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# Nutrition Through the Life Cycle

8th Edition



Judith Brown

# Nutrition

Through the **Life Cycle**

8th Edition

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***Nutrition Through the Life Cycle, Eighth Edition***  
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WCN: 02-300

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Library of Congress Control Number: 2023910892

Student Edition:

ISBN: 978-0-357-73042-3

Loose-leaf Edition:

ISBN: 978-0-357-73043-0

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# Preface

**It is our privilege to offer you the 8th edition of *Nutrition Through the Life Cycle*.** This text was initially developed, and has been revised, to address the needs of instructors teaching, and students taking, a two- to four-credit course in life-cycle nutrition. It is written at a level that assumes students have taken an introductory nutrition course. Overall, the text is intended to give instructors a tool they can productively use to enhance their teaching efforts, and to give students an engaging and rewarding educational experience they will carry with them throughout their lives and careers.

The authors of *Nutrition Through the Life Cycle* represent a group of experts with experience in clinical practice, teaching, and research related to nutrition during specific phases of the life cycle. All of us remain totally dedicated to the goals established for the text at its conception: to make the text comprehensive, logically organized, evidence-based, realistic, and relevant to the needs of instructors and students.

Chapter 1 summarizes key elements of introductory nutrition and gives students a chance to update or renew their knowledge. Students can test their knowledge of many aspects of introductory nutrition by answering the review questions listed at the end of the chapter. Coverage of the life-cycle phases begins with preconception nutrition and continues with each major phase of the life cycle through adulthood and the needs of older adults. Each of these 19 chapters was developed based on a common organizational framework that includes learning objectives, prevalence statistics, physiological principles, nutritional needs and recommendations, model programs, case studies, and recommended practices. Chapters end with a list of key points and review questions.

To meet the needs of students with the variety of career goals represented in many life-cycle nutrition courses, we include two chapters for each life-cycle phase. The first chapter for each phase covers normal nutrition topics, and the second covers nutrition-related conditions and interventions. Every chapter focuses on scientifically based information and employs up-to-date resources and references.

## New to the Eighth Edition

Advances in knowledge about nutrition and health through the life cycle are expanding at a remarkably high rate. New research is taking our understanding of the roles played by healthy dietary patterns, nutrients, gene variants and nutrient–gene interactions, body fat, physical activity, and dietary supplements to new levels. You will see in this edition these emerging areas of direct relevance to nutrition addressed as well as the new tools available through the updated MyPlate.gov resources.

## Chapter-by-Chapter Changes

Advances in knowledge about nutrition and health across the life cycle occur frequently and these advances have led to changes in the eighth edition of *Nutrition Through the Life Cycle*. Review questions and case studies have been revised to match the updated content.

Following are the major changes to the chapters.

### Chapter 1: Nutrition Basics

- Included information on the Daily Recommended Intake (DRI) for Energy update
- Updated information and images for the Nutrition Facts Label
- Strengthened the section on food security/insecurity
- Updated information on trans fats
- Expanded the section on eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) intake
- Strengthened the section on the top chronic conditions Americans are facing
- Included updated Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) eligibility standards
- Updated Healthy People 2030 Objectives
- Updated the key elements of the *Dietary Guidelines for Americans 2020–2025*

### Chapter 2: Preconception Nutrition

- Updated data and statistics throughout the chapter
- Revised folic acid supplementation levels in fortified cereals
- Updated the Healthy People 2030 Objectives related to pregnancy and childbirth

### Chapter 3: Preconception Nutrition: Conditions and Interventions

- Updated data and prevalence of metabolic syndrome
- Expanded the section on metabolic healthy individuals
- Strengthened the section on gestational diabetes
- Updated gluten-free section including requirements for the nutrition facts label
- Provided new gluten-free images
- Updated prevalence of weight criteria including underweight, normal weight, overweight, and obesity

# Preface

- Added a section on dysgeusia including a definition
- Expanded the section on surrogate pregnancy and increased risk factors in this population

## Chapter 4: Nutrition During Pregnancy

- Provided updated DRI for energy during pregnancy
- Updated the infant mortality rate per 1,000 births chart
- Defined the heart is the first functional organ to develop
- Expanded the section on intrauterine growth restriction (IUGR) and included fetal growth restriction as the updated terminology
- Described the impact of obesity on miscarriage risks and rates
- Updated mortality charts for both women and infants
- Revised the birthweight by gestational age chart
- Updated the rates of preterm delivery, low birthweight in the United States by ethnic backgrounds
- Updated Fish Advice image
- Updated food safety guidelines image

## Chapter 5: Nutrition During Pregnancy: Conditions and Interventions

- Updated pregnancy outcomes related to pre-pregnancy weight
- Expanded the section on bariatric surgery to include more updated surgery options
- Included a section on metabolic surgery as one of the reasons for undergoing bariatric surgery
- Strengthened the section on gestational diabetes
- Provided updates and risk factors impacting pregnancy
- Strengthened the section on multifetal pregnancy
- Updated data on twin birth weights

## Chapter 6: Nutrition During Lactation

- Updated breastfeeding information
- Provided updated DRI for energy during lactation
- Added a new chart on nutritional components of mammal milk
- Strengthened the section on colostrum, including updating data on composition of colostrum and mature milk
- Expanded the section on growth in the breastfed infant
- Expanded information on cholesterol in human milk
- Added key term *human milk oligosaccharide* and provided information
- Strengthened the vitamin D section
- Expanded the section on benefits to breastfeed for women

