

Understanding Normal *and* Clinical Nutrition

▶ ELEVENTH EDITION

ROLFES • PINNA
WHITNEY

Understanding Normal & Clinical Nutrition

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Eleventh Edition

Sharon Rady Rolfes
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Australia • Brazil • Mexico • Singapore • United Kingdom • United States

**Understanding Normal & Clinical Nutrition,
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To Ellie Whitney, my mentor, partner, and friend, with much appreciation for believing in me, sharing your wisdom, and giving me the opportunity to pursue a career more challenging and rewarding than any I could have imagined.

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To my parents, John and Tina Pinna, whose zest for learning inspired my own.

Kathryn

To the memory of Gary Woodruff, the editor who first encouraged me to write.

Ellie

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Preface

As we launch this eleventh edition of *Understanding Normal and Clinical Nutrition*, nutrition research continues to uncover the many complex relationships between nutrition and health. Our goals for this edition are to incorporate these current research findings into the core information necessary for an introductory course in nutrition. As with previous editions, each chapter has been substantially updated and revised to include new topics as well as expand on existing topics. The chapters include practical information and valuable resources to help readers apply nutrition knowledge and skills to their daily lives and the clinical setting.

A main objective in writing this book has always been to share our enthusiasm about nutrition in a manner that motivates students to study and learn. Moreover, we seek to provide accurate information that is meaningful to the student or health professional. Students of nutrition often find the subject to be both fascinating and overwhelming; there are so many details to learn—new terms, new chemical structures, and new biological concepts. Taken one step at a time, however, the science of nutrition may seem less daunting and the facts more memorable. We hope that this book serves you well.

A Book Tour of This Edition

Understanding Normal and Clinical Nutrition presents updated, comprehensive coverage of the fundamentals of nutrition and nutrition therapy for an introductory nutrition course. The early chapters introduce the nutrients and their work in the body as well as recommendations about nutrition that are essential for maintaining health and preventing disease. The later chapters provide instruction in clinical nutrition—the pathophysiology and nutrition care for a wide range of medical conditions.

The Chapters Chapter 1 begins by exploring why we eat the foods we do and continues with a brief overview of the nutrients, the science of nutrition, recommended nutrient intakes, and important relationships between diet and health. Chapter 2 describes the menu-planning principles and food guides used to create diets that support good health and includes instructions on how to read a food label. In Chapter 3, readers follow the journey of digestion and absorption as the body breaks down foods into absorbable nutrients. Chapters 4 through 6 describe carbohydrates, fats, and proteins—their chemistry, roles in the body, and places in the diet. Chapter 7 shows how the body derives energy from these three nutrients. Chapters 8 and 9 continue the story with a look at energy balance, the factors associated with overweight and underweight, and the benefits and risks of weight loss and weight gain. Chapters 10

through 13 describe the vitamins, the minerals, and water—their roles in the body, deficiency and toxicity symptoms, and sources. Chapters 14 through 16 complete the “normal” chapters by presenting the special nutrient needs of people through the life cycle—pregnancy and lactation; infancy, childhood, adolescence; and adulthood and the later years.

The remaining “clinical” chapters of the book focus on the nutrition care of individuals with health problems. Chapter 17 explains how illnesses and their treatments influence nutrient needs and describes the process of nutrition assessment. Chapter 18 discusses how nutrition care is implemented and introduces the different types of therapeutic diets used in patient care. Chapter 19 explores the potential interactions between nutrients and medications and examines the benefits and risks associated with herbal products. Chapters 20 and 21 describe specialized methods for providing nutrients to people who are unable to consume a regular diet. Chapter 22 describes the inflammatory process and shows how metabolic and respiratory stress influence nutrient needs. Chapters 23 through 29 explore the pathology, medical treatment, and nutrition therapy for specific diseases, including gastrointestinal disorders, liver disease, diabetes mellitus, cardiovascular diseases, renal diseases, cancer, and HIV infection.

The Highlights Every chapter is followed by a highlight that provides readers with an in-depth look at a current, and often controversial, topic that may relate to its companion chapter. For example, Highlight 4 examines the scientific evidence behind some of the current controversies surrounding carbohydrates and their role in weight gain and weight loss. New to this edition are Critical Thinking Questions designed to encourage readers to develop clear, rational, open-minded, and informed thoughts based on the evidence presented in the highlight.

Special Features The art and layout in this edition have been carefully designed to be inviting while enhancing student learning. For example, numbered steps have been added to several figures to clarify sequences and processes. In addition, special features help readers identify key concepts and apply nutrition knowledge. For example, when a new term is introduced, it is printed in bold type, and a **definition** is provided. These definitions often include pronunciations and derivations to facilitate understanding. The glossary at the end of the text includes all defined terms.

definition (DEF-eh-NISH-en): the meaning of a word.

- **de** = from
- **finis** = boundary

LEARNING GPS

The opening page of each chapter provides a Learning GPS that serves as an outline and directs readers to the main headings (and subheadings) within the chapter. Each main heading is followed by a Learn It—a learning objective for the content covered in that section. The Learn It also appears within the text at the start of each main section as well as at the start of each Review It. After reading and studying the chapter, students should be able to demonstrate competency in the Learn It objectives.

Nutrition in Your Life/Nutrition in the Clinical Setting

Chapters 1 through 16 open with a paragraph called Nutrition in Your Life that introduces the chapter's content in a friendly and familiar way. This short paragraph closes with a preview of how readers might apply that content to their daily lives by inviting them to use the Nutrition Portfolio section at the end of those chapters. Similarly, Chapters 17 through 29 open with a Nutrition in the Clinical Setting paragraph, which introduces real-life concerns associated with diseases or their treatments.

