrate (Glucose)

Your body sets a high priority on maintaining an adequate amount of glucose circulating in the bloodstream. **TABLE 8.2** shows the amount of energy, in kilocalories, that a typical 70-kilogram man has available. Blood glucose is the primary source of energy for your brain, central nervous system, and red blood cells. In fact, while you are at rest, your brain consumes about 60 percent of the energy consumed by your entire body.

The brain stores little glucose—only about 8 kilocalories. About 140 kilocalories of glucose circulate in the blood or are stored in adipose tissue. Your primary carbohydrate stores are in the form of glycogen. Muscle tissue holds about 1,200 kilocalories of glycogen, and the liver stores another 400 kilocalories.

Quick Bites sprinkled throughout the book offer fun facts about nutrition-related topics such as exotic foods, social customs, origins of phrases, folk remedies, medical history, and so on.

Key Concepts summarize previous text and highlight important information.


FYI For Your Information

Changing the Culture of Campus Drinking

From car crashes to alcohol poisoning, the culture of drinking on many college campuses puts students at grave risk. Alcohol use is pervasive among college students, many of whom are younger than the legal drinking age. Alcohol use is associated with 56 percent of motor-vehicle-related fatalities among people ages 21 to 24 years. Annually, at least 1,800 student deaths and nearly 600,000 unintentional injuries involve alcohol. College students who drink are more likely to drink and drive, have failing grades, and have medical and legal problems. Increased

FYI (For Your Information) offers more in-depth discussions of controversial and timely topics, such as unfounded claims about the effects of sugar, whether athletes need more protein, and the usefulness of the glycemic index.

Containing new and current scientific research, **Nutrition Science in Action** is an exciting feature that walks students through science experiments involving nutrition. Each *Nutrition Science in Action* presents observations and hypotheses or study questions; an experimental plan; and results, conclusions, and discussions that allow students to apply their knowledge of nutrition to real-life experiments outside of the classroom.

Nutrition Science *in Action*

High-Protein Diets and Kidney Function

Background

Little is known about the effect of low-carbohydrate, high-protein diets (such as the Atkins diet) on kidney function, especially in obese adults. Potential adverse effects of following such diets on kidney function include prolonged elevation in glomerular filtration rate (GFR), increased proteinuria, and derangements in electrolyte, acid–base, and bone mineral status. This is of particular concern in the obese population because obese persons are at risk for kidney failure and kidney-related abnormalities.

Hypothesis

In obese adults, following a low-carbohydrate, high-protein diet will be associated with greater adverse renal effects than following a low-fat weight-loss diet.

Experimental Plan

Three hundred and seven obese adults (BMI of 30–40 kg/m^2) ages 18–65 years and who weighed less than 136 kilograms (299 pounds) were recruited. Participants did not have serious medical illness, take lipid-lowering medications, have a blood pressure of greater than or equal to 140/90 mm Hg, were not pregnant or lactating, or were not taking medications that affect body weight. Participants were randomly assigned to either a low-carbohydrate, high-protein diet or a low-fat weight-loss diet for 24 months. Participants were provided with behavioral treatment weekly for 20 weeks, every other week for 20 weeks, and then every month for the remainder of the 2-year study period. Body weight and indicators of kidney function were measured throughout the study.

Results

The low-carbohydrate, high-protein diet was associated with small changes in measures of kidney function throughout the study as compared with the low-fat weight-loss diet. There was a minor reduction in serum creatinine and cystatin at 3 months and relative increases in creatinine clearance at 3 and 12 months; serum urea at 3, 12, and 24 months; and 24-hour urinary volume at 12 and 24 months. Urinary calcium excretion increased at 3 and 12 months without changes in bone mineral density or clinical diagnosis of new kidney stones.

Conclusion and Discussion

In obese individuals without preexisting kidney disease, following a low-carbohydrate, high-protein diet over a 2-year period is not associated with renal harm or significant changes in fluid and electrolyte balance as compared to a low-fat diet. Additional studies are needed to examine the longer-term effect of this diet on obese individuals with underlying chronic kidney disease, diabetes, and hypertension as well as those at risk for kidney stones.

Source: Data from Friedman AN, Ogden LG, Foster GD, et al. Comparative effects of low-carbohydrate high-protein versus low-fat diets on the kidney. *Clin J Am Soc Nephrol.* 2012;7: 1103-1111.

Updated to reflect the most current environmental concerns, **Going Green** boxes address the nutrition community's concern about the importance of environmental issues in our time. This environmental theme runs through each chapter and expands our nutrition focus to show that we are all citizens of an endangered planet with opportunities to reduce our environmental footprint.

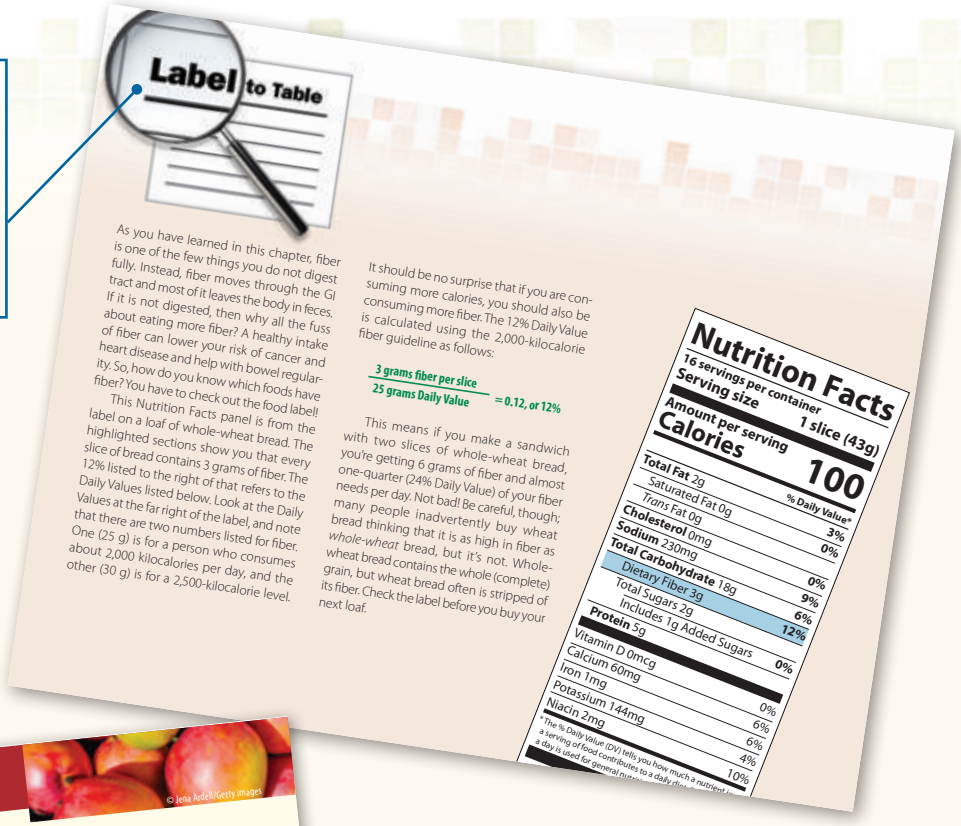
Going Green

Fish: Good for You and the Environment

Fatty fish or fatty meat? What is a "good" source of fat, a lean protein high in vitamins and minerals, and does not contribute to the production of methane greenhouse gas? Fish! Methane, produced by farm animals, is a powerful greenhouse gas and is considered 20 times more powerful than carbon dioxide at trapping solar energy. In comparison, no methane is produced from harvesting salmon, and fish offers you a healthier meal than a rib-eye steak. Choosing to eat fish while decreasing your beef intake not only will give you all of the health benefits associated with omega-3 fatty acids, but also will potentially decrease dangerous greenhouse gas production. An American Heart Association scientific statement on fish consumption, fish oils, omega fatty acids, and cardiovascular disease emphasizes the benefits of eating fish and recommends at least two servings of fish per week from choices that are low in mercury such as salmon, mackerel, herring, lake trout, and albacore tuna. EPA and DHA are the omega-3 fatty acids found in oily fish, with mackerel, salmon, trout, sardines, and herring being excellent sources. Approximately 1 gram of EPA/DHA can be obtained from 100 grams (3.5 ounces) of oily fish.

There are many choices when it comes to incorporating healthful fats into your diet. Just remember, even though these fatty acids provide a "good" source of fat, don't go overboard. Fat is still fat, even if it is good for you and for the environment, so make your choices wisely.

Label to Table helps students apply their new decision-making skills at the supermarket. It walks students through the various types of information that appear on food labels, including government-mandated terminology, misleading advertising phrases, and amounts of ingredients.



The **Learning Portfolio** at the end of each chapter condenses all aspects of nutrition information that students need to solidify their understanding of the material. The various formats will appeal to students according to their individual learning and studying styles.

Key Terms list all new vocabulary alphabetically with the page number of the first appearance. This arrangement allows students to review any term they do not recall and turn immediately to the definition and discussion of it in the chapter. This approach also promotes the acquisition of knowledge, not simply memorization.

Study Questions encourage students to probe deeper into the chapter content, making connections and gaining new insights. Although these questions can be used for pop quizzes, they will also help students to review, especially students who study by writing out material.

Study Points summarize the content of each chapter with a synopsis of each major topic. The points are in the order in which they appear in the chapter, so related concepts flow together.

Try This

The Sweetness of NutraSweet

The purpose of this experiment is to see the effect of high temperatures on the dipeptide known as NutraSweet (aspartame). Make a cup of hot tea (or coffee) and add one packet of Equal (one brand of aspartame). Stir and taste the tea; note its sweetness. Reheat the tea (in a microwave or on the stovetop) so that it boils for 30 to 60 seconds. After the tea cools, taste it. Does it still taste sweet? Why or why not?

The Vegan Challenge

The purpose of this activity is to eat a completely vegan diet for 1 day. Begin by making a list of your typical meals and snacks. Once the list is complete, review each food item and determine whether it contains animal products. Cross off items that contain animal products and circle the remaining vegan-friendly options. Double-check the circled list with a friend or roommate. You might have missed something! Create a full day's worth of meals and snacks using your circled foods as well as additional vegan options. Make sure your menu looks complete and nutritionally balanced. Try to stick to this menu for at least 1 day. Pay attention to any deviations you make and whether these are vegan food choices.

Getting Personal

General instructions: List all of the foods and drinks that you consume in a 24-hour period, ideally a day where your schedule is fairly predictable and you are eating what is considered normal for you.

Take a minute to review your food intake with a special focus on protein.

Part A: Comparing your intake to the recommendations:

1. How do you think you did? Do you think you are lower or higher than the RDA?
2. Let's calculate your **RDA**. Your protein RDA is calculated as follows:

   ____ (your weight in pounds) ÷ 2.2 pounds = ____ kilograms × 0.8 g/kg/day = ____ g protein daily
3. Compare your protein RDA with your protein intake. Are you surprised by the results? Are you eating too much protein or just the right amount? How much more/less (grams) should you consume?
4. Another way to evaluate your protein intake is in terms of calories. What was your total kilocalorie intake ___? If your total protein intake is ___ grams, (× 4 kcal/gram) = ___ kilocalories come from protein.
   a. We can include an example here: 96 g protein × 4 kcal/g = 384 kcal from protein. Assuming a 2,300 kcal diet, this amount is 17 percent of calories from protein and then compare to the recommended AMDR 10 to 35 percent of calories from protein
5. What percentage of your total calories comes from protein? How does this compare to the **AMDR** for your caloric intake? General guidelines recommend that 10 to 35 percent of energy come from protein. (See previous sample calculation). Does the percentage of protein in your diet fall within the recommended range?
6. Compare the two numbers (your RDA calculation vs. your AMDR) numbers for recommended protein intake—do you meet the guidelines for protein intake using both recommendations? What could be the reason?

Part B: Now let's look at the protein-containing foods in your diet:

7. What are the foods that contribute most to the protein in your diet?
8. **Activity:** Meatless Monday planning. Try to increase your plant-based choices: For each animal product on your list, suggest a plant-based substitute for that food and compare the amount protein in the plant-based food to the animal product.
   a. Questions
      i. What happens to your protein intake when you go meatless? What effect does this have on your total calorie and fat intake?
      ii. What other nutrients could these changes affect?
      iii. What would be some challenges to eat a diet that is more plant-based?
      iv. List three plant-based foods that would be a good source of protein that you are willing to try.

References

1. Matthews DE. Proteins and amino acids. In: Ross AC, Caballero B, Cousins RJ, Tucker KL, Ziegler TR, eds. *Modern Nutrition in Health and Disease*. 11th ed. Lippincott Williams and Wilkins; 2014.
2. Ibid.

