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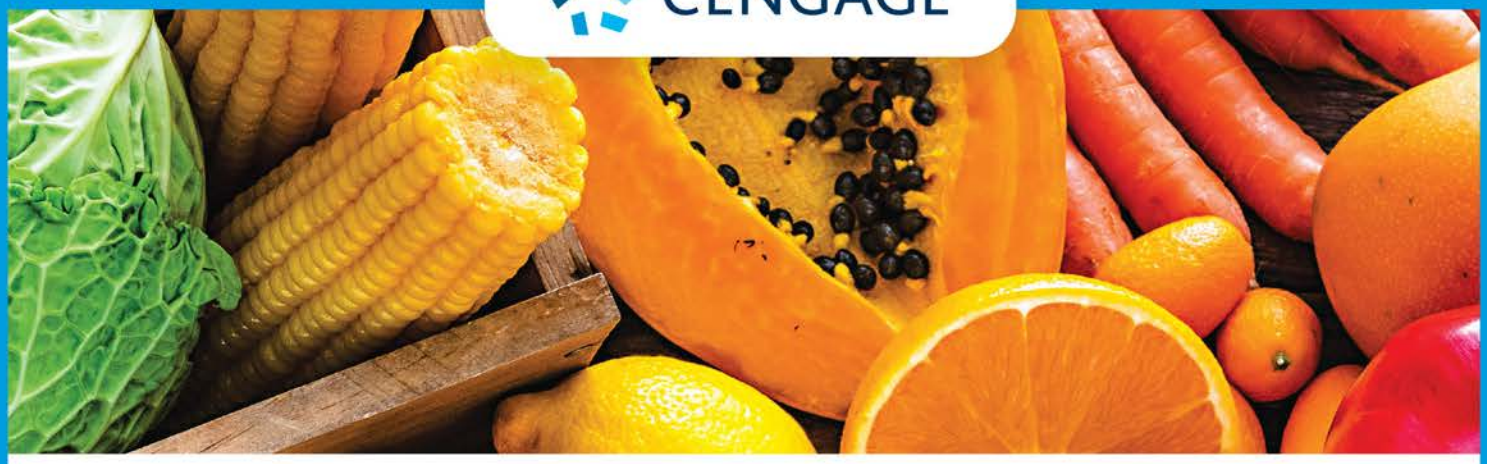

Nutrition

Concepts & Controversies 16e

Sizer | Whitney

Nutrition

Concepts & Controversies

16e

Frances Sienkiewicz Sizer | Ellie Whitney

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***Nutrition: Concepts & Controversies,* 16e**
Frances Sienkiewicz Sizer
and Ellie Whitney

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For Cara and David, my alpha and omega, and for Philip.

–Fran

Eleanor Noss Whitney

Ph.D., received her B.A. in biology from Radcliffe College in 1960 and her Ph.D. in biology from Washington University, St. Louis, in 1970. Formerly on the faculty at Florida State University and a dietitian registered with the Academy of Nutrition and Dietetics, she now devotes her time to research, writing, and consulting in nutrition, health, and environmental issues. Her earlier publications include articles in *Science*, *Genetics*, and other journals. Her textbooks include *Understanding Nutrition*, *Understanding Normal and Clinical Nutrition*, *Nutrition and Diet Therapy*, and *Essential Life Choices* for college students and *Making Life Choices* for high school students. Her most intense interests currently include energy conservation, solar energy uses, alternatively fueled vehicles, and ecosystem restoration. She is an activist who volunteers full-time for the Citizens Climate Lobby.

To Max, Zoey, Emily, Rebecca, Kalijah, and Duchess with love.

–Ellie

Brief Contents

Contents

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Chapter 5

The Lipids: Fats, Oils, Phospholipids, and Sterols 140

paulista/Shutterstock.com

Chapter 6

The Proteins and Amino Acids 178

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Chapter 15

Hunger and the Future of Food 562

Preface

A billboard in Louisiana reads, "Come as you are. Leave different," meaning that once you've seen, smelled, tasted, and listened to Louisiana, you'll never be the same. This book extends the same invitation to its readers: come to nutrition science as you are, with all of the knowledge and enthusiasm you possess, with all of your unanswered questions and misconceptions, and with the habits and preferences that now dictate what you eat.

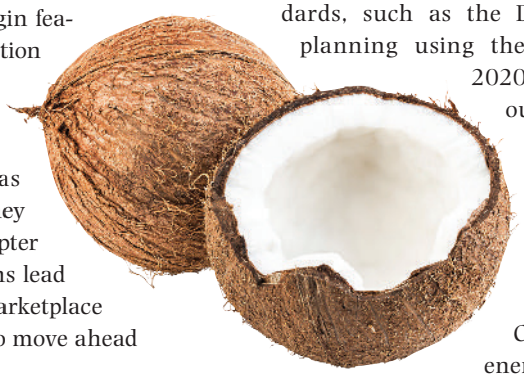
But leave different. Take with you from this study a more complete understanding of nutrition science. Take a greater ability to discern between nutrition truth and fiction, to ask sophisticated questions, and to find the answers. Finally, take with you a better sense of how to feed yourself in ways that not only please you and soothe your spirit but nourish your body as well.

For almost half a century, *Nutrition: Concepts and Controversies* has been a cornerstone of nutrition classes across North America, serving the needs of students and professors. In keeping with our tradition, in this, our 16th edition, we continue exploring the ever-changing frontier of nutrition science, confronting its mysteries through its scientific roots. We not only embrace the power of electronic media in education, but we also maintain our sense of personal connection with instructors and learners, writing for them in the clear, informal style that has always been our trademark.

Pedagogical Features

Throughout these chapters, features tickle the reader's interest and inform. For both verbal and visual learners, our logical presentation and our lively figures keep interest high and understanding at a peak. The photos that adorn many of our pages add pleasure to reading.

Many tried-and-true features return in this edition: Each chapter begins with What Do You Think? questions to pique interest. What Did You Decide? at the chapter's end asks readers to draw conclusions. A list of Learning Objectives (LO) offers a preview of the chapter's major goals, and the LO reappear under section headings to make clear the main take-away messages. Do the Math margin features challenge readers to solve nutrition problems, with examples provided. Think Fitness reminders alert readers to links among nutrition, fitness, and health. Food Feature sections act as bridges between theory and practice; they are practical applications of the chapter concepts. The Consumer's Guide sections lead readers through an often bewildering marketplace with scientific clarity, preparing them to move ahead with sound marketplace decisions. Each Consumer's Guide ends with review questions to improve recall of its main points.



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By popular demand, we have retained our Snapshots of vitamins and minerals. These concentrated capsules of information depict food sources of vitamins and minerals, present DRI values, and offer the chief functions of each nutrient along with deficiency and toxicity symptoms.

New or major terms are defined in the margins of chapter pages or in nearby tables, and they also appear in the Glossary at the end of the book. Terms defined in margins are printed in **blue** boldface type; terms in tables are in **black**. Readers who wish to locate any term can quickly do so by consulting the Index, which lists the page numbers of definitions in boldface type. Each chapter closes with an indispensible Self Check that provides study questions, with answers in Appendix G to provide immediate feedback to the learner.

Controversies

The Controversies of this book's title invite you to explore beyond the safe boundaries of established nutrition knowledge. These optional readings, which appear at the end of each chapter, delve into current research themes and ongoing debates among nutrition scientists. These fast-changing topics capture interest and demonstrate how scientific investigations both build nutrition knowledge and challenge it.

Chapter Contents

Chapter 1 begins the text with a personal challenge to students. It asks the question so many people ask of nutrition educators—"Why should people care about nutrition?" We answer with a lesson in the ways in which nutritious foods affect diseases, and present a continuum of diseases from purely genetic in origin to those almost totally preventable by nutrition. After presenting some beginning facts about genes, nutrients, bioactive food components, and motivations that drive people's food choices, the chapter concludes with a discussion of scientific research and quackery.

Chapter 2 brings together the concepts of nutrient standards, such as the Dietary Reference Intakes, and diet planning using the Dietary Guidelines for Americans 2020–2025. Chapter 3 presents a thorough, but brief, introduction to the workings of the human body from the genes to the organs, with major emphasis on the digestive system and its microbiota. It ends with a discussion of alcohol consumption and its effects on body systems. Chapters 4 through 6 are devoted to the energy-yielding nutrients: carbohydrates,

lipids, and protein. Controversy 4 turns its focus to theories and fables surrounding the health effects of added sugars in the diet. Controversy 5 considers the scientific underpinnings of lipid guidelines.

Chapters 7 and 8 present the vitamins, minerals, and water. Chapter 9 relates energy balance to body composition, obesity, and underweight and provides guidance on lifelong weight maintenance. Chapter 10 describes relationships among physical activity, athletic performance, and nutrition, with some guidance about products marketed to athletes. Chapter 11 applies the essence of the first 10 chapters to chronic disease development and prevention. The chapter also points out the critical roles of nutrition in maintaining the body's immune defenses, and ends by explaining potential harms that can arise when nutrients interact with medical drugs

Chapter 12 delivers urgently important concepts of food safety and ends with practical pointers for applying them in real-life situations. It also addresses the usefulness and safety of food additives, including low-calorie and artificial sweeteners. Chapters 13 and 14 emphasize the importance of nutrition through the life span. Chapter 13 focuses on the critical roles of nutrition during pregnancy and infancy, while Chapter 14 includes nutrition advice for feeding preschoolers, schoolchildren, teens, and the elderly.

Chapter 15 devotes attention to hunger and malnutrition, both in the United States and worldwide. It also touches on the vast network of problems that threaten our future food supply, and explores potential paths to solutions.

Our Message to You

Our purpose in writing this text, as always, is to enhance our readers' understanding of nutrition science. We also hope the information on this book's pages will reach beyond the classroom into our readers' lives. Take the information you find inside this book home with you. Use it in your life: nourish yourself, educate your loved ones, and nurture the health of others. Stay up with the news, too—for despite all the conflicting messages, inflated claims, and even quackery that abound in the marketplace, true nutrition knowledge progresses with a genuine scientific spirit, and important new truths are constantly unfolding.

New to This Edition

Every section of each chapter of this text reflects advances in nutrition science occurring since the last edition. The changes range from subtle shifts of emphasis to entirely new sections that demand our attention. Appendix F supplies current references; older references may be viewed in previous editions, available from the publisher.

Notable Changes to the 16th edition

In addition to updated text material throughout, the following changes are notable.

Chapter 1
- Updated to Healthy People 2030.
- New section evaluating the reliability of research.

Chapter 2
- Introduced, defined, and discussed Chronic Disease Risk Reduction (CDRR).
- All text and figures updated to reflect the 2020–2025 Dietary Guidelines for Americans and food groups.
- Updated labeling figure and discussion.
- Reorganized and updated phytochemical Controversy.

Chapter 3
- Defined inflammation.
- Removed choking figure.
- New table of alcohol statistics.

Chapter 4
- New section and figure explaining glycemic response.
- New table of top U.S. sources of added sugars.

Chapter 5
- Improved figure of bile action.
- New figure of U.S. saturated fat sources.
- Explained fully hydrogenated versus partially hydrogenated fats.
- Expanded the Controversy discussion of arguments surrounding lipid guidelines.

Chapter 6
- Improved complementary protein figure.
- New figure comparing protein values on cereal labels.
- New emphasis on plant-based foods and diets.

Chapters 7 and 8
- New figure of valid quality testing symbols.
- Water safety information moved to Chapter 12.
- Sodium CDRR update.
- New discussion and table of plant-based calcium sources.

Chapter 9
- New obesity maps data.
- Expanded Do the Math activity.
- New "keto" and "paleo" diet discussions.
- New table of adverse effects of ketogenic diets.
- Moved prescription drug table to instructor's materials.
- New discussions and table of motivational interviewing and mindful eating.

Chapter 10
- Updated content and definitions to reflect the Physical Activity Guidelines for Americans, second edition.
- New figure of physical activity guidelines for adults.
- Discussion of lactate as fuel.
- Expanded Do the Math activity.
- Improved pregame meal figure.
- Added nitrate section to Controversy.

Chapter 11

- Added information about COVID-19 and ranking among leading causes of death.
- Revised and simplified table of chronic disease risk factors.
- New Consumer's Guide, Nutrition and the Immune System.
- Introduced the American Heart Association's "My Life Check" and Life's Simple 7.
- Reflects the latest information from the World Cancer Research Fund and the American Institute for Cancer Research.
- Controversy update: Nutrient-Drug Interactions: Who Should Be Concerned?

Chapter 12

- Expanded coverage of the Food Safety and Modernization Act.
- Reorganized safe food temperature and thermometer figures.
- New section, Water Safety and Sources.
- Table of contaminants in foods moved to instructors' materials.
- New genetically engineered U.S. crop data.
- New figure of USDA bioengineering food labels.

Chapter 13

- New table of food and nutrient strategies to promote healthy pregnancy outcomes.
- Included new information about preeclampsia.
- Added a brief discussion of COVID-19 and breastfeeding.
- New table of key recommendations for infants and toddlers from the 2020–2025 Dietary Guidelines.
- Introduced and defined baby-led weaning.
- Added a brief discussion of possible heavy-metal contamination of some infant and toddler foods.
- Controversy update: Nutritional genomics.

Chapter 14

- New figure of U.S. diet quality through the lifespan.
- Updated childhood and older adult resources and recommendations in agreement with the 2020–2025 Dietary Guidelines.
- New discussion and table of beverage suggestions for children.
- New Consumer's Guide on acne and nutrition.
- New table of key activity guidelines for older adults.
- New table of fluid strategies for older adults.
- Aging and telomere length discussion, with new table of factors associated with telomere length.
- Controversy update: Childhood obesity and early chronic diseases.

Chapter 15

- Updated U.S. and world food security discussions, statistics, and figures.
- New section addressing links between poverty, obesity, and chronic disease.
- New figure on how poverty fosters malnutrition and obesity.
- New figure on the environmental costs of producing food.
- New figure depicting the ecological footprints of countries.
- New figure of greenhouse gas emissions associated with dietary protein sources.

Ancillary Materials

Students and instructors alike will appreciate the innovative teaching and learning materials that accompany this text.

MindTap: MindTap for Sizer/Whitney, *Nutrition: Concepts & Controversies*, 16e, today's most innovative online learning platform, powers your students from memorization to mastery. MindTap gives you complete control of your course to provide engaging content, challenge every individual and build students' confidence.

Instructor Companion Site: Everything you need for your course in one place! This collection of product-specific lecture and class tools is available online via www.cengage.com/login. Access and download PowerPoint presentations, images, instructors' manual, and more.

Test Bank with Cognero: Cengage Testing, powered by Cognero® is a flexible, online system that allows you to import, edit, and manipulate content from the text's test bank or elsewhere, including your own favorite test questions; create multiple test versions in an instant; and deliver tests from your LMS, your classroom, or wherever you want.

Diet & Wellness Plus: Diet & Wellness Plus helps you understand how nutrition relates to your personal health goals. Track your diet and activity, generate reports, and analyze the nutritional value of the food you eat. Diet & Wellness Plus includes over 75,000 foods as well as custom food and recipe features. Diet & Wellness Plus is also available as an app that can be accessed from the app dock in MindTap.

Acknowledgments

Our thanks to our partners Linda Kelly DeBruyne and Sharon Rady Rolfes for decades of support. Thank you, Lauren Fleischer, for your excellent graphic and photo review work.

We are also grateful to Linda DeBruyne, M.S., R.D.N. for her work in Chapters 11 and 13. Linda received her master's degree in nutrition from Florida State University and is a founding member of Nutrition and Health Associates. She also coauthors the college nutrition texts *Nutrition and Diet Therapy* and *Nutrition for Health and Health Care*.

Our special thanks to our publishing team—Courtney Heilman, Lori Hazzard, and Samantha Rundle—for their superb work and dedication to excellence.

Reviewers of Recent Editions

As always, we are grateful for the instructors who so carefully reviewed our work in this revision. Your suggestions were invaluable in strengthening the book and suggesting new lines of thought. We hope you will continue to provide your comments and suggestions.

Jill Tarver, *Santa Rosa Junior College*
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Glenda Johnson, *Southern University and A&M College*

1 Food Choices and Human Health

Controversy 1 Sorting Impostors from Real Nutrition Experts

Learning Objectives

After reading this chapter, you should be able to accomplish the following:

- **LO 1.1** Describe the ways in which food choices impact a person's health.
- **LO 1.2** Describe the relationship between nutrition and genetics with regard to disease development.
- **LO 1.3** Name the six classes of nutrients.
- **LO 1.4** Give examples of challenges and solutions people face in choosing a health-promoting diet.
- **LO 1.5** Describe the science of nutrition.
- **LO 1.6** Describe the characteristics of the six stages of behavior change.
- **LO 1.7** Explain how the concept of nutrient density can facilitate diet planning.
- **LO 1.8** Evaluate the authenticity of any given nutrition information source.

What do you think?

- Can your diet make a real difference between getting **sick** or staying **healthy**?
- What makes your favorite foods your **favorites**?
- Are **supplements** more powerful than food for ensuring good nutrition?
- Are **news and media nutrition reports** informative or confusing?

If you care about your body, and if you have strong feelings about **food**, then you have much to gain from learning about **nutrition**—the science of how food nourishes the body. Nutrition is a fascinating, much-talked-about subject. Each day, newspapers, websites, radio, and television present stories of new findings on nutrition and heart health or cancer prevention, and at the same time, advertisements and commercials bombard us with multicolored pictures of tempting foods—pizza, burgers, soft drinks, and chips. If you are like most people, when you eat you sometimes wonder, "Is this food good for me?" or you berate yourself, "I probably shouldn't be eating this."