Nutrition Portfolio/Clinical Portfolio

At the end of Chapters 1 through 16, a Nutrition Portfolio prompts readers to consider whether their personal choices are meeting the dietary goals presented in the chapter. Chapters 17 through 29 finish with a Clinical Portfolio section, which enables readers to practice their clinical skills by addressing hypothetical clinical situations. Many of these assignments include instructions that use the Diet & Wellness Plus program. Such tools help students assess their current choices and make informed decisions about healthy options.

► **REVIEW IT** Each major section within a chapter concludes with a Review It paragraph that summarizes key concepts. Similarly, Review It tables cue readers to important summaries.

Also featured in this edition are the 2015–2020 *Dietary Guidelines for Americans*, which are introduced in Chapter 2 and presented throughout the text whenever their subjects are discussed. Look for the following design.

► DIETARY GUIDELINES FOR AMERICANS 2015–2020

These guidelines provide science-based advice to promote health and to reduce the risk of chronic disease through diet and physical activity.

> How To

Many of the chapters include “How To” features that guide readers through problem-solving tasks. For example, a “How

To” in Chapter 1 presents the steps in calculating energy intake from the grams of carbohydrate, fat, and protein in a food.

► **TRY IT** Each “How To” feature ends with a “Try It” activity that gives readers an opportunity to practice these new lessons.

CASE STUDY

The clinical chapters include case studies that present problems and pose questions that allow readers to apply chapter material to hypothetical situations. Readers who successfully master these exercises will be better prepared to face real-life challenges that arise in the clinical setting.

Nutrition Assessment Checklist

The clinical chapters close with Nutrition Assessment Checklists that help readers evaluate how various disorders impair nutrition status. These sections highlight the medical, dietary, anthropometric, biochemical, and physical findings most relevant to patients with specific diseases.

DIET-DRUG Interactions

Most of the clinical chapters also include a section on Diet-Drug Interactions that presents the nutrition-related concerns associated with the medications commonly used to treat the disorders described in the chapter.

The Appendixes The appendixes are valuable references for a number of purposes. Appendix A summarizes background information on the hormonal and nervous systems, complementing Appendixes B and C on basic chemistry, the chemical structures of nutrients, and major metabolic pathways. Appendix D describes measures of protein quality. Appendix E provides supplemental coverage of nutrition assessment, and Appendix F presents the estimated energy requirements for men and women at various levels of physical activity. Appendix G presents the 2014 *Choose Your Foods: Food Lists for Diabetes and Weight Management*. Appendix H is a 4000-item food composition table. Appendix I presents nutrition recommendations from the World Health Organization (WHO).

Appendix J presents the Healthy People 2020 nutrition-related objectives. Appendix K features aids to calculations, a short tutorial on converting metric measures and handling basic math problems commonly found in the world of nutrition. Appendix L provides examples of commercial enteral formulas commonly used in tube feedings or to supplement oral diets.

The Inside Covers The inside covers put commonly used information at your fingertips. The inside front covers (pp. A–C) present the current nutrient recommendations, and the inside back covers feature the Daily Values used on food labels and a glossary of nutrient measures (p. Y on the left) as well as suggested weight ranges for various heights (p. Z on the right).

Notable Changes in This Edition

Because nutrition is an active science, staying current is paramount. Just as nutrition research continuously adds to and revises the accepted body of knowledge, this edition builds on the science of previous editions with the latest in nutrition research. Much has changed in the world of nutrition and in our daily lives since the first edition. The number of foods has increased dramatically—even as we spend less time than ever in the kitchen preparing meals. The connections between diet and disease have become more apparent—and consumer interest in making smart health choices has followed. More people are living longer and healthier lives. The science of nutrition has grown rapidly, with new facts emerging daily. In this edition, as with all previous editions, every chapter has been revised to enhance learning by presenting current information accurately and attractively. For all chapters and highlights we have:

- Reviewed and updated content
- Created several new figures and tables and revised others to enhance learning
- Included 2015-2020 *Dietary Guidelines for Americans*

Chapter 1

- Created table to summarize ways to describe six classes of nutrients
- Introduced *registered dietitian nutritionist (RDN)*, another term to describe an RD

Chapter 2

- Revised section on Dietary Guidelines to reflect 2015–2020 recommendations
- Revised figure comparing nutrient density of two breakfasts to include potassium and vitamin D
- Introduced proposed food labels and revised figure to illustrate differences
- Introduced front-of-package labeling and added figure to illustrate

Chapter 3

- Introduced *microbiome* and revised section on gastrointestinal bacteria

Chapter 4

- Revised table showing nutrients in sugars and other foods to include potassium and vitamin D
- Created tables to define glucose for normal and diabetes; to show the glycemic index of a few common foods; to list the functions of sugars in foods; and to present ways to prevent dental caries
- Included fructose metabolism in the highlight

Chapter 5

- Created tables to define blood lipids for heart health; to list fat choices among protein foods and among milk products; to show omega-3 fatty acid quantities in a variety of fish and seafood
- Created new figure on how to read fish oil supplement labels
- Added definitions for resistin and adiponectin

Chapter 6

- Expanded discussion on the association between dietary protein and body weight

Chapter 7

- Created new figure illustrating labels on beer, wine, and liquor

Chapter 8

- Discussed “3500 kcalorie rule” and its limitations
- Created new tables for estimating energy expended on basal metabolism and on thermic effect of foods and for percent body fat at various BMI
- Revised section on female athlete triad to include new expanded term—Relative Energy Deficiency in Sports (RED-S)—and created new table of its adverse consequences
- Added discussion of food addiction to section on binge eating disorder