Try This activities provide suggestions for hands-on activities that encourage students to put theory into practice. It will especially help students whose major learning style is experimental.

Getting Personal encourages students to consider their newly gained knowledge in the context of their own diets.

The Integrated Learning and Teaching Package

Integrating the text with constructive instructor resources is crucial to deriving their full benefit. Based on feedback from instructors and students, Jones & Bartlett Learning has made the following resources available to qualified instructors:

- Test Bank, including more than 800 questions
- Slides in PowerPoint format, featuring more than 800 slides
- Instructor's Manual, containing lecture outlines, discussion questions, and answers to the in-text Study Questions
- Image Bank, supplying key figures from the text

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About the Authors

The *Nutrition* author team represents a culmination of years of teaching and research in nutrition science and psychology. The combined experience of the authors yields a balanced presentation of both the science of nutrition and the components of behavioral change.

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Chapter **1**

Food Choices: Nutrients and Nourishment

Revised by Kimberley McMahon

THINK About It

1. What, if anything, might persuade or influence you to change your food preferences?
2. Are there some foods that you avoid eating, and if so, why?
3. How do you define nutrients?
4. What are some of your most likely sources of nutrition information, and how do you determine if the information is accurate?

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CHAPTER Outline

- Why Do We Eat the Way We Do?
- Introducing the Nutrients
- Applying the Scientific Process to Nutrition
- From Research Study to Headline
- Key Terms
- Study Points
- Study Questions
- Try This
- Getting Personal
- References

LEARNING Objectives

- Define *nutrition*.
- List factors that influence food choices.
- Describe the standard American diet.
- List the six classes of nutrients essential for health.
- Determine the kilocalorie content of various foods.
- Outline the basic steps in the nutrition research process.
- Recognize credible scientific research and reliable sources of nutrition information.

Consider these scenarios. A group of friends goes out for pizza every Thursday night. A young man greets his girlfriend with a box of chocolates. A 5-year-old shakes salt on her meal after watching her parents do this. A man says hot dogs are his favorite food because they remind him of going to baseball games with his father. A parent punishes a misbehaving child by withholding dessert. What do all of these people have in common? They are all using food for something other than its nutrient value. Can you think of a holiday that is not celebrated with food? For most of us, food is more than a collection of nutrients. Many factors affect what we choose to eat. Many of the foods people choose are nourishing and contribute to good health. The same, of course, may be true of the foods we reject.

The National Institutes of Health (NIH) define **nutrition** as the field of study focused on foods and substances in foods that help people and animals (and plants) to grow and stay healthy.[1]

The science of nutrition helps us improve our food choices by identifying the amounts of nutrients we need, the best food sources of those nutrients, and the other components in foods that may be helpful or harmful.

Learning about nutrition will help us to be informed and more likely to make good nutrition choices, which in turn may not only improve our health, but also reduce our risk of some diseases and may even help us to live longer. Keep in mind, though, that no matter how much you know about nutrition, you are still likely to choose some foods regardless of the nutrients they provide, simply for their taste or just because it makes you feel good to eat them.

nutrition The science of foods and their components (nutrients and other substances), including the relationships to health and disease (actions, interactions, and balances); processes within the body (ingestion, digestion, absorption, transport, functions, and disposal of end products); and the social, economic, cultural, and psychological implications of eating.

Quick Bite

An Expanded Definition of Nutrition

Nutrition science includes behaviors and social factors related to food choices, and the foods we eat provide energy (calories) and nutrients such as protein, fat, carbohydrate, vitamins, minerals, and water. Eating healthy food in the right amounts gives your body energy to perform daily activities, helps to maintain a healthy body weight, and can lower your risk for certain diseases such as diabetes and heart disease.

Why Do We Eat the Way We Do?

Do you "eat to live" or "live to eat"? For all of us, the first is certainly true—you must eat to live. But there may be times when our enjoyment of food is more important to us than the nourishment we get from it. We use food to project a desired image, forge relationships, express friendship, show creativity, and disclose our feelings. We cope with anxiety or stress by eating or not eating; we reward ourselves with food for a good grade or a job well done; or, in extreme cases, we punish failures by denying ourselves the benefit and comfort of eating. Factors such as age, gender, genetic makeup, occupation, lifestyle, family, and cultural background can all affect our daily and habitual food choices, or diet. In this book we use the term "diet" to refer to a person's daily and habitual food choices rather than a regimen of eating and drinking for the purpose of weight loss such as "dieting to lose weight."

Quick Bite

Try It Again, You Just Might Like It

Studies have found that children between the ages of 2 and 6 years commonly dislike things that are new or unfamiliar. This is also the time when kids are most likely to reject vegetables. Kids have a better chance to overcome this tendency if they are repeatedly exposed to the food they initially reject—somewhere between 5 and 15 exposures should do it.

Personal Preferences

What we eat reveals much about who we are. Food preferences begin early in life and then change as we interact with parents, friends, and peers. Further experiences with different people, places, and situations often cause us to expand or change our preferences. Taste and other sensory factors such as texture influence our food choices; cost and convenience, cultural and social pressures, genetics, physiological mechanisms, and cognitive-affective factors such as perceived stress, health attitude, and anxiety and depression are important factors, too.[2] Parenting style influences a child's overall diet quality and is another component of what helps to establish food preferences.[3] Early-life experiences with various tastes and flavors have a role in promoting eating in future life.[4] Parental food habits and feeding strategies are found to be among the most dominant determinants of a child's eating behavior and food choices; therefore, parents should expose their children to a range of food choices while acting as positive role models.[5]

THINK About It 1

Age is another factor in food choices. Consider taste preferences and how they might be influenced even before birth. Science shows that, when compared to adults, children naturally prefer higher levels of sweet and salty tastes and reject bitter tastes.[6] This might help explain why children are drawn to more unhealthy food choices. In support of this idea, studies have found that sensory experiences, beginning early in life, can shape preferences in both a positive and a negative way. For example, an expecting mother who consumes a diet rich in healthy foods can help develop her child's taste preferences in a positive way because flavors from foods that the mother eats are transmitted to amniotic fluid and to mother's milk, creating an environment in which breastfed infants are more accepting of these flavors.[7] In contrast, infants fed formula learn to prefer its unique flavor profile and may have more difficulty initially accepting flavors not found in formula, such as those of fruits and vegetables.[8] Having healthy food experiences early in life may go a long way toward promoting healthy eating throughout a person's life span.

neophobia A dislike for anything new or unfamiliar.

Although young children prefer sweet or familiar foods, babies and toddlers are generally willing to try new things (see **FIGURE 1.1**). Experimental evidence suggests children who are repeatedly exposed to a variety of foods are more likely to accept those foods, thus adding more variety to their diet and allowing them to eat more healthfully. This result is even stronger for children whose willingness to try new foods is encouraged by their caregivers.[9]

FIGURE 1.1 Adventures in eating. Babies and toddlers are willing to try new things, generally after repeated exposure.
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Preschoolers typically go through a period of food **neophobia**, a dislike for anything new or unfamiliar. School-age children tend to accept a wider array of foods, and teenagers are strongly influenced by the preferences and habits of their peers. If you track the kinds of foods you have eaten in the past year, you might be surprised to discover how few basic foods your diet includes. By the time we reach adulthood, we have formed a core group of foods we prefer. Of this group, only about 100 basic items account for 75 percent of our food intake.

Like many aspects of human behavior, food choices are influenced by many interrelated factors. Generally, hunger and satiety (the feeling of being full) dictate when we eat, but what we choose to eat is not always determined by physiological or nutritional needs. When we consider that our food preferences are also dictated by factors such as sensory properties of foods (taste, smell, and texture), emotional and cognitive factors (habits, comfort/discomfort foods, food advertising and promotion, eating away from home, etc.), and environmental factors (economics, lifestyle, food availability, culture, religion, and socioeconomics), we can better understand why we choose to eat the foods that we do (see **FIGURE 1.2**).

Sensory Influences: Taste, Smell, and Texture

In making food choices, what appeals to our senses also contributes to our personal preferences. People often refer to **flavor** as a collective experience that describes both taste and smell. Texture also plays a part. You may prefer foods that have a crisp, chewy, or smooth texture. You may reject foods that feel grainy, slimy, or rubbery. Other sensory characteristics that affect food choice are color, moisture, and temperature.

We are familiar with the classic four tastes—sweet, sour, bitter, and salty—but do you know that there is another? **Umami** is a Japanese term used to describe the taste produced by glutamate. Umami substances elicit salivary secretions, enhance appetite, and increase food palatability.[10] It is the brothy, meaty, savory flavor in foods such as meat, seafood, and vegetables. A seasoning commonly added to Chinese food, canned vegetables, soups, and processed meats, called monosodium glutamate (MSG), enhances this umami flavor. Despite many people identifying themselves as being sensitive to MSG, the Food and Drug Administration (FDA) considers that adding MSG to foods is "generally recognized as safe." People who claim sensitivity report symptoms such as headache, flushing, sweating, and nausea; however, studies have not been able to consistently trigger these reactions.[11]

Sensory Influences
Taste
Smell
Texture

Emotional and Cognitive Influences
Habits
Comfort/discomfort foods
Food advertising and promotion
Meals prepared way from home
Food and Diet trends

Social Factors
Knowledge of health and nutrition

Environment
Economics
Lifestyle
Food Availability
Religion

FIGURE 1.2 Factors that affect food choices. We often select a food to eat automatically without thought. But, in fact, our choices are complex events involving the interactions of a multitude of factors.
© Steve Mason/Photodisc/Getty Images

flavor The collective experience that describes both taste and smell.

umami [ooh-MA-mee] A Japanese term that describes a delicious meaty or savory sensation. Chemically, this taste detects the presence of glutamate.

Emotional and Cognitive Influences

Habits

Your eating and cooking habits likely reflect what you learned from your parents. We typically learn to eat three meals per day, at about the same times each day. Quite often we eat the same foods, particularly for breakfast (e.g., cereal and milk) and lunch (e.g., sandwiches). This routine makes life convenient, and we don't have to think much about when or what to eat. But we don't have to follow this routine. How would you feel about eating mashed potatoes for breakfast and cereal for dinner? Some people might get a stomachache just thinking about it, whereas others may enjoy the prospect of doing things differently. Think about your eating habits and how often you make the same choices every day.

Comfort/Discomfort Foods

THINK About It 2

Our desire for particular foods often is based on behavioral motives, even though we may not be aware of them. For some people, food becomes an emotional security blanket. Consuming our favorite foods can make us feel better, relieve stress, and allay anxiety (see **FIGURE 1.3**). Starting with the first days of life, food and affection are intertwined. Breastfed infants, for example, experience physical, emotional, and psychological satisfaction when nursing. As we grow older, this experience is continually reinforced. For example, chicken soup and hot tea with honey may be favorites when we feel ill because someone had prepared those foods for us when we were not feeling well. If we were rewarded for good behavior with a particular food (e.g., ice cream, candy, cookies), our positive feelings about that food may persist for a lifetime. In contrast, at some point you may have gotten sick soon after eating a certain food, and you still avoid that food.

FIGURE 1.3 Comfort foods. Depending on your childhood food experiences, a bowl of traditional soup, a remembered sweet, or a mug of hot chocolate can provide comfort in times of stress.
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Quick Bite

Sweetness and Salt

Salt can do more than just make your food taste salty. Researchers at the Monell Chemical Senses Center demonstrated that salt also suppresses the bitter flavors in foods. When combined with chocolate, for example, in a chocolate-covered pretzel, salt blocks some of the bitter flavor, making the chocolate taste sweeter. This may explain why people in many cultures salt their fruit.

Quick Bite

See, Like, Share, Remember

How do adolescents respond to unhealthy food advertising? One study found that advertising for unhealthy food evoked significantly more positive responses, compared to nonfood and healthy food. Adolescents are more likely to "share" unhealthy posts, rate peers more positively when they had unhealthy posts in their feeds, recall and recognize a greater number of unhealthy food brands, and view unhealthy advertising posts for longer.

Data from Murphy G, Corcoran C, Tatlow-Golden M, et al. See, Like, Share, Remember: Adolescents' Responses to Unhealthy-, Healthy- and Non-Food Advertising in Social Media.