When you study nutrition, you learn which foods serve you best, and you can work out ways of choosing foods, planning meals, and designing your **diet** wisely. Knowing the facts can enhance your health and your enjoyment of eating while relieving your feelings of guilt or worry that you aren't eating well.

This chapter addresses these "why," "what," and "how" questions about nutrition:

- *Why* care about nutrition? Why be concerned about the **nutrients** in your foods? Why not just take supplements?
- *What* are the nutrients in foods, and what roles do they play in the body? What are the differences between vitamins and minerals?
- *What* constitutes a nutritious diet? What factors motivate your food and beverage choices?
- *How* do we know what we know about nutrition? How does nutrition science work, and how can a person keep up with changing information?

Controversy 1 concludes the chapter by offering ways to distinguish between trustworthy sources of nutrition information and those that are less reliable.

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When you choose foods with nutrition in mind, you choose in favor of your health.

A Lifetime of Nourishment

LO 1.1 Describe the ways in which food choices impact a person's health.

If you live for 65 years or longer, you will have consumed more than 70,000 meals, and your remarkable body will have disposed of 50 tons of food. The foods you choose exert cumulative effects on your body.[1*] As you age, you will see and feel those effects—if you know what to look for.

Your body renews its structures continuously. Each day, it builds a little muscle, bone, skin, and blood, replacing old tissues with new. It may also add a little fat if you consume excess food energy (calories) or subtract a little if you consume less than you require. Some of the food you eat today becomes part of "you" tomorrow.

The best food for you, then, is the kind that supports the growth and maintenance of strong muscles, sound bones, healthy skin, and sufficient blood to cleanse and nourish all parts of your body. This means you need food that provides not only the right

food scientifically, materials, usually of plant or animal origin, that contain essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals, and that are ingested and assimilated by an organism to produce energy, stimulate growth, and maintain life; socially, a more limited number of such materials defined as acceptable by a culture.

nutrition the study of the nutrients in foods and in the body; sometimes also the study of human behaviors related to food.

diet the foods (including beverages) a person usually eats and drinks.

nutrients components of food that are indispensable to the body's functioning. They provide energy, serve as building material, help maintain or repair body parts, and support growth. The nutrients include water, carbohydrate, fat, protein, vitamins, and minerals.

*Reference notes are in Appendix F.

Table 1–1

Leading Causes of Death Linked with Diet and Alcohol

In 2020, the infectious disease COVID-19 ranked third among causes of U.S. deaths, behind heart disease and cancers.

	Percentage of Total Deaths
■ Heart disease	20.5
■ Cancers	17.8
■ Accidents	5.5
■ Strokes	5.2
■ Diabetes	3.0

amount of energy but also sufficient nutrients—that is, enough water, carbohydrates, fats, protein, vitamins, and minerals. If the foods you eat provide too little or too much of any nutrient today, your health may suffer just a little today. If the foods you eat provide too little or too much of one or more nutrients every day for years, then in later life you may suffer severe disease effects.

A well-chosen diet supplies enough energy and enough of each nutrient to prevent **malnutrition**. Malnutrition includes deficiencies, imbalances, and excesses of nutrients, alone or in combination, any of which can take a toll on health over time.

Key Points

- The nutrients in food support growth, maintenance, and repair of the body.
- Deficiencies, excesses, and imbalances of energy and nutrients bring on the diseases of malnutrition.

The Diet–Health Connection

Your choice of diet profoundly affects your health, both today and in the future. Among the common lifestyle habits that alter people's development of serious diseases, only two are more influential than food habits: smoking and using other forms of tobacco and drinking alcohol in excess. Of the leading causes of death listed in Table 1–1, four—heart disease, cancers, strokes, and diabetes—are directly related to nutrition, and another—accidents—is related to drinking alcohol.

Many people suffer from debilitating conditions that could have been largely prevented had they applied the nutrition principles known today.[2] The major **chronic diseases**—heart disease, some kinds of cancer, strokes, and diabetes, along with dental disease, and adult bone loss—all have a connection to poor diet. These diseases cannot be prevented by a good diet alone; they are to some extent determined by a person's genetic constitution, activities, and lifestyle. Within the range set by your genetic inheritance, however, the likelihood of developing these diseases is strongly influenced by your daily choices.

Key Point

- Nutrition profoundly affects health.

Other Lifestyle Choices

Besides food choices, what other lifestyle choices affect people's health? Tobacco use and alcohol and other substance abuse can destroy health. Physical activity, sleep, emotional stress, and other environmental factors can also modify the severity of some diseases. Physical activity is so closely linked with nutrition in supporting health that most chapters of this book offer a feature called Think Fitness, such as the one near here.

Much of this text centers on the nutrients at the core of nutrition science. As your course of study progresses, the individual nutrients will become like old friends, revealing more and more about themselves as you move through the chapters.

malnutrition any condition caused by excess or deficient food energy or nutrient intake or by an imbalance of nutrients. Nutrient or energy deficiencies are forms of undernutrition; nutrient or energy excesses are forms of overnutrition.

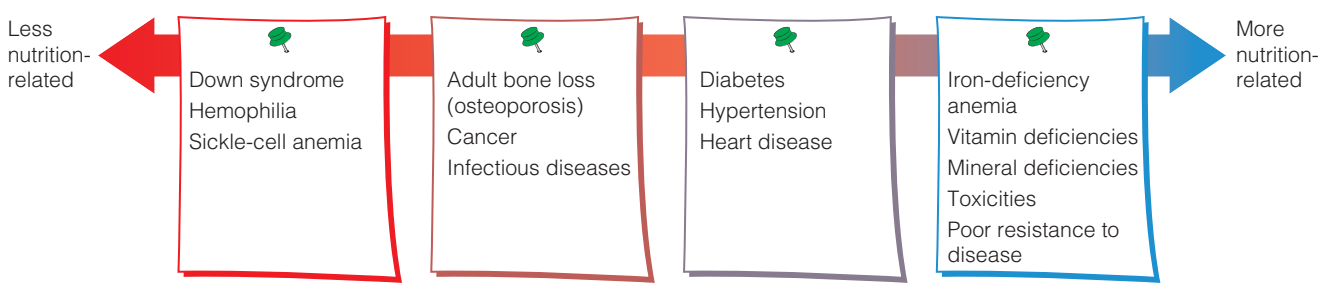
chronic diseases degenerative conditions or illnesses that progress slowly are long in duration, and lack an immediate cure. Chronic diseases limit functioning, productivity, and the quality and length of life. Examples include heart disease, cancer, and diabetes.

anemia a blood condition in which red blood cells, the body's oxygen carriers, are inadequate or impaired and so cannot meet the oxygen demands of the body.

Figure 1–1

Nutrition and Disease

Not all diseases are equally influenced by diet. Some, such as sickle-cell anemia, are almost purely genetic. Some, such as diabetes, may be inherited (or the tendency to develop them may be inherited in the genes) but may be influenced by diet. Some, such as vitamin-deficiency diseases, are purely dietary.



Key Point

- Life choices, such as being physically active or using tobacco or alcohol, can improve or damage health.

Genetics, Nutrition, and Individuality

LO 1.2 Describe the relationship between nutrition and genetics with regard to disease development.

Figure 1–1 demonstrates that genetics and nutrition affect different diseases to varying degrees. The **anemia** caused by sickle-cell disease, for example, is purely hereditary and thus appears at the left of Figure 1–1 as a genetic condition largely unrelated to nutrition. Nothing a person eats affects the person's chances of contracting this anemia, although nutrition therapy may help ease its course. At the other end of the spectrum, iron-deficiency anemia most often results from undernutrition. Diseases and conditions of poor health appear all along this continuum, from almost entirely genetically based to purely nutritional in origin; the more nutrition-related a disease or health condition is, the more successfully sound nutrition can prevent it.

Furthermore, some diseases, such as heart disease and cancer, are not one disease but many. Two people may both have heart disease but not the same form; one person's cancer may be nutrition-related, but another's may not be. Individual people differ genetically from each other in thousands of subtle ways, so no simple statement can be made about the extent to which diet can help any one person avoid such diseases or slow their progress.

The human **genome** represents the entire sequence of the **genes** in human **DNA**. In essence, it constitutes the body's instructions for making all of the working parts of a human being. The human genome is 99.9 percent the same in all people; all of the normal variations such as differences in hair color, as well as variations that result in diseases such as sickle-cell anemia, lie in the 0.1 percent of the genome that varies.

genome (GEE-nome) the full complement of genetic information in the chromosomes of a cell. In human beings, the genome consists of about 35,000 genes and supporting materials. The study of genomes is *genomics*. Also defined in Controversy 13.

genes units of a cell's inheritance; sections of the larger genetic molecule DNA (deoxyribonucleic acid). Each gene directs the making of one or more of the body's proteins.

DNA an abbreviation for deoxyribonucleic (dee-OX-ee-RYE-bow-nu-CLAY-ick) acid, the thread-like molecule that encodes genetic information in its structure; DNA strands coil up densely to form the chromosomes (Chapter 3 provides more details).

personalized nutrition an emerging science-based approach to nutrition advice that employs an individual's genetic and other information to promote diet-related behaviors that result in measurable health outcomes.

Think Fitness — Why Be Physically Active?

Why should people bother to be physically active? A person's daily food choices can powerfully affect health, but the combination of nutrition and physical activity is more powerful still. People who combine regular physical activity with a nutritious diet can expect to receive at least some of these benefits:

- Reduced risks of cardiovascular diseases, diabetes, certain cancers, hypertension, and other diseases.
- Increased endurance, strength, and flexibility.
- More cheerful outlook and less likelihood of depression.
- Improved mental functioning.
- Feeling of vigor.
- Feeling of belonging—the companionship of sports.
- Stronger self-image.
- Reduced body fat and increased lean tissue.
- A more youthful appearance, healthy skin, and improved muscle tone.
- Greater bone density and lessened risk of adult bone loss in later life.
- Increased independence in the elderly.
- Sound, beneficial sleep.
- Faster wound healing.
- Reduced menstrual distress.
- Improved resistance to infection.

If even half of these benefits were yours for the asking, wouldn't you step up to claim them? In truth, they are yours to claim, at the price of including physical activity in your day. Chapter 10 lists the Physical Activity Guidelines for Americans, which specify activity amounts needed for health.

Start now! Ready to make a change? Keep track of your physical activities—all of them—for three days. (You may choose to use pencil and paper, an internet wellness program, a cell phone application, or any other method for tracking.) After you have recorded your activities, see how much time you spent exercising at a moderate to vigorous level (described in Table H-1 of Appendix H at the back of the book). Should you increase the intensity level or amount of your activity? If so, write down some realistic ways in which you might increase your activity, and then apply them. Notice and keep track of any benefits that your new level of activity brings.

Today, scientists are working to apply this wealth of knowledge to benefit human health. New treatments for formerly untreatable conditions, including some forms of cancer, are emerging from genomics research. In the future, **personalized nutrition** may allow dietitians to take into account variations in a client's genome to more precisely meet the nutrient needs of the individual.[3] Later chapters expand on the emerging story of nutrition and the genes.

Key Points

- Diet influences long-term health within the range set by genetic inheritance.
- Nutrition exerts little influence on some diseases but strongly affects others.

The Human Body and Its Food

LO 1.3 Name the six classes of nutrients.

As your body moves and works each day, it must use **energy**. The energy that fuels the body's work comes indirectly from the sun by way of plants. Plants capture and store the sun's energy in their tissues as they grow. When you eat plant-derived foods such as fruit, grains, or vegetables, you obtain and use the solar energy they have stored. Plant-eating animals obtain their energy in the same way, so when you eat animal tissues, you are eating compounds containing energy that originally came from the sun.

The body requires six kinds of nutrients—families of molecules indispensable to its functioning—and foods deliver these. Table 1–2 lists the six classes of nutrients. Four of these are **organic**; that is, the nutrients contain the element carbon derived from living things.

Meet the Nutrients

The human body and foods are made of the same materials, arranged in different ways (see Figure 1–2). When considering quantities of foods and nutrients, scientists often measure them in **grams** or fractions of grams, units of weight.

The Energy-Yielding Nutrients Of the four organic nutrients, three are **energy-yielding nutrients**, meaning that the body can use the energy they contain. These are carbohydrate, fat, and protein, often referred to as the **macronutrients**, and they contribute to the calories you consume. Among them, protein stands out for doing double duty: it can yield energy, but it also provides materials that form

energy the capacity to do work. The energy in food is chemical energy; it can be converted to mechanical, electrical, thermal, or other forms of energy in the body. Food energy is measured in calories, defined on page 7.

organic carbon containing. Four of the six classes of nutrients are organic: carbohydrate, fat, protein, and vitamins. Organic compounds include only those made by living things and do not include compounds such as carbon dioxide, diamonds, and a few carbon salts.

grams (g) metric units of weight. About 28 grams equal an ounce. A *milligram* is one-thousandth of a gram. A *microgram* is one-millionth of a gram.

energy-yielding nutrients the nutrients the body can use for energy: carbohydrate, fat (also called *lipids*), and protein. These also may supply building blocks for body structures.

macronutrients another name for the energy-yielding nutrients: carbohydrate, fat, and protein.

Table 1–2

Elements in the Six Classes of Nutrients

The nutrients that contain carbon are organic.

	Carbon	Oxygen	Hydrogen	Nitrogen	Minerals
Carbohydrate	✓	✓	✓		
Fat	✓	✓	✓		
Protein	✓	✓	✓	✓	[b]
Vitamins	✓	✓	✓	✓[a]	[b]
Minerals					✓
Water		✓	✓		✓

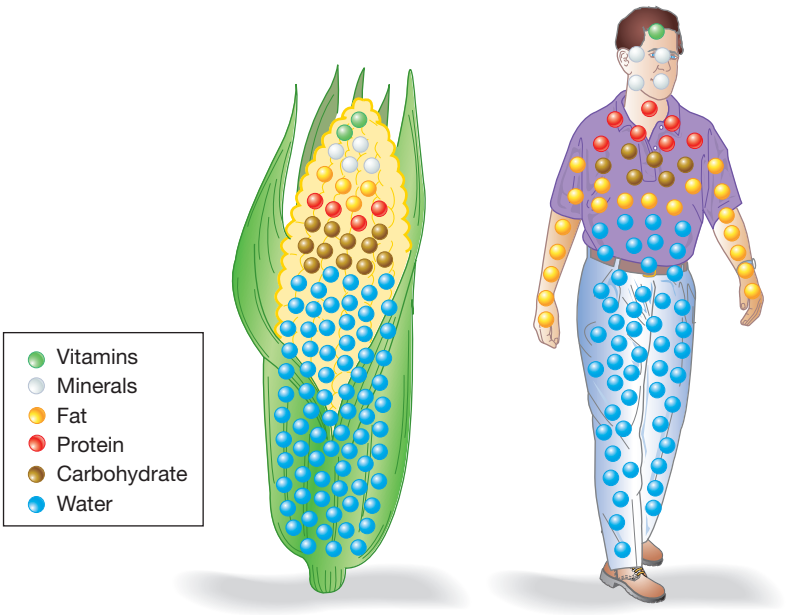
[a] *All of the B vitamins contain nitrogen;* amine *means nitrogen.*

[b] *Protein and some vitamins contain the mineral sulfur; vitamin* B_{12} *contains the mineral cobalt.*

Figure 1–2

Components of Food and the Human Body

Foods and the human body are made of the same materials.



structures and working parts of body tissues. (Alcohol yields energy, too—see Table 1–3 comments.)

Vitamins and Minerals The fourth and fifth classes of nutrients are the vitamins and the minerals, most of which are known as **micronutrients** because they are present in tiny amounts in living tissues. These provide no energy to the body. A few minerals serve as parts of body structures (calcium and phosphorus, for example, are major constituents of bone), but all vitamins and minerals act as regulators. As regulators, the vitamins and minerals assist in all body processes: digesting food; moving muscles; disposing of wastes; growing new tissues; healing wounds; obtaining energy from carbohydrate, fat, and protein; and participating in every other process necessary to maintain life. Later chapters are devoted to these six classes of nutrients.

Water Although last on the list, water is foremost in quantity among the six classes of nutrients in the body. The body constantly loses water, mainly through sweat, breath, and urine, and that water must constantly be replaced. Without sufficient water, the body's cells cannot function.

The Concept of Essential Nutrients When you eat food, then, you are providing your body with energy and nutrients. Furthermore, some of the nutrients are **essential nutrients**, meaning that if you do not ingest them, you will develop deficiencies; the body cannot make these nutrients for itself. Essential nutrients are found in all six classes of nutrients. Water is an essential nutrient; so is a form of carbohydrate; so are some lipids, some parts of protein, all of the vitamins, and the minerals important in human nutrition.

You may wonder why **fiber**, famous for its beneficial health effects, is not listed among the essential nutrients. The reason is that most fiber passes through the body unabsorbed, and omitting it from the diet does not reliably cause a specific deficiency disease. Even so, in research, health benefits often follow eating a fiber-rich diet (Chapter 4 has details).

Calorie Values Food scientists measure food energy in kilocalories, units of heat. This book uses the common word **calories** to mean the same thing. It behooves the person who wishes to control food energy intake and excess body fat to study Table 1-3

Table 1–3

Energy-Yielding Nutrients

The energy a person consumes in a day's meals comes from these three energy-yielding nutrients; alcohol, if consumed, also contributes energy at a rate of about 7 calories per gram (see note).