Chapter 9

- Added discussion of brite adipocytes to section on brown adipocyte tissue and uncoupling proteins
- Updated table on FDA-approved weight loss drugs
- Revised figure on gastric surgery used to treat obesity
- Deleted discussion and figure on unrealistic expectations
- Created new table of national strategies to prevent obesity
- Updated table on popular weight loss diets

Chapter 11

- Added a paragraph on “golden rice,” a genetically modified rice used in the worldwide fight against vitamin A deficiency
- Added details on vitamin D’s non-bone-related roles
- Rewrote the introduction to vitamin E
- Rewrote the food sources of vitamin K paragraph to include the terms phylloquinone (vitamin K₁) and menaquinone (vitamin K₂)

Chapter 12

- Revised calcium balance figure

Chapter 13

- Created table of factors influencing iron absorption

Chapter 14

- Created several new tables: benefits of WIC, risk factors for gestational diabetes, signs and symptoms of pre-eclampsia, complications from smoking during pregnancy, tips to prevent listeriosis
- Reorganized sections on fetal programming and fetal development of chronic diseases

Chapter 15

- Created several new tables: protective factors in breast milk, tips for picky eaters, examples of foods and non-food items children can choke on, iron recommendations for adolescents
- Added information about fluoride and formula preparation
- Added brief discussion about new AAP guidelines for reduced, low-fat, and fat-free milk for toddlers
- Added discussion of new school meal initiatives

Chapter 16

- Created new figure comparing healthy lens with cataract lens

Chapter 17

- Added a table showing the relationship between the rate of involuntary weight loss and nutritional risk
- Updated the laboratory values in the table on routine laboratory tests
- Added a paragraph about C-reactive protein in the section on biochemical analyses
- Revised the discussion on fluid retention

Chapter 19

- Reorganized the beginning paragraphs of the highlight on complementary and alternative medicine

Chapter 20

- Refined the terms related to nutrition support: introduced the terms *specialized nutrition support* and *oral nutrition support*
- Shortened the section on oral supplements
- Updated the feeding tube photo
- Modified the sections on initiating and advancing tube feedings and meeting water needs

Chapter 21

- Added additional details in the table on patient monitoring during parenteral nutrition
- Revised the section on discontinuing parenteral nutrition
- Revised the glossary definitions in the highlight on ethical issues

Chapter 22

- Added glossary definitions for *complement*, *indirect calorimetry*, and *minute ventilation*
- Revised the sections on estimating energy needs during acute stress, use of glutamine or arginine during acute illness, and micronutrient needs in acute stress
- Modified the How To feature for estimating energy needs using stress factors
- In the table on predictive equations used in ventilator-dependent patients, updated the Ireton-Jones and Penn State equations, and used the Penn State equation in the example
- Shortened the section on causes of chronic obstructive pulmonary disease, and modified some sections on nutrition therapy for respiratory failure

Chapter 23

- Added a discussion about gastroparesis
- Modified some material in the sections on gastritis, gastroesophageal reflux disease, and bariatric surgery; added glossary definitions for *bloating* and *bacterial overgrowth*
- In the section on bariatric surgery, added a figure showing the sleeve gastrectomy surgery

Chapter 24

- Revised some of the material in the sections on constipation, intestinal gas, acute and chronic pancreatitis, cystic fibrosis, celiac disease, irritable bowel syndrome, and diverticular disease of the colon
- Added calcium channel activators to the table of laxatives and bulk-forming agents
- Revised the table of foods that increase intestinal gas
- Introduced the concept of *FODMAPs* and added a definition for *bacterial translocation*

Chapter 25

- Shortened the paragraph on nutrition treatment for hepatitis
- Modified some sections about cirrhosis complications, including the table listing the clinical features of hepatic encephalopathy
- Revised the section on the medical treatment for cirrhosis

Chapter 26

- Updated statistics throughout the chapter
- Added a margin table comparing glycated hemoglobin (HbA_{1c}) and plasma glucose levels
- In the section on diabetic neuropathy, distinguished between peripheral and autonomic neuropathy and added glossary definitions for these two different forms of neuropathy
- Revised various sections on nutrition therapy to reflect the updated clinical guidelines
- Revised the discussion on exchange lists to reflect the food lists released in 2014 (Appendix G was also updated to show the 2014 food lists)
- Added inhaled insulin and sodium-glucose cotransporter 2 (SGLT2) inhibitors to the tables listing the different types of insulin and antidiabetic drugs
- Revised the discussion on insulin use in type 2 diabetes
- Updated several sections in the Nutrition in Practice on metabolic syndrome
- Added a figure showing how metabolic syndrome varies among ethnic groups and removed the figure showing how it varies with age

Chapter 27

- Revised various paragraphs in the sections on atherosclerosis, cardiovascular disease (CVD) risk assessment, CVD lifestyle management, hypertension, and heart failure
- Revised the How To feature about identifying and treating high blood cholesterol
- Eliminated the box on assessing risk of heart disease
- Updated the section on hypertension treatment
- In the highlight on feeding disabilities, revised the section related to altered energy requirements

Chapter 28

- Modified the table on causes of acute kidney injury, and revised the discussion about the evaluation of acute kidney injury
- Updated the section on the evaluation of chronic kidney disease to reflect new clinical practice guidelines
- Clarified and updated some sections related to nutrition therapy for chronic kidney disease to reflect current recommendations

- In the section on kidney stones, introduced hypocitraturia as a risk factor and reformatted the table on food sources of oxalates