- Expanded the section on presenting the breast to the suckling infant
- Strengthened the section on infant colic
- Updated the Healthy People 2030 Objectives for breastfeeding
- Added information on the Texas 10-step program
- Expanded the section on baby-friendly hospital practices and updated the mPINC indicators associated with the ten steps for successful breastfeeding
- Added information in the Model Breastfeeding promotion programs
- Updated the Centers for Disease Control and Prevention (CDC) breastfeeding report card data information including in the rates of any and exclusive breastfeeding table

## Chapter 7: Nutrition During Lactation: Conditions and Interventions

- Expanded the section on flat/inverted nipples
- Added a section on small or large nipples
- Included a new key term: *milk bleb/milk blister*
- Expanded the section on hyperlactation
- Updated the mastitis section
- Strengthened the section on Domperidone use
- Strengthened the section on use of galactagogues
- Added a section on e-cigarettes
- Expanded the section on marijuana
- Added a section on methadone
- Updated information on multiple births and neonatal intensive-care unit (NICU) stay on breastfeeding
- Added information on the impact of the COVID-19 pandemic for breastfeeding support
- Strengthened the section on colic and food intolerances
- Expanded model programs to include the Hear Her Campaign

## Chapter 8: Infant Nutrition

- Updated nutrition-related baseline and target measures for infants in the U.S. Healthy People 2030 Objectives
- Updated U.S. vital statistics data related to infant birth and infant mortality
- Added information and table on responsive feeding
- Added section on *Dietary Guidelines for Americans 2020–2025* with inclusion for the first time of recommendations for infants
- Updated information on infant formula types and indications for use

# Preface

- Added new section on baby-led weaning
- Added information and table on healthy beverage consumption in early childhood from the Healthy Eating Research Expert Panel

## Chapter 9: Infant Nutrition: Conditions and Interventions

- Provided updated DRI for energy for infants
- Updated information on nutrient composition of infant formulas
- Expanded section on growth in preterm infants: How to determine corrected age, how to plot measurements on the World Health Organization (WHO) growth charts, and how to assess growth

## Chapter 10: Toddler and Preschooler Nutrition

- Updated Healthy People objectives with 2030 information
- Revised the estimated energy requirements and table for boys and girls with the updated DRI for energy information and calculations
- Updated charts with total kcaloric intake of carbohydrates, protein, and fat
- Provided information on new growth charts for boys and girls 2–18 years for extended body mass index (BMI)
- Updated poverty percentages including ethnic groups at risk
- Updated changes to the Childrens Food and Beverage Advertising Initiative (CFBAI)
- Expanded the section on blood levels
- Updated information on dental carries
- Strengthened the section on food security to include the impact of COVID-19
- Updated information on prevalence of overweight and obese toddlers and preschool-aged children

## Chapter 11: Toddler and Preschooler Nutrition: Conditions and Interventions

- Updated information on children with special health needs
- Strengthened the section on Avoidant Restrictive Food Intake Disorder (ARFID)
- Added additional information on celiac disease
- Expanded the section on asthma and included ethnic groups at risk

- Added information on parents' self-diagnosis of food allergies in their children and implications
- Added a section on COVID-19 pandemic

## Chapter 12: Child and Preadolescent Nutrition

- Updated statistics of children living in poverty and without health insurance
- Provided updated DRI for energy for children and preadolescents
- Included Healthy People 2030 Objectives related to school-aged children
- Included American Academy of Pediatrics 2020 policy statement on digital advertising to school-aged children
- Provided data about dietary intake of school-aged children related to *Dietary Guidelines for Americans 2020–2025*
- Included most recent Academy of Nutrition and Dietetics position paper on treatment of pediatric overweight and obesity
- Provided data on the relationship between soft drink consumption, BMI, and trends in sugar-sweetened beverage intake
- Updated information on nutrition education in schools
- Added information on the impact of the COVID-19 pandemic on the food security of school-aged children

## Chapter 13: Child and Preadolescent Nutrition: Conditions and Interventions

- Included information from the National Survey of Children's Health, including statistics on children with special health-care needs
- Updated statistics about children in schools with specific learning disabilities, speech and language impairment, autism, developmental delay, and other medical conditions
- Expanded information on pediatric feeding disorders
- Updated information on children with attention-deficit/hyperactivity disorder (ADHD)

## Chapter 14: Adolescent Nutrition

- Updated to reflect the *Dietary Guidelines for Americans 2020–2025* scientific report
- Updated information related to frequency of consuming meals and snacks
- Updated information regarding current intake of food groups



# Preface

- Updated information on school meals program regulations and best practices
- Modified illustrations and tables
- Provided updated DRI for energy during adolescence

## Chapter 15: Adolescent Nutrition: Conditions and Interventions

- Updated information on prevalence and treatment of overweight and obesity among teens
- Updated information on disordered eating and eating disorders among teens
- Updated content related to screening and intervention for chronic health conditions
- Modified illustrations and tables

## Chapter 16: Adult Nutrition

- Updated statistics to reflect latest available information
- Added the term *health inequity* and differentiated it from *health disparity*
- Provided updated DRI for energy for adults
- Included the impact of gender-affirming intervention on body composition for transgender persons
- Added a section on immunosenescence and the relationship of adipose tissue with immune function and inflammation
- Incorporated latest information from *Dietary Guidelines for Americans*, including concern about the contribution of beverages to excess caloric intake
- Noted newer alcohol consumption study findings that question the protective effect of moderate amounts of alcohol and raise concerns about binge drinking among younger adults
- Revised the Case Study to feature a Somali woman dealing with physical training and fasting during Ramadan