Energy Nutrient	Energy
Carbohydrate	4 cal/g
Fat (lipid)	9 cal/g
Protein	4 cal/g

Note: Alcohol is not classed as a nutrient because it interferes with growth, maintenance, and repair of body tissues.

micronutrients nutrients required in very small amounts: the vitamins and most minerals.

essential nutrients the nutrients the body cannot make for itself (or cannot make fast enough) from other raw materials; nutrients that must be obtained from food to prevent deficiencies.

fiber a collective term for various indigestible plant materials, many of which bear links with human health. See also Chapter 4.

calories units of energy. In nutrition science, the unit used to measure the energy in foods is a kilocalorie (also called *kcalorie* or *Calorie*): it is the amount of heat energy necessary to raise the temperature of a kilogram (a liter) of water 1 degree Celsius. This book follows the common practice of using the lowercase term *calorie* (abbreviated *cal*) to mean the same thing.

Do the Math:

Calculate calories from grams of energy nutrients.

The calories (cal) provided by a food equal the sum of its calories from carbohydrate, protein, and fat, measured in grams (g).

Reminder:

- carbohydrate = 4 cal per g
- protein = 4 cal per g
- fat = 9 cal per g

Look at any food label to find grams of these nutrients in a serving. Now, calculate the calories in a serving of the food.

1. Multiply grams of each energy nutrient by its calorie value.

   Example: 1 slice of toasted bread with 1 tablespoon of peanut butter provides 16 g carbohydrate, 7 g protein, and 9 g fat:

   16 g carbohydrate × 4 cal/g = 64 cal
   7 g protein × 4 cal/g = 28 cal
   9 g fat × 9 cal/g = 81 cal

2. Add the three calorie values:

   64 + 28 + 81 = 173 total calories

and learn the calorie values of the energy nutrients listed there. The most energy-rich of the nutrients is fat, which contains 9 calories in each gram. Carbohydrate and protein each contain only 4 calories in a gram. Weight, measure, and other conversion factors needed for the study of nutrition appear in Appendix C at the back of the book.

Scientists have worked out ways to measure the energy and nutrient contents of foods. They have also calculated the amounts of energy and nutrients various types of people need—by sex, age, life stage, and activity. Thus, after studying human nutrient requirements (in Chapter 2), you will be able to state with some accuracy just what your own body needs—this much water, that much carbohydrate, so much vitamin C, and so forth. So why not simply take pills or **dietary supplements** in place of food? Because, as it turns out, food offers more than just the six basic nutrients.

Key Points

- The energy-yielding nutrients are carbohydrate, fat (lipid), and protein.
- The regulator nutrients are vitamins and minerals.
- Foremost among the nutrients in food is water.
- Essential nutrients in the diet prevent deficiencies.
- Food energy is measured in calories; nutrient quantities are often measured in grams.

Can I Live on Just Supplements?

Nutrition science can state what nutrients human beings need to survive—at least for a time. Scientists are becoming skilled at making **elemental diets**—life-saving liquid diets of precise chemical composition for hospital patients and others who cannot eat ordinary food. These formulas, administered for days or weeks, support not only continued life but also recovery from nutrient deficiencies, infections, and wounds.

Liquid nutritional supplements, sometimes called formula diets, are essential to help sick people to survive, but they do not enable people to thrive over long periods. Even in hospitals, diet formulas do not support optimal growth and health. Lately, marketers have taken these liquid supplement formulas out of the medical setting and have advertised them heavily to healthy people of all ages as "meal replacers" or "insurance" against malnutrition. The truth is that real food is the superior source of nutrients and other food constituents needed by the body. Most healthy people who eat a nutritious diet need no dietary supplements at all.

Food Is Best Even if a person's basic nutrient needs are perfectly understood and met, concoctions of nutrients still lack something that foods provide. Hospitalized clients who are fed nutrient mixtures through a vein often improve dramatically when they can finally eat food. Something in real food is important to health—but what is it? What does food offer that cannot be provided through a needle or a tube? Science has some partial explanations, some physical and some psychological.

In the digestive tract, the stomach and intestine are dynamic, living organs, changing constantly in response to the foods they receive—even to just the sight, aroma, and taste of food. When a person is fed through a vein, the digestive organs, like unused muscles, weaken and grow smaller. The digestive organs also release hormones in response to food, and these send messages to the brain that bring the eater a feeling of satisfaction: "There, that was good. Now I'm full." Eating offers both physical and emotional comfort. Medical science now dictates that a person should be fed through a vein for as short a time as possible and that real food taken by mouth should be reintroduced as early as possible.

Complex Interactions Foods are chemically complex. In addition to their nutrients, foods contain **phytochemicals**, compounds that confer color, taste, and other characteristics to foods. Some may be **bioactive** food components that interact with metabolic processes in the body and may affect disease risks. Even an ordinary baked potato contains hundreds of different compounds. Nutrients and other food components interact with each other in the body and operate best in harmony with one another. In view of all this, it is not surprising that food gives us more than just nutrients. If it were otherwise, *that* would be surprising.

dietary supplements pills, liquids, or powders that contain purified nutrients or other ingredients (see Controversy 7).

elemental diets diets composed of purified ingredients of known chemical composition; intended to supply, to the greatest extent possible, all essential nutrients to people who cannot eat foods.

phytochemicals bioactive compounds in plant-derived foods (*phyto,* pronounced FYE-toe, means "plant").

bioactive having chemical or physical properties that affect the functions of the body tissues. See Controversy 2.

Key Points

- Nutritious food is superior to supplements for maintaining optimal health.
- Most healthy people who eat a nutritious diet do not need supplements at all.

The Challenge of Choosing Foods

LO 1.4 Give examples of challenges and solutions people face in choosing a health-promoting diet.

Well-planned meals convey pleasure and are nutritious, too, fitting your tastes, personality, family and cultural traditions, lifestyle, and budget. Given the astounding numbers and varieties available, consumers can easily lose track of what individual foods contain and how to put them together into a health-promoting diet. Figure 1-3 illustrates the contrast between whole foods and foods that are ultra-processed. A few definitions and basic guidelines can help.

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Some foods offer phytochemicals in addition to the six classes of nutrients.

An Abundance of Foods

A list of the foods available 100 years ago would be relatively short. It would consist mostly of **whole foods**—foods that have been around for a long time, such as vegetables, fruits, meats, milk, and grains (Table 1–4 defines food types, p. 10; terms in tables are in black bold type, margin definitions are in blue). These foods have been called basic, unprocessed, natural, or farm foods. By any name, these foods form the basis of a nutritious diet. On a given day, however, well over 80 percent of our population consumes too few servings of fruit and vegetables each day.[4] And when people do eat a vegetable, the one they most often choose is potatoes, usually prepared as French fries. Such choices, repeated over time, make development of chronic diseases more likely.

The terms defined in Table 1–4 reveal that all types of foods and beverages—including **fast foods, processed foods**, and **ultra-processed foods and beverages**—offer various constituents to the eater, some more health-promoting than others.[5] Often deemed the least supportive of human nutrition and health, ultra-processed foods and beverages currently make up more than half of the nation's diet.[6] You may also hear about **functional foods**, a marketing term coined to identify foods containing

Figure 1–3

Grocery Options

Whole foods are foods in their natural state. Ultra-processed foods are manufactured to taste delicious, need little preparation, and compete for shoppers' attention.

Baloncici/Shutterstock.com

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Table 1–4

Glossary of Food Types

- **enriched foods** and **fortified foods** foods to which nutrients have been added. If the starting material is a whole, basic food such as milk or whole grain, the result may be highly nutritious. If the starting material is a concentrated form of sugar or fat, the result is less nutritious.
- **fast foods** restaurant foods that are available within minutes after customers order them—traditionally, hamburgers, French fries, and milkshakes; more recently, salads and other vegetable dishes as well. These foods may or may not meet people's nutrient needs, depending on the selections provided and on the energy allowances and nutrient needs of the eaters.
- **functional foods** a marketing term for foods that contain bioactive food components believed to provide health benefits, such as reduced disease risks, beyond the benefits that their nutrients confer. However, all nutritious foods support health in some ways; Controversy 2 provides details.
- **medical foods** foods specially manufactured for use by people with medical disorders and administered on the advice of a physician.
- **natural foods** a term that has no legal definition but is often used to imply wholesomeness.
- **organic foods** understood to mean foods grown without synthetic pesticides or fertilizers. In chemistry, however, all foods are made mostly of organic (carbon-containing) compounds.
- **processed foods** foods subjected to any process, such as milling, alteration of texture, addition of additives, cooking, or others. Depending on the starting material and the process, a processed food may or may not be nutritious.
- **staple foods** foods used frequently or daily—for example, rice (in East and Southeast Asia) or potatoes (in Ireland). Many of these foods are sufficiently nutritious to provide a foundation for a healthful diet.
- **ultra-processed foods and beverages** highly palatable manufactured food and beverage products often high in industrial ingredients, such as sugars, refined starches, modified protein, hydrogenated fats, salt, and additives intended to disguise or improve undesirable sensory qualities of the final product. Additives may include colorants, flavorings, moisturizers, sweeteners, and many others. Examples of ultra-processed foods and beverages include, sugary refined breakfast cereals, candies, cookies, fried chicken nuggets, liquid nutritional supplements, potato "tots," snack chips and cakes, and soft drinks.
- **whole foods** dairy products; meats and similar foods such as fish and poultry; vegetables, including dried beans and peas; fruits; and grains. These foods are generally considered to form the basis of a nutritious diet. Also called *basic foods*.

substances, natural or added, that might lend protection against chronic diseases. The trouble with trying to single out the most health-promoting foods is that almost every naturally occurring food—even chocolate—is functional in some way with regard to human health.

The extent to which foods support good health depends on the calories, nutrients, and phytochemicals they contain. In short, to select well among foods, you need to know more than their names; you need to know the foods' inner qualities. Even more important, you need to know how to combine foods into nutritious diets. Foods are not nutritious by themselves; each is of value only insofar as it contributes to a nutritious diet. A key to wise diet planning is to make sure that the foods you eat daily, your **staple foods**, are especially nutritious.

Key Point

- Foods that form the basis of a nutritious diet are whole foods, such as ordinary dairy products; meats, fish, and poultry; vegetables and dried peas and beans; fruits; and grains.

How, Exactly, Can I Recognize a Nutritious Diet?

A nutritious diet is really a **dietary pattern**, a habitual way of choosing foods, with five characteristics. First is **adequacy**: the foods provide enough of each essential nutrient, fiber, and energy. Second is **balance**: the choices do not overemphasize one nutrient or food type at the expense of another. Third is **calorie control**: the foods provide the amount of energy you need to maintain appropriate weight—not more, not less. Fourth is **moderation**: the foods do not provide excess fat, salt, sugar, or other unwanted constituents. Fifth is **variety**: the foods chosen differ from one day to the next. In addition, to maintain a steady supply of nutrients, meals should occur with regular timing throughout the day. To recap, then, a nutritious diet is a dietary pattern that follows the A, B, C, M, V principles: Adequacy, Balance, Calorie control, Moderation, and Variety.

dietary pattern the combination of foods and beverages that constitute an individual's complete dietary intake over time; a person's usual diet. Also called *eating pattern*.

adequacy the dietary characteristic of providing all of the essential nutrients, fiber, and energy in amounts sufficient to maintain health and body weight.

balance the dietary characteristic of providing foods of a number of types in proportion to each other, such that foods rich in some nutrients do not crowd out the diet foods that are rich in other nutrients.

calorie control the dietary characteristic of controlling energy intake; a feature of a sound diet plan.

moderation the dietary characteristic of providing constituents within set limits, not to excess.

variety the dietary characteristic of providing a wide selection of foods—the opposite of monotony.

Adequacy Any nutrient could be used to demonstrate the importance of dietary adequacy. Iron provides a familiar example. It is an essential nutrient: you lose some every day, so you have to keep replacing it, and you can get it into your body only by eating foods that contain it.* If you eat too few iron-containing foods, you can develop iron-deficiency anemia. With anemia, you may feel weak, tired, cold, sad, and unenthusiastic; you may have frequent headaches; and you can do very little muscular work without disabling fatigue. Some foods are rich in iron; others are notoriously poor. If you add iron-rich foods to your diet, you soon feel more energetic. Meat, fish, poultry, and **legumes** are rich in iron, and an easy way to obtain the needed iron is to include these foods regularly.

Maks Narodenko/Shutterstock.com

Balance To appreciate the importance of dietary balance, consider a second essential nutrient, calcium. A diet lacking calcium causes poor bone development during the growing years and increases a person's susceptibility to disabling bone loss in adult life. Most foods that are rich in iron are poor in calcium. Calcium's richest food sources are dairy products, which happen to be extraordinarily poor iron sources. Clearly, to obtain enough of both iron and calcium, people have to balance their food choices among the types of foods that provide both nutrients. Balancing the whole diet to provide enough of every one of the 40-odd nutrients the body needs for health requires considerable juggling, however. As you will see in Chapter 2, food group plans ease this task by clustering rich sources of nutrients into food groups that will help you achieve both dietary adequacy and balance within a dietary pattern that meets your needs.

Calorie Control Your intake of energy (calories) should not exceed or fall short of energy needs. Named *calorie control*, this characteristic ensures that energy intakes from food balance energy expenditures required for body functions and physical activity. Eating such a diet helps control body fat content and weight. You will read about many strategies that promote this goal in Chapter 9.

Moderation Your intakes of certain food constituents such as saturated fats, added sugars and salt should be limited for your health's sake. Some people take this to mean that they must never indulge in a delicious hot-fudge sundae or a hot dog with relish, but they are misinformed: moderation, not total abstinence, is the key. A steady diet of ice cream and hot dogs might be harmful, but once a week as part of an otherwise healthful dietary pattern, these foods may have little impact; as once-a-month treats, these foods would have practically no effect at all. Moderation also means that limits are necessary, even for desirable food constituents. For example, a certain amount of fiber in foods contributes to the health of the digestive system, but too much fiber leads to nutrient losses.

Variety As for variety, nutrition scientists agree that you should not eat the same foods, even highly nutritious ones, day after day, for a number of reasons. First, a varied diet is more likely to be adequate in nutrients. Second, some less-well-known nutrients and phytochemicals could be important to health, and some foods may be better sources of these than others. Third, a monotonous diet may deliver large amounts of toxins or contaminants. Such undesirable compounds in one food are diluted by all the other foods eaten with it and are diluted still further if the food is not eaten again for several days. Finally, variety adds interest—trying new foods can be a source of pleasure.

Variety applies to nutritious foods consumed within the context of all of the other dietary principles just discussed. Relying solely on the principle of variety to dictate food choices could easily result in a low-nutrient, high-calorie dietary pattern with a variety of nutrient-poor snack foods and sweets. If you establish the habit of using all of the principles just described, you will find that choosing a healthful diet becomes as automatic as brushing your teeth or falling asleep. Establishing the A, B, C, M, V habit may take some effort, but the payoff in terms of improved health is overwhelming

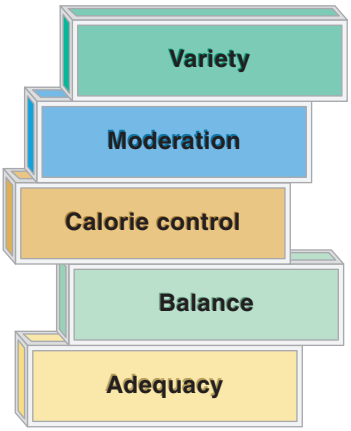
legumes (leg-GOOMS, LEG-yooms) beans, peas, and lentils, valued as inexpensive food sources of protein, vitamins, minerals, and fiber that contribute little fat to the diet. Also defined in Chapter 6.

*A person can also take supplements of iron, but as later discussions demonstrate, eating iron-rich foods is preferable.

Figure 1–4

Components of a Nutritious Diet

All of these factors help to build a nutritious diet:



(Figure 1-4 sums up these principles). Table 1–5 takes an honest look at some common excuses for *not* eating well.

Key Point

- A well-planned diet is adequate, balanced, moderate in energy, and moderate in unwanted constituents and offers a variety of nutritious foods.

Why People Choose Foods

Eating is an intentional act. Each day, people choose from the available foods, prepare the foods, and decide where to eat, which customs to follow, and with whom to dine. Many factors influence food-related choices.

Cultural and Social Meanings Attached to Food Like wearing traditional clothing or speaking a native language, enjoying traditional **cuisines** and **foodways** can be a celebration of your own or a friend's heritage. Sharing **ethnic foods** can be symbolic: people offering foods are expressing a willingness to share cherished values with others. People accepting those foods are symbolically accepting not only the person doing the offering but also the person's culture. Developing **cultural competence** is particularly important for professionals who help others to achieve a nutritious diet.[7]

Cultural traditions regarding food are not inflexible; they keep evolving as people move about, learn about new foods, and teach each other. Today, some people are ceasing to be **omnivorous** and are becoming **vegetarians**. Vegetarians often choose this lifestyle because they honor the lives of animals or because they have discovered the health and other advantages associated with dietary patterns rich in beans, whole grains, fruit, nuts, and vegetables. Controversy 6 explores the strengths and weaknesses of both vegetarians' and meat eaters' diets.