Food Advertising and Promotion

For most people, the sight or smell of certain foods can initiate a strong desire to eat. Such cravings are a form of food cue reactivity, and according to learned-based models of behavior, food cue reactivity and cravings are conditioned responses that lead to increased eating and subsequent weight gain.[12] Food and beverage advertising creates an environment of cue-induced cravings, which has been shown to increase eating in both children and adults.[13] Consider children exposed to advertisements while watching TV. Television viewing among children has been found to predict obesity even when levels of physical activity are controlled for, which suggests it is not just the effect of a sedentary lifestyle that increases the risk factors for weight gain.[14] Food advertising promotes largely energy-dense, nutrient-poor foods, and even short-term exposure to such advertising results in children increasing their food consumption,[15] as well as takes advantage of children's vulnerabilities as they engage in television and other screen viewing.[16] The Children's Food and Beverage Advertising Initiative (CFBAI) is the self-regulatory program used in the United States, and when compared to the guidelines used by the World Health Organization (WHO), CFBAI uses less stringent criteria in relationship to sweetener levels, sodium levels, and calories.[17] To this end, some experts agree that food advertising directed to children could result in more desirable food choices if self-regulatory nutrition criteria were stronger.[18]

Although the majority of food advertisements are for less healthy foods, positive food advertising also exists. We are seeing more innovative advertising that promotes locally grown, hormone- and pesticide-free foods, plus whole grains, nuts, berries, vegetarian foods, and other nutrient-dense products.

Eating Meals Prepared Outside of the Home

In recent years there has been a general shift away from domestic cooking and toward the use of foods prepared away from home, such as restaurant meals or grocery store ready-prepared food such as salad bar options or sushi bars. There has also been an upsurge in time and money devoted to these foods. Over one-half of total food spending goes to foods that are prepared away from home, and consumers underestimate the amount of calories and fat in these foods, which is likely contributing to increasing weight and obesity.[19] This trend has promoted an increased interest in information on calories, fat, sodium, and other nutrients on menus. When calories are present on menus, people order foods with fewer calories compared to when they are ordering from menus without calories identified, and parents order foods with fewer calories for their children.[20] The FDA has implemented guidelines in which nutrition labeling in chain restaurants and similar food establishments provides consumers with clear and consistent nutrition information in a direct and accessible manner.

Food and Diet Trends

The popularity of different diets can influence changes in food product consumption. Beginning in the late 1980s, low-fat diets became popular and were accompanied by an explosion of reduced-fat, low-fat, and fat-free products. When the low-carbohydrate (low-carb) diet became popular, so did the rise in low-carb and no-carb products. Diet and health-related products also compete for consumer dollars. For example, sales of gluten-free products in the United States continue to rise due to the increased diagnosis of celiac disease and the belief that eliminating gluten, a protein found in wheat and related grains such as barley and rye, from the diet will treat other conditions as well. Some notable food trends of the last decade include organic foods, locally grown and prepared foods, fermented foods that contain live cultures, and "craft foods" that hail from a particular location and claim to have unique

tastes. Other trends relate more to our behaviors than particular foods, but they ultimately affect our food purchases; they include snacking throughout the day, using online grocery shopping and delivery services, using apps to calculate the exact nutritional content of meals, and shopping at supermarkets that have been converted into socializing spaces (see **FIGURE 1.4**).

Social Factors

Social factors exert a powerful influence on food choice. Food is often at the center of family gatherings, social events, and office parties. Perhaps even more influential, though, are the messages from peers about what to eat or how to eat.

As **FIGURE 1.5** illustrates, eating is a social event that brings people together for a variety of purposes (e.g., religious or cultural celebrations, business meetings, family dinners). Social pressures, however, also can restrict our food intake and selection. We might, for example, order nonmeat dishes when dining with a group of vegetarian friends.

Knowledge of Health and Nutrition

Many people select and emphasize certain foods they think are "good for them" (see **FIGURE 1.6**). Consumer health beliefs, perceptions of disease susceptibility, and desires to take action in order to prevent or delay disease onset can have powerful influences on diet and food choices. For example, people who feel vulnerable to disease and believe that dietary change might lead to positive results are more likely to pay attention to information about links among dietary choices, dietary fat, and health risks. A desire to lose weight or alter one's physical appearance also can be a powerful force shaping decisions to accept or reject particular foods. Furthermore, when consumers recognize that a particular food carries a positive health claim, they are more likely to perceive that food as being a healthy choice, and therefore more likely to select it.[21]

Key Concepts Many factors influence our decisions about what to eat and when to eat. Some of the main factors include personal preferences; sensory influences such as taste, texture, and smell; our habits with eating; the emotional connections of comfort or discomfort that are linked to certain foods; advertisements and promotions; whether we choose to eat our meals at home or away from home; current food and diet trends; social factors; and our knowledge of health and nutrition.

Environment

Your environment—where you live, how you live, whom you live with—has a lot to do with what you choose to eat. People around us influence our food choices, and we generally prefer the foods we grew up eating. Environmental factors that influence our food choices include economics, food availability, culture, and religion. In the United States, our environment and the choices we make play a significant role in the current obesity epidemic. We live in what has been termed an **obesogenic environment**—in other words, an environment that promotes gaining weight and one that is not conducive to weight loss within the home or workplace.

Economics

Where you live not only influences which foods are most accessible to you, but also affects food costs, which are a major determinant of food choice. You may have "lobster taste" but a "hot dog budget." The types of foods purchased

FIGURE 1.4 Food and Diet Trends. Online grocery shopping and delivery are popular across the United States.
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FIGURE 1.5 Social facilitation. Interactions with others can affect your eating behaviors.
© Fuse/Thinkstock

FIGURE 1.6 Where do you get your nutrition information? We are constantly bombarded by food messages. Which sources do you find most influential? Are they reliable?
© Jones & Bartlett Learning. Photographed by Sarah Cebulski.

obesogenic environment Circumstances in which a person lives, works, and plays in a way that promotes the overconsumption of calories and discourages physical activity and calorie expenditure.

and the percentage of income used for food are affected by total income. Households spend more money on food when incomes rise. In 2017, middle income families spent an average of $7,061 on food per year, representing about 14 percent of income, whereas the lowest income households spent an average of $4,070 on food per year, representing 34 percent of income.[22] Rising food prices and falling incomes put pressure on food budgets. How much does it cost to follow dietary recommendations? According to the U.S. Department of Agriculture (USDA) 2019 cost estimates, for a family of two adults, weekly cost for food is between $89.50 and $177.50, or between $4,654 and $9,230 per year. For a family of four, the cost is about $130.70 to $254.80 per week, or between $6,796.40 and $13,249.60 per year.[23]

Lifestyle

Another influential factor is lifestyle. Our fast-paced society has little time or patience for food preparation. Convenience foods, from frozen entrees to complete meals delivered in a box, are saturating supermarkets and home delivery services. Rising incomes and busier lifestyles have led consumers to spend less time cooking and more time taking advantage of the convenience of food prepared away from home.

Food Availability

food deserts Low-income areas where it is difficult to purchase food that is fresh, of good quality, and affordable.

Poor access to healthy, nutritious foods can negatively affect food choices, and therefore health and well-being. Millions of Americans live in areas defined as **food deserts**, or low-income areas where residents lack access to a supermarket or large grocery store to buy affordable fruits, vegetables, whole grains, low-fat dairy, and other foods that make up the full range of a healthy diet.[24] Food deserts are usually measured by the distance people have to travel in order to gain access to foods provided at a grocery store.[25] Many people who live in food deserts rely on "quick markets" that offer highly processed, high-sugar, and high-fat foods. Because their communities often lack healthy food providers, such as grocery stores and farmers' markets, food needs typically are served by inexpensive restaurants and convenience stores, which offer few fresh foods.

Going Green

Are you taking part in the green revolution? What are your environmental concerns?

Are you familiar with the terms *eco-friendly, carbon footprint, greenhouse gases, global climate,* and *global warming*? These phrases reflect perspectives on our interrelated world, signaling our recent awareness of an environment in trouble. Continuing abuse of our environment has resulted in a global climatic backlash: widespread disruptions threaten irreversible damage to our planet. The result could be a far less livable planet, which is inhospitable to a way of life we have taken for granted. Some green protesters are taking action. For example, to stop Brazilian rainforest destruction, some soybean traders refuse to sell soy from deforested areas of the Amazon.

It is important to focus on our nutrition environment. Here are several examples of the green technology. Only three kinds of plants supply 65 percent of the global food supply. You might be surprised to learn that they are rice, wheat, and corn. Again, although modern agricultural methods depend heavily on fertilizers, pesticides, and herbicides, we can also turn to newer, ecologically friendly farming technologies that increasingly lower costs and preserve the quality of soils. And although surrounded by controversy, genetically modified crops and foods are used to resist pests and increase yields and are finding a niche in our nutrition environment.

Food and Culture

Do you ever wonder why people choose prickly pears over apples, or pomegranates over blueberries? For the most part, food choices are a result of what people are accustomed to or what they have learned. Dietary habits are as diverse as individuals, and culture plays a key role in the food choices people make. Cultural influences often determine what roles various foods play in dietary habits, health beliefs, and everyday behaviors. As cultural diversity becomes more common among populations, regional food favorites become less foreign. Although beliefs and traditions can be modified through geography, economics, or experiences, core values and customs typically remain similar within a specific group.[a–c]

Food plays a major role in most religions and religious customs. Religious beliefs usually are learned early and can define certain dietary habits. For example, Jewish dietary laws specify that foods must be *kosher*. To be kosher, meat must come from animals that chew their cud, have split hooves, and are free from blemishes to their internal organs. Fish must have fins and scales. Pork, crustaceans and shellfish, and birds of prey are not kosher. Kosher laws prohibit eating meat and milk at the same meal or even preparing or serving them with the same plates and utensils. Islam identifies acceptable foods as *halal* and has rules similar to those of Judaism for the slaughtering of animals. Islam prohibits the consumption of pork, the flesh of clawed animals, alcohol, and other intoxicating drugs. The Church of Jesus Christ of Latter Day Saints disapproves of coffee, tea, and alcoholic beverages. Most Hindus are vegetarians and do not eat eggs, and some avoid onions and garlic. The Orthodox Jain religion in India forbids eating meat or animal products (e.g., milk, eggs) and any root vegetables (e.g., potatoes, carrots, garlic). In Buddhism, mind-altering substances or intoxicating beverages are prohibited, but dietary habits vary considerably based on the sect and geographical location.[d] Some Buddhists follow strict forms of vegetarianism, whereas others do not. In Christianity and many other religions, food plays a key role in religious ceremonies and various religious holidays, from what foods may or may not be eaten (e.g., Catholics do not eat meat on Fridays during Lent) to when foods can be consumed (e.g., only from sundown to sunrise during Islam's Ramadan). Food plays an important role not only in physical survival, but also in many people's spiritualism.

Many cultures have traditional medical practices based on the belief that nature is composed of two opposing forces. In traditional Chinese medicine, for example, these forces, called *yin* and *yang*, must be in proper balance for good health.[e] It is believed that excesses in either direction cause illness. The illness must then be treated by giving foods of the opposite force. This idea of balance or harmony, accompanied by terms describing illness and foods as either cold (e.g., banana, fish, juices) or hot (e.g., beef, nuts, ginger), or yin or yang, also is found in other Asian cultures, including India and the Philippines, and in Latin American cultures and ethnicities.

Numerous cultures view a variety of foods as having medicinal properties. Treatments commonly use assorted herbs, herbal teas, and special foods. From generation to generation, knowledge of such remedies is passed on. Remarkably, various cultures all over the world use remedies based on similar common substances, such as chamomile, garlic, and honey. These familiar substances often are more trusted and are considered safer than modern medicines. In addition to traditions and culture, the complete array of herbs and foods used daily and also as medicines is based on the geographical region, growing conditions, and climate.

The interplay of diet and culture helps to define a person's values, preferences, and practices. As a result, even in the face of changing world events and populations, neither is abandoned easily or quickly. Just as there is diversity in individuals and families, there is also diversity within cultures. One must be alert to avoid the assumption that all people of a specific culture eat, believe, or follow traditions in the exact same manner. Even so, the question arises: What impact will our increasing mobility and globalization have on food choice? Undoubtedly, cultural interactions and exposure to various cuisines will increase. Will this expand our appreciation and preservation of cultural culinary practices and result in the formation of new hybrid cuisines?

[a] Welcome to food, culture and tradition. http://www.food-links.com. Accessed December 18, 2015.

[b] EthnoMed. Cultures. http://ethnomed.org/culture. Accessed December 18, 2015.

[c] PBS. The meaning of food: food and culture. http://www.pbs.org/opb/meaningoffood/. Accessed April 10, 2015.

[d] HerbMed. Top 20 herbs. http://www.herbmed.org/#param.wapp?sw_page=top20. Accessed December 18, 2015.

[e] China Highlights. Chinese medicinal cuisine/food therapy. http://www.chinahighlights.com/travelguide/chinese-food/medicinal-cuisine.htm. Accessed December 18, 2015.

Cultural Influences

One of the strongest influences on food preferences is tradition or cultural background. In all societies, no matter how simple or complex, eating is the primary way of initiating and maintaining human relationships.

To a large extent, culture defines our attitudes. Cultural forces are so powerful that if you were permitted only a single question to establish someone's food preferences, a good choice would be "What is your ethnic background?" (See the FYI feature "Food and Culture.")