## Chapter 17: Adult Nutrition: Conditions and Interventions

- Added definitions and new content for precision nutrition, metabolically healthy obesity, intermittent fasting, time-restricted eating, cardiovascular health score and primordial prevention
- Included special considerations in the screening and management of obesity and chronic conditions among transgender persons and gender minorities
- Expanded content to distinguish between metabolically healthy obesity and unhealthy obesity
- Expanded assessment of obesity to include visceral fat assessment and body composition

- Updated obesity and diabetes sections to Incorporated latest evidence-based recommendations
- Revised the bariatric surgery section and noted its broader application to metabolic disease
- Included newer emphasis on preserving health through earlier, upstream action, including consideration of the social determinants of health, and culturally relevant, personalize intervention, with special initiatives to reach underserved and vulnerable populations
- Emphasized the role of intensive, multicomponent interventions for weight management and chronic disease intervention to bring about lifestyle change
- Noted cancer disparities experienced by persons in marginalized populations, and new initiatives to improve cancer screening, diagnosis, treatment and outcomes for these populations
- Revised Table 17.1 to contrast causes of death by decades of the adult years
- Removed the section on HIV/AIDS

## Chapter 18: Nutrition and Older Adults

- Updated statistics of all the sections and their corresponding references
- Revised the life expectancy section
- Updated Healthy People (HP) to included HP 2030
- Revised the section on Dietary Recommendations for Older adults and replaced the *Dietary Guidelines (DG) 2015–2020* with the *DG 2020–2025*.
- Deleted the Tufts University and University of Florida MyPlate for older adults and replaced with USDA MyPlate for different life stages
- Added the new estimated energy requirement equations released by the National Academies of Sciences, Engineering and Medicine in 2023
- Revised the fat and cholesterol section
- Updated the nutrient intake sections
- Added the *2018 Physical Activity Guidelines for Americans*
- Revised the community food and nutrition programs section
- Took out the store-to-door non-governmental small food program
- Revised and updated most of the tables and deleted illustrations 18.4 and 18.5
- Deleted Appendix A
- Provided updated DRI for energy for older adults



# Preface

## Chapter 19: Nutrition and Older Adults: Conditions and Interventions

- Updated the statistics in all the sections and the corresponding references
- Revised the nutritional remedies for cardiovascular diseases section and updated the American Heart Association (AHA) guidelines for cardiovascular disease.
- Revised the section on alcohol
- Revised the section on diabetes nutrition interventions
- Updated the expert consensus on bone health
- Updated the definition of constipation
- Updated the section on cognitive impairment, dementia, and Alzheimer's disease
- Updated osteoarthritis risk factors and potential remedies
- Deleted Tables 19.3 and 19.16

## Student and Instructor Resources

**MindTap:** Today's leading online learning platform, MindTap for Brown's *Nutrition Through the Life Cycle*, 8th Edition, gives the instructor complete control of the course to craft a personalized, engaging learning experience that challenges students, builds confidence, and elevates performance.

MindTap introduces students to core concepts from the beginning of the course, using a simplified learning path that progresses from understanding to application and delivers access to eTextbooks, study tools, interactive media, auto-graded assessments, and performance analytics.

Use MindTap for Brown's *Nutrition Through the Life Cycle*, 8th Edition as is, or personalize it to meet specific course needs. Instructors can also easily integrate MindTap into their Learning Management System (LMS).

**Instructor 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](http://www.cengage.com/login). Download PowerPoint presentations, the instructor's manual, and more.

**Test Bank with Cognero:** 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 solutions.
- Create multiple test versions in an instant.
- Deliver tests from your LMS, your classroom, or wherever you want.

**Diet & Wellness Plus:** Diet & Wellness Plus is a Diet Analysis app that helps students understand how nutrition relates to their personal health goals. Track diet and activity, generate reports, and analyze the nutritional value of the food you eat, for a picture of your total health. Diet & Wellness Plus includes more than 80,000 foods with information pulled from a verified database.

## Acknowledgments

It takes the combined talents and efforts of authors, editors, assistants, and the publisher to develop a new edition of a textbook and its instructional resources. We have had the pleasure of working with an ambitious and thorough group of professionals at Cengage, including Courtney Heilman, senior product manager; Paula Dohnal, senior learning designer; and Caitlin Bonaventure, content manager. Their careful and complete work on the development and implementation of this new edition is appreciated greatly. Lori Hazzard, senior project manager from MPS Limited, once again served as the textbook producer. She kept us on time and on target in an effective and thoughtful way.

# Preface

## Reviewers

Many thanks to the following reviewers, whose careful reading and thoughtful comments helped enormously in shaping revisions to the 8th edition.

Jennifer Bean  
University of Missouri

Jane Burrell  
Syracuse University

Cinda Catchings  
Alcorn State University

Dorothy Chen Maynard  
California State University, San  
Bernardino

Janet Colson  
Middle Tennessee State University

Reynollette Ettienne  
University of New England

Mary Katherine Lockwood  
University of New Hampshire

Keith Pearson  
Samford University

Linda Shepherd  
College St. Benedict/St. John's  
University

Aimee Tritt  
University of Minnesota, Twin  
Cities

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May you enjoy using this text as much as the authors relish the opportunity of making it available to you.

Judith Brown *with*  
Ellen Lechtenberg  
Robyn Wong  
Beth L. Leonberg  
Jamie Stang  
Patricia Splett  
Nadine Sahyoun



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# Nutrition Basics

Prepared by Judith E. Brown with Ellen Lechtenberg

## Learning Objectives

After studying the materials in this chapter, you should be able to:

- 1.1 Understand the meaning of the nutrition concepts presented.
- 1.2 Read and understand the elements of nutrition labels; you will be able to understand the nutritional value of most food products.
- 1.3 Cite two examples of how nutrient needs change during the life cycle and how nutritional status at one stage during the life cycle can influence health status during another.
- 1.4 Describe the components of individual-level nutrition assessment.
- 1.5 Identify the basic elements of four public food and nutrition programs.
- 1.6 Design a healthy dietary pattern.