Factors that Drive Food Choices Taste prevails as the number-one factor driving people's food choices, with price following closely behind.[8] Consumers also value convenience so highly that they are willing to spend almost half of their food budgets on meals prepared outside the home.

Fewer people are learning the skills needed to prepare nutritious meals at home. Instead, they frequently eat out, bring home ready-to-eat meals, or have food delivered. When they do cook, they want to prepare meals in 15 to 20 minutes, using only a few ingredients. Such convenience incurs a cost in terms of nutrition, however: eating away from home reduces intakes of fruit, vegetables, milk, and whole grains. It also increases intakes of calories, saturated fat, sodium, and added sugars. Convenience doesn't have to mean that nutrition flies out the window, however. This chapter's Food Feature (p. 20) explores the trade-offs of time, money, and nutrition that many busy people face today.

cuisines styles of cooking.

foodways the sum of a culture's habits, customs, beliefs, and preferences concerning food.

ethnic foods foods associated with particular cultural subgroups within a population.

cultural competence having an awareness and acceptance of one's own and others' cultures and abilities, leading to effective interactions with all kinds of people.

omnivorous people who eat foods of both plant and animal origin, including animal flesh.

vegetarians people who exclude from their diets animal flesh and possibly other animal products such as milk, cheese, and eggs.

Table 1–5

What's Today's Excuse for Not Eating Well?

If you find yourself saying, "I know I should eat well, but I'm too busy" (or too fond of fast food, or have too little money, or a dozen other excuses), take note:

- *No time to cook.* Everyone is busy. Convenience packages of fresh or frozen vegetables, jars of pasta sauce, and prepared meats and salads make nutritious meals in little time.
- *Not a high priority.* Priorities change drastically and instantly when illness strikes—better to spend a little effort now nourishing your body's defenses than to spend enormous resources later fighting illnesses.
- *Crave fast food and sweets.* Occasional fast-food meals and sweets in moderation are acceptable in a nutritious diet.
- *Too little money.* Eating right might cost a little more than eating poorly, but the cost of coping with a chronic illness is unimaginably high.
- *Take vitamins instead.* Vitamin pills or even advertised "nutritional drinks" cannot make up for consistently poor food choices.

Source: D. P. Reidlinger, T. A. Sanders, and L. M. Goff, How expensive is a cardioprotective diet? Analysis from the CRESSIDA study, Public Health Nutrition *(2017), epub ahead of print, doi: 10.1017/S1368980016003529.*

Many other factors—psychological, physical, social, and philosophical—also influence people's food choices. College students, for instance, often choose to eat at restaurants to socialize, to get out, to save time, or to date; they are not always conscious of their bodies' needs for nutritious food. A list of other factors follows:

- *Advertising*. The media have persuaded you to consume these foods.
- *Availability*. They are present in the environment and accessible to you.
- *Cost*. They are within your financial means.[9]
- *Emotional comfort*. They can bring joy, or they can make you feel better for a while.
- *Habit*. They are familiar; you always eat them.
- *Personal preference and genetic inheritance*. You like the way these foods taste.
- *Positive or negative associations*. *Positive:* They are eaten by people you admire, or they indicate status, or they remind you of fun. *Negative*: They were forced on you, or you became ill while eating them.
- *Region of the country*. They are foods favored in your area.
- *Social norms*. Your companions or social media friends are eating them, or they are offered and you feel you cannot refuse them.[10]
- *Values or beliefs*. They fit your religious or cultural traditions, square with your political views, or honor an environmental ethic (see Chapter 15).
- *Weight*. You think they will help control body weight.


Kzenon/Shutterstock.com

Sharing traditional food is a way of sharing culture.

One other factor affects food choices:

- *Nutrition and health benefits*. You think they are good for you.[11]

The next section addresses one of the "how" questions posed earlier in this chapter: How do we know what we know about nutrition?

Key Points

- Cultural traditions and social values often revolve around foodways.
- Many factors other than nutrition drive food choices.

The Science of Nutrition

LO 1.5 Describe the science of nutrition.

Understanding nutrition depends on a firm base of scientific knowledge. This section describes the nature of such knowledge.

Unlike sciences such as astronomy and physics, nutrition is a relatively young science. Most nutrition research has been conducted since 1900. The first vitamin was identified in 1897, and the first protein structure was not fully described until the mid-1940s. Because nutrition science is an active, changing, growing body of knowledge, new findings often seem to contradict one another or are subject to conflicting interpretations. Bewildered consumers complain in frustration, "Those scientists don't know anything. If they don't know what's true, how am I supposed to know?"

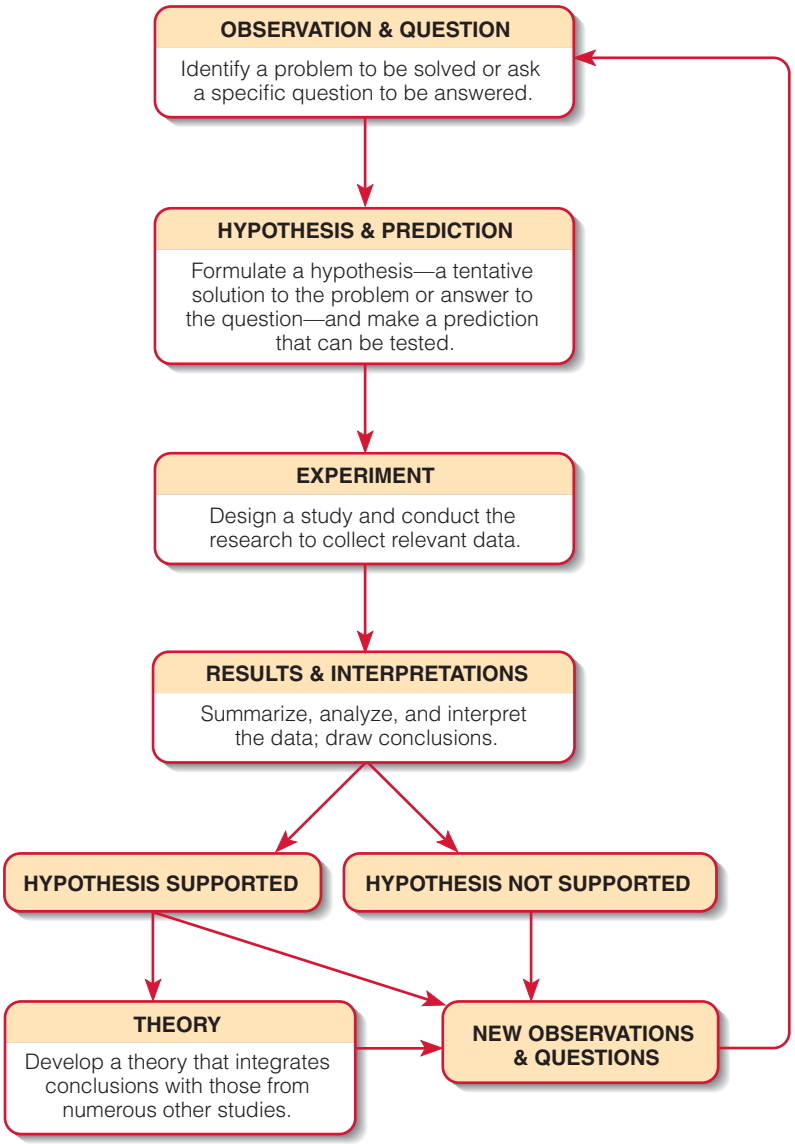
Yet experimenters have confirmed many nutrition facts with great certainty through repeated testing. To understand why apparent contradictions exist, we need to look first at what scientists do.

The Scientific Approach

In truth, it is a scientist's business not to know. Scientists obtain facts by systematically asking honest, objective questions—that's their job. Following the scientific method (outlined in Figure 1–5, p. 14), researchers attempt to answer scientific questions.

Figure 1–5
The Scientific Method

Research scientists follow the scientific method. Note that most research projects result in new questions, not final answers. Thus, research continues in a somewhat cyclical manner.



They design and conduct various experiments to test for possible answers (see Figure 1–6, and Table 1–6 on p. 16). When they have ruled out some possibilities and found evidence for others, they submit their findings not to the news media but to boards of reviewers composed of other scientists who try to pick apart the findings and may call for further evidence before approving publication. Finally, the work is published in scientific journals where still more scientists can read it. Then the news reporters read it and write about it, and the public can read about it, too. In time, other scientists replicate the experiments and report their own findings, which either support or refute earlier conclusions.

Key Points

- Nutrition is a young and fast-growing science.
- Scientists ask questions and then design research experiments to test possible answers.
- Researchers follow the scientific method and apply it to various research study designs.

Scientific Challenge

An important truth in science is that one experiment does not "prove" or "disprove" anything. When a finding has stood up to rigorous repeated testing in several kinds of experiments performed by several different researchers, it is finally considered confirmed. Even then, strictly speaking, science consists not of facts that are set in stone but of *theories* that can always be challenged and revised. Some findings, though, such as the theory that the earth revolves about the sun, are so well supported by observations and experimental findings that they are generally accepted as facts. What we "know" in nutrition is confirmed in the same way—through years of replicating study findings. This slow path of repeated studies stands in sharp contrast to the media's desire for today's latest news.

To repeat: the only source of valid nutrition information is slow, painstaking, well-designed, unbiased, repeatable scientific research. We believe a nutrition fact to be true because it has been supported, time and again, in experiments designed to rule out all other possibilities. For example, we know that eyesight depends partly on vitamin A because:

- In case studies, individuals with blindness report having consumed a steady diet devoid of vitamin A; and
- In epidemiological studies, populations with diets lacking in vitamin A are observed to suffer high rates of blindness; and
- In intervention studies (**controlled clinical trials**), vitamin A–rich foods provided to groups of people with vitamin A deficiency reduce their blindness rates dramatically; and
- In laboratory studies, animals deprived of vitamin A and only that vitamin begin to go blind; when it is restored soon enough in the diet, their eyesight returns; and

Figure 1–6

Examples of Research Design

The type of study chosen for research depends on what sort of information the researchers require. Studies of individuals (**case studies**) yield observations that may lead to possible avenues of research. A study of a man who ate gumdrops and became a famous dancer might suggest that an experiment be done to see if gumdrops contain dance-enhancing power.

Studies of whole populations (**epidemiological studies**) provide another sort of information. Such a study can reveal a **correlation**. For example, an epidemiological study might find no worldwide correlation of gumdrop eating with fancy footwork but, unexpectedly, might reveal a correlation with tooth decay.

Studies in which researchers actively intervene to alter people's eating habits (**intervention studies**) go a step further. In such a study, one set of subjects (the **experimental group**) receives a treatment, and another set (the **control group**) goes untreated or receives a **placebo** or sham treatment. If the study is a **blind experiment**, the subjects do not know who among the members receives the treatment and who receives the sham. If the two groups experience different effects, then the treatment's effect can be pinpointed. For example, an intervention study might show that withholding gumdrops, together with other candies and confections, reduced the incidence of tooth decay in an experimental population compared to that in a control population.

Laboratory studies can pinpoint the mechanisms by which nutrition acts. What is it about gumdrops that contributes to tooth decay: their size, shape, temperature, color, ingredients? Feeding various forms of gumdrops to rats might yield the information that sugar, in a gummy carrier, promotes tooth decay. In the laboratory, using animals or plants or cells, scientists can inoculate with diseases, induce deficiencies, and experiment with variations on treatments to obtain in-depth knowledge of the process under study. Intervention studies and laboratory experiments are among the most powerful tools in nutrition research because they show the effects of treatments.

Case Study

Bob Daemmrich/Alamy Stock Photo

"This person eats too little of nutrient X and has illness Y."

Epidemiological Study

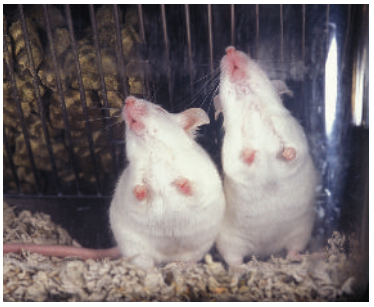
"This country's food supply contains more nutrient X, and these people suffer less illness Y."

Intervention Study

bokan/Shutterstock.com

"Let's add foods containing nutrient X to some people's food supply and compare their rates of illness Y with the rates of others who don't receive the nutrient."

Laboratory Study



Leslie Newman & Andrew Flowers/Science Source

"Now let's see if a nutrient X deficiency causes illness Y by inducing a deficiency in these rats."

- Further laboratory studies elucidate the molecular mechanisms for vitamin A activity in eye tissues; and
- Replication of these studies yields the same results.
- Later, a **meta-analysis** of previous studies also detects the effect.

Now we can say with certainty, "Eyesight depends on sufficient vitamin A."

Key Points

- Single studies must be replicated before their findings can be considered valid.
- A theory is strengthened when results from follow-up studies with a variety of research designs support it.

Table 1–6

Research Design Terms

- **blind experiment** an experiment in which the subjects do not know whether they are members of the experimental group or the control group. In a *double-blind experiment*, neither the subjects nor the researchers know to which group the members belong until the end of the experiment.
- **case study** a study of a single individual. When in clinical settings, researchers can observe treatments and their apparent effects. To prove that a treatment has produced an effect requires simultaneous observation of an untreated similar subject (a *case control*).
- **control group** a group of individuals who are similar in all possible respects to the group being treated in an experiment but who receive a sham treatment instead of the real one. Also called *control subjects.*
- **controlled clinical trial** an experiment in which one group of subjects (the **experimental group**) receives a treatment and a comparable group (the **control group**) receives an imitation treatment and outcomes for the two are compared. Ideally, neither subjects nor researchers know who receives the treatment and who gets the placebo (a double-blind study).
- **meta-analysis** a computer-driven statistical summary of evidence gathered from multiple previous studies.
- **correlation** the simultaneous change of two factors, such as the increase of weight with increasing height (a *direct* or *positive* correlation) or the decrease of cancer incidence with increasing fiber intake (an *inverse* or *negative* correlation). A correlation between two factors suggests that one may cause the other but does not rule out the possibility that both may be caused by chance or by a third factor.
- **epidemiological studies** studies of populations; often used in nutrition to search for correlations between dietary habits and disease incidence; a first step in seeking nutrition-related causes of diseases.
- **experimental group** the people or animals participating in an experiment who receive the treatment under investigation. Also called *experimental subjects.*
- **intervention studies** studies of populations in which observation is accompanied by experimental manipulation of some population members—for example, a study in which half of the subjects (the *experimental subjects*) follow diet advice to reduce fat intakes, while the other half (the *control subjects*) do not, and both groups' heart health is monitored.
- **laboratory studies** studies that are performed under tightly controlled conditions and are designed to pinpoint causes and effects. Such studies often use animals as subjects.
- **placebo** a sham treatment often used in scientific studies; an inert, harmless medication. The *placebo effect* is the healing effect that the act of treatment, rather than the treatment itself, often has.

Can I Trust the Media for Nutrition Information?

The news media are hungry for new findings, and reporters often latch onto hypotheses from scientific laboratories before they have been fully tested. Also, a reporter who lacks a strong understanding of science may misunderstand or misreport complex scientific principles. To tell the truth, sometimes scientists get excited about their findings, too, and leak them to the press before they have been through a rigorous review by the scientists' peers. As a result, the public is often exposed to late-breaking nutrition news stories before the findings are fully confirmed. Then, when a hypothesis being tested fails to hold up to a later challenge, consumers feel betrayed by what is simply the normal course of science at work.

Real scientists are trend watchers. They evaluate the methods used in each study, assess each study in light of the evidence gleaned from other studies, and modify little by little their picture of what may be true. As evidence accumulates, the scientists become more and more confident about their ability to make recommendations that apply to people's health and lives.

Sometimes media sensationalism overrates the importance of even true, replicated findings. For example, the media eagerly report that oat products lower blood cholesterol, a lipid indicative of heart disease risk. Although the reports are true, they often fail to mention that eating a nutritious diet that is low in certain fats is still the major step toward lowering blood cholesterol. They also may skip over important questions: How much oatmeal must a person eat to produce the desired effect? Do little oat bran pills or powders meet the need? Do oat bran cookies? If so, how many cookies? For oatmeal, it takes a bowl and a half daily to affect blood lipids. A few pills or cookies do not provide nearly so much bran and certainly cannot undo damage from an ill-chosen diet.

Today, the cholesterol-lowering effect of oats is well established. The whole process of discovery, challenge, and vindication took almost 10 years of research. Some other lines of research have taken much longer. In science, a single finding almost never makes a crucial difference to our knowledge, but like each individual frame in a movie, it contributes a little to the big picture. Many such frames are needed to tell the whole story. The Consumer's Guide section (p. 19) offers some tips for evaluating news stories about nutrition.

Key Point

- News media often sensationalize single-study findings and so may not be trustworthy sources.

National Nutrition Research

As you study nutrition, you are likely to hear of findings based on ongoing nationwide nutrition and health research projects. A national food and nutrient intake survey, called *What We Eat in America*, reveals what we know about the population's food and supplement intakes. It is conducted as part of a larger research effort, the **National Health and Nutrition Examination Surveys (NHANES)**, which also conducts physical examinations and measurements and laboratory tests.[12] Boiled down to its essence, NHANES involves:

- Asking people what they have eaten and
- Recording measures of their health status.

Past NHANES results have provided important data for developing growth charts for children, guiding food fortification efforts, developing national guidelines for reducing chronic diseases, and many other beneficial programs. Some agencies involved with these efforts are listed in Table 1–7.