Knowledge, beliefs, customs, and habits all are defining elements of human culture. In many cultures, food has symbolic meanings related to

Quick Bite

Nerve Poison for Dinner?

The puffer fish is a delicacy in Japan. Danger is part of its appeal; eating a puffer fish can be life threatening! The puffer fish contains a poison called tetrodotoxin (TTX), which blocks the transmission of nerve signals and can be fatal. Chefs who prepare the puffer fish must have special training and licenses to prepare the fish properly so that diners feel nothing more than a slight numbing feeling.

family traditions, social status, and even health. In fact, many folk remedies rely on food. Some of these have gained wide acceptance, such as the use of spices and herbal teas for purposes ranging from allaying anxiety to preventing cancer and heart disease. Just as cultural distinctions eventually blur when ethnic groups take part in the larger American culture, so do many of the unique expectations about the ability of certain foods to prevent disease, restore health among those with various afflictions, or enhance longevity. However, food habits may be among the last practices to change when an immigrant adapts to a new culture.

Religion

Food is an important part of religious rites, symbols, and customs. Some religious rules apply to everyday eating, whereas others are concerned with special celebrations. Christianity, Judaism, Hinduism, Buddhism, and Islam, for example, all have distinct dietary rules or guidelines, but within each religion different interpretations of these rules or guidelines give rise to variations in dietary practices. (See the FYI feature "Food and Culture.")

Social-Ecological Model

An individual's health behavior is influenced by their surroundings; personal, family, social, sociocultural, organizational, community, policy, and physical environmental factors, each of which can impact a person's engagement in physical activity.[26] These factors can be viewed as a framework called the **ecological model**, which the NIH describes as levels that provide interactive effects of factors that determine behavior.[27] Increasing the number of adults in the United States who are physically active is a national priority and the social-ecological model can be used to illustrate how individual factors, environmental settings, various sectors of influence, and social and cultural elements of society overlap to form the food and physical activity choices for an individual.[28] The social-ecological model illustrates that implementing multiple changes at various levels is an effective way to improve eating and physical activity behavior (see **FIGURE 1.7**).

ecological model Levels that provide interactive effects of factors that determine behavior.

Key Concepts The cultural environments in which people grow up have a major influence on what foods they prefer, what foods they consider edible, and what foods they eat in combination and at what time of day. Many factors work to define a group's culture: environment, economics, lifestyle, food availability, traditions, and religious beliefs. As people from other cultures immigrate to new lands, they will adopt new behaviors consistent with their new homes. However, food habits are among the last to change. The social-ecological model can be used to help us understand how layers of influence converge to affect a person's food and physical activity choices.

Quick Bite

Social Networks Can Affect Weight

Studies find that the social media you follow can impact your eating habits. People are more likely to mimic the food habits and trends that they see most often on social media. Your own meal prepping and vegetable eating can keep you on the track of healthy eating, and serve as a boost for your friends as well.

The Standard American Diet

What is a typical *American diet*? As a country influenced by the practices of so many cultures, religions, backgrounds, and lifestyles, there is no easy or single answer to this question. The U.S. diet is as diverse as Americans themselves, even though many people around the world imagine that the American diet consists mainly of hamburgers, french fries, and cola drinks. Our fondness for fast food and the marketability of such restaurants overseas make them seem like icons of American culture, and many of the stereotypes are true.

So, how healthful is the American diet? The average American falls short of the USDA's MyPlate recommendations.[29] **TABLE 1.1** identifies dietary eating patterns that do not align with the Healthy U.S.-Style Pattern.[30]

For individuals age 2 years and older, the estimated average total intakes of the following foods are all well below the *Dietary Guidelines for Americans*: fruit intake is 1.03 cups, with 33 percent consumed as fruit juice;

TABLE 1.1
An Overview of Current Eating Patterns in the United States

- About three-quarters of Americans do not eat the recommended amounts of vegetables, fruits, dairy, and oils each day.
- Most Americans exceed the recommendations for added sugars, saturated fats, and sodium.
- The eating patterns of many Americans are too high in calories.

Data from the 2015-2020 Dietary Guidelines Figure 2-1. Dietary Intakes Compared to Recommendations. Percent of the U.S. Population Ages 1 Year and Older Who are Below, At, or Above Each Dietary Goal or Limit.

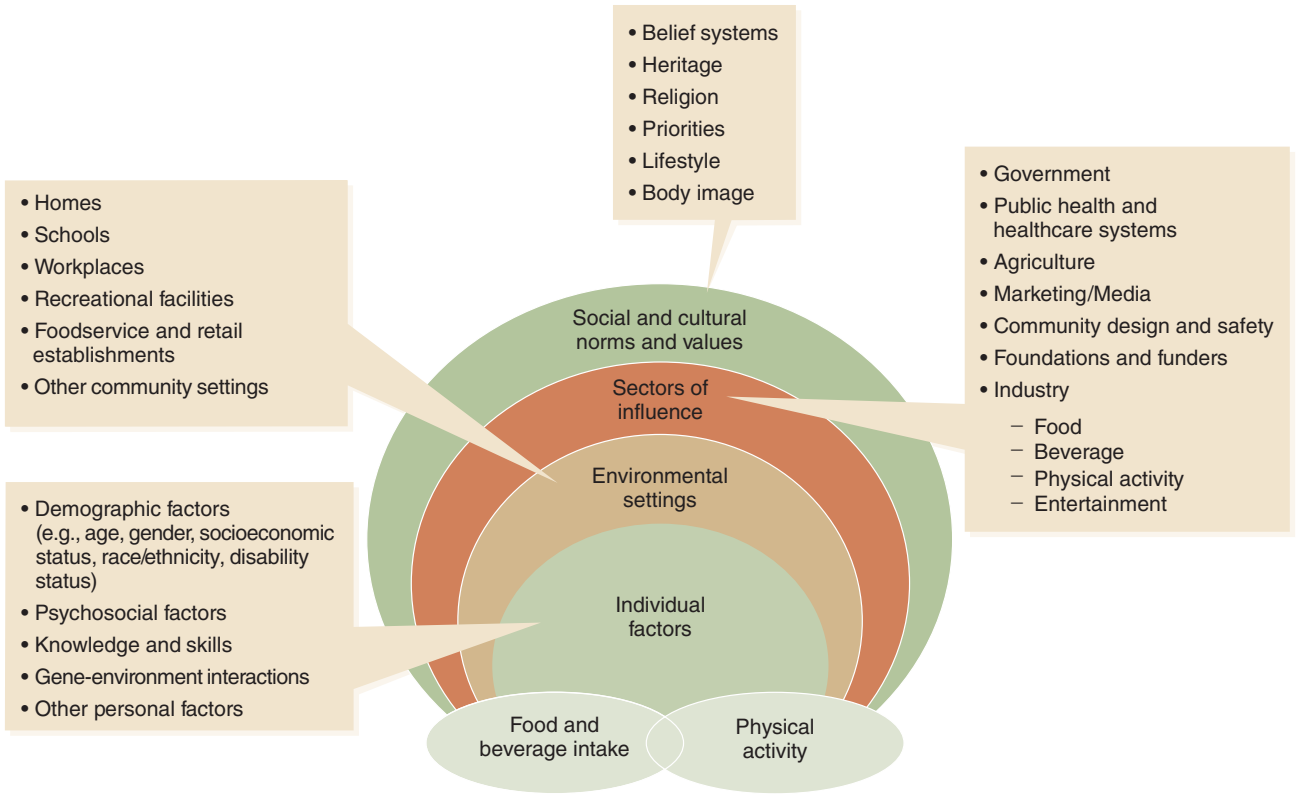


FIGURE 1.7 A social-ecological framework for nutrition and physical activity decisions. Ecological model with examples of areas for physical activity interventions within the domains of active living.

Modified from 2015–2020 Dietary Guidelines. Chapter 3: Everyone has a role in supporting healthy eating patterns: the social-ecological model. https://health.gov/dietaryguidelines/2015/guidelines/chapter-3/social-ecological-model/. Accessed March 6, 2021; Institute of Medicine. Preventing childhood obesity: health in the balance. The National Academies Press; 2005:85; Story M, Kaphingst KM, Robinson-O'Brien R, Glanz K. Creating healthy food and eating environments: policy and environmental approaches. *Annu Rev Public Health.* 2008;29:253–272.

vegetable intake is 1.47 cups, of which 22 percent is potatoes and 20 percent is tomatoes; whole grains consumption is less than 1 ounce; average dairy intake is 1.8 cups, of which 44 percent is cheese and 51 percent is fluid milk; average solid fat intake is 37 grams, oil is 25 grams, and sugar intake is estimated to be 18.4 teaspoon equivalents (see **TABLE 1.2**). Americans are not eating enough nutrient-dense foods but are eating too much of the foods known to be harmful. Together, solid fats and added sugars contribute nearly 800 calories per day while providing minimal important nutrients.[31] Soda,

TABLE 1.2
Estimated Average Intake Compared to the *Dietary Guidelines for Americans*

	Estimated Average Intake	Recommended Intake
Fruit	1.03 cups	2 cups per day
Vegetables	1.47 cups	2½ cups per day
Whole grains	< 1 ounce per day	> 3 ounces per day
Dairy	1.8 cups	3 cups per day
Solid fat intake	37 grams	Limit solid fat intake
Sugar	18.4 teaspoon equivalents	< 10% of calories per day

Data from: Bowman, S. Clemens J, Friday J, Moshfegh, A. Food patterns equivalents intakes from food: Mean amounts consumed per individual, what we eat in America, NHANES 2011–2012; Tables 1-4. http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=312662. Accessed September 25, 2019.

sugar-sweetened beverages, and grain-based desserts (sweet breads or flour-based products such as cakes, cookies, and brownies) are the major sources of added sugars for many Americans. Regular cheese, grain-based desserts, and pizza are the top contributors of solid and saturated fat in the American diet. In addition, Americans of all age groups are eating more than the recommended amounts of sodium, mainly in the form of processed foods.[32]

Although good health and nutrition information can be found in multiple publications and at a variety of venues, this does not necessarily translate into better food choices. People are not natural nutritionists, and they generally do not know instinctively which foods to choose for good health. So, it is not surprising when national surveys indicate that although Americans know that nutrition and food choices are important factors in health, few have made the recommended changes, such as eating less fat, sugar, and salt, and eating more fruits and vegetables.

You are in a position to gather more information than the average consumer. By taking this course in nutrition, you will be getting the full story—the nutrients we need for good health, the science behind the health messages, and the food choices it will take to implement them. Whether you use this information is up to you, but at least you will be a well-informed consumer.

Key Concepts "American" cuisine is truly a melting pot of cultural contributions to foods and tastes. Although Americans receive and believe many messages about the role of diet in good health, these beliefs do not always translate into better food choices. The typical American diet contains too much sodium, solid fat, saturated fat, and sugar and not enough vegetables, fruits, low-fat dairy, oils, and whole grains.

Introducing the Nutrients

Although we give food meaning through our culture and experience and make dietary decisions based on many factors, ultimately the reason for eating is to obtain nourishment—nutrition.

Food is a mixture of chemicals called **nutrients**. You need nutrients for normal growth and development, for maintaining cells and tissues, for fuel to perform physical and metabolic work, and for regulating the hundreds of thousands of body processes that go on inside of you every second of every day. Some nutrients either exist in the body or the body can synthesize them. Examples of these nutrients are the amino acids alanine, arginine, asparagine, and others. These nutrients are referred to as **nonessential nutrients** because it is not necessary to obtain these nutrients from foods that we eat. On the other hand, there are other nutrients that the body cannot synthesize, or cannot make enough of, and they must be provided through the foods that we eat. These nutrients are termed **essential nutrients**. There are six classes of essential nutrients: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, and water (see **FIGURE 1.8**). The minimum diet for human growth, development, and maintenance must supply about 45 essential nutrients. Although termed *nonessential* and *essential*, all nutrients are required by the body for supporting daily processes and to maintain health. Adequate amounts of both nonessential and essential nutrients are necessary for optimal health.

THINK About It 3

Definition of Nutrients

In studying nutrition, we focus on the functions of nutrients in the body so that we can see why they are important in the diet. However, to define a nutrient in technical terms, we focus on what happens in its absence. A nutrient is a chemical whose absence from the diet for a long enough time results in a specific change in health; in its absence, we say that a person has a deficiency of that nutrient. A lack of vitamin C, for example, can eventually lead to a condition called scurvy. A diet with too little iron will result in iron-deficiency

Quick Bite

High Fructose Corn Syrup

High fructose corn syrup (HFCS) is a desired ingredient for food manufacturers because it provides the sweet taste we get from table sugar, it works well in many different products to help maintain a longer shelf life, and it is inexpensive compared to other sweeteners. HFCS is a likely ingredient in foods such as soft drinks and other canned beverages, ice cream, cereal, baked goods, and snack foods. But, did you know that HFCS can also be found in products that do not taste sweet, such as sliced bread, processed meats, and condiments? Reading food labels is the easiest way to determine whether a food has added HFCS.

nutrients Any substances in food that the body can use to obtain energy, synthesize tissues, or regulate functions.

nonessential nutrients Those nutrients that can be made by the body.

essential nutrients Substances that must be obtained in the diet because the body either cannot make them or cannot make adequate amounts of them.