Chapter 29

- Updated the tables on factors that influence cancer risk
- Revised the section on biological therapies for cancer to include more examples of cancer immunotherapy; included new definitions for *monoclonal antibodies* and *immune checkpoint inhibitors*
- Revised the section about food safety concerns for immunosuppressed cancer patients
- Expanded the section on the prevention of HIV infection to include a discussion about prophylactic medications used in persons at risk of HIV exposure
- Updated the definition of AIDS-wasting syndrome to reflect current guidelines

Student and Instructor Resources

Nutrition MindTap for Understanding Normal and Clinical Nutrition

MindTap is well beyond an eBook, a homework solution or digital supplement, a resource center website, a course delivery platform, or a Learning Management System. More than 70 percent of students surveyed said that it was unlike anything they have ever seen before. MindTap is a new personal learning experience that combines all of your digital assets—readings, multimedia, activities, and assessments—into a singular learning path to improve student outcomes.

Diet & Wellness Plus

Diet & Wellness Plus helps you gain a better understanding of how nutrition relates to your personal health goals. It enables you to track your diet and activity, generate reports, and analyze the nutritional value of the food you eat! It includes over 55,000 foods in the database, custom food and recipe features, the latest Dietary References, as well as your goal and actual percentages of essential nutrients, vitamins, and minerals. It also helps you to identify a problem behavior and make a positive change. After completing a Wellness Profile questionnaire, Diet & Wellness Plus will rate the level of concern for eight different areas of wellness, helping you determine the areas where you are most at risk. It then helps you put together a plan for positive change by helping you select a goal to work toward, complete with a reward for all your hard work. Diet & Wellness Plus is also available as an App that can be accessed from the App dock in MindTap and can be used throughout the course for students to track their diet, activity, and behavior change.

Global Health Watch

Updated with today's current headlines, Global Health Watch is your one-stop resource for classroom discussion and research projects. This resource center provides access to

thousands of trusted health sources, including academic journals, magazines, newspapers, videos, podcasts, and more. It is updated daily to offer the most current news about topics related to your health course.

Cognero Test Bank

Cengage Learning Testing Powered by Cognero is a flexible, online system that allows you to:

- Author, edit, and manage test bank content from multiple Cengage Learning solutions
- Create multiple test versions in an instant
- Deliver tests from your learning management system (LMS), your classroom, or wherever you want

Instructor's Companion Site

Everything you need for your course in one place! This collection of book-specific lecture and class tools is available online via www.cengage.com/login. Access and download PowerPoint presentations, images, the instructor's manual, videos, and more.

Closing Comments

We have taken great care to provide accurate information and have included many references at the end of each chapter and highlight. To keep the number of references manageable over the decades, however, many statements that appeared in previous editions with references now appear without them. All statements reflect current nutrition knowledge, and the authors will supply references upon request. In addition to supporting text statements, the end-of-chapter references provide readers with resources for finding a good overview or more details on the subject. Nutrition is a fascinating subject, and we hope our enthusiasm for it comes through on every page.

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1

An Overview of Nutrition

Nutrition in Your Life

Believe it or not, you have probably eaten at least 20,000 meals in your life. Without any conscious effort on your part, your body uses the nutrients from those foods to make all its components, fuel all its activities, and defend itself against diseases. How successfully your body handles these tasks depends, in part, on your food choices. Nutritious food choices support healthy bodies. In the Nutrition Portfolio at the end of this chapter, you can see how your current food choices are influencing your health and risk of chronic diseases.

Nutrition has always played a significant role in your life. Every day, several times a day, you select **foods** that influence your body's health. Each day's food choices may benefit or harm health only a little, but over time, the consequences of these choices become major. That being the case, paying close attention to good eating habits now supports health benefits later. Conversely, carelessness about food choices can contribute to **chronic diseases**. Of course, some people will become ill or die young no matter what choices they make, and others will live long lives despite making poor choices. For most of us, however, the food choices we make will benefit or impair our health in proportion to the wisdom of those choices.

Although most people realize food habits affect health, they often choose foods for other reasons. After all, foods bring pleasures, traditions, and associations as well as nourishment. The challenge, then, is to combine favorite foods and fun times with a nutritionally balanced **diet**. Take a moment to review the definition and note that *diet* does *not* mean a restrictive food plan designed for weight loss. It simply refers to the foods and beverages a person consumes. Whether it's a vegetarian diet, a weight-loss diet, or any other kind of diet depends on the types of foods and beverages a person chooses.

LEARNING GPS

1-1 Food Choices 4

LEARN IT Describe how various factors influence personal food choices.

1-2 The Nutrients 6

LEARN IT Name the six major classes of nutrients and identify which are organic and which yield energy.

Nutrients in Foods and in the Body 6

The Energy-Yielding Nutrients:

Carbohydrate, Fat, and Protein 8

The Vitamins 11

The Minerals 11

Water 12

1-3 The Science of Nutrition 12

LEARN IT Explain the scientific method and how scientists use various types of research studies and methods to acquire nutrition information.

Conducting Research 12

Analyzing Research Findings 16

Publishing Research 17

1-4 Dietary Reference Intakes 18

LEARN IT Define the four categories of the DRI and explain their purposes.

Establishing Nutrient Recommendations 18

Establishing Energy Recommendations 20

Using Nutrient Recommendations 21

Comparing Nutrient Recommendations 21

1-5 Nutrition Assessment 22

LEARN IT Explain how the four assessment methods are used to detect energy and nutrient deficiencies and excesses.