Key Point

- National nutrition research projects, such as NHANES, provide data on U.S. food consumption and nutrient status.

Table 1–7

Nutrition Research and Policy Agencies

These agencies are actively engaged in nutrition policy development, research, and monitoring:

- Centers for Disease Control and Prevention (CDC)
- U.S. Department of Agriculture (USDA)
- U.S. Department of Health and Human Services (DHHS)
- U.S. Food and Drug Administration (FDA)

Healthy People Objectives for the Nation

Envisioning a future when every person in our society can lead a long and healthy life, the U.S. Department of Health and Human Services releases its science-based *Healthy People* nutrition and health objectives for the nation. These standards, updated every decade, are used by federal programs and others to set priorities and measure improvements in behaviors and health outcomes.*

Progress toward meeting the *Healthy People 2030* objectives is mixed. More U.S. adults report spending more of their leisure time in physical activity; at the same time, most people's diets still lack vegetables, and obesity rates are climbing.[13] To fully meet the *Healthy People* nutrition goals, our nation must change its habits.

Key Point

- Each decade, the U.S. Department of Health and Human Services sets health and nutrition objectives for the nation.

SDI Productions/E+/Getty Images

The aim of Healthy People 2030 *is to help people live long, healthy lives.*

Changing Behaviors

LO 1.6 Describe the characteristics of the six stages of behavior change.

Nutrition knowledge is of little value if it only helps people to make A's on tests. The value comes when people use it to improve their diets. To act on knowledge, people must change their behaviors, and although this may sound simple enough, behavior change often takes substantial effort.

National Health and Nutrition Examination Surveys (NHANES) a program of studies designed to assess the health and nutritional status of adults and children in the United States by way of interviews and physical examinations.

*You can read the current nutrition and other health objectives at www.healthypeople.gov.

Photographee.eu/Shutterstock.com

Many people need to change their daily habits to protect their health.

The Process of Change

Psychologists often describe the six stages of behavior change, offered in Table 1–8. Knowing where you stand in relation to these stages may help you move along the path toward achieving your goals. When offering diet help to others, keep in mind that their stages of change can influence their reaction to your message.

Taking Stock and Setting Goals

Once aware of a problem, you can plan to make a change. Some problems, such as *never* consuming a vegetable, are easy to spot. More subtle dietary problems, such as failing to meet your need for calcium, may be hidden but can exert serious repercussions on health. Tracking food and beverage intakes over several days' time and then comparing intakes to standards (see Chapter 2) can reveal all sorts of interesting tidbits about strengths and weaknesses of your dietary pattern.

Once a weakness is identified, setting small, achievable goals to correct it becomes the next step to making improvements. The most successful goals are set for specific behaviors, not overall outcomes. For example, if losing 10 pounds is the desired outcome, goals should be set in terms of food intakes and physical activity to help achieve weight loss. After goals are set and changes are under way, a means of tracking progress increases the likelihood of success.

Start Now

As you progress through this text, you may want to change some of your own habits. To help you, little reminders titled "Start Now" and "Moving Ahead" close each chapter's Think Fitness and Consumer's Guide sections. They invite you to take inventory of your current behaviors, set goals, track progress, and practice new behaviors until they become as comfortable and familiar as the old ones were.

Key Points

- Behavior change follows a multistep pattern.
- Setting goals and monitoring progress facilitate behavior change.

Table 1–8

The Stages of Behavior Change

Stage	Characteristics	Actions
Precontemplation	Not considering a change; have no intention of changing; see no problems with current behavior.	Collect information about health effects of current behavior and potential benefits of change.
Contemplation	Admit that change may be needed; weigh pros and cons of changing and not changing.	Commit to making a change and set a date to start.
Preparation	Preparing to change a specific behavior, taking initial steps, and setting some goals.	Write an action plan, spelling out specific parts of the change. Set small-step goals; tell others about the plan.
Action	Committing time and energy to making a change; following a plan set for a specific behavior change.	Perform the new behavior. Manage emotional and physical reactions to the change.
Maintenance	Striving to integrate the new behavior into daily life and striving to make it permanent.	Persevere through lapses. Teach others and help them achieve their own goals. (This stage can last for years.)
Adoption/Moving On	The former behavior is gone, and the new behavior is routine.	After months or a year of maintenance without lapses, move on to other goals.

A Consumer's Guide to . . . Reading Nutrition News

At a coffee shop, Nick, a health-conscious consumer, sets his cup down on the Lifestyle section of the newspaper. He glances at the headline—"Eating Fat OK for Heart Health!"—and jumps to a wrong conclusion: "Do you mean to say that I could have been eating burgers and butter all this time? I can't keep up! As soon as I change my diet, the scientists change their story." Nick's frustration is understandable. Like many others, he feels betrayed when, after working for years to make diet changes for his health's sake, headlines seem to turn dietary advice upside down. He shouldn't blame science, however.

Tricks and Traps

The trouble started when Nick was "hooked" by a catchy headline. Media headlines often seem to reverse current scientific thought because new "breakthrough" studies are exciting; they grab readers' attention and make them want to buy a newspaper, book, or magazine. (By the way, you can read the true story behind changing lipid intake guidelines in Controversy 5.) Even if Nick had read the entire newspaper article, he could have still been led astray by phrases like "Now we know" or "The truth is." Journalists use such phrases to imply finality, the last word. In contrast, scientists use tentative language, such as "may" or "might," because they know that the conclusions from one study will be challenged, refined, and even refuted by others that follow.

Markers of Authentic Reporting

To approach nutrition news with a trained eye, look for these signs of a scientific approach:

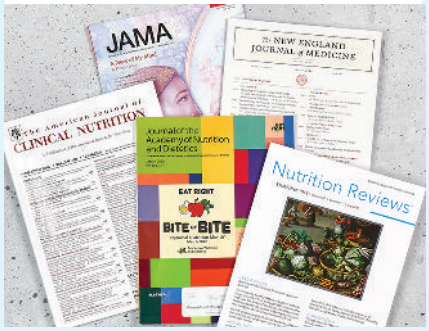
- When an article describes a scientific study, that study should have been published in a peer-reviewed journal, such as the *American Journal of Clinical Nutrition* (see Figure 1–7). An unpublished study may or may not be valid; readers have no way of knowing because the study lacks scrutiny by other experts (the authors' peers).
- The news item should describe the researchers' methods. In truth, few popular reports provide these details. For example, it matters whether the study participants numbered 8 or 80,000 or whether researchers personally observed participants' behaviors or relied on self-reports given over the telephone.
- The report should define the study subjects—were they single cells, animals, or human beings? If they were human beings, the more you have in common with them (age and sex, for example), the more applicable the findings may be for you.
- Valid reports also present new findings in the context of previous research. Some reporters in popular media regularly follow developments in a research area and thus acquire the background knowledge needed to report meaningfully. They strive for adequacy, balance, and completeness, and they cover such things as cost of a treatment, potential harms and benefits, strength of evidence, and who might stand to gain from potential sales relating to the finding.*
- For a helpful *scientific* overview of current topics in nutrition, look for review articles written by experts. They regularly appear in scholarly journals such as *Nutrition Reviews*.

The most credible sources of scientific nutrition information are scientific journals. Controversy 1, which follows this chapter, addresses other sources of nutrition information and misinformation.

** An organization that promotes valid health-care reporting is HealthNewsReview.org, available at www.healthnewsreview.org/.*

Figure 1–7
Peer-Reviewed Journals

For the whole story on a nutrition topic, read articles from peer-reviewed journals such as these. A review journal examines all available evidence on major topics. Other journals report details of the methods, results, and conclusions of single studies.



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Moving Ahead

Develop a critical eye, and let scientific principles guide you as you read nutrition news. When a headline touts a shocking new "answer" to a nutrition question, approach it with caution. It may indeed be a carefully researched report that respects the gradual nature of scientific discovery and refinement, but more often it is a sensational news flash intended to grab your attention.

Review Questions†

1. To keep up with nutrition science, consumers should _____.
   a. seek out the health and fitness sections of newspapers and magazines and read them with a trained eye
   b. read studies published in peer-reviewed journals, such as the

(continued)

† Answers to Consumer's Guide review questions are in Appendix G.

American Journal of Clinical Nutrition

c. look for review articles published in peer-reviewed journals, such as *Nutrition Reviews*

d. all of the above

2. To answer nutrition questions, _____.

a. rely on articles that include phrases such as "Now we know" or "The answer is," which appear to provide conclusive answers to nutrition questions

b. look to science for answers, with the expectation that scientists will continually revise their understandings

c. realize that problems in nutrition are probably too complex for consumers to understand

d. a and c

3. Scholarly review journals such as *Nutrition Reviews* _____.

a. are behind the times when it comes to nutrition news

b. discuss all available research findings on a topic in nutrition

c. are filled with medical jargon

d. are intended for use by practitioners only, not students

Food Feature

Nutrient Density: How to Get Enough Nutrients without Too Many Calories

LO 1.7 Explain how the concept of nutrient density can facilitate diet planning.

In the United States, only a tiny percentage of adults manage to choose a dietary pattern that achieves both adequacy and calorie control. The foods that can help in doing so are foods richly endowed with nutrients relative to their energy contents; that is, they are foods with high **nutrient density**.[14] Figure 1–8 is a simple depiction of this concept. Consider calcium sources, for example. Ice cream and fat-free milk both supply calcium, but a cup of rich ice cream contributes more than 350 calories, whereas a cup of fat-free milk has only 85—and almost double the calcium. Most people cannot, for their health's sake, afford to choose foods without regard to their energy contents. Those who do very often exceed calorie allowances while leaving nutrient needs unmet.

Among foods that often rank high in nutrient density are the vegetables, particularly the nonstarchy vegetables such as dark leafy greens (cooked and raw), red bell peppers, broccoli, carrots, mushrooms, and tomatoes.These inexpensive foods take time to prepare, but time invested in this way pays off in

nutrient density a measure of nutrients provided per calorie of food. A *nutrient-dense food* provides needed nutrients with relatively few calories.

Figure 1–8

A Way to Judge Which Foods Are Most Nutritious

These two breakfasts provide about 500 calories each, but they differ greatly in the nutrients they provide per calorie. Note that the sausage in the larger breakfast is lower-calorie turkey sausage, not the high-calorie pork variety. Making small choices like this at each meal can add up to large calorie savings, making room in the diet for more servings of nutritious foods and even some treats.

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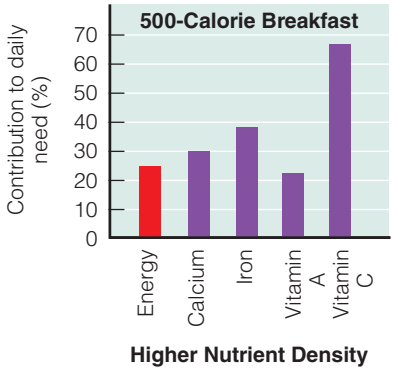
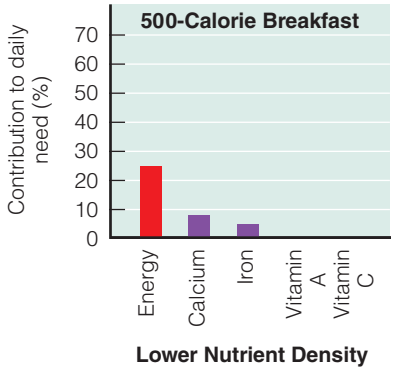


Higher Nutrient Density



Lower Nutrient Density

nutritional health. Twenty minutes spent peeling and slicing vegetables for a salad is a better investment in nutrition than 20 minutes spent fixing a fancy, high-fat, high-sugar dessert. Besides, the dessert ingredients often cost more money and strain the calorie budget, too.

Time, however, is a concern to many people. Today's working families, college students, and active people of all ages may have little time to devote to food preparation. Busy cooks should seek out convenience foods that are nutrient-dense, such as bags of ready-to-serve salads, ready-to-cook fresh vegetables, refrigerated prepared low-fat meats and poultry, canned beans, and frozen vegetables. A tip for lower-cost convenience is to double the amount of whole vegetables for a recipe; wash, peel, and chop them; and then refrigerate or freeze the extra to use on another day. Dried fruit and dry-roasted nuts require only that they be kept on hand and make a tasty, nutritious topper for salads and other foods. To round out a meal, fat-free milk or yogurt is both nutritious and convenient. Other convenience selections, such as most potpies, many frozen pizzas, ramen noodles, and "pocket"-style pastry sandwiches, are less nutritious overall because they contain too few vegetables and too many calories, making them low in nutrient density. The Food Features of later chapters offer many more tips for choosing convenient and nutritious foods.

All of this discussion leads to a principle that is central to achieving nutritional health: no particular foods must be included or excluded in the diet. Instead, your dietary pattern—the way you combine foods into meals and the way you arrange meals to follow one another over days and weeks—determines how well you are nourishing yourself. Nutrition is a science, not an art, but it can be used artfully to create a pleasing, nourishing diet. The rest of this book is dedicated to helping you make informed choices and combine them artfully to meet all the body's nutrition needs.

What did you decide?

- Can your diet make a real difference between getting **sick** or staying **healthy**?
- Are **supplements** more powerful than food for ensuring good nutrition?
- What makes your favorite foods your **favorites**?
- Are **news and media nutrition reports** informative or confusing?

Self Check

1. (LO 1.1) Both heart disease and cancer are due to genetic causes, and diet cannot influence whether they occur.
   T F
2. (LO 1.1) Some conditions, such as _____, are almost entirely nutrition related.
   a. cancer
   b. Down syndrome
   c. iron-deficiency anemia
   d. sickle-cell anemia
3. (LO 1.2) Human diseases are all equally influenced by diet.
   T F
4. (LO 1.3) Energy-yielding nutrients include all of the following except _____.
   a. vitamins
   b. carbohydrates
   c. fat
   d. protein

5. (LO 1.3) Organic nutrients include all of the following except _____.
   a. minerals
   b. fat
   c. carbohydrates
   d. protein
6. (LO 1.3) Both carbohydrates and protein have 4 calories per gram.
   T F
7. (LO 1.4) One of the characteristics of a nutritious diet is that the diet provides no constituent in excess. This principle of diet planning is called _____.
   a. adequacy
   b. balance
   c. moderation
   d. variety
8. (LO 1.4) Which of the following is an example of a processed food?
   a. carrots
   b. bread
   c. nuts
   d. watermelon
9. (LO 1.4) People most often choose foods for the nutrients they provide.
   T F
10. (LO 1.5) Studies of populations in which observation is accompanied by experimental manipulation of some population members are referred to as _____.
    a. case studies
    b. intervention studies
    c. laboratory studies
    d. epidemiological studies
11. (LO 1.5) An important national food and nutrient intake survey, called *What We Eat in America*, is part of _____.
    a. NHANES
    b. FDA
    c. USDA
    d. none of the above
12. (LO 1.5) The nutrition objectives for the nation, as part of *Healthy People 2030*
    a. envision a society in which all people live long, healthy lives.
    b. track and identify cancers as a major killer of people in the United States.
    c. set U.S. nutrition- and weight-related goals, one decade at a time.
    d. a and c.
13. (LO 1.5) According to a national health report,
    a. most people's diets lacked enough fruit, vegetables, and whole grains.
    b. fewer adults reported being sufficiently physically active.
    c. the number of overweight people was declining.
    d. the nation had fully met the previous *Healthy People* objectives.
14. (LO 1.6) Behavior change is a process that takes place in stages.
    T F
15. (LO 1.6) A person who is setting goals in preparation for a behavior change is in a stage called *precontemplation*.
    T F
16. (LO 1.7) A slice of peach pie supplies 357 calories with 48 units of vitamin A; one large peach provides 42 calories and 53 units of vitamin A. This is an example of _____.
    a. calorie control
    b. nutrient density
    c. variety
    d. essential nutrients
17. (LO 1.7) A person who wishes to meet nutrient needs while not overconsuming calories is wise to master
    a. the concept of nutrient density.
    b. the concept of carbohydrate reduction.
    c. the concept of nutrients per dollar.
    d. French cooking.
18. (LO 1.8) "Red flags" that can help identify nutrition quackery include
    a. enticingly quick and simple answers to complex problems.
    b. efforts to cast suspicion on the regular food supply.
    c. solid support and praise from users.
    d. all of the above.
19. (LO 1.8) In this nation, stringent controls make it difficult to obtain a bogus nutrition credential.
    T F

Answers to these Self Check questions are in Appendix G.

Controversy 1 Sorting Impostors from Real Nutrition Experts

LO 1.8 Evaluate the authenticity of any given nutrition information source.

From the time of snake oil salesmen in horse-drawn wagons to today's internet sales schemes, nutrition **quackery** has been a problem that often escapes government regulation and enforcement. To avoid being sitting ducks for quacks, consumers themselves must distinguish between authentic, useful nutrition products or services and a vast array of faulty advice and outright scams.

Each year, consumers spend a deluge of dollars on nutrition-related services and products from both legitimate and fraudulent businesses. Each year, nutrition and other health **fraud** diverts tens of *billions* of consumer dollars from legitimate health care.

More than Money at Stake

When scam products are garden tools or stain removers, hoodwinked consumers may lose a few dollars and some pride. When the products are ineffective, untested, or even hazardous "dietary supplements" or "medical devices," consumers stand to lose the very thing they are seeking: good health. When a sick person wastes time with quack treatments, serious problems can advance while proper treatment is delayed. And ill-advised "dietary supplements" have inflicted dire outcomes, even liver failure, on previously well people who took them in hopes of *improving* their health.