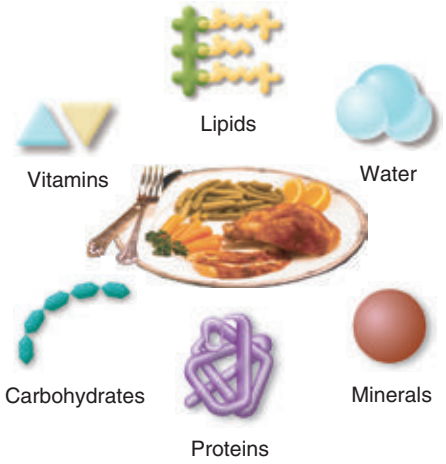


FIGURE 1.8 The six classes of nutrients. Water is the most important nutrient, and we cannot survive long without it. Because our bodies need large quantities of carbohydrate, protein, and fat, they are called macronutrients. Our bodies need comparatively small amounts of vitamins and minerals, so they are called micronutrients.

anemia. To complete the definition of a nutrient, it also must be true that putting the essential chemical back in the diet will reverse the change in health, if done before permanent damage occurs. For example, if taken early enough, adequate amounts of vitamin A can reverse the effects of deficiency on the eyes. If not, prolonged vitamin A deficiency can cause permanent blindness.

Nutrients are not the only chemicals in food. Other substances add flavor and color, some contribute to texture, and others, like caffeine, have physiological effects on the body. **Phytochemicals** are compounds in plants that contribute to their color, taste, and smell. Although not all, many phytochemicals are believed to provide health benefits beyond those provided by traditional nutrients. **Zoochemicals** are the animal equivalent of phytochemicals in plants; that is, they are found in animal tissues that we consume. Although not nutrients, nor considered essential in the diet, phyto- and zoochemicals have important health benefits. For instance, research suggests that phytochemicals in fruits and vegetables provide **antioxidant** activity, which may reduce risk for heart disease or cancer.[33]

The six classes of nutrients serve three general functions: (1) they provide energy, (2) they regulate body processes, and (3) they contribute to body structures (see **FIGURE 1.9**). Although virtually all nutrients can be said to regulate

phytochemicals Substances in plants that may possess health-protective effects, even though they are not essential for life.

zoochemicals The animal equivalent of phytochemicals in plants that are believed to provide health benefits beyond the traditional nutrients that foods contain.

antioxidant A substance that combines with or otherwise neutralizes a free radical, thus preventing oxidative damage to cells and tissues.

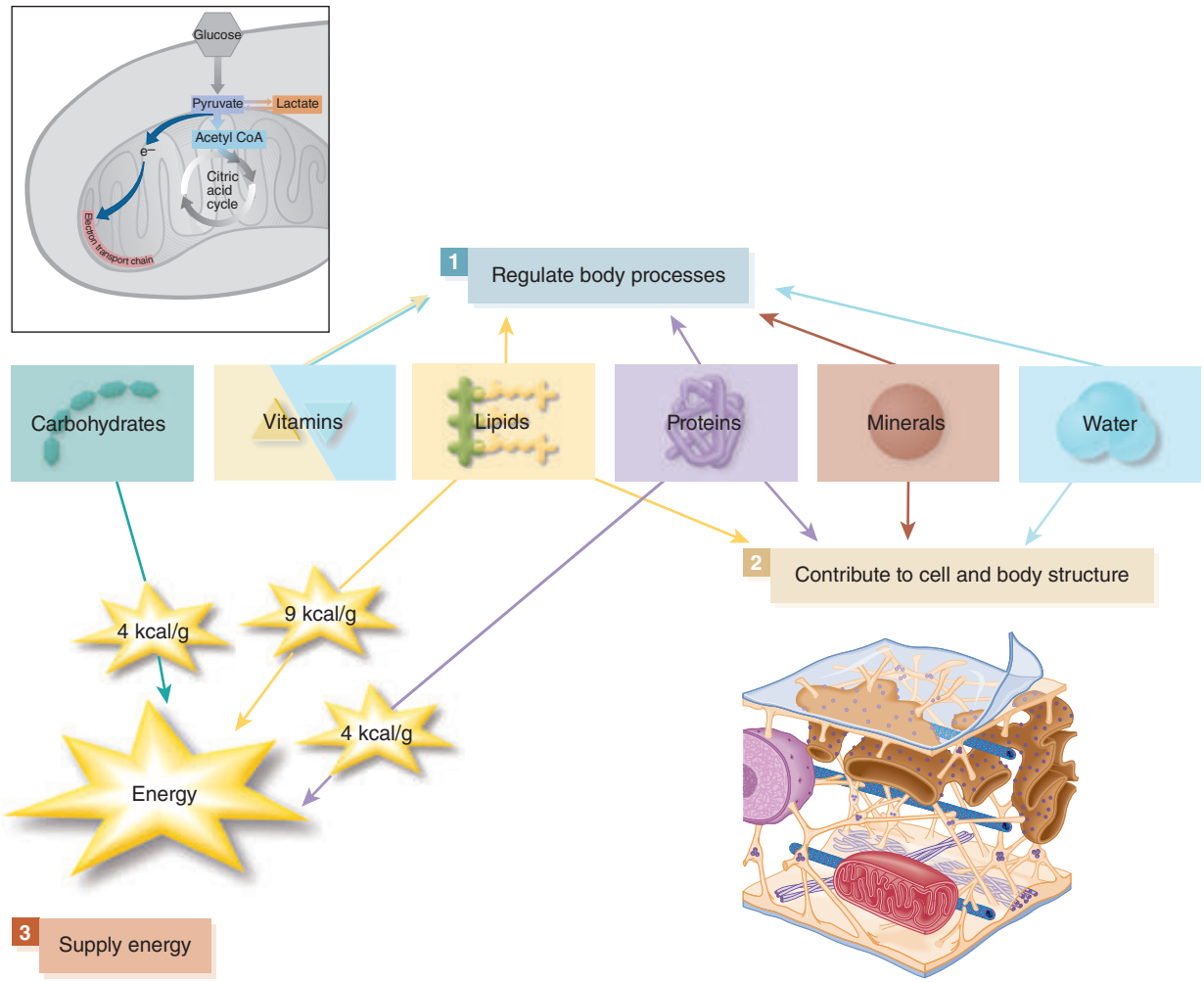


FIGURE 1.9 Nutrients have three general functions in your body. (1) Micronutrients, some lipids and proteins, and water help regulate body processes such as blood pressure, energy production, and temperature. (2) Lipids, proteins, minerals, and water help provide structure to bone, muscle, and other cells. (3) Macronutrients supply energy to power muscle contractions and cellular functions.

body processes, and many contribute to body structures, only proteins, carbohydrates, and fats are sources of energy.

Because the body needs large quantities of carbohydrates, proteins, and fats, they are called **macronutrients**; vitamins and minerals are called **micronutrients** because the body needs comparatively small amounts of these nutrients. Even though micronutrients are needed in far smaller amounts than macronutrients, a healthy diet must supply both in adequate amounts.

In addition to their functions, there are several other key differences among the classes of nutrients. First, the chemical composition of nutrients varies widely. One way to divide the nutrient groups is based on whether the compounds contain the element carbon. Substances that contain carbon are **organic** substances; those that do not are **inorganic**. Carbohydrates, lipids, proteins, and vitamins are all organic; minerals and water are not. Structurally, nutrients can be very simple—minerals such as sodium are single elements, although we often consume them as larger compounds (e.g., sodium chloride, which is table salt). Water also is simple in structure. The organic nutrients have more complex structures—the carbohydrates, lipids, and proteins we eat are made of smaller building blocks, whereas the vitamins are elaborately structured compounds.

It is rare for a food to contain just one nutrient. Meat is not just protein, and bread is not solely carbohydrate. Foods contain mixtures of nutrients, although in most cases protein, fat, or carbohydrate dominates. So, although bread is certainly rich in carbohydrates, it also contains some protein, a little fat, and many vitamins and minerals. If it is whole-grain bread you are eating, you also get fiber, which is not technically a nutrient, but is an important compound for good health nonetheless.

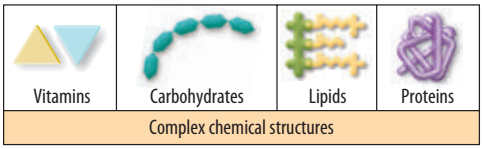
Key Concepts Nutrients are the essential chemicals in food that the body needs for normal functioning and good health and that must come from the diet because they either cannot be made in the body or cannot be made in sufficient quantities. Six classes of nutrients—carbohydrates, proteins, lipids, vitamins, minerals, and water—can be described by their composition or by their function in the body.

macronutrients Nutrients, such as carbohydrates, fats, or proteins, that are needed in relatively large amounts in the diet.

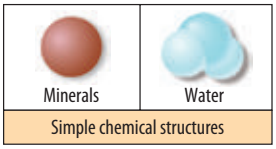
micronutrients Nutrients, such as vitamins and minerals, that are needed in relatively small amounts in the diet.

organic In chemistry, any compound that contains carbon, except carbon oxides (e.g., carbon dioxide) and sulfides and metal carbonates (e.g., potassium carbonate). This term also is used to denote crops that are grown without synthetic fertilizers or chemicals.

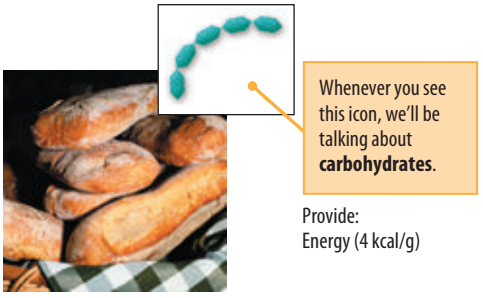
inorganic Any substance that does not contain carbon, excepting certain simple carbon compounds such as carbon dioxide and carbon monoxide. Common examples include table salt (sodium chloride) and baking soda (sodium bicarbonate).



Organic – contains carbon



Inorganic – no carbon



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Carbohydrates

If you think of water when you hear the word *hydrate*, then the word *carbohydrate*—or literally "hydrate of carbon"—tells you exactly what this nutrient is made of. **Carbohydrates** are made of carbon, hydrogen, and oxygen and are a major source of fuel for the body. Dietary carbohydrates are the starches and sugars found in grains, vegetables, **legumes** (dry beans and peas), and fruits. We also get carbohydrates from dairy products and from fiber, a type of carbohydrate made up of long chains of sugars that cannot be broken down by human digestive enzymes. Although fiber doesn't fit the classical definition of a nutrient, it plays important roles in the body, especially in improving digestive function. Your body converts most nonfiber dietary carbohydrates to glucose, a simple sugar compound that provides a source of energy for cells and tissues. **Circulation** moves glucose and other substances through the vessels of the cardiovascular and lymphatic systems.

Lipids

The term **lipids** refers to substances we know as fats and oils, but it also refers to fatlike substances in foods, such as cholesterol and phospholipids. Lipids are organic compounds and, like carbohydrates, contain carbon, hydrogen, and oxygen. Fats and oils—or, more correctly, **triglycerides**—are another major fuel source for the body. In addition, triglycerides, cholesterol, and phospholipids have other important functions: providing structure for body cells, carrying the fat-soluble vitamins (A, D, E, and K), and providing the

carbohydrates Compounds, including sugars, starches, and dietary fibers, that usually have the general chemical formula $(CH_2O)_n$, where n represents the number of CH_2O units in the molecule. Carbohydrates are a major source of energy for body functions.

legumes A family of plants with edible seed pods, such as peas, beans, lentils, and soybeans. Also called pulses.

circulation Movement of substances through the vessels of the cardiovascular or lymphatic system.

lipids A group of fat-soluble compounds that includes triglycerides, sterols, and phospholipids.

triglycerides Fats composed of three fatty acid chains linked to a glycerol molecule.

starting material (cholesterol) for making many **hormones**. Dietary sources of lipids include the fats and oils we cook with or add to foods; the naturally occurring fats in meats and dairy products; and less obvious plant sources, such as coconuts, olives, and avocados.