Nutrition Assessment of Individuals 22

Nutrition Assessment of Populations 24

1-6 Diet and Health 26

LEARN IT Identify several risk factors and explain their relationships to chronic diseases.

Chronic Diseases 26

Risk Factors for Chronic Diseases 27

Highlight 1 Nutrition Information and Misinformation 30

LEARN IT Recognize misinformation and describe how to identify reliable nutrition information.

nutrition: the science of the nutrients in foods and their actions within the body. A broader definition includes the study of human behaviors related to food and eating.

foods: products derived from plants or animals that can be taken into the body to yield energy and nutrients for the maintenance of life and the growth and repair of tissues.

chronic diseases: diseases characterized by slow progression and long duration. Examples include heart disease, diabetes, and some cancers.

• **chronos** = time

diet: the foods and beverages a person eats and drinks.



Corbis Premium RF/Alamy Stock Photo

1-1 Food Choices

› **LEARN IT** Describe how various factors influence personal food choices.

People decide what to eat, when to eat, how much to eat, and even whether to eat in highly personal ways based on a complex interaction of genetic, behavioral, or social factors rather than on an awareness of nutrition's importance to health.¹ A variety of food choices can support good health, and an understanding of human nutrition helps you make sensible selections more often.

Preferences As you might expect, the number one reason most people choose certain foods is taste—they like the flavor. Two widely shared preferences are for the sweetness of sugar and the savoriness of salt.² High-fat foods also appear to be a universally common preference. Other preferences might be for the hot peppers common in Mexican cooking or the curry spices of Indian cuisine. Research suggests that genetics may influence taste perceptions and therefore food likes and dislikes.³ Similarly, the hormones of pregnancy seem to influence food cravings and aversions (see Chapter 14).

Habit People sometimes select foods out of habit. They eat cereal every morning, for example, simply because they have always eaten cereal for breakfast. Eating a familiar food and not having to make any decisions can be comforting.

Ethnic Heritage and Regional Cuisines Among the strongest influences on food choices are ethnic heritage and regional cuisines. People tend to prefer the foods they grew up eating. Every country, and in fact every region of a country, has its own typical foods and ways of combining them into meals. These cuisines reflect a unique combination of local ingredients and cooking styles. Chowder in New England is made with clams, but in the Florida Keys conch is the featured ingredient. The Pacific Northwest is as famous for its marionberry pie as Georgia is for its peach cobbler. Philly has its cheesesteaks and New Orleans has its oyster po'boys. The "American diet" includes many ethnic foods and regional styles, all adding variety to the diet.

Enjoying traditional **ethnic foods** provides an opportunity to celebrate a person's heritage (see Photo 1-1). People offering ethnic foods share a part of their culture with others, and those accepting the foods learn about another's way of life. Developing **cultural competence** honors individual preferences and is particularly important for professionals who help others plan healthy diets.

Social Interactions Most people enjoy companionship while eating. It's fun to go out with friends for a meal or share a snack when watching a movie together. Meals are often social events, and sharing food is part of hospitality. Social customs invite people to accept food or drink offered by a host or shared by a group—regardless of hunger signals. Chapter 9 describes how people tend to eat more food when socializing with others.

Availability, Convenience, and Economy People often eat foods that are accessible, quick and easy to prepare, and within their financial means. Consumers who value convenience frequently eat out, bring home ready-to-eat meals, or have food delivered. Even when they venture into the kitchen, they want to prepare a meal in 15 to 20 minutes, using less than a half dozen ingredients—and those "ingredients" are often semiprepared foods, such as canned soups and frozen foods.

Consumer emphasis on convenience limits food choices to the selections offered on menus and products designed for quick preparation. Whether decisions based on convenience meet a person's nutrition needs depends on the choices made. Eating a banana or a candy bar may be equally convenient, but the fruit provides more vitamins and minerals and less sugar and fat.

Rising food costs have shifted some consumers' priorities and changed their shopping habits.⁴ They are less likely to buy higher-priced convenience foods and

› **PHOTO 1-1** An enjoyable way to learn about a culture is to taste the ethnic foods.

ethnic foods: foods associated with particular cultural groups.

cultural competence: having an awareness and acceptance of cultures and the ability to interact effectively with people of diverse cultures.

more likely to buy less-expensive store brand items and prepare home-cooked meals. In fact, more than 70 percent of meals are prepared in the home.⁵ Those who frequently prepare their own meals report more positive emotions and healthier food choices.⁶ They tend to eat fast food less often and are more likely to meet dietary guidelines for fat, calcium, fruits, vegetables, and whole grains. Not surprisingly, when eating out, consumers choose low-cost fast-food outlets over more expensive fine-dining restaurants. Foods eaten away from home, especially fast-food meals, tend to be high in calories, total fat, saturated fat, and *trans* fat—which can contribute to a variety of health problems.⁷

Unfortunately, healthful diets that include plenty of fruits and vegetables tend to be more costly than less healthful diets featuring foods containing solid fats and added sugars.⁸ These low-cost foods are often high in calories and low in nutrients.⁹ Consumers can improve the quality of their diets without increasing their spending by choosing more plant-based foods, such as nuts, legumes, and whole grains, and fewer refined grains, red and processed meats, and high-fat milk products.¹⁰

Positive and Negative Associations People tend to like particular foods associated with happy occasions—such as hot dogs at ball games or cake and ice cream at birthday parties. By the same token, people can develop aversions and dislike foods that they ate when they felt sick or that they were forced to eat in negative situations. Similarly, children learn to like and dislike certain foods when their parents use foods as rewards or punishments. Negative experiences can have long-lasting influences on food preferences. More than 50 years after World War II, veterans who had experienced intense combat in the Pacific dislike Chinese and Japanese food significantly more than their peers who were not engaged in battle or those who fought elsewhere.