# Introduction

Need to freshen up your knowledge of nutrition? Or do you need to get up to speed on basic nutrition for the course? This chapter presents information about nutrition that paves the way to understanding specific needs and benefits related to nutrition by life-cycle stage.

Nutrition is an interdisciplinary science focused on the study of how foods, **nutrients**, and other food constituents affect health. The body of knowledge about nutrition is large and is growing rapidly, changing views on what constitutes the best nutrition advice. You are encouraged to stay up to date on the best nutrition advice for diet- and health-related issues.

This chapter centers on (1) the principles of the science of nutrition, (2) nutrients and other constituents of food, (3) healthy dietary patterns, (4) public food and nutrition programs, (5) nutritional assessment, and (6) nationwide priorities for improvements in the public’s nutritional health.

## 1.1 Principles of the Science of Nutrition

Every field of science is governed by a set of principles that provides the foundation for growth in knowledge. These principles change little with time. Knowledge of the principles of nutrition, listed in Table 1.1, will serve as a springboard to greater understanding of the nutrition and health relationships explored in the chapters to come.

### Nutrition Principle 1

Food is a basic need of humans.

Humans need enough food to live and the right assortment of foods for optimal health (Figure 1.1). People who can acquire and consume food to meet their needs at all times experience **food security**. They may acquire food in socially appropriate ways and legal means in the United States—such as purchasing food from grocers or markets without needing to scavenge or illegally acquire food. **Food insecurity** exists when the availability of safe, nutritious foods, or the ability to acquire them in socially appropriate ways and legal means, is limited or uncertain.<sup>1</sup>

**nutrients** Chemical substances in foods that are used by the body for growth and health.

**food security** Access at all times to a sufficient supply of safe, nutritious foods.

**food insecurity** Limited or uncertain availability of safe, nutritious foods, or the ability to acquire them in socially acceptable, legal ways.

**calorie** A unit of measure of the amount of energy supplied by food. Also known as the “kilocalorie” (kcal), or the “large Calorie.”

Table 1.1 Principles of human nutrition

|                               |  |
|-------------------------------|--|
| <b>Nutrition Principle 1</b>  | Food is a basic need of humans.  |
| <b>Nutrition Principle 2</b>  | Foods provide energy (calories), nutrients, and other substances needed for growth and health.                     |
| <b>Nutrition Principle 3</b>  | Health problems related to nutrition originate within cells.   |
| <b>Nutrition Principle 4</b>  | Poor nutrition can result from both inadequate and excessive levels of nutrient intake.                            |
| <b>Nutrition Principle 5</b>  | Humans have adaptive mechanisms for managing fluctuations in food intake.  |
| <b>Nutrition Principle 6</b>  | Malnutrition can result from poor diets and from disease states, genetic factors, or combinations of these causes. |
| <b>Nutrition Principle 7</b>  | Some groups of people are at higher risk of becoming inadequately nourished than others.                           |
| <b>Nutrition Principle 8</b>  | Poor nutrition can influence the development of certain chronic diseases.  |
| <b>Nutrition Principle 9</b>  | Adequacy, variety, and balance are key characteristics of healthy dietary patterns.                                |
| <b>Nutrition Principle 10</b> | There are no “good” or “bad” foods.  |

It exists in 10.5 percent of households within the United States and 15.9 percent of households in Canada in 2020. In the United States, 21 percent of Black households experienced food insecurity. Indigenous Peoples in Canada had significant higher food insecurity with 30.7 percent experiencing limitations and uncertainty during this same time.<sup>2,3</sup>

### Nutrition Principle 2

Foods provide energy (calories), nutrients, and other substances needed for growth and health.

People eat foods for many different reasons. The most compelling reason is the requirement for **calories** (energy), nutrients, and other substances supplied by foods for growth and health.

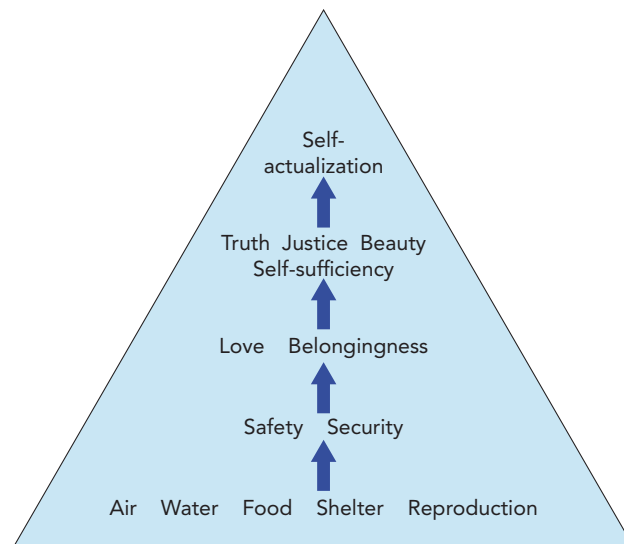


Figure 1.1 The need for food is part of Maslow’s hierarchy of needs.



A calorie is a measure of the amount of energy transferred from food to the body. Because calories are a unit of measure and not a substance actually present in food, they are not considered to be nutrients.