Proteins

Proteins are organic compounds made of smaller building blocks called **amino acids**. Unlike carbohydrates and lipids, amino acids contain nitrogen as well as carbon, hydrogen, and oxygen. Proteins are found in a variety of foods. Meats and dairy products are concentrated sources of protein. Grains, legumes, and vegetables are also sources of protein, whereas fruits contribute negligible amounts. The amino acids that we get from dairy protein combine with the amino acids made in the body to make hundreds of different body proteins. Proteins are the main structural material in the body. They are also important components in blood, cell membranes, enzymes, and immune factors. Proteins regulate body processes and can also be used for energy.

Vitamins

Vitamins are organic compounds that contain carbon and hydrogen and perhaps nitrogen, oxygen, phosphorus, sulfur, or other elements. The main function of vitamins is to help regulate many body processes such as energy production, blood clotting, and calcium balance. Vitamins help to keep organs and tissues functioning and healthy. Because vitamins have such diverse functions, a lack of a particular vitamin can have widespread effects. Although the body does not break down vitamins to yield energy, vitamins have vital roles in the extraction of energy from carbohydrate, fat, and protein.

Each of the 13 vitamins belongs to one of two groups: fat-soluble or water-soluble. The four fat-soluble vitamins—A, D, E, and K—have very diverse roles. What they have in common is the way they are absorbed and transported in the body and the fact that they are more likely to be stored in larger quantities than the water-soluble vitamins. The water-soluble vitamins include vitamin C and eight B vitamins: thiamin, riboflavin, niacin, pyridoxine (B_6), cobalamin (B_{12}), folate, pantothenic acid, and biotin. Most of the B vitamins are involved in some way with the pathways for energy metabolism.

Vitamins are found in a wide variety of foods, not just fruits and vegetables—although these are important sources—but also meats, grains, legumes, dairy products, and even fats. Choosing a well-balanced diet usually makes vitamin supplements unnecessary. In fact, when taken in large or excessive doses, vitamin supplements (especially those containing vitamins A, D, B_6, or niacin) can be harmful.

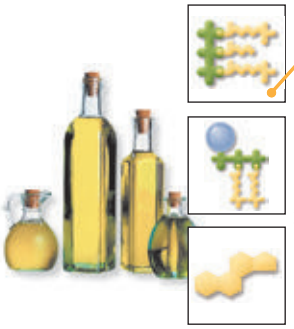
Minerals

Structurally, **minerals** are simple, inorganic substances. Minerals are important for keeping your body healthy, and your body uses minerals for many different functions. There are two kinds of minerals: **macrominerals** and trace minerals. Macrominerals are minerals your body needs in relatively large amounts compared to other minerals; these include calcium, phosphorus, magnesium, sodium, potassium, chloride, and sulfur. The body needs the remaining minerals only in very small amounts. These **microminerals**, or **trace minerals**, include iron, zinc, copper, manganese, molybdenum, selenium, iodine, and fluoride. As with vitamins, the functions of minerals are diverse. Minerals can be found in structural roles (e.g., calcium, phosphorus, and fluoride in bones and teeth) as well as regulatory roles (e.g., control of fluid balance, regulation of muscle contraction).

hormones Chemical messengers that are secreted into the blood by one tissue and act on cells in another part of the body.

proteins Large, complex compounds consisting of many amino acids connected in varying sequences and forming unique shapes.

amino acids Compounds that function as the building blocks of protein.



Whenever you see one of these three icons, we'll be talking about **lipids**.

Provide:
Energy (9 kcal/g)
Structure
Regulation (hormones)

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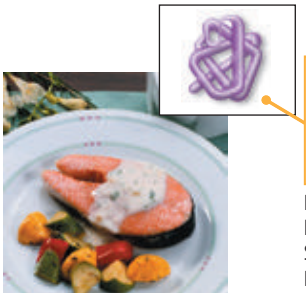

Whenever you see this icon, we'll be talking about **proteins**.

Provide:
Energy (4 kcal/g)
Structure
Regulation

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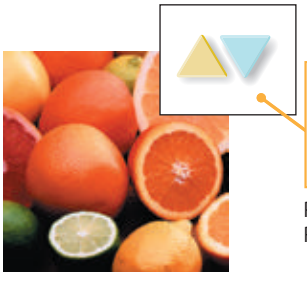
vitamins Organic compounds necessary for reproduction, growth, and maintenance of the body. Vitamins are required in miniscule amounts.

minerals Inorganic compounds needed for growth and for regulation of body processes.

macrominerals Major minerals required in the diet and present in the body in large amounts compared with trace minerals.

microminerals See *trace minerals*.

trace minerals Those minerals present in the body and required in the diet in relatively small amounts compared with major minerals. Also known as *microminerals*.



Whenever you see these icons, we'll be talking about **vitamins**.

Provide:
Regulation

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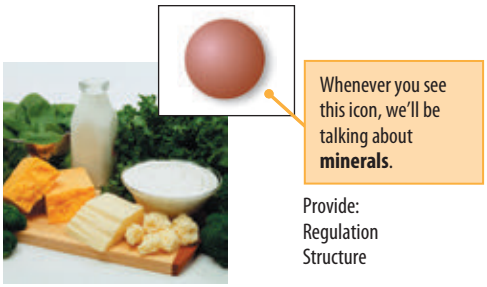
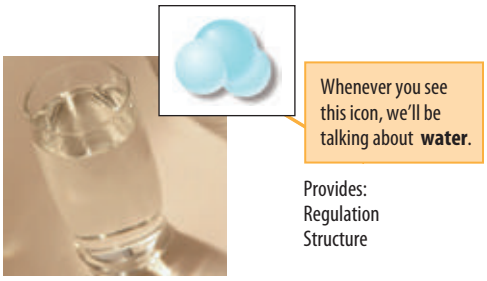


Whenever you see this icon, we'll be talking about **minerals**.

Provide:
Regulation
Structure

© Mitch Hrdlicka/Photodisc/Getty Images



Whenever you see this icon, we'll be talking about **water**.

Provides:
Regulation
Structure

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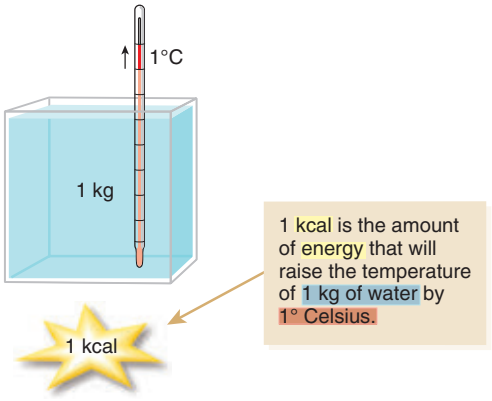


energy The capacity to do work. The energy in food is chemical energy, which the body converts to mechanical, electrical, or heat energy.

kilocalories (kcal) [KILL-oh-kal-oh-rees] Units used to measure food energy (1,000 calories = 1 kilocalorie).

calorie The general term for energy in food and used synonymously with the term *energy*. Often used instead of kilocalorie on food labels, in diet books, and in other sources of nutrition information.

Food sources of minerals are just as diverse as mineral functions. Although we often associate minerals with animal foods, such as meats and milk, plant foods are important sources as well. Deficiencies of minerals—with the exception of iron, calcium, iodine (in patients with cystic fibrosis or pregnancy), and selenium—are generally uncommon. A balanced diet provides enough minerals for most people. However, some individuals, particularly those with restrictive diets, can benefit from mineral supplements. For example, individuals with iron-deficiency anemia may need iron supplements, or individuals with inadequate dairy intake may benefit from calcium supplements. As is true for vitamins, excessive intake of some minerals as supplements can be toxic.

Water

Water is the most essential nutrient. We can survive far longer without any of the other nutrients in the diet (indeed without food at all) than we can without water. Like minerals, water is inorganic. Water has many roles in the body, including temperature control, lubrication of joints, and transportation of nutrients and wastes.

Because your body is nearly 60 percent water, regular fluid intake to maintain adequate hydration is important. Water is found not only in beverages, but also in most food products. Fruits and vegetables in particular are high in water content. Through many chemical reactions, the body makes some of its own water, but this is only a fraction of the amount needed for normal function.

Key Concepts The body needs larger amounts of carbohydrates, lipids, and proteins (macronutrients) than vitamins and minerals (micronutrients). Carbohydrates, lipids, and proteins provide energy; proteins, vitamins, minerals, water, and some fatty acids regulate body processes; and proteins, lipids, minerals, and water contribute to body structure.

Nutrients and Energy

One major reason we eat food, and the nutrients it contains, is for **energy**. Every cellular reaction, every muscle movement, and every nerve impulse requires energy. Three of the nutrient classes—carbohydrates, lipids (triglycerides only), and proteins—are energy sources. Although not considered a nutrient, another energy source is alcohol. When we speak of the energy in foods, we are really talking about the *potential* energy that foods contain.

Different scientific disciplines use different measures of energy. In nutrition, we discuss the potential energy in food, or the body's use of energy, in units of heat called **kilocalories** (1,000 calories). One kilocalorie (or kcal) is the amount of energy (heat) it would take to raise the temperature of 1 kilogram (kg) of water by 1 degree Celsius. For now, this may be an abstract concept, but, as you learn more about nutrition, you will discover how much energy you likely need to fuel your daily activities. You also will learn about the amounts of potential energy in various foods. You will find that food labels, diet books, and other sources of nutrition information generally use the term **calorie** rather than *kilocalorie*. Technically, the potential energy in foods is best measured in kilocalories; however, the term *calorie* has become familiar and commonplace. Throughout the text we will use the terms *calorie* and *kilocalorie (kcal)* to mean generally the same thing.

Energy in Foods

Energy is available from foods because foods contain carbohydrate, fat, and protein. These nutrients can be broken down completely (metabolized) to yield energy in a form that cells can use. When completely metabolized in

the body, carbohydrate and protein yield 4 kilocalories of energy for every gram (g) consumed; fat yields 9 kilocalories per gram; and alcohol contributes 7 kilocalories per gram (see **FIGURE 1.10**). Therefore, the energy available from a given food or from a total diet is determined by the amount of each of these substances consumed. Because fat is a concentrated source of energy, adding or removing fat from the diet can have a big effect on available energy.

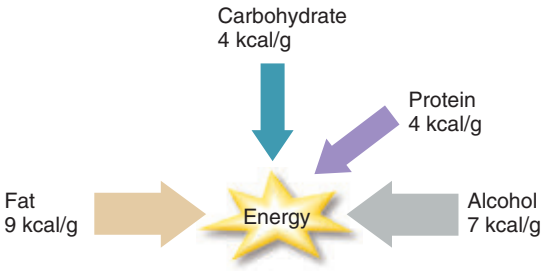


FIGURE 1.10 Energy sources. Carbohydrate, fat, protein, and alcohol provide different amounts of energy per gram.

How Can We Calculate the Energy Available from Foods?

To calculate the energy available from food, multiply the number of grams of carbohydrate, protein and fat by 4, 4, and 9, respectively; then add the results.

Here is an example:

One bagel with cream cheese contains 39 grams of carbohydrate, 10 grams of protein, and 16 grams of fat; thus, we can determine the available energy from each component.

Example:

39 g carbohydrate × 4 kcal/g	=	156 kcal
10 g protein × 4 kcal/g	=	40 kcal
16 g fat × 9 kcal/g	=	144 kcal
Total kcal in one serving of this food	=	340 kcal

CALCULATING THE ENERGY AVAILABLE FROM FOODS

g carbo × 4 = _____
\+ g protein × 4 = _____
\+ g fat × 9 = _____
= Total kcal

Example:
275 g carbohydrate × 4 kcal/g = 1,100 kcal
75 g protein × 4 kcal/g = 300 kcal
67 g fat × 9 kcal/g = 600 kcal (rounded from 603 kcal)
Total = 2,000 kcal

Example:

- 39 g carbohydrate × 4 kcal/g = 156 kcal from carbohydrate

  156 kcal from carbohydrate ÷ 340 total kcal in on serving of food = 0.459

  0.459 × 100 (to convert into % of kcal) = 46% kcal from carbohydrate per serving

- 10 g protein × 4 kcal/g = 40 kcal from protein

  40 kcal from protein ÷ 340 total kcal in one serving of food = 0.118

  0.118 x 100 (to convert into % of kcal) = 12% kcal from protein per serving

- 16 g fat × 9 kcal/g = 144 kcal from fat

  144 kcal from fat ÷ 340 total kcal in one serving of food = × 100 = 0.424

  0.42 x 100 (to convert into % of kcal in one serving of food) = 42% kcal from fat per serving

- Round up the percentage to the higher number:

  39 g carbohydrate × 4 kcal/g = 156 kcal

  10 g protein × 4 kcal/g = 40 kcal

  16 g fat × 9 kcal/g = 144 kcal

  Total = 340 kcal

CALCULATING THE PERCENTAGE OF KILOCALORIES FROM NUTRIENTS

g carbo × 4 = _____
\+ Total kcal x 100 = % carbo kcal
g protein × 4 = _____
\+ Total kcal x 100 = % protein kcal
g fat × 9 = _____
\+ Total kcal x 100 = % fat kcal

Example:
275 g carbohydrate × 4 = 1,100 kcal
1,100 kcal + 2,000 kcal x 100 = 55% carbo kcal

75 g protein × 4 = 300 kcal
300 kcal + 2,000 kcal x 100 = 15% protein kcal

67 g fat × 9 = 600 kcal (rounded from 603 kcal)

600 kcal + 2,000 kcal x 100 = 30% fat kcal

Be Food Smart: Calculate the Percentages of Calories in Food

To calculate the *percentage* of calories that carbohydrate, protein, and fat each contributes to the total, divide the amount of kcal from each nutrient by the total amount of kcal and then multiply by 100.