Information Sources

When questions about nutrition arise, most people consult the internet, a popular book or magazine, or television for the answer.[1]* Sometimes these sources provide sound, scientific, trustworthy information. More often, though, **infomercials**, **advertorials**, and **urban legends** (defined in Table C1–1) pretend to inform but in fact aim primarily to sell products by making fantastic promises of health or weight loss with minimal effort and at bargain prices.

How can people learn to distinguish valid nutrition information from misinformation? Some quackery is easy to identify—like the claims of the salesman in Figure C1–1 (p. 24)—whereas other types are more subtle. Between the extremes of accurate scientific data and intentional quackery lies an abundance of nutrition misinformation.† An instructor at a gym, a physician, a health-food store clerk, an author of books, or an advocate for a "cleansing diet" product or weight-loss gadget may sincerely believe that the recommended nutrition regimen is beneficial. But what qualifies these people to give nutrition advice? Would following their advice be helpful or harmful? To sift

** Reference notes are in Appendix F*

Table C1–1
Quackery Terms

- **advertorials** lengthy advertisements in newspapers and magazines that read like feature articles but are written for the purpose of touting the virtues of products and may or may not be accurate.
- **anecdotal evidence** information based on interesting and entertaining, but not scientific, personal stories.
- **critical thinking** the mental activity of rationally and skillfully analyzing, synthesizing, and evaluating information.
- **fraud** or **quackery** the promotion, for financial gain, of devices, treatments, services, plans, or products (including diets and supplements) claimed to improve health, well-being, or appearance without proof of safety or effectiveness. (The word *quackery* comes from the term *quacksalver*, meaning a person who quacks loudly about a miracle product—a lotion or a salve.)
- **infomercials** feature-length television commercials that follow the format of regular programs but are intended to convince viewers to buy products and not to educate or entertain them.
- **urban legends** stories, usually false, that may travel rapidly throughout the world via the internet, gaining the appearance of validity solely on the basis of repetition.

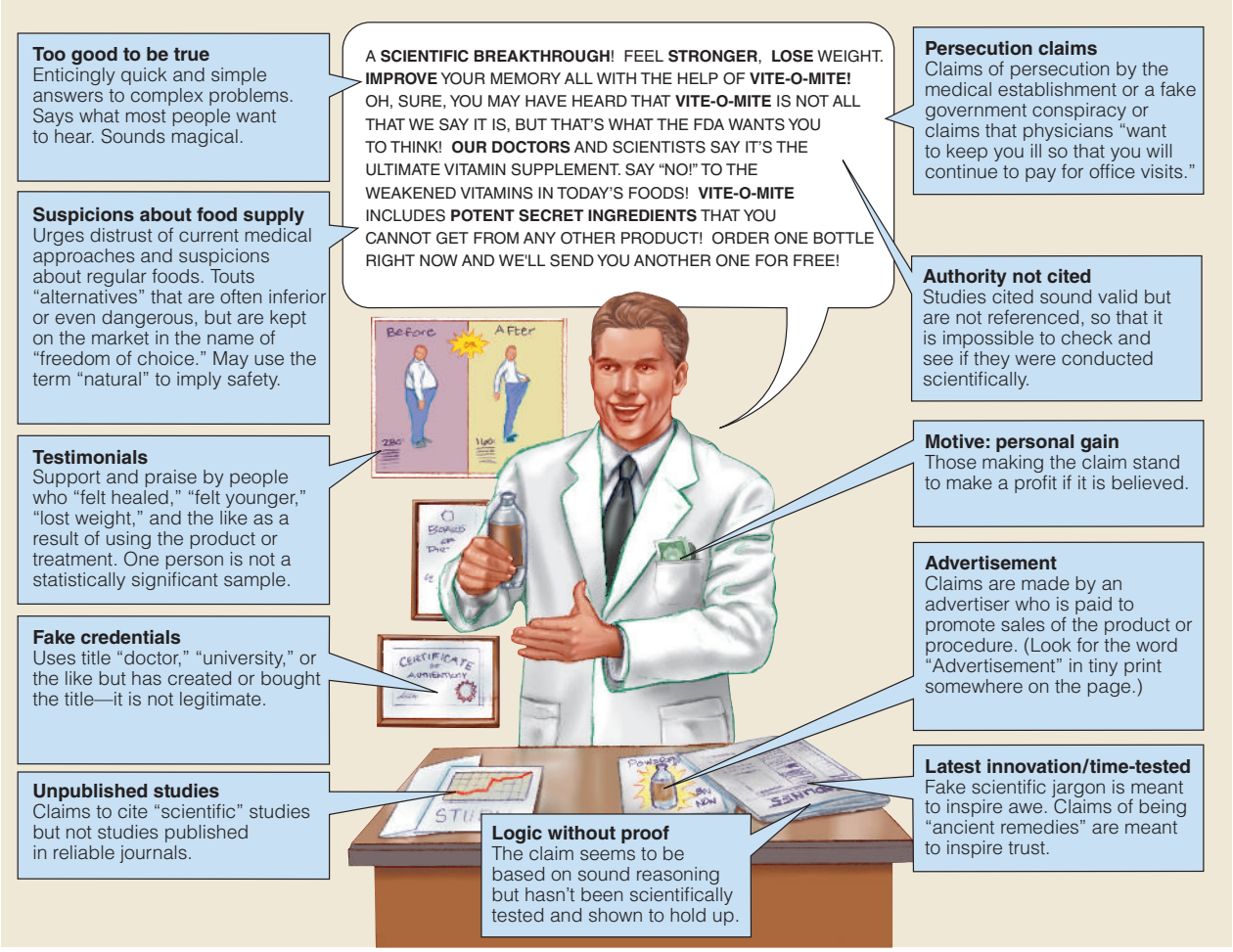
Suthichai Hantraku/Shutterstock.com

Who speaks on nutrition?

† Reliable information on quackery is available. Search for the National Council Against Health Fraud or the Food and Drug Administration on the internet, or call (888) INFO-FDA.

Figure C1–1

Earmarks of Nutrition Quackery



meaningful nutrition information from rubbish, you must learn to identify both.

Chapter 1 explained that valid nutrition information arises from scientific research and does not rely on **anecdotal evidence** or testimonials. Table C1–2 lists some sources of such authentic nutrition information.

Identifying nutrition misinformation requires more than simply gathering accurate information, though. It also requires you to develop skills in **critical thinking**. Critical thinking allows a person who has gathered information to:

- Understand how concepts are related.
- Evaluate the pros and cons of an argument.
- Detect inconsistencies and errors in thinking.
- Solve problems.
- Judge the relevance of new information.

This book's Controversy sections are dedicated to helping you to develop your critical thinking skills.

Nutrition on the Net

If you have a question, the internet has an answer. It offers convenient access to reliable reports of scientific research published in refereed journals. It also delivers an abundance of incomplete, misleading, or inaccurate information. Simply put: anyone can publish anything online. For example, popular self-governed internet "encyclopedia" websites allow anyone to post information or change others' postings on all topics. Information on the sites may be correct, but it may not be—readers must evaluate it for themselves. Table C1–3 provides some clues to judging the reliability of nutrition information websites.

Blogs, YouTube videos, and podcasts contain the authors' personal opinions and are often not reviewed by experts before posting. In addition, email and social media messages often circulate hoaxes and scare stories. Be suspicious when:

- Someone other than the sender or some authority you know wrote the contents.
- A phrase like "Forward this to everyone you know" appears anywhere in the piece.

Table C1–2

Credible Sources of Nutrition Information

Government agencies, volunteer associations, consumer groups, and professional organizations provide consumers with reliable health and nutrition information. Credible sources of nutrition information include:

- Nutrition and food science departments at a university or community college
- Local agencies such as the health department or County Cooperative Extension Service
- Government resources such as:
  - Centers for Disease Control and Prevention (CDC) — **www.cdc.gov**
  - Department of Agriculture (USDA) — **www.usda.gov**
  - Department of Health and Human Services (DHHS) — **www.hhs.gov**
  - Dietary Guidelines for Americans — **www.dietaryguidelines.gov/**
  - Food and Drug Administration (FDA) — **www.fda.gov**
  - Healthy People — **www.healthypeople.gov**
  - MyPlate — **www.choosemyplate.gov**
  - National Institutes of Health (NIH) — **www.nih.gov**
  - Physical Activity Guidelines for Americans — **www.health.gov/paguidelines**
- Volunteer health agencies such as:
  - American Cancer Society — **www.cancer.org**
  - American Diabetes Association — **www.diabetes.org**
- International authorities such as:
  - Food and Agriculture Organization of the United Nations (FAO) — **http://www.fao.org/home/en/**
  - World Health Organization (WHO) — **https://www.who.int/**
  - American Heart Association — **www.heart.org/**
- Reputable consumer groups such as:
  - American Council on Science and Health — **www.acsh.org**
  - International Food Information Council — **www.foodinsight.org**
- Professional health organizations such as:
  - Academy of Nutrition and Dietetics — **www.eatright.org**
  - American Medical Association — **www.ama-assn.org**
- Journals such as:
  - *American Journal of Clinical Nutrition* — **https://academic.oup.com/ajcn**
  - *Journal of the Academy of Nutrition and Dietetics* — **www.andjrnl.org**
  - *New England Journal of Medicine* — **www.nejm.org**
  - *Nutrition Reviews* — **www.ilsi.org**

- The piece states, "This is not a hoax"; chances are it is.
- The information seems shocking or something that you've never heard from legitimate sources.
- The language is overly emphatic or sprinkled with capitalized words or exclamation marks.
- No references are offered or, if present, prove to be of questionable validity when examined.
- Websites such as www.quackwatch.org have debunked the message.

In contrast, one of the most trustworthy sites for scientific investigation is the National Library of Medicine's PubMed website, which provides free access to over 10 million abstracts (short descriptions) of research papers published in scientific journals around the world. Many abstracts provide

Table C1–3

Is This Site Reliable?

To judge whether a website offers reliable nutrition information, answer the following questions.

Who? Who is responsible for the site? Is it staffed by qualified professionals? Look for the authors' names and credentials. Have experts reviewed the content for accuracy?
When? When was the site last updated? Because nutrition is an ever-changing science, sites need to be dated and updated frequently.
Where? Where is the information coming from? The three letters following the dot in a Web address identify the site's affiliation. Addresses ending in "gov" (government), "edu" (educational institute), and "org" (organization) generally provide reliable information; "com" (commercial) sites represent businesses and, depending on their qualifications and integrity, may or may not offer dependable information. Many reliable sites provide links to other sites to facilitate your quest for knowledge, but this provision alone does not guarantee a reputable intention. Be aware that any site can link to any other site without permission.
Why? Why is the site giving you this information? Is the site providing a public service or selling a product? Many commercial sites provide accurate information, but some do not. When money is the prime motivation, be aware that the information may be biased.
What? What is the message, and is it in line with other reliable sources? Information that contradicts common knowledge should be questioned.

links to full articles posted on other sites. The site is easy to use and offers instructions for beginners. Figure C1–2 introduces this resource.

Challenges to Scientific Journals

By far, most scientific journal articles are reliable because publishers of these journals spend considerable resources weeding out plagiarism and fabricated or falsified data in papers submitted for publication. In recent years, increasingly sophisticated assaults on scientific integrity have been brought by rogue groups attempting to publish unscientific data.[2] Their aim is often to legitimize misconceptions and create "evidence" to help advance goals unrelated to science.[3] A few such frauds evade even the strictest editorial controls, gain publication, and must later be retracted.[4]

Luckily, the scientific method itself stands guard, defending its own scientific integrity. A phony study is readily exposed when real scientists scrutinize it for use in their subsequent work on a topic. All readers must learn to turn on their critical thinking skills when reading nutrition information from any source, even in a scientific journal.

Who Are the True Nutrition Experts?

Most people turn to their physicians for dietary advice, but physicians vary in their knowledge of nutrition. Physicians have extensive training in human biochemistry and physiology, the bedrocks of nutrition science, but typical medical schools in the United States do not require students to take a comprehensive nutrition course, such as the class taken by students reading this text.[5]

An exceptional physician has a specialty area in clinical nutrition and is highly qualified to advise on nutrition. Membership in the **Academy of Nutrition and Dietetics (AND)** or the Society for Clinical Nutrition, whose journals are cited many times throughout this text, can be a clue to a physician's nutrition knowledge.

Fortunately, a credential that indicates a qualified nutrition expert is easy to spot—you can confidently call on a **registered dietitian nutritionist (RDN)**. To become an RDN, a person must earn a bachelor's or master's of science degree from an **accredited** college or university based on course work that typically includes biochemistry, chemistry, human anatomy and physiology, microbiology, and food and nutrition sciences, along with food service systems management, business, statistics, economics, computer science, sociology, and counseling or education courses. Then the person must complete an accredited and supervised practice program and, finally, pass a national examination administered by AND. Once credentialed, the expert must maintain **registration** by participating in required continuing education activities.

Additionally, some states require that **nutritionists** and **dietitians** obtain a **license to practice**. Meeting state-established criteria in addition to **registration** with **AND** certifies that an expert is the genuine article. Table C1–4 defines nutrition specialists along with other relevant terms.

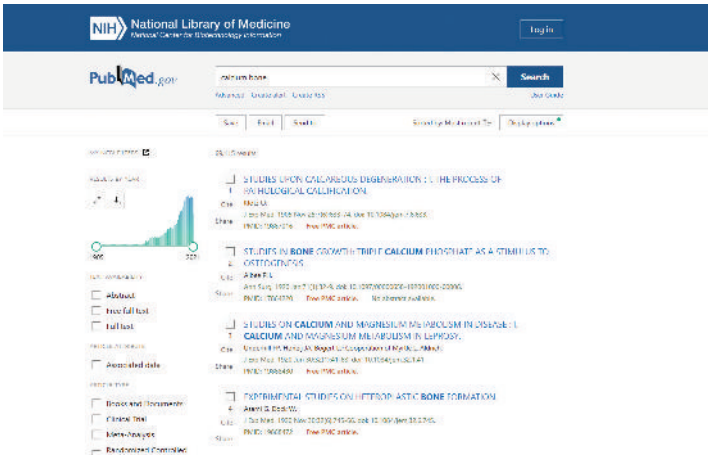
RDNs are easy to find in most communities because they perform a multitude of duties in a variety of settings (see Table C1–5). They work in food service operations, pharmaceutical companies, sports nutrition programs, corporate wellness programs, the food industry, home health agencies, long-term care institutions, private practice, community and public health settings, cooperative extension offices,* research centers, universities, hospitals, health maintenance organizations (HMO), and other facilities. In hospitals, they may offer **medical nutrition therapy** as part of patient care, or they may run the food service operation, or they may specialize as **certified diabetes educators (CDE)** to help people with diabetes manage the disease. **Public health nutritionists** take leadership roles in government agencies as expert consultants and advocates or in direct service delivery.

Figure C1–2

PubMed (https://pubmed.ncbi.nlm.nih.gov/): Internet Resource for Scientific Nutrition References

The U.S. National Library of Medicine's PubMed website offers tutorials to help teach beginners to use the search system effectively. Often, simply visiting the site, typing a query in the search box, and clicking *Search* will yield satisfactory results.

For example, to find research concerning calcium and bone health, typing in "calcium bone" nets almost 3,000 results. To refine the search, try setting limits on dates, types of articles, languages, and other criteria to obtain a more manageable number of abstracts to peruse.



Courtesy of National Center for Biotechnology Information

Table C1–4

Terms Associated with Nutrition Advice

- **Academy of Nutrition and Dietetics (AND)** the professional organization of dietitians in the United States (formerly the American Dietetic Association). The Canadian equivalent is the Dietitians of Canada (DC), which operates similarly.
- **accredited** approved; in the case of medical centers or universities, certified by an agency recognized by the U.S. Department of Education.
- **certified diabetes educator (CDE)** a health-care professional who has completed an intensive professional training program and examination to earn a certificate attesting to the attainment of knowledge and skill in educating people with diabetes to help them manage their disease through medical and lifestyle means. Professional certifications in many other practice areas also exist.
- **certified specialist in sports dietetics (CSSD)** a Registered Dietitian Nutritionist with special credentials and expertise to deliver safe, effective, evidence-based nutrition assessments and guidance for health and performance to athletes and other physically active people.
- **dietitian** a person trained in the science of nutrition and dietetics. See also *Registered Dietitian Nutritionist*.
- **diploma mill** an organization that awards meaningless degrees without requiring students to meet educational standards. Diploma mills are not the same as diploma forgers (providing fake diplomas and certificates bearing the names of real, respected institutions). Although visually indistinguishable from authentic diplomas, forgeries can be unveiled by checking directly with the institution.
- **Fellow of the Academy of Nutrition and Dietetics (FAND)** members of the academy who are recognized for their outstanding service and integrity in the dietetics profession.
- **license to practice** permission under state or federal law, granted on meeting specified criteria, to use a certain title (such as *dietitian*) and to offer certain services. Licensed dietitians may use the initials LD after their names.
- **medical nutrition therapy (MNT)** evidence-based nutrition services administered by registered dietitian nutritionists in the treatment of injury, illness, or other conditions; includes assessment of nutrition status and dietary intake and corrective applications of diet, counseling, and other nutrition services.
- **nutrition and dietetics technician, registered (NDTR)** a dietetics professional who has completed an academic degree from an accredited college or university and an approved dietetic technician program. This professional has also passed a national examination and maintains registration through continuing professional education.
- **nutritionist** someone who studies or advises others on nutrition, and who may or may not have an academic degree in nutrition. In states with responsible legislation, the term applies only to people who have master of science (MS) or doctor of philosophy (PhD) degrees from properly accredited institutions.
- **public health nutritionist** a dietitian or other person with an advanced degree in nutrition who specializes in public health nutrition.
- **registered dietitian nutritionist (RDN)** food and nutrition expert who has earned at least a bachelor's degree from an accredited college or university with a program approved by the Academy of Nutrition and Dietetics. The dietitian must also serve in an approved internship or coordinated program, pass the registration examination, and maintain professional competency through continuing education. Many states also require licensing of practicing dietitians. Also called *registered dietitian (RD)*.
- **registration** listing with a professional organization that requires specific course work, experience, and passing of an examination.