Nutrients are chemical substances in food that the body uses for a variety of functions that support growth, tissue maintenance and repair, and ongoing health. Essentially, every part of our body was once a nutrient consumed in food. There are six categories of nutrients (listed in Table 1.2). Each category except water consists of a number of different substances.

## Essential and Nonessential Nutrients

Of the many nutrients required for growth and health, some must be provided by the diet while others can be made by the body.

**Essential Nutrients** Nutrients the body cannot manufacture, or generally produce in adequate amounts, are referred to as **essential nutrients**. Here, *essential* means “required in the diet.” All of the following nutrients are considered essential:

- Carbohydrates
- Certain amino acids (the **essential amino acids**: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine)
- Linoleic acid and alpha-linolenic acid (essential fatty acids)
- Vitamins
- Minerals
- Water

**Table 1.2** The six categories of nutrients

|                         |  |
|-------------------------|--|
| 1. <b>Carbohydrates</b> | Chemical substances in foods that consist of a single sugar molecule or multiples of sugar molecules in various forms. Sugar and fruit, starchy vegetables, and whole grain products are good dietary sources.   |
| 2. <b>Proteins</b>      | Chemical substances in foods that are made up of chains of amino acids. Animal products and dried beans are examples of protein sources.   |
| 3. <b>Fats (Lipids)</b> | Components of food that are soluble in fat but not in water. They are more properly referred to as “lipids.” Most fats are composed of glycerol attached to three fatty acids. Oil, butter, sausage, and avocado are examples of rich sources of dietary fats. |
| 4. <b>Vitamins</b>      | Fourteen specific chemical substances that perform specific functions in the body. Vitamins are present in many foods and are essential components of the diet. Vegetables, fruits, and grains are good sources of vitamins.                                   |
| 5. <b>Minerals</b>      | In the context of nutrition, minerals consist of 15 elements found in foods that perform particular functions in the body. Milk; dark, leafy vegetables; and meat are good sources of minerals.  |
| 6. <b>Water</b>         | An essential component of the diet provided by food and fluid.   |

**Nonessential Nutrients** Cholesterol, creatine, and glucose are examples of nonessential nutrients. **Nonessential nutrients** are present in food and used by the body, but they do not have to be part of our diets. Many of the beneficial chemical substances in plants are not considered essential, for example, yet they play important roles in maintaining health.

**Requirements for Essential Nutrients** All humans require the same set of essential nutrients, but the amount of nutrients needed varies, based on:

- Age
- Body size
- Biological sex
- Genetic traits
- Growth
- Illness
- Physical activity
- Medication use
- Pregnancy and lactation

Amounts of essential nutrients required each day vary a great deal, from cups (for water) to micrograms (e.g., for folate and vitamin B<sub>12</sub>).

## Dietary Intake Standards

Dietary intake standards developed for the public cannot account for all of the factors that influence nutrient needs, but they do account for the major ones of age, biological sex, growth, and pregnancy and lactation. Intake standards are called Dietary Reference Intakes (DRIs).

- *Dietary Reference Intakes (DRIs)*. This is the general term used for the nutrient intake standards for healthy people.
- *Recommended Dietary Allowances (RDAs)*. These are levels of essential nutrient intake judged to be adequate to meet the known nutrient needs of practically all (98 percent) of healthy people while decreasing the risk of certain chronic diseases.
- *Adequate Intakes (AIs)*. These are “tentative” RDAs. AIs are based on less conclusive scientific information than are the RDAs.

**essential nutrients** Substances required for growth and health that cannot be produced, or produced in sufficient amounts, by the body. They must be obtained from the diet.

**essential amino acids** Amino acids that cannot be synthesized in adequate amounts by humans and therefore must be obtained from the diet. Also called *indispensable amino acids*.

**nonessential nutrients** Nutrients required for growth and health that can be produced by the body from other components of the diet.

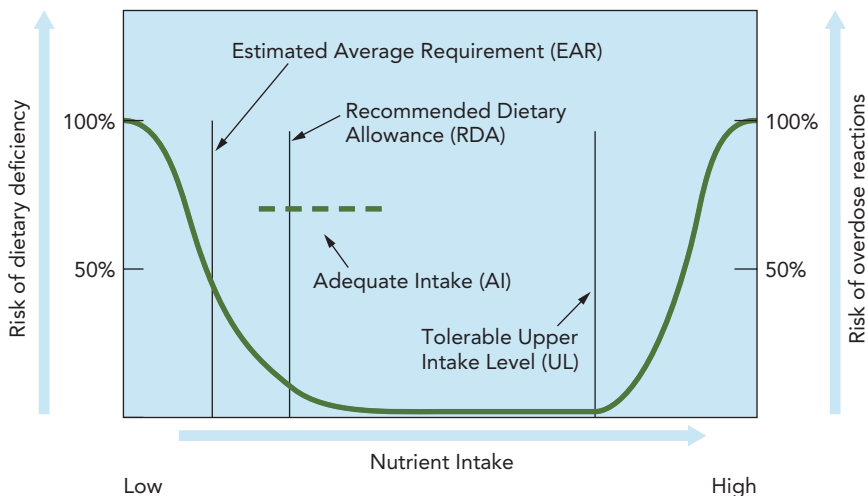
- *Estimated Average Requirements (EARs)*. These are nutrient intake values that are estimated to meet the requirements of half the healthy individuals in a group. The EARs are used to assess adequacy of intakes of population groups.
- *Tolerable Upper Intake Levels (ULs)*. These are upper limits of nutrient intake compatible with health. The ULs do not reflect desired levels of intake. Rather, they represent total, daily levels of nutrient intake from food, fortified foods, and supplements that should not be exceeded.