Emotions Emotions guide food choices and eating behaviors.¹¹ Some people cannot eat when they are emotionally upset. Others may eat in response to a variety of emotional stimuli—for example, to relieve boredom or depression or to calm anxiety. A depressed person may choose to eat rather than to call a friend. A person who has returned home from an exciting evening out may unwind with a late-night snack. These people may find emotional comfort, in part, because foods can influence the brain's chemistry and the mind's response. Carbohydrates and alcohol, for example, tend to calm, whereas proteins and caffeine are more likely to stimulate. Eating in response to emotions and stress can easily lead to overeating and obesity, but it may be helpful at times. For example, sharing food at times of bereavement serves both the giver's need to provide comfort and the receiver's need to be cared for and to interact with others as well as to take nourishment.

Values Food choices may reflect people's religious beliefs, political views, or environmental concerns. For example, some Christians forgo meat on Fridays during Lent (the period prior to Easter), Jewish law includes an extensive set of dietary rules that govern the use of foods derived from animals, and Muslims fast between sunrise and sunset during Ramadan (the ninth month of the Islamic calendar). Some vegetarians select foods based on their concern for animal rights. A concerned consumer may boycott fruit picked by migrant workers who have been exploited. People may buy vegetables from local farmers to save the fuel and environmental costs of foods shipped from far away. They may also select foods packaged in containers that can be reused or recycled. Some consumers accept or reject foods that have been irradiated, grown organically, or genetically modified, depending on their approval of these processes.

Body Weight and Image Sometimes people select certain foods and supplements that they believe will improve their physical appearance and avoid those they believe might be detrimental. Such decisions can be beneficial when based on sound nutrition and fitness knowledge, but decisions based on fads or carried to



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> **PHOTO 1-2** To enhance your health, keep nutrition in mind when selecting foods. To protect the environment, shop at local markets and reuse cloth shopping bags.

extremes undermine good health, as pointed out in the later discussion of eating disorders (Highlight 8).

Nutrition and Health Benefits Finally, of course, many consumers make food choices they believe will improve their health (see Photo 1-2).¹² Food manufacturers and restaurant chefs have responded to scientific findings linking health with nutrition by offering an abundant selection of health-promoting foods and beverages.¹³ Foods that provide health benefits beyond their nutrient contributions are called **functional foods**. Functional foods include whole foods as well as fortified, enriched, or enhanced foods.¹⁴ Whole foods—as natural and familiar as oatmeal or tomatoes—are the simplest functional foods. In some cases, foods have been modified to provide health benefits, perhaps by lowering the *trans*-fat contents. In other cases, manufacturers have fortified foods by adding nutrients or **phytochemicals** that provide health benefits (see Highlight 13). Examples of these functional foods include orange juice fortified with calcium to help build strong bones and margarine made with a plant sterol that lowers blood cholesterol.

Consumers typically welcome new foods into their diets, provided that these foods are reasonably priced, clearly labeled, easy to find in the grocery store, and convenient to prepare. These foods must also taste good—as good as the traditional choices. Of course, a person need not eat any “special” foods to enjoy a healthy diet; many “regular” foods provide numerous health benefits as well. In fact, “regular” foods such as whole grains; vegetables and legumes; fruits; seafood, meats, poultry, eggs, nuts, and seeds; and milk products are among the healthiest choices a person can make.

> **REVIEW IT** Describe how various factors influence personal food choices.

A person selects foods for a variety of reasons. Whatever those reasons may be, food choices influence health. Individual food selections neither make nor break a diet’s healthfulness, but the balance of foods selected over time can make an important difference to health.¹⁵ For this reason, people are wise to think “nutrition” when making their food choices.

1-2 The Nutrients

> **LEARN IT** Name the six major classes of nutrients and identify which are organic and which yield energy.

Biologically speaking, people eat to receive nourishment. Do you ever think of yourself as a biological being made of carefully arranged atoms, molecules, cells, tissues, and organs? Are you aware of the activity going on within your body even as you sit still? The atoms, molecules, and cells of your body continuously move and change, even though the structures of your tissues and organs and your external appearance remain relatively constant. The ongoing growth, maintenance, and repair of the body’s tissues depend on the **energy** and the **nutrients** received from foods.

Nutrients in Foods and in the Body Amazingly, our bodies can derive all the energy, structural materials, and regulating agents we need from the foods we eat (see Photo 1-3). This section introduces the nutrients that foods deliver and shows how they participate in the dynamic processes that keep people alive and well.

Nutrient Composition of Foods Chemical analysis of a food such as a tomato shows that it is composed primarily of water (95 percent). Most of the solid materials are carbohydrates, lipids (fats), and proteins. If you could remove

functional foods: foods that have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels.

phytochemicals (FIE-toe-KEM-ih-cals): nonnutrient compounds found in plants. Some phytochemicals have biological activity in the body.