A **certified specialist in sports dietitics (CSSD)** counsels people who must perform physically for sports, emergency response, military defense, and the like.[6] The roles are so diverse that many pages would be required to cover them thoroughly.

In some facilities, a dietetic technician assists a registered dietitian nutritionist in administrative and clinical responsibilities. A dietetic technician has been educated in nutrition and trained to perform practical tasks in patient care, food service, and other areas of dietetics.[7] Upon passing a national examination, the technician earns the title **nutrition and dietetics technician, registered (NDTR).**

Detecting Fake Credentials

In contrast to RDNs and other credentialed nutrition professionals, thousands of people possess fake nutrition degrees and claim to be nutrition counselors, nutritionists, or "dietists." These and other such titles may sound meaningful, but most of these people lack the established credentials of AND–sanctioned dietitians. If you look closely, you can see signs that their declared expertise is fake.

Educational Background

A fake nutrition expert may display a degree from a 6-week course of study; such a degree is simply not the same as the extensive requirements for legitimate nutrition credentials. In some cases, schools posing as legitimate institutions are actually **diploma mills**—fraudulent businesses that sell certificates of competency to anyone who pays the fees, from under a thousand dollars for a bachelor's degree to several thousand for a doctorate. To obtain these "degrees," a candidate need not read any books or pass any examinations, and the only written work is a signature on a check. Here are a few red flags to identify these scams:

- A degree is awarded in a very short time—sometimes just a few days.
- A degree can be based entirely on work or life experience.
- An institution provides only an email address, with vague information on physical location.
- It provides sample styles of certificates and diplomas for choosing.
- It offers a choice of graduation dates to appear on a diploma.

** Cooperative extension agencies are associated with land grant colleges and universities and may be found in the telephone book's government listings or on the internet.*

Table C1–5

Professional Responsibilities of Registered Dietitian Nutritionists

Registered Dietitian Nutritionists perform varied and important roles in the workforce. This table lists just a few responsibilities of just a few specialties.

Specialty	Sample Responsibilities
Education	▪ Write curricula to deliver to students nutrition knowledge that is appropriate for their goals and that meets criteria of accrediting agencies and professional groups. ▪ Teach and evaluate student progress; research, write, and publish.
Food Service Management	▪ Plan and direct an institution's food service system, from kitchen to delivery. ▪ Plan and manage budgets; develop products; market services.
Health and Wellness	▪ Design and implement research-based programs for individuals or populations to improve nutrition, health, and physical fitness.
Hospital Health Care/Clinical Care	▪ Design and implement disease prevention services. ▪ Order therapeutic diets independently. ▪ Coordinate patient care with other health-care professionals. ▪ Assess client nutrient status and requirements. ▪ Provide client care and diet plan counseling.
Laboratory Research	▪ Design, execute, and interpret food and nutrition research. ▪ Write and publish research articles in peer-reviewed journals and lay publications. ▪ Provide science-based guidance to nutrition practitioners. ▪ Write and manage grants.
Public Health Nutrition	▪ Influence nutrition policy, regulations, and legislation. ▪ Plan, coordinate, administer, and evaluate food assistance programs. ▪ Consult with agencies; plan and manage budgets.
Sports Team Nutrition	▪ Provide individual and group/team nutrition counseling and education to enhance the performance of competitive and recreational athletes, on-site and during travel. ▪ Perform assessments of body composition. ▪ Track and document performance and other outcomes. ▪ Manage budgets, dining facilities, and personnel.

Source: Academy Quality Management Committee, Academy of Nutrition and Dietetics: Revised 2017 Scope of Practice for the Registered Dietitian Nutritionist, *Journal of the Academy of Nutrition and Dietetics* 118 (2018): 141–165.

Selling degrees is big business; networks of many bogus institutions are often owned by a single entity. In 2011, more than 2,600 such diploma and accreditation mills were identified, and 2,000 more were under investigation.

Accreditation and Licensure

Lack of proper accreditation is the identifying sign of a fake educational institution. To guard educational quality, an accrediting agency recognized by the U.S. Department of Education certifies those schools that meet the criteria defining a complete and accurate schooling, but in the case of nutrition, quack accrediting agencies cloud the picture. Fake nutrition degrees are available from schools "accredited" by more than 30 phony accrediting agencies.*

State laws do not necessarily help consumers distinguish experts from fakes; some states allow anyone to use the title *dietitian* or *nutritionist*. But other states have responded to the need by allowing only RDNs or people with certain graduate degrees and state licenses to call themselves dietitians. Licensing provides a way to identify people who have met minimum standards of education and experience.

** To find out whether an online school is accredited, write the Distance Education and Training Council, Accrediting Commission, 1601 Eighteenth Street, NW, Washington, DC 20009; call 202-234-5100; or visit their website (www.detc.org).*

To find out whether a school is properly accredited for a dietetics degree, visit the U.S. Department of Education's Database of Accredited Postsecondary Institutions and Programs at https://ope.ed.gov/accreditation. You can also write the Academy of Nutrition and Dietetics, Division of Education and Research, 120 South Riverside Plaza, Suite 2000, Chicago, IL 60606–6995: call 800-877-1600; or visit their website (www.eatright.org).

The American Council on Education publishes Accredited Institutions of Postsecondary Education Programs, *a directory of accredited institutions, professionally accredited programs, and candidates for accreditation that is available at many libraries. For additional information, write the American Council on Education, One Dupont Circle NW, Suite 800, Washington, DC 20036; call 202-939-9382; or visit their website (www.acenet.edu).*

A Failed Attempt to Fail

To dramatize the ease with which anyone can obtain a fake nutrition degree, one writer paid $82 to enroll in a nutrition diploma mill that billed itself as a correspondence school. She made every attempt to fail, intentionally giving all wrong answers to the examination questions. Even so, she received a "nutritionist" certificate at the end of the course, together with a letter from the "school" officials explaining that they were sure she must have misread the test.

Would You Trust a Nutritionist Who Eats Dog Food?

In a similar stunt, Mr. Eddie Diekman was named a "professional member" of an association of nutrition "experts" (see Figure C1–3). For his efforts, Eddie received a diploma suitable for framing and displaying. Eddie is a cocker spaniel. His owner, Connie B. Diekman, then president of AND, paid Eddie's tuition to prove that he could be awarded the title "nutritionist" merely by sending in his name.

Staying Ahead of the Scammers

In summary, to stay one step ahead of the nutrition quacks, check a provider's qualifications. First, look for the degrees and credentials listed after the person's name (such as MD, RDN, MS, PhD, or LD). Then, find out what you can about the reputations of institutions that are affiliated with the provider. If the person objects, or if your findings raise suspicions, look for someone better qualified to offer nutrition advice. Your health is your most precious asset, and protecting it is well worth the time and effort it takes to do so.

Figure C1–3

A "Professional Member" of a Fake Association

Eddie displays his professional credentials.

© Courtesy of eatright.org

Critical Thinking

1. Describe how you would respond to the following situation:

   A friend has started taking ginseng, a supplement that claims to help with weight loss. You are thinking of trying ginseng, but you want to learn more about the herb and its effects before deciding. What research would you do, and what questions would you ask your friend to determine if ginseng is a legitimate weight loss product?

2. Recognizing a nutrition authority that you can consult for reliable nutrition information can be difficult because it is so easy to acquire questionable nutrition credentials. Read the education and experience of the "nutrition experts" described as follows and put them in order, beginning with the person with the strongest and most trustworthy nutrition expertise and ending with the person with the weakest and least trustworthy nutrition expertise:

   1. A nutrition and dietetics technician, registered (NDTR) working in a clinic
   2. A highly successful athlete/coach who has a small business as a nutrition counselor and sells a line of nutrition supplements
   3. An individual who has completed 30 hours of nutrition training through the American Association of Nutrition Counseling
   4. A Registered Dietitian Nutritionist (RDN) associated with a hospital

2 Nutrition Tools—Standards and Guidelines

Controversy 2 Are Some Foods "Superfoods" for Health?

Learning Objectives

After completing this chapter, you should be able to accomplish the following:

LO 2.1 State the significance of Dietary Reference Intakes (DRI) and Daily Values as nutrient standards.

LO 2.2 Define the role of the Dietary Guidelines as part of the overall U.S. dietary guidance system.

LO 2.3 Describe how the U.S. Department of Agriculture (USDA) Dietary Patterns support the planning of a nutritious diet.

LO 2.4 Given a specified number of calories, create a healthful diet plan using the USDA Dietary Patterns.

LO 2.5 Describe the information that appears on food labels.

LO 2.6 Compare one day's nutrient-dense meals with meals not planned for nutrient density.

LO 2.7 Summarize the potential health effects of phytochemicals from both food sources and supplements.

What do you think?

- How can you tell **how much of each nutrient** you need to consume daily?
- Can we trust the **government's dietary recommendations**?
- Are the health claims on food labels **accurate and reliable**?
- Can certain "**superfoods**" boost your health with more than just nutrients?

Eating well is easy in theory—just choose foods that supply appropriate amounts of the essential nutrients, fiber, phytochemicals, and energy without excess intakes of fat, sugar, and salt, and be sure to get enough physical activity to help balance the foods you eat. In practice, eating well proves harder to do. Many people are overweight, or are undernourished, or suffer from nutrient excesses or deficiencies that impair their health—that is, they are malnourished. You may not think that this statement applies to you, but you may already have less than optimal nutrient intakes without knowing it. Accumulated over years, the effects of your habits can seriously impair the quality of your life.

Putting it positively, you can enjoy the best possible vim, vigor, and vitality throughout your life if you learn now to nourish yourself optimally. To learn how, you first need some general guidelines and the answers to several basic questions. How much of each nutrient and how many calories should you consume? Which types of foods supply which nutrients? How much of each type of food do you have to eat to get enough? And how can you eat all these foods without gaining excess weight? This chapter begins by identifying some ideals for nutrient and energy intakes and ends by showing how to achieve them.

Nutrient Recommendations

LO 2.1 State the significance of Dietary Reference Intakes (DRI) and Daily Values as nutrient standards.

Nutrient recommendations are sets of standards against which people's nutrient and energy intakes can be measured. Nutrition experts use the recommendations to assess intakes and to offer advice on amounts to consume. Individuals may use them to decide how much of a nutrient they need and how much is too much.

Two Sets of Standards

Two sets of standards are important for students of nutrition: one for people's nutrient intakes and one for food labels. The first set are the **Dietary Reference Intakes (DRI)**. A committee of nutrition experts from the United States and Canada develops, publishes, and updates the DRI.* The DRI committee has set recommended intakes and limits for all of the vitamins and minerals, as well as for carbohydrates, fiber, lipids, protein, water, and energy.

The other standards, the **Daily Values**, are familiar to anyone who has read a food label. Nutrient standards—the DRI and Daily Values—are used and referred to so often that they

Dietary Reference Intakes (DRI) a set of five lists of values for measuring the nutrient intakes of healthy people in the United States and Canada. The lists are Estimated Average Requirements (EAR), Recommended Dietary Allowances (RDA), Adequate Intakes (AI), Tolerable Upper Intake Levels (UL), and Acceptable Macronutrient Distribution Ranges (AMDR).

Daily Values nutrient standards used on food labels and on grocery store and restaurant signs.

* This is a committee of the Food and Nutrition Board of the National Academy of Sciences' Institute of Medicine.

Figure 2–1
Alphabet Soup?

Don't let the "alphabet soup" of nutrient intake standards confuse you. Their names make sense when you learn their purposes.

Photodisc/Getty Images

are printed in full on the very last group of pages of this book, pp. A–D. Nutritionists refer to these values by their acronyms, and this book does, too (see Figure 2–1).

Key Points

- The Dietary Reference Intakes are U.S. and Canadian nutrient intake standards.
- The Daily Values are U.S. standards used on food labels.

The DRI Lists and Purposes

For each nutrient, the DRI establish a number of values, each serving a different purpose. The values that most people find useful are those that set goals for nutrient intakes (RDA, AI, CDRR, and AMDR, described next) and those that describe nutrient safety (UL, addressed later). In total, the DRI include five sets of values:

1. **Recommended Dietary Allowances (RDA)**—adequacy
2. **Adequate Intakes (AI)**—adequacy
3. **Chronic Disease Risk Reduction Intakes (CDRR)**—risk reduction
4. **Tolerable Upper Intake Levels (UL)**—safety
5. **Estimated Average Requirements (EAR)**—research and policy
6. **Acceptable Macronutrient Distribution Ranges (AMDR)**—healthful ranges for energy-yielding nutrients

RDA and AI—Recommended Nutrient Intakes A great advantage of the DRI values lies in their applicability to the diets of individuals.[1*] People may adopt the RDA and AI as their own nutrient intake goals. The AI values are not the scientific equivalent of the RDA, however.

The RDA form the indisputable bedrock of the DRI recommended intakes because they derive from solid experimental evidence and reliable observations—they are expected to meet the needs of almost all healthy people. AI values, in contrast, are based as far as possible not only on the available scientific evidence but also on some educated guesswork. Whenever the DRI committee members find insufficient evidence to generate an RDA, they establish an AI value instead. This book refers to the RDA and AI values collectively as the DRI.

CDRR—Chronic Disease Risk Reduction The newest of the DRI values, the CDRR, identify nutrient intake levels associated with lowered risks of chronic diseases. This sets the CDRR apart from all other DRI categories, which focus on nutrient deficiency or toxicity. The CDRR, in contrast, reflect a level of nutrient intake that can be expected to reduce the risk of a chronic disease in a healthy population, taking into account that such risks vary among individuals in ways unrelated to nutrition.[2]

Currently, a CDRR for sodium is established in relation to heart disease and hypertension. High-quality scientific evidence demonstrates that increasing sodium intakes beyond this level incurs a higher risk of these life-threatening diseases in healthy people. People who currently consume more than the CDRR of sodium can expect to reduce their risks by reducing their intakes.[3]

EAR—Nutrition Research and Policy The EAR, also set by the DRI committee, establish the average nutrient requirements that researchers and nutrition policy makers use in their work. Public health officials may also use them to assess the prevalence of inadequate intakes in populations and make recommendations. The EAR values form the scientific basis upon which the RDA values are set (a later section explains how).

UL—Safety Beyond a certain point, it is unwise to consume large amounts of any nutrient, so the DRI committee sets the UL to identify potentially toxic levels of nutrient intake. Usual intakes of a nutrient below its UL pose a low risk of causing illness; chronic

Recommended Dietary Allowances (RDA) nutrient intake goals for individuals; the average daily nutrient intake level that meets the needs of nearly all (97 to 98 percent) healthy people in a particular sex and life stage group.

Adequate Intakes (AI) nutrient intake goals for individuals set when scientific data are insufficient to allow establishment of an RDA value and assumed to be adequate for healthy people.

Chronic Disease Risk Reduction Intakes (CDRR) levels of nutrient intake associated with low risks of chronic diseases. For sodium, the level above which intake reduction is expected to reduce chronic disease risk within an apparently healthy population.

Tolerable Upper Intake Levels (UL) the highest average daily nutrient intake levels that are likely to pose no risk of toxicity to almost all healthy individuals of a particular population group.

Estimated Average Requirements (EAR) nutrient values used in nutrition research and policy making and the basis upon which RDA values are set; the average daily nutrient intake estimated to meet the requirement of half of the healthy individuals in a particular sex and life stage group.

Acceptable Macronutrient Distribution Ranges (AMDR) values for carbohydrate, fat, and protein expressed as percentages of total daily caloric intake; ranges of intakes set for the energy-yielding nutrients that are sufficient to provide adequate total energy and nutrients while minimizing the risk of chronic diseases.

*Reference notes are in Appendix F.

intakes above the UL pose increasing risks. The UL are indispensable to consumers who take supplements or consume foods and beverages to which vitamins or minerals have been added—a group that includes almost everyone. Public health officials also rely on UL values to set safe upper limits for nutrients added to our food and water supplies.

The DRI numbers for nutrients do not mark a rigid line dividing safe and hazardous intakes (as Figure 2–2 illustrates). Instead, nutrient needs fall within a range, and a danger zone exists both below and above that range. People's tolerances for high doses of nutrients vary, so caution is in order when nutrient intakes approach the UL values (listed at the back of the book, p. C).

Some nutrients lack UL values. The absence of a UL for a nutrient does not imply that it is safe to consume it in any amount, however. It means only that insufficient data exist to establish a value.