DRIs have been developed for most of the essential nutrients and will be updated periodically. (These are included at the end of this text.) Current DRIs were developed through a joint U.S.–Canadian effort, and the standards apply to both countries. The DRIs are levels of nutrient intake intended for use as reference values for planning and assessing diets for healthy people. They consist of the RDAs and the other categories of intake standards described in Figure 1.2. It is recommended that individuals aim for nutrient intakes that approximate the RDAs or AI levels. Additional tests are required to confirm inadequate nutrient intakes and status.<sup>4,5</sup>

## Standards of Nutrient Intake for Nutrition Labels

The Nutrition Facts panel on packaged foods uses standard levels of nutrient intakes based on an earlier edition of recommended dietary intake levels. The levels are known as **Daily Values (DVs)** and are used to identify the

**daily values (DVs)** Scientifically agreed-upon standards for daily intakes of nutrients from the diet developed for use on nutrition labels.



**Figure 1.2** Theoretical framework, terms, and abbreviations used in the Dietary Reference Intakes.

**Table 1.3** Daily Values (DVs) for nutrition labeling based on intakes of 2000 calories per day in adults and children aged 4 years and above

| Mandatory Components of the Nutrition Label |                     |
|---|---------------------|
| Food Component                              | Daily Value (DV)    |
| Total fat                                   | 78 g <sup>a</sup>   |
| Saturated fat                               | 20 g                |
| Cholesterol                                 | 300 mg <sup>a</sup> |
| Sodium                                      | 2,300 mg            |
| Total carbohydrate                          | 275 g               |
| Dietary fiber                               | 28 g                |
| Protein                                     | 50 g                |
| Vitamin D                                   | 20 mcg              |
| Calcium                                     | 1,300 mg            |
| Iron  | 18 mg               |

<sup>a</sup>g = grams; mg = milligrams; IU = International Units

amount of a nutrient provided in a serving of food compared to the standard level.

The “% DV” listed on nutrition labels represents the percentages of the standards obtained from one serving of the food product. Table 1.3 lists DV standard amounts for nutrients that are mandatory or voluntary components of nutrition labels. Additional information on nutrition labeling is presented later in this chapter.

## Carbohydrates

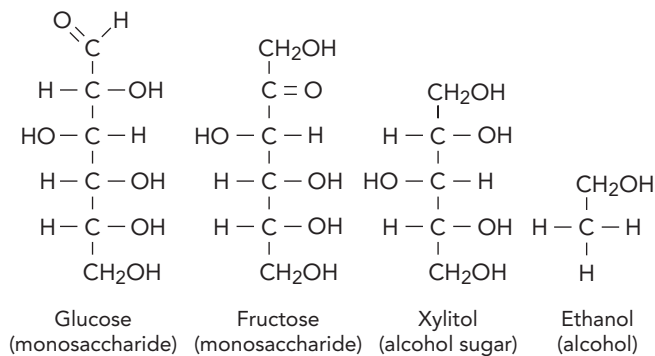
Carbohydrates are used by the body mainly as a source of readily available energy. They consist of the simple sugars (monosaccharides and disaccharides), complex carbohydrates (the polysaccharides), most dietary sources of fiber, and alcohol sugars. Alcohol (ethanol) is closely related chemically to carbohydrates and is usually considered to be part of this nutrient category. Figure 1.3 shows the similarity in the chemical structure of basic carbohydrate units.

The most basic forms of carbohydrates are single molecules called monosaccharides.

Glucose (also called “blood sugar” and “dextrose”), fructose (“fruit sugar”), and galactose are the most common monosaccharides. Molecules containing two monosaccharides are called disaccharides. The most common disaccharides are:

- Sucrose (glucose + fructose, or common table sugar)
- Maltose (glucose + glucose, or malt sugar)
- Lactose (glucose + galactose, or milk sugar)

Complex carbohydrates (also called polysaccharides) are considered “complex”



**Figure 1.3** Chemical structures of some simple carbohydrates.

because they have more elaborate chemical structures than the simple sugars. They include:

- Starches (the plant form of stored carbohydrate)
- Glycogen (the animal form of stored carbohydrate)
- Most types of fiber

Each type of simple and complex carbohydrate, except fiber, provides 4 calories per gram. Dietary fiber supplies 2 calories per gram on average, even though fiber cannot be broken down by human digestive enzymes. Bacteria in the large intestine can digest some types of dietary fiber, however. These bacteria excrete fatty acids as a waste product of fiber digestion. The fatty acids are absorbed and used as a source of energy. The total contribution of fiber to our energy intake is modest (around 50 calories), and supplying energy is not a major function of fiber.<sup>6,7</sup> The main function of fiber is to provide “bulk” for normal elimination. It has other beneficial properties, however. High-fiber diets reduce the rate of glucose absorption (a benefit for people with diabetes) and may help prevent cardiovascular disease and obesity.<sup>8</sup>

Alcohol sugars (nonalcoholic in the beverage sense) are like simple sugars, except they include a chemical component of alcohol. Xylitol, mannitol, and sorbitol are common forms of alcohol sugars. Some are very sweet, and only small amounts are needed to sweeten commercial beverages, gums, yogurt, and other products. Unlike the simple sugars, alcohol sugars do not promote tooth decay.

Alcohol (consumed as ethanol) is considered to be part of the carbohydrate family because its chemical structure is similar to that of glucose. It is a product of the fermentation of sugar with yeast. With 7 calories per gram, alcohol has more calories per gram than do other carbohydrates.