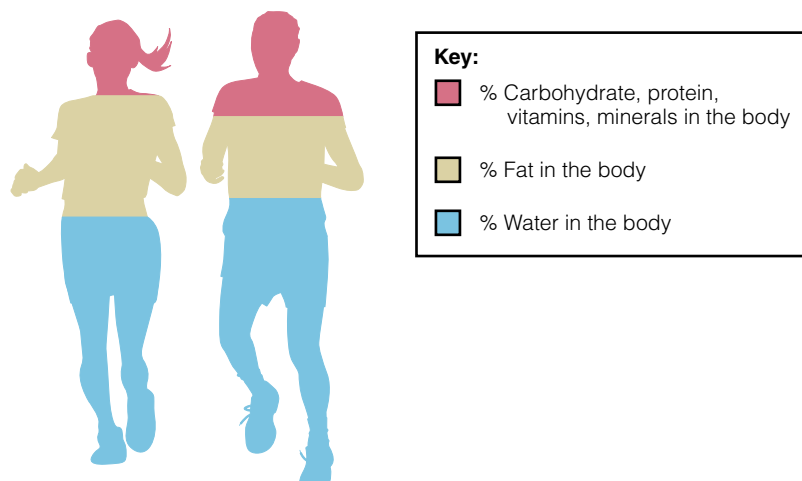
• **phyto** = plant

energy: the capacity to do work. The energy in food is chemical energy. The body can convert this chemical energy to mechanical, electrical, or heat energy.

nutrients: chemical substances obtained from food and used in the body to provide energy, structural materials, and regulating agents to support growth, maintenance, and repair of the body’s tissues. Nutrients may also reduce the risks of some diseases.

> FIGURE 1-1 Body Composition of Healthy-Weight Men and Women

The human body is made of compounds similar to those found in foods—mostly water (60 percent) and some fat (18 to 21 percent for young men, 23 to 26 percent for young women), with carbohydrate, protein, vitamins, minerals, and other minor constituents making up the remainder. (Chapter 8 describes the health hazards of too little or too much body fat.)



these materials, you would find a tiny residue of vitamins, minerals, and other compounds. Water, carbohydrates, lipids, proteins, vitamins, and some of the minerals found in foods represent the six classes of nutrients—substances the body uses for the growth, maintenance, and repair of its tissues.

This book focuses mostly on the nutrients, but foods contain other compounds as well—fibers, phytochemicals, pigments, additives, alcohols, and others. Some are beneficial, some are neutral, and a few are harmful. Later sections of the book touch on these compounds and their significance.

Nutrient Composition of the Body A chemical analysis of your body would show that it is made of materials similar to those found in foods (see Figure 1-1). A healthy 150-pound body contains about 90 pounds of water and about 20 to 45 pounds of fat. The remaining pounds are mostly protein, carbohydrate, and the major minerals of the bones. Vitamins, other minerals, and incidental extras constitute a fraction of a pound.

Chemical Composition of Nutrients The simplest of the nutrients are the minerals. Each mineral is a chemical element; its atoms are all alike. As a result, its identity never changes. For example, iron may have different electrical charges, but the individual iron atoms remain the same when they are in a food, when a person eats the food, when the iron becomes part of a red blood cell, when the cell is broken down, and when the iron is lost from the body by excretion. The next simplest nutrient is water, a compound made of two elements—hydrogen and oxygen. Minerals and water are **inorganic** nutrients—which means they do not contain carbon.

The other four classes of nutrients (carbohydrates, lipids, proteins, and vitamins) are more complex. In addition to hydrogen and oxygen, they all contain carbon, an element found in all living things; they are therefore called **organic** compounds (meaning, literally, “alive”).* This chemical definition of *organic* differs from the agricultural definition. Agriculturally speaking, organic farming refers to growing crops and raising livestock according to standards set by the US Department of Agriculture (USDA). Protein and some vitamins also contain nitrogen and may contain other elements such as sulfur as well.

* Note that this definition of *organic* excludes coal, diamonds, and a few carbon-containing compounds that contain only a single carbon and no hydrogen, such as carbon dioxide (CO₂), calcium carbonate (CaCO₃), magnesium carbonate (MgCO₃), and sodium cyanide (NaCN).



> PHOTO 1-3 Foods bring pleasure—and nutrients.

inorganic: not containing carbon or pertaining to living organisms. The two classes of nutrients that are inorganic are minerals and water.

• **in** = not

organic: in chemistry, substances or molecules containing carbon-carbon bonds or carbon-hydrogen bonds that are characteristic of living organisms. The four classes of nutrients that are organic are carbohydrates, lipids (fats), proteins, and vitamins.

TABLE 1-1 The Six Classes of Nutrients

Nutrient	Organic	Inorganic	Energy-yielding	Macronutrient	Micronutrient
Carbohydrates	✓		✓	✓	
Lipids (fats)	✓		✓	✓	
Proteins	✓		✓	✓	
Vitamins	✓				✓
Minerals		✓			✓
Water		✓			

Essential Nutrients The body can make some nutrients, but it cannot make all of them. Also, it makes some in insufficient quantities to meet its needs and, therefore, must obtain these nutrients from foods. The nutrients that foods must supply are **essential nutrients**. When used to refer to nutrients, the word *essential* means more than just “necessary”; it means “needed from outside the body”—normally, from foods.

The Energy-Yielding Nutrients: Carbohydrate, Fat, and Protein

In the body, three of the organic nutrients can be used to provide energy: carbohydrate, fat, and protein. In contrast to these **energy-yielding nutrients**, vitamins, minerals, and water do not yield energy in the human body.

Carbohydrate, fat, and protein are sometimes called *macronutrients* because the body requires them in relatively large amounts (many grams daily). In contrast, vitamins and minerals are *micronutrients*, required only in small amounts (milligrams or micrograms daily). Table 1-1 summarizes some of the ways the six classes of nutrients can be described.