AMDR—Calorie Percentage Ranges The DRI committee also sets healthy ranges of intake for carbohydrate, fat, and protein known as Acceptable Macronutrient Distribution Ranges. Each of these three energy-yielding nutrients contributes to the day's total calorie intake, and their contributions can be expressed as a percentage of the total. According to the committee, a diet that provides adequate energy in the following proportions can provide adequate nutrients while minimizing the risk of chronic diseases:

- 45 to 65 percent of calories from carbohydrate.
- 20 to 35 percent of calories from fat.
- 10 to 35 percent of calories from protein.

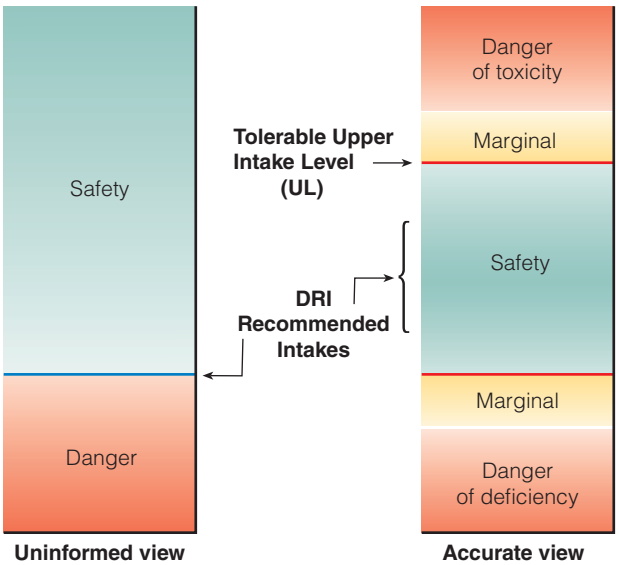
The chapters on the energy-yielding nutrients revisit these ranges.

Fortunately, you don't have to calculate these percentages for yourself when planning nutritious meals. The sample calculation in the margin shows how the math is done, but policy makers have translated these guidelines into a pattern of food groups that relieves the meal planner of this task. (See "Dietary Guidelines for Americans," beginning on page 36.).

Figure 2–2

The Uninformed View versus the Accurate View of Optimal Nutrient Intakes

A common but naïve belief is that consuming *less* than the DRI amount of a nutrient is dangerous, but that consuming any amount more is safe. The accurate view, shown on the right, is that DRI values fall within a safety range, with the UL marking tolerable upper levels.



Do the Math:

Calculate percentages of energy nutrient calories.

Calculate the percentage of calories from an energy nutrient in a day's meals by using this general formula:

(A nutrient's calorie amount ÷ Total calories) × 100

Calculate the percentage of calories from protein in a day's meals:

A day's meals provide 50 grams of protein and 1,754 total calories.

1. Convert the protein *grams* to protein *calories* (protein provides 4 calories per gram):

   50 g protein × 4 cal per g = ____ cal from protein

2. Using this answer, apply the general formula:

   (Protein calorie amount ÷ Total calories) × 100

   (___ ÷ 1,754) × 100 = ___ percent calories from protein.

Follow the same procedure when considering carbohydrate (4 cal per g) and fat (9 cal per g).

Norman Chan/Shutterstock.com

Key Points

- The DRI include nutrient intake goals for individuals, standards for researchers and public policy makers, and tolerable upper limits.
- RDA, AI, CDRR, EAR, and UL are all DRI standards, along with AMDR ranges for energy-yielding nutrients.

Understanding the DRI

Nutrient recommendations have been much misunderstood. One young woman posed this question: "Do you mean that some bureaucrat says that I need exactly the same amount of vitamin D as everyone else? Do they really think that 'one size fits all'?" In fact, the opposite is true.

DRI for Population Groups The DRI committee acknowledges differences among individuals and takes them into account when setting nutrient values. It has made separate recommendations for specific groups of people—men, women, pregnant women, lactating women, infants, and children—and for specific age ranges. Children aged 4 to 8 years, for example, have their own DRI. Each individual can look up the recommendations for his or her own sex and age group. Within each group, the committee advises adjusting nutrient intakes in special circumstances that may increase or decrease nutrient needs, such as illness or smoking. Later chapters provide details about who may need to adjust intakes of which nutrients.

For almost all healthy people, a diet that consistently provides the RDA or AI amount for a specific nutrient is very likely to be adequate in that nutrient. To make your diet nutritionally adequate, aim for nutrient intakes that, over time, average 100 percent of your DRI.

Other Characteristics of the DRI The following facts will help put the DRI into perspective:

- The values reflect daily intakes to be achieved on average, over time. They assume that intakes will vary from day to day and are set high enough to ensure that the body's nutrient stores will meet nutrient needs during periods of inadequate intakes lasting several days to several months, depending on the nutrient.
- The values are based on available scientific research to the greatest extent possible and are updated to reflect current scientific knowledge.
- The values are based on the concepts of probability and risk. The DRI are associated with a low probability of deficiency for people of a given sex and life stage group, and they pose almost no risk of toxicity for that group.
- The values are intended to ensure optimal intakes, not minimum requirements. They include a generous safety margin and meet the needs of virtually all healthy people in a specific sex and age group.
- The values are set in reference to certain indicators of nutrient adequacy, such as blood nutrient concentrations, normal growth, or reduction of certain chronic diseases or other disorders, rather than prevention of deficiency symptoms alone.

The DRI Apply to Healthy People Only The DRI are designed for health maintenance and disease prevention in healthy people, not for the restoration of health or repletion of nutrients in those with deficiencies. Under the stress of serious illness or malnutrition, a person may require a much higher intake of certain nutrients or may not be able to handle even the DRI amount. Therapeutic diets take into account the increased nutrient needs imposed by certain medical conditions, such as recovery from surgery, burns, fractures, illnesses, malnutrition, or addictions.

Key Points

- The DRI set separate recommendations for specific groups of people at different ages.
- The DRI intake recommendations (RDA and AI) are up-to-date, optimal, and safe nutrient intakes for healthy people in the United States and Canada.

balance study a laboratory study in which a subject is fed a controlled diet and the intake and excretion of a nutrient are measured. Balance studies are valid only for nutrients such as calcium (chemical elements) that do not change while they are in the body.

How the Committee Establishes DRI Values—An RDA Example

A theoretical discussion will help to explain how the DRI committee goes about setting DRI values. Suppose we are the DRI committee members with the task of setting an RDA for nutrient X (an essential nutrient).* Ideally, our first step will be to find out how much of that nutrient various healthy individuals need. To do so, we review studies of deficiency states, nutrient stores and their depletion, and the factors influencing them. We then select the most valid data for use in our work. Serious science goes into setting all of the five nutrient standards that comprise the DRI, but setting the RDA demands the most rigorous science and tolerates the least guesswork.

Determining Individual Requirements

One experiment we would review or conduct is a **balance study**. In this type of study, scientists measure the body's intake and excretion of a nutrient to find out how much intake is required to balance excretion. For each individual subject, we can determine a **requirement** to achieve balance for nutrient X. With an intake below the requirement, a person will slip into negative balance or experience declining stores that could, over time, lead to deficiency of the nutrient.

We find that different individuals, even of the same age and sex, have different requirements. Mr. A needs 40 units of the nutrient each day to maintain balance; Mr. B needs 35; Mr. C needs 57. If we look at enough individuals, we find that their requirements are distributed, as shown in Figure 2–3—with most requirements near the midpoint (here, 45) and only a few at the extremes.

Accounting for the Needs of the Population To set the value, we have to decide what intake to recommend for everybody. Should we set it at the mean (45 units in Figure 2–3)? This is the Estimated Average Requirement for nutrient X, mentioned earlier as valuable to scientists and policy makers but not appropriate as an individual's nutrient goal. The EAR value is probably close to everyone's minimum need, assuming the distribution shown in Figure 2–3. (Actually, the data for most nutrients indicate a distribution that is much less symmetrical.) But if people took us literally and consumed exactly this amount of nutrient X each day, half the population would begin to develop nutrient deficiencies and, in time, even observable symptoms of deficiency diseases. Mr. C (at 57 units) would be one of those people.

Perhaps we should set the recommendation for nutrient X at or above the extreme—say, at 70 units a day—so that everyone will be covered. (Actually, we didn't study everyone, and some individual we didn't happen to test might have an even higher requirement.) This might be a good idea in theory, but what about a person like Mr. B who requires only 35 units a day? The recommendation would be twice his requirement, and to follow it, he might spend money needlessly on foods containing nutrient X to the exclusion of foods containing other vital nutrients.

The Decision The decision we finally make is to set the value high enough so that 97 to 98 percent of the population will be covered but not so high as to be excessive (Figure 2–4 illustrates such a value). In this example, a reasonable choice might be 63 units a day. Moving the value farther toward the extreme would pick up a few additional people, but it would inflate the recommendation for most people, including Mr. A and Mr. B. The committee makes judgments of this kind when setting the DRI for many nutrients. Relatively few healthy people have requirements that are not covered by the DRI.

Key Point

- The DRI are based on scientific data and generously cover the needs of virtually all healthy people in the United States and Canada.

*This discussion describes how an RDA value is set. To set an AI value, the committee would use some educated guesswork, as well as scientific research results, to determine an approximate amount of the nutrient most likely to support health.

Figure 2–3
Individuality of Nutrient Requirements

Each square represents a person. A, B, and C are Mr. A, Mr. B, and Mr. C. Each has a different requirement.

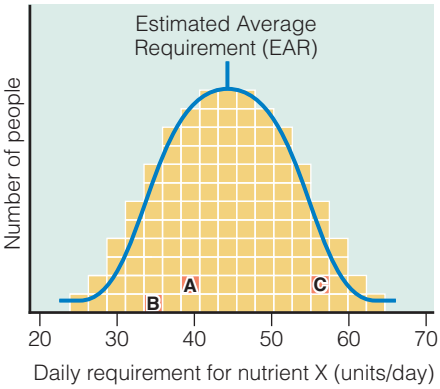
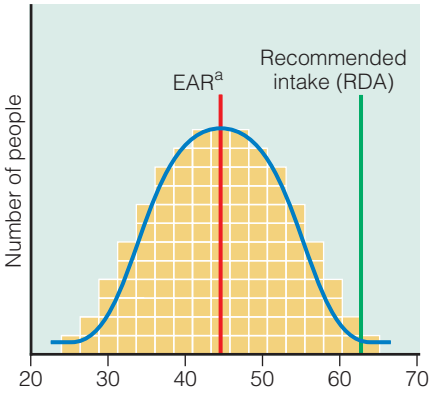


Figure 2–4
Nutrient Recommended Intake: Example

Intake recommendations for most vitamins and minerals are set so that they will meet the requirements of nearly all people.



[a]Estimated Average Requirement

requirement the amount of a nutrient that will just prevent the development of specific deficiency signs; distinguished from the DRI value, which is a generous allowance with a margin of safety.

Setting Energy Requirements

In contrast to the recommendations for nutrients, the value set for energy, the **Estimated Energy Requirement (EER)**, is not generous; instead, it is set at a level predicted to maintain body weight for an individual of a particular age, sex, height, weight, and physical activity level consistent with good health. The energy DRI values reflect a balancing act: enough food energy is critical to support health and life, but too much energy causes unhealthy weight gain. Because even small amounts of excess energy consumed day after day cause unneeded weight gain and increase chronic disease risks, the DRI committee did not set a Tolerable Upper Intake Level for energy.

Key Point

- Estimated Energy Requirements are predicted to maintain body weight and to discourage unhealthy weight gain.

Why Are Daily Values Used on Labels?

On learning about the Daily Values, many people ask why yet another set of nutrient standards is needed for food labels—why not use the DRI? The reason they are not used is that DRI values for a nutrient vary, sometimes widely, to address the different nutrient needs of different population groups. Food labels, in contrast, must list a single value for each nutrient that may be used by anyone who picks up a package of food and reads the label.[4]

The Daily Values reflect the highest level of nutrient need among all population groups, from children of age 4 years through aging adults; for example, the Daily Value for iron is 18 milligrams (mg), an amount that far exceeds a man's RDA of 8 mg (but that meets a young woman's high need precisely). Thus, the Daily Values are ideal for allowing general comparisons among *foods*, but they cannot serve as nutrient intake goals for individuals. The recently updated Daily Values are listed in the back of the book, p. D.

Key Point

- The Daily Values are standards used solely on food labels to enable consumers to compare the nutrient values of foods.

Dietary Guidelines for Americans

LO 2.2 Define the role of the Dietary Guidelines as part of the overall U.S. dietary guidance system.

Appendix B offers World Health Organization (WHO) guidelines.

Many countries set dietary guidelines to answer the question, "What should I eat to stay healthy?" In this country, the U.S. Department of Agriculture publishes its *Dietary Guidelines for Americans* as part of a national nutrition guidance system. Although the DRI values set nutrient intake goals, the *Dietary Guidelines for Americans* offer food-based strategies for achieving them. If everyone followed their advice, people's energy intakes and most of their nutrient needs would easily be met.[5]* Table 2–1 lists the key recommendations of the 2020–2025 Dietary Guidelines.

The Guidelines Promote Health People who follow the Dietary Guidelines—that is, those who stay within their calorie needs, who take in enough of a variety of nutrient-dense foods and beverages, and who make physical activity a habit—often enjoy the best possible health. Only a few people in this country fit this description, however. Instead, well over half of American adults suffer from one or more *preventable* chronic diseases related to poor diets and sedentary lifestyles.[6]

Estimated Energy Requirement (EER) the average dietary energy intake predicted to maintain energy balance in a healthy adult of a certain age, sex, weight, height, and level of physical activity consistent with good health.

*The USDA Dietary Patterns may not meet the DRI for vitamin D or potassium.

Table 2–1

Four Key Dietary Guidelines for Americans 2020–2025

Guideline 1 Follow a healthy dietary pattern at every life stage.

At every life stage—infancy, toddlerhood, childhood, adolescence, adulthood, pregnancy, lactation, and older adulthood—it is never too early or too late to eat healthfully.

- For about the first 6 months of life, exclusively feed infants human milk. If human milk is unavailable, feed infants an iron-fortified commercial infant formula. (Details are in Chapter 13.)
- At about 6 months, introduce infants to nutrient-dense complementary foods. Include foods rich in iron and zinc, particularly for infants fed human milk. (Details are in Chapter 13.)
- From 12 months through older adulthood, follow a healthy dietary pattern across the lifespan to meet nutrient needs, help achieve a healthy body weight, and reduce the risk of chronic disease.

Guideline 2 Customize and enjoy nutrient-dense food and beverage choices to reflect personal preferences, cultural traditions, and budgetary considerations.

A healthy dietary pattern can benefit all individuals regardless of age, race, or ethnicity, or current health status. The *Dietary Guidelines* provides a framework intended to be customized to individual needs and preferences, as well as the foodways of the diverse cultures in the United States.

Guideline 3 Focus on meeting food group needs with nutrient-dense foods and beverages, and stay within calorie limits.

A healthy dietary pattern consists of nutrient-dense forms of foods and beverages across all food groups, in recommended amounts, and within calorie limits. (The food groups and their application are explained in the next section.)

Guideline 4 Limit foods and beverages higher in added sugars, saturated fat, and sodium, and limit alcoholic beverages.

At every life stage, meeting food group recommendations with nutrient-dense choices requires most of a person's daily calorie needs and sodium limits. A healthy dietary pattern doesn't have much room for extra added sugars, saturated fat, or sodium—or for alcoholic beverages. A small amount of added sugar, fat, or sodium can be added to nutrient-dense choices to help meet food group recommendations. Limits are:

- *Added sugars*—Less than 10 percent of calories per day starting at age 2. Avoid foods and beverages with added sugars for those younger than age 2.
- *Saturated fat*—Less than 10 percent of calories per day, starting at age 2.
- *Sodium*—Less than 2,300 milligrams per day—and even less for children younger than age 14.
- *Alcoholic beverages*—Adults of legal drinking age can choose not to drink or to drink in moderation by limiting intake to 2 drinks or less in a day for men and 1 drink or less in a day for women, when alcohol is consumed. Drinking less is better for health than drinking more. Some adults, such as those who are pregnant and people with certain medical conditions, should not drink alcohol.

In previous editions, the Dietary Guidelines applied only to people 2 years of age and older—children, adolescents, and adults. The *2020–2025 Dietary Guidelines for Americans* expanded this scope to include the special needs of people during pregnancy, lactation, and infancy. This change highlights the importance of early nutrition and dietary patterns on later food choices and well-being.

Jacob Lund/Shutterstock.com

The Dietary Guidelines answer the question, "What should I eat to stay healthy?"

How Does the U.S. Diet Compare with the Guidelines? The Dietary Guidelines committee reviewed nationwide survey results reflecting current nutrient intakes, along with biochemical assessments and other forms of evidence. The results are clear: important needed nutrients are undersupplied by the current U.S. diet, while other, less healthful nutrients are oversupplied (see Table 2–2, p. 38).[7] Figure 2–5 (p. 38) shows that, typically, people take in far too few nutritious foods from most food groups when compared with the ideals of the Dietary Guidelines for Americans (discussed fully in the next section). They also take in too many calories and too much red and processed meat, refined grain, added sugar, sodium, and saturated fat. Figure 2–6 (p. 39) displays strategies for applying the guidelines to remedy these problems.

Note that the Dietary Guidelines for Americans do not require that you give up your favorite foods or eat strange, unappealing foods. They advocate achieving a healthy dietary pattern through careful food and beverage choices and not by way of supplements except when medically necessary. With a little planning and a few adjustments, almost anyone's diet can contribute to health instead of disease. Part of the plan must