**Glycemic Index of Carbohydrates and Carbohydrates in Foods** In the not-too-distant past, it was assumed that “a carbohydrate is a carbohydrate is a carbohydrate.” If all types of carbohydrates had the same effect on blood glucose levels and health, then it didn’t matter what type was consumed. As is the case with many untested assumptions, this one fell by the wayside. It is now known that some types of simple and complex carbohydrates in

foods elevate blood glucose levels more than do others. Such differences are particularly important to people with disorders such as **insulin resistance** and **type 2 diabetes**.<sup>9</sup>

Carbohydrates and carbohydrate-containing foods are now being classified by the extent to which they increase blood glucose levels. This classification system is called the **glycemic index**. Carbohydrates that are digested and absorbed quickly have a high glycemic index and raise blood glucose levels to a higher extent than do those with lower glycemic index values (Table 1.4).<sup>11,12</sup>

**Recommended Intake Level** Recommended intake of carbohydrates is based on their contribution to total energy intake. It is recommended that 45 to 65 percent of calories come from carbohydrates. Added sugar should constitute no more than 10 percent of total caloric intake. It is recommended that adult females consume between 21 and 28 g, and males 30 to 38 g of total dietary fiber daily.<sup>10</sup>

**Food Sources of Carbohydrates** Carbohydrates are widely distributed in plant foods, while milk is the only important animal source of carbohydrates (lactose). Table 1.5 lists selected food sources by type of carbohydrate.

## Protein

Protein in foods provides the body with **amino acids** used to build and maintain protein-based components of the body such as muscle, bone, enzymes, and red blood cells. The body can also use protein as a source of energy—it provides 4 calories per gram. However, this is not a primary function of protein. Of the common types of amino acids, nine must be provided by the diet and are classified as essential amino acids. Amino acids that the body needs but can manufacture from other amino acids and components of the diet are classified as **nonessential amino acids**.

**insulin resistance** A condition in which cell membranes have a reduced sensitivity to insulin so that more insulin than normal is required to transport a given amount of glucose into cells.

**type 2 diabetes** A disease characterized by high blood glucose levels due to the body’s inability to use insulin normally, to produce enough insulin, or both.

**glycemic index** A measure of the extent to which blood glucose levels are raised by consumption of an amount of food that contains 50 g of carbohydrate compared to 50 g of glucose. A portion of white bread containing 50 g of carbohydrate is sometimes used for comparison instead of 50 g of glucose.

**amino acids** The “building blocks” of protein. Unlike carbohydrates and fats, amino acids contain nitrogen.

**nonessential amino acids** Amino acids that can be readily produced by humans from components of the diet. Also referred to as *dispensable amino acids*.



**Table 1.4** Glycemic Index (GI) of selected foods<sup>11,12</sup>

| High GI                | (70 and higher) | Medium GI                        | (56–69) | Low GI              | (55 or lower) |
|------------------------|-----------------|----------------------------------|---------|---------------------|---------------|
| Glucose                | 100             | Breadfruit                       | 69      | Honey               | 55            |
| French bread           | 95              | Fruit Loops                      | 69      | Oatmeal             | 54            |
| Scone                  | 92              | Orange soda                      | 68      | Corn                | 53            |
| Sticky rice            | 87              | Pita bread                       | 68      | Cracked wheat bread | 53            |
| Broken rice            | 86              | Sucrose                          | 68      | Orange juice        | 52            |
| Potato, baked          | 85              | Taco shells                      | 68      | Banana              | 52            |
| Potato, instant mashed | 85              | Croissant                        | 67      | Mango               | 51            |
| Special K, rice        | 84              | Angel food cake                  | 67      | Potato, boiled      | 50            |
| Corn Chex              | 83              | Fruit punch                      | 67      | Corn tortilla       | 49            |
| Pretzel                | 83              | Cherries                         | 66      | Green peas          | 48            |
| Rice Krispies          | 82              | Cream of Wheat                   | 66      | Pasta               | 48            |
| Cornflakes             | 81              | Brown rice                       | 66      | Carrots, raw        | 47            |
| Corn Pops              | 80              | Couscous                         | 65      | Lactose             | 46            |
| Gatorade               | 78              | Quaker Quick Oats                | 65      | Milk chocolate      | 43            |
| Jelly beans            | 78              | Raisins                          | 64      | All-Bran            | 42            |
| Cocoa pops             | 77              | Chapati                          | 62      | Orange              | 42            |
| Doughnut, cake         | 76              | French bread with butter and jam | 62      | Peach               | 42            |
| Waffle, frozen         | 76              | Raisin Bran                      | 61      | Apple juice         | 40            |
| Doughnuts              | 75              | Sweet potato                     | 61      | Apple               | 38            |
| French fries           | 75              | Bran muffin                      | 60      | Pear                | 38            |
| Grape Nuts             | 75              | Just Right cereal                | 60      | Tomato juice        | 38            |
| Shredded Wheat         | 75              | Blueberry muffin                 | 59      | Yam                 | 37            |
| White rice             | 75              | Mini Wheats                      | 59      | Yogurt              | 31            |
| Cheerios               | 74              | Coca-Cola                        | 58      | Flour tortilla      | 30            |
| Popcorn                | 72              | Power Bar                        | 56      | Dried beans         | 25            |
| Watermelon             | 72              | Special K                        | 56      | Grapefruit          | 25            |
| Carrots, diced, cooked | 70              |                                  |         | Milk                | 25            |
| Wheat bread            | 70              |                                  |         | Fructose            | 19            |
| White bread            | 70              |                                  |         | Pinto beans         | 14            |
|                        |                 |                                  |         | Hummus              | 6             |

Food sources of protein (Table 1.6) differ in quality based on the types and amounts of amino acids they contain. Foods of high protein quality include a balanced assortment of all of the essential amino acids. Protein from milk, cheese, meat, eggs, and other animal products is considered high quality. Plant sources of protein, with the exception of soybeans for adults, do not provide all nine essential amino acids in amounts needed to support

**kwashiorkor** A severe form of protein-energy malnutrition in young children. It is characterized by swelling, fatty liver, susceptibility to infection, profound apathy, and poor appetite. The cause of kwashiorkor is unclear.

growth in children and tissue maintenance. Combinations of plant foods, such as grains or seeds with dried beans, however, yield high-quality protein. The variety of amino acids found in these foods complement each other, thus providing a source of high-quality protein.