Energy Measured in kCalories The energy released from carbohydrates, fats, and proteins can be measured in **calories**—tiny units of energy so small that a single apple provides tens of thousands of them. To ease calculations, energy is expressed in 1000-calorie metric units known as kilocalories (shortened to *kcalories*, but commonly called “calories”). When you read in popular books or magazines that an apple provides “100 calories,” it actually means 100 *kcalories*. This book uses the term *kcalorie* and its abbreviation *kcal* throughout, as do other scientific books and journals. How To 1-1 on p. 9 provides a few tips on “thinking metric.”

Energy from Foods The amount of energy a food provides depends on how much carbohydrate, fat, and protein it contains. When completely broken down in the body, a gram of carbohydrate yields about 4 *kcalories* of energy; a gram of protein also yields 4 *kcalories*; and a gram of fat yields 9 *kcalories* (see Table 1-2).^{*} How To 1-2 on p. 10 explains how to calculate the energy available from foods.

Because fat provides more energy per gram, it has a greater **energy density** than either carbohydrate or protein. Figure 1-2 on p. 10 compares the energy density of two breakfast options, and later chapters describe how foods with a high energy density help with weight *gain*, whereas those with a low energy density help with weight *loss*.

One other substance contributes energy—alcohol. Alcohol, however, is not considered a nutrient. Unlike the nutrients, alcohol does not sustain life. In fact, it interferes with the growth, maintenance, and repair of the body. Its only common characteristic with nutrients is that it yields energy (7 *kcalories* per gram) when metabolized in the body.

Most foods contain the energy-yielding nutrients, as well as vitamins, minerals, water, and other substances. For example, meat contains water, fat, vitamins,

TABLE 1-2 kCalorie Values of Energy Nutrients

Nutrients	Energy
Carbohydrate	4 kcal/g
Fat	9 kcal/g
Protein	4 kcal/g

NOTE: Alcohol contributes 7 kcal/g that can be used for energy, but it is not considered a nutrient because it interferes with the body’s growth, maintenance, and repair.

essential nutrients: nutrients a person must obtain from food because the body cannot make them for itself in sufficient quantity to meet physiological needs; also called *indispensable nutrients*. About 40 nutrients are currently known to be essential for human beings.

energy-yielding nutrients: the nutrients that break down to yield energy the body can use:

- carbohydrate
- fat
- protein

calories: a measure of *heat* energy. Energy provided by foods and beverages is measured in *kilocalories* (1000 calories equal 1 kilocalorie), abbreviated *kcalories* or *kcal*. One *kcalorie* is the amount of heat necessary to raise the temperature of 1 kilogram (kg) of water 1°C. The scientific use of the term *kcalorie* is the same as the popular use of the term *calorie*.

energy density: a measure of the energy a food provides relative to the weight of the food (*kcalories* per gram).

^{*}For those using kilojoules: 1 g carbohydrate = 17 kJ; 1 g protein = 17 kJ; 1 g fat = 37 kJ; and 1 g alcohol = 29 kJ.

>1-1 How To

Think Metric

Like other scientists, nutrition scientists use metric units of measure. They measure food energy in kilocalories, people's height in centimeters, people's weight in kilograms, and the weights of foods and nutrients in grams, milligrams, or micrograms. For ease in using these measures, it helps to remember that the prefixes imply 1000. For example, a *kilogram* is 1000 grams, a *milligram* is 1/1000 of a gram, and a *microgram* is 1/1000 of a milligram.

Most food labels and many recipes provide "dual measures," listing both

household measures, such as cups, quarts, and teaspoons, and metric measures, such as milliliters, liters, and grams. This practice gives people an opportunity to gradually learn to "think metric."

A person might begin to "think metric" by simply observing the measure—by noticing the amount of soda in a 2-liter bottle, for example. Through such experiences, a person can become familiar with a measure without having to do any conversions.

The international unit for measuring food energy is the joule—the amount of energy expended when 1 kilogram is moved 1 meter by a force of 1 newton. The joule is thus a

measure of work energy, whereas the calorie is a measure of heat energy. While many scientists and journals report their findings in kilojoules (kJ), many others, particularly those in the United States, use calories (kcal). To convert energy measures from calories to kilojoules, multiply by 4.2; to convert kilojoules to calories, multiply by 0.24. For example, a 50-kcalorie cookie provides 210 kilojoules:

$$50 \text{ kcal} \times 4.2 = 210 \text{ kJ}$$

Appendix K provides assistance and conversion factors for these and other units of measure.

Volume: Liters (L)

1 L = 1000 milliliters (mL)
0.95 L = 1 quart
1 mL = 0.03 fluid ounces
240 mL = 1 cup



A liter of liquid is approximately one US quart. (Four liters are only about 5 percent more than a gallon.)



One cup of liquid is about 240 milliliters; a half-cup of liquid is about 120 milliliters.

Weight: Grams (g)

1 g = 1000 milligrams (mg)
1 g = 0.04 ounce (oz)
1 oz = 28.35 g (or 30 g)
100 g = 3½ oz
1 kilogram (kg) = 1000 g
1 kg = 2.2 pounds (lb)
454 g = 1 lb



A half-cup of vegetables weighs about 100 grams; one pea weighs about ½ gram.

© Thomas Harm & Tom Peterson/Quest Photographic, Inc.



A 5-pound bag of potatoes weighs about 2 kilograms, and a 176-pound person weighs 80 kilograms.

Stephen Barnes/Farming/Alamy Stock Photo

> **TRY IT** Convert your body weight from pounds to kilograms and your height from inches to centimeters.

and minerals as well as protein. Bread contains water, a trace of fat, a little protein, and some vitamins and minerals in addition to its carbohydrate. Only a few foods are exceptions to this rule, the common ones being sugar (pure carbohydrate) and oil (essentially pure fat).