For example, to determine the percentage of calories from fat in the bagel with cream cheese example:

% of energy as carbohydrates	=	156 kcal/340 kcal	=	0.459 × 100	=	46% kcal from carbohydrate
% of energy from protein	=	40 kcal/340 kcal	=	0.118 × 100	=	12% kcal from protein
% of energy from fat	=	144 kcal/340 kcal	=	0.424 × 100	=	42% kcal from fat

Current health recommendations suggest limiting fat intake to about 20 to 35 percent of *total* energy intake. You can monitor this for yourself in two ways. If you like counting fat grams, you can first determine your suggested maximum fat intake. For example, if you need to eat 2,000 kilocalories each day to maintain your current weight, at most 35 percent of those calories can come from fat:

2,000 kcal × 0.35	=	700 kcal from fat
700 kcal from fat ÷ 9 kcal/g	=	77.8 g of fat

Therefore, your maximum fat intake should be about 78 grams. You can check food labels to see how many fat grams you typically eat.

Another way to monitor your fat intake is to know the percentage of calories that come from fat in various foods. If the proportion of fat in each food choice throughout the day exceeds 35 percent of calories, then the day's total of fat will be too high as well. Some foods contain virtually no fat calories (e.g., fruits, vegetables), whereas others are nearly 100 percent fat calories (e.g., margarine, salad dressing). Being aware that a snack like the bagel with cream cheese provides 42 percent of its calories from fat can help you select lower-fat foods at other times of the day.

Diet and Health

disease A particular quality, habit, or disposition regarded as adversely affecting a person or group of people.

What does it mean to be healthy? The WHO defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." Although we often focus on the last part of that definition, "the absence of disease or infirmity," the first part is equally important. As you have learned, nutrition is an important part of physical, mental, and social well-being. It also is important for preventing disease.

Disease can be defined as "an impairment of the normal state of the living animal or plant body or one of its parts that interrupts or modifies the performance of the vital functions" and can arise from environmental factors or specific infectious agents, such as bacteria or viruses. Diseases can be *acute* (short-lived illnesses that arise and resolve quickly) or *chronic* (diseases with a slow onset and long duration). Although nutrition can affect our susceptibility to acute diseases, our food choices are more likely to affect our risk for developing chronic diseases such as heart disease or cancer. Other lifestyle factors, such as smoking and exercise, in addition to genetic factors, also may determine who gets sick and who remains healthy. The 10 leading causes of death are listed in **TABLE 1.3**. Nutrition plays a role in the prevention or treatment of more than half of the conditions listed. Heart disease and cancer, together, account for almost half of all deaths.[34]

The foods we choose to eat do more than provide us with an adequate diet. The balance of energy sources can affect our risk of chronic disease.

TABLE 1.3
Leading Causes of Death: United States

Rank	Cause of Death
1	Heart disease[a]
2	Cancer[a]
3	Accidents (unintentional injuries)
4	Chronic lower respiratory diseases
5	Stroke (cerebrovascular diseases)
6	Alzheimer's disease
7	Diabetes[a]
8	Influenza and pneumonia
9	Kidney disease[a]
10	Intentional self-harm (suicide)

[a] Causes for which nutrition is thought to be important in the prevention or treatment of the condition.

Reproduced from Kochanek KD, Xu J, Murphy SL, Miniño AM, Kung H-C. Deaths: preliminary data for 2009. *National Vital Statistics Reports*. 2011;59(4). www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_04.pdf. Accessed December 18, 2015

Preamble to the Constitution of WHO as adopted by the International Health Conference, New York, 19 June–22 July 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of WHO, no. 2, p. 100) and entered into force on 7 April 1948. The definition has not been amended since 1948.

For example, high-fat diets have been linked to heart disease and cancer. Excess calories contribute to obesity, which also increases disease risk. Other nutrients, such as the minerals sodium, chloride, calcium, and magnesium, affect blood pressure, whereas a lack of the vitamin folate prior to conception and in early pregnancy can cause serious birth defects. Non-nutrient components in the diet (e.g., phytochemicals) may have antioxidant or immune-enhancing properties that also can keep us healthy. The choices we make can reduce our disease risk, as well as provide energy and essential nutrients.

Physical Activity

Active Children and Adolescents

Regular physical activity in children and adolescents promotes health and fitness. Compared to those who are inactive, physically active youth have higher levels of cardiorespiratory fitness and stronger muscles, as well as lower body fatness.[35] Kids who participate in regular activity have stronger bones, and they may have reduced symptoms of anxiety and depression.[36] Additionally, because physical activity makes it less likely that risk factors for chronic disease will develop, youth who exercise regularly have a better chance of a healthy adulthood compared to those who are not physically active.[37] Current physical activity guidelines recommend that children and adolescents do 60 minutes or more of physical activity each day.[38] Children should be encouraged to participate in activities that are age-appropriate, are enjoyable, and offer variety. Aerobic activity should make up most of a child's activity time, but muscle strengthening, such as gymnastics or doing push-ups, and bone strengthening, such as jumping rope or running, count as well.

Active Adults

Adults who are physically active are healthier and less likely to develop many chronic diseases than adults who are inactive.[39] Physically active people generally outlive those who are inactive, and, as a risk factor for heart disease, inactivity can be almost as significant as high blood pressure, smoking, or high blood cholesterol. Physical activity also plays a significant role in long-term weight management. For adults, the Centers for Disease Control and Prevention set the recommendations to be measured as a weekly total, with the understanding that one can reach the suggested weekly time goals by breaking up exercise time into shorter increments of time. Recommendations for adults include 150 minutes of moderate-intensity aerobic activity every week and muscle-strengthening activity on 2 or more days per week, or 75 minutes of vigorous-intensity aerobic activity every week and muscle-strengthening activities on 2 or more days per week.[40]

Key Concepts All cells and tissues need energy to keep the body functioning. Energy in foods and in the body is measured in kilocalories. The carbohydrates, lipids, and proteins in food are potential sources of energy, meaning that the body can extract energy from them. Excess energy intake is a contributing factor to obesity, a major public health issue. All individuals should aim to be physically active.

Applying the Scientific Process to Nutrition

Whether it is identifying essential nutrients, establishing recommended intake levels, or exploring the effects of vitamins on cancer risk, scientific studies are the cornerstone of nutrition. The fundamentals of nutrition are developed through the scientific process of observation and inquiry.

The scientific process enables researchers to test the validity of a hypothesis that arises from observations. A hypothesis is a supposition or proposed explanation made on the basis of limited evidence as a starting

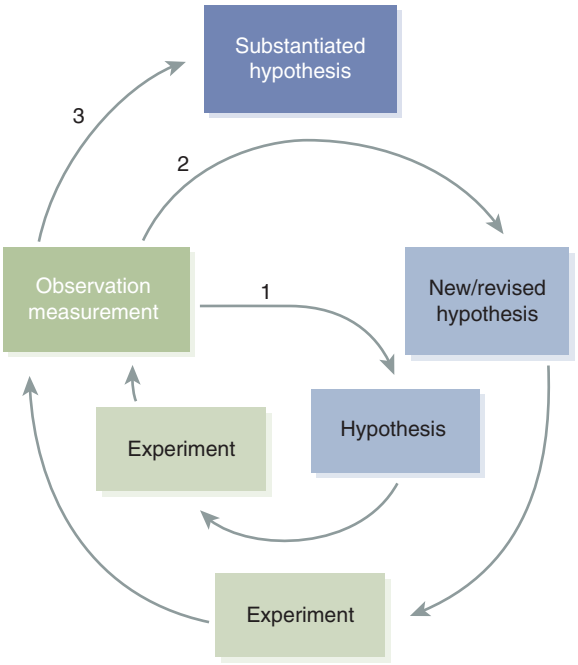


FIGURE 1.11 The scientific process. The scientific process (also referred to as the scientific method) follows these general steps: (1) make observations; (2) formulate a hypothesis; (3) test the hypothesis; (4) analyze the data and draw conclusions; and (5) communicate results.

point for further investigation. For example, it was common knowledge in the eighteenth century that sailors on long voyages would likely develop scurvy (which we now know results from a deficiency of vitamin C). Scurvy had been recognized since ancient times, and its common symptoms—pinpoint skin hemorrhages, swollen and bleeding gums, joint pain, fatigue and lethargy, and psychological changes such as depression and hysteria—were well known. Native populations had discovered plant foods that would cure this illness; among Native Americans these included cranberries in the Northeast and many tree extracts in other parts of the country. From observations such as these, that certain plant foods would cure scurvy, come questions that lead to hypotheses, or "educated guesses," about factors that might be responsible for the observed phenomenon. Scientists then test hypotheses using appropriate research designs. Poorly designed research, on the other hand, can produce useless results or false conclusions.

By following the steps of the scientific process (**FIGURE 1.11**), researchers can minimize influences that may arise during a research study (such as bias, prejudice, or coincidence). The scientific process (also referred to as the scientific method) follows these general steps: (1) make observations, ask questions, or describe phenomena; (2) formulate a hypothesis to explain the observation, question, or phenomena; (3) test the hypothesis by conducting an experiment; (4) analyze data and draw conclusions; and (5) communicate results indicating whether the hypothesis is accepted or not. Throughout the research process, researchers must follow ethical procedures in all areas of the study design.

Nutrition research is exciting and always changing. Scientists ask questions to be answered and define problems to be solved. Investigators choose a study design that will best answer their research question or hypothesis. Throughout the research process, researchers must follow rigorous ethical procedures in all areas of the study design.

Study designs can be classified under two general categories: observational studies and interventional studies. Each study design has limits; therefore, choosing the appropriate study design for the intended research is important in order to draw the most accurate conclusions. Observational study designs either look for evidence that something has happened, or follows people to see whether something happens, and do not include any intervention other than the normal standard of care. Observational studies are often retrospective and are used to assess potential causation in exposure-outcome relationships and therefore influence preventive methods.[41] An interventional study is where something is done in the study, such as using a treatment, which is recorded and analyzed. Interventional studies are those where the researcher intervenes as part of the study design.[42] Study design can also be classified by the role that time plays in the data collection, either retrospective, where data are collected from the past (either through records created at the time, or by asking participants to recall the sought information), or prospective, where data are collected as participants are followed over time. Retrospective studies are more prone to different biases, particularly recall bias. Prospective studies are less prone to some types of bias and can more easily demonstrate that the exposure preceded the disease, thereby more strongly suggesting causation.[43] Measurement of risk is generally categorized one of two ways: those that indicate an association and those that suggest causation. **TABLE 1.4** describes some study designs commonly used in nutrition research. **TABLE 1.5** identifies strengths and weaknesses of observational and interventional studies.