**Recommended Protein Intake** DRIs for protein are shown on the inside front cover of this text. In general, proteins should contribute 10 to 35 percent of total energy intake.<sup>10</sup> Protein deficiency, although rare in economically developed countries, leads to loss of muscle tissue, growth failure, weakness, reduced resistance to disease, and kidney and heart problems. It contributes to the development of a severe form of protein-energy malnutrition in young children known as **kwashiorkor**.

**Table 1.5** Food sources of carbohydrates

| <b>A. Simple Sugars (Mono- and Disaccharides)</b>    |                     |                               |                             |                     |   |
|--|---------------------|-------------------------------|-----------------------------|---------------------|---|
| <b>The Simple Sugar Content of Some Common Foods</b> |                     |                               |                             |                     |   |
|  | <b>Portion Size</b> | <b>Grams of Carbohydrates</b> |                             | <b>Portion Size</b> | <b>Grams of Carbohydrates<sup>a</sup></b> |
| <b>Sweeteners</b>                                    |                     |                               | <b>Beverages</b>            |                     |   |
| Corn syrup   | 1 tsp               | 5                             | Fruit drinks                | 1 cup               | 29  |
| Honey  | 1 tsp               | 6                             | Soft drinks                 | 12 oz               | 38  |
| Maple syrup  | 1 tsp               | 4                             | Skim milk                   | 1 cup               | 12  |
| Table sugar  | 1 tsp               | 4                             | Whole milk                  | 1 cup               | 11  |
| <b>Fruits</b>  |                     |                               | <b>Candy</b>                |                     |   |
| Apple  | 1 medium            | 16                            | Gumdrops                    | 1 oz                | 25  |
| Peach  | 1 medium            | 8                             | Hard candy                  | 1 oz                | 28  |
| Watermelon   | 1 wedge (4" × 8")   | 25                            | Caramels                    | 1 oz                | 21  |
| Orange   | 1 medium            | 14                            | Fudge                       | 1 oz                | 21  |
| Banana   | 1 medium            | 21                            | Milk chocolate              | 1 oz                | 16  |
| <b>Vegetables</b>                                    |                     |                               | <b>Breakfast cereals</b>    |                     |   |
| Broccoli   | ½ cup               | 2                             | Apple Jacks                 | 1 oz                | 13  |
| Corn   | ½ cup               | 3                             | Raisin Jacks                | 1 oz                | 19  |
| Potato   | 1 cup               | 1                             | Cheerios                    | 1 oz                | 14  |
| <b>B. Complex Carbohydrates (Starches)</b>           |                     |                               |                             |                     |   |
| <b>Complex</b>                                       |                     |                               |                             |                     |   |
|  | <b>Portion Size</b> | <b>Grams of Carbohydrates</b> |                             | <b>Portion Size</b> | <b>Grams of Carbohydrates</b>             |
| <b>Grain and grain products</b>                      |                     |                               | <b>Dried beans (cooked)</b> |                     |   |
| Rice (white), cooked                                 | ½ cup               | 21                            | Lima beans                  | ½ cup               | 11  |
| Pasta, cooked  | ½ cup               | 15                            | White beans                 | ½ cup               | 13  |
| Cornflakes   | 1 cup               | 11                            | Kidney beans                | ½ cup               | 12  |
| Oatmeal, cooked                                      | ½ cup               | 12                            | <b>Vegetables</b>           |                     |   |
| Cheerios   | 1 cup               | 11                            | Potato                      | 1 medium            | 30  |
| Whole wheat bread                                    | 1 slice             | 7                             | Corn                        | ½ cup               | 10  |
|  |                     |                               | Broccoli                    | ½ cup               | 2   |
| <b>C. Dietary Fiber</b>                              |                     |                               |                             |                     |   |
|  | <b>Portion Size</b> | <b>Grams of Fiber</b>         |                             | <b>Portion Size</b> | <b>Grams of Fiber</b>                     |
| <b>Grain and grain products</b>                      |                     |                               | <b>Fruits</b>               |                     |   |
| Bran Buds  | ½ cup               | 12.0                          | Raspberries                 | 1 cup               | 8.0                                       |
| All Bran   | ½ cup               | 11.0                          | Avocado                     | ½ medium            | 7.0                                       |
| Raisin Bran  | 1 cup               | 7.0                           | Mango                       | 1 medium            | 4.0                                       |
| Granola (homemade)                                   | ½ cup               | 6.0                           | Pear (with skin)            | 1 medium            | 4.0                                       |
| Bran Flakes  | ¾ cup               | 5.0                           | Apple (with skin)           | 1 medium            | 3.3                                       |
| Oatmeal  | 1 cup               | 4.0                           | Banana                      | 6" long             | 3.1                                       |
| Spaghetti noodles                                    | 1 cup               | 4.0                           | Orange (no peel)            | 1 medium            | 3.0                                       |
| Shredded Wheat