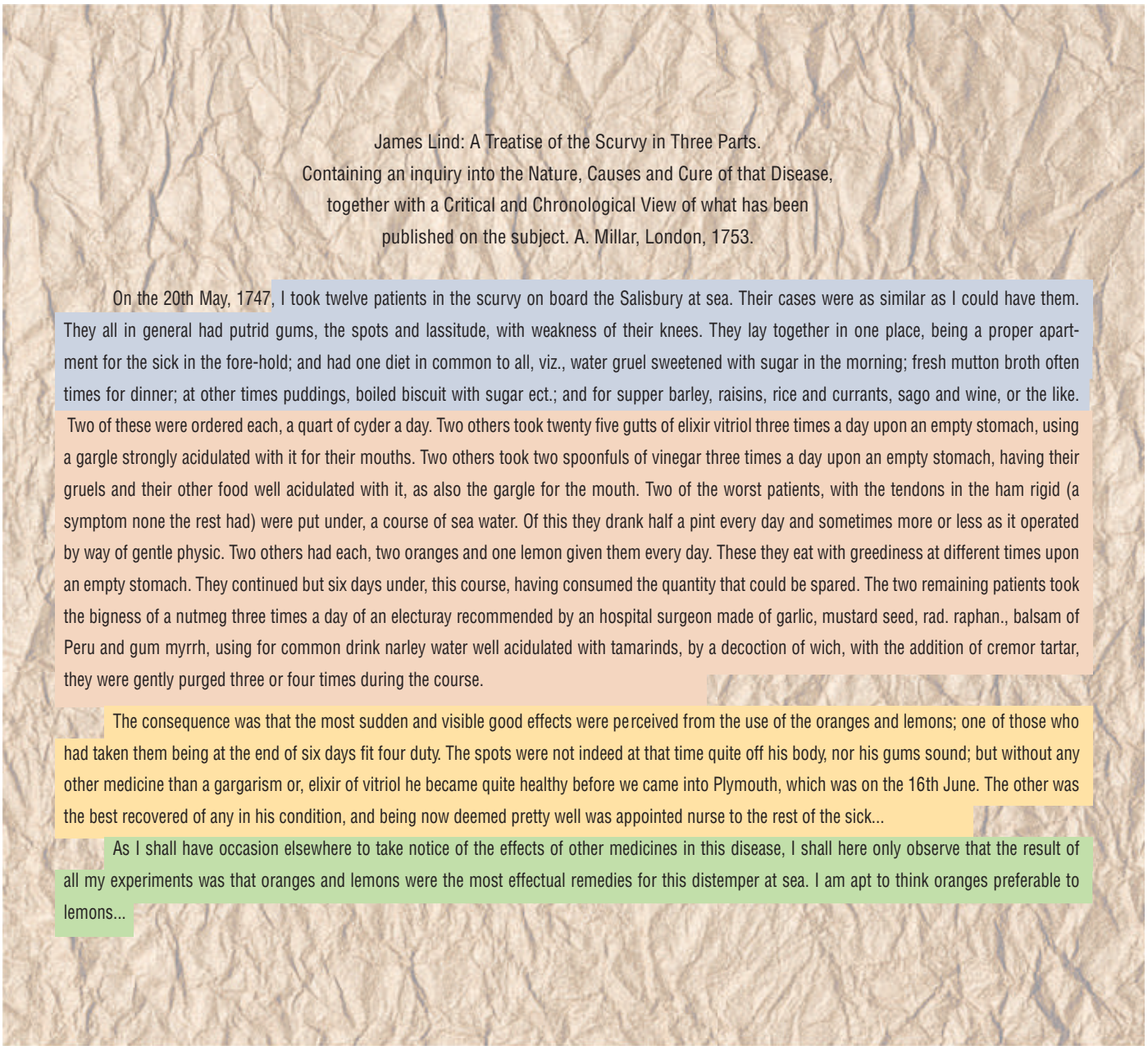
TABLE 1.4
Common Study Designs, Including Strengths and Weaknesses

Study Type	Description
Human studies	
Epidemiological study (observational)	An epidemiological study compares disease rates among population groups and attempts to identify related conditions or behaviors such as diet and smoking habits. Epidemiological studies can provide useful information about relationships but often do not clarify cause and effect. The results of these studies show correlations—relationships between two or more factors; however, they do not establish or address cause and effect. Epidemiological studies can provide important clues and insights that lead to animal and human studies that can further clarify diet and disease relationships. The relationship between inadequate vitamin C intake and scurvy is one example of this.
Case control study (observational)	Case control studies are small-scale epidemiological studies in which individuals who have a condition (e.g., breast cancer) are compared with similar individuals who do not have the condition. Researchers then identify factors other than the disease in question that differ between the two groups. These factors provide researchers with clues about the cause, progression, and prevention of the disease.
Clinical trial (interventional)	Clinical trials are controlled studies where some type of intervention (e.g., nutrient supplement, controlled diet, exercise program) is used to determine its impact on certain health parameters. These studies include an experimental group (the people who experience the intervention) and a control group (similar people who are not treated). Scientists measure aspects of health or disease in each group and compare the results.
Animal studies	Animal studies can provide preliminary data that often lead to human studies or can be used to study hypotheses that cannot be tested on humans. Although animal studies give scientists important information that furthers nutrition knowledge, the results of animal studies cannot be extrapolated directly to humans. Animal studies need to be followed with cell culture studies and ultimately human clinical studies to determine specific effects in humans.
Cell culture studies	Another way to study nutrition is to isolate specific types of cells and grow them in the laboratory. Scientists then can use these cells to study the effects of nutrients or other components on metabolic processes in the cell. An important area of nutrition research, called nutrigenomics, explores the effect of specific nutrients and other chemical compounds on gene expression. This area of molecular biology helps us explain individual differences in chronic disease risk factors and may lead to designing diets based on an individual's genetic profile.

TABLE 1.5
Strengths and Weaknesses of Different Types of Study Design

	Strengths	Weaknesses
Observational studies	• Quick • Inexpensive • Data collected can be individualized • Made of a wide variety of individuals, therefore lack ethical controversy • Requires only observations and recording information, making the design relatively simple • Able to control for multiple confounding variables • Good to study uncommon or rare diseases, or investigating outbreaks	• Only one outcome can be assessed • Etiology is studied only indirectly • Selection of controls can be difficult and can introduce bias • Can introduce recall bias • Difficult to get accurate data if record keeping is either inadequate or unreliable
Interventional studies	• Avoids bias related to confounding factors (because there is a control group) • Eliminates selection bias (through randomization) • Eliminates interpretation bias (through double blinding)	• Subjects used for this type of study are markedly different from the situation in real life • Contains a mix of both good and poor responders, which often mitigates the average therapeutic response

James Lind's experiments with sailors aboard the *Salisbury* in 1747 are considered to be the first dietary clinical trial (see **FIGURE 1.12**). His observation that oranges and lemons were the only dietary elements that seemed to cure scurvy was an important finding. However, it took more than 40 years before the British Navy began routinely giving all sailors citrus juice or fruit, such as lemons or limes—a practice that led to the nickname "limeys" when referring to British sailors. It took nearly 200 years (until the 1930s) for scientists



James Lind: A Treatise of the Scurvy in Three Parts.
Containing an inquiry into the Nature, Causes and Cure of that Disease,
together with a Critical and Chronological View of what has been
published on the subject. A. Millar, London, 1753.

On the 20th May, 1747, I took twelve patients in the scurvy on board the Salisbury at sea. Their cases were as similar as I could have them. They all in general had putrid gums, the spots and lassitude, with weakness of their knees. They lay together in one place, being a proper apartment for the sick in the fore-hold; and had one diet in common to all, viz., water gruel sweetened with sugar in the morning; fresh mutton broth often times for dinner; at other times puddings, boiled biscuit with sugar ect.; and for supper barley, raisins, rice and currants, sago and wine, or the like. Two of these were ordered each, a quart of cyder a day. Two others took twenty five gutts of elixir vitriol three times a day upon an empty stomach, using a gargle strongly acidulated with it for their mouths. Two others took two spoonfuls of vinegar three times a day upon an empty stomach, having their gruels and their other food well acidulated with it, as also the gargle for the mouth. Two of the worst patients, with the tendons in the ham rigid (a symptom none the rest had) were put under, a course of sea water. Of this they drank half a pint every day and sometimes more or less as it operated by way of gentle physic. Two others had each, two oranges and one lemon given them every day. These they eat with greediness at different times upon an empty stomach. They continued but six days under, this course, having consumed the quantity that could be spared. The two remaining patients took the bigness of a nutmeg three times a day of an electuray recommended by an hospital surgeon made of garlic, mustard seed, rad. raphan., balsam of Peru and gum myrrh, using for common drink narley water well acidulated with tamarinds, by a decoction of wich, with the addition of cremor tartar, they were gently purged three or four times during the course.

The consequence was that the most sudden and visible good effects were perceived from the use of the oranges and lemons; one of those who had taken them being at the end of six days fit four duty. The spots were not indeed at that time quite off his body, nor his gums sound; but without any other medicine than a gargarism or, elixir of vitriol he became quite healthy before we came into Plymouth, which was on the 16th June. The other was the best recovered of any in his condition, and being now deemed pretty well was appointed nurse to the rest of the sick...

As I shall have occasion elsewhere to take notice of the effects of other medicines in this disease, I shall here only observe that the result of all my experiments was that oranges and lemons were the most effectual remedies for this distemper at sea. I am apt to think oranges preferable to lemons...

FIGURE 1.12 The first clinical trial. In 1753, physician James Lind reported the careful process of his clinical trial among British sailors afflicted with scurvy.

to isolate the compound we call vitamin C and show that it had antiscurvy activity. The chemical name for vitamin C, ascorbic acid, comes from its role as an antiscorbutic (antiscurvy) compound.

Modern clinical trials include several important elements: random assignment to groups, use of placebos, and the double-blind method. Subjects are assigned randomly—as by the flip of a coin—to the experimental group or the control group. Randomization potentially reduces, minimizes, or eliminates selection and volunteer bias. People in the experimental group receive the treatment or specific protocol (e.g., consuming a certain nutrient at a specific level). People in the control group do not receive the treatment but usually receive a placebo. A placebo is an imitation treatment (such as a sugar pill) that looks the same as the experimental treatment but has no effect. The placebo also is important for reducing bias because subjects do not know if they

are receiving the intervention and are less inclined to alter their responses or reported symptoms based on what they think should happen. The *expectation* that a medication will be effective can be nearly as effective as the medication itself—a phenomenon called the placebo effect. Because the placebo effect can exert a powerful influence, research studies must take it into account.

When the members of neither the experimental nor the control group know what treatment they are receiving, we say the subjects are "blinded" to the treatment. If a clinical trial is designed so neither the subjects nor the researchers collecting data are aware of the subjects' group assignments (experimental or control), the study is called a double-blind study. This reduces the possibility that researchers will see the results they want to see even if these results do not occur. In this case, another member of the research team holds the code for subject assignments and does not participate in the data collection. Double-blind, placebo-controlled clinical trials are considered the "gold standard" of nutrition studies. These studies can show clear cause-and-effect relationships but often require large numbers of subjects and are expensive and time consuming to conduct.

Key Concepts The scientific method is used to expand our nutrition knowledge. Hypotheses are formed from observations and are then tested by experiments. Epidemiological studies observe patterns in populations. Animal and cell culture studies can test the effects of various treatments. For human studies, randomized, double-blind, placebo-controlled clinical trials are the best research tools for determining cause-and-effect relationships.

From Research Study to Headline

How can you evaluate the nutrition and health headlines you see online or on television, or hear about from friends or family? Consumers often are confused by what they see as the "wishy-washiness" of scientists—for example, coffee is good, then coffee is bad. Margarine is better than butter. . . . No wait, maybe butter is better after all. These contradictions, despite the confusion they cause, show us that nutrition is truly a science: dynamic, changing, and growing with each new finding. Let's take a look at what happens (or what *should* happen) before nutrition information becomes news.

Publishing Experimental Results

Once an experiment is complete, scientists publish the results in a scientific journal to communicate new information to other people who work in that field of study. Generally, before articles are published in scientific journals, other scientists who have expert knowledge of the subject critically review them. This **peer review** greatly reduces the chance that low-quality research is published. Examples of peer-reviewed journals are the *American Journal of Clinical Nutrition* and the *Journal of the Academy of Nutrition and Dietetics.*

peer review An appraisal of research against accepted standards by professionals in the field.

From Journals to the Public

Let us examine the process by which the results of primary nutrition research reach most of us. There are usual several steps involved. Typically, secondary sources of information (e.g., scientific magazines such as *Discover* or *Scientific American*) will gather information from the primary-source journal article. This information is further translated into articles in general magazines (e.g., *Time*) and other news sources. Finally, mass-media outlets—such as various websites, nightly news broadcasts, tabloids, and social media—will present the information. By this last step in the chain of information, the original research may have become a 30-second sound bite or a "click bait" headline that fails to reflect the caveats or limitations of the original study. In some cases, the study may be distorted, with its results misstated or overstated (see **FIGURE 1.13**).

Quick Bite

Controlling the Pesky Placebo

When researchers tested the effectiveness of a medication in reducing binge eating among people with bulimia, they used a double-blind, placebo-controlled study to eliminate the placebo effect. After a baseline number of binge-eating episodes was determined, 22 women with bulimia were given the medication or a placebo. After a period of time, the number of binge-eating episodes was reassessed. The group taking the medication had a 78 percent reduction in binge-eating episodes. Sounds good, right? But the placebo group had a similar reduction of 70 percent. The placebo effect was nearly as powerful as the medication.

FIGURE 1.13 Sorting facts and fallacies. From original research to the evening news, each step along the way introduces biases as information is summarized and restated. Whether on television, radio, or the Internet, or in print, the best consumer information cites sources for reported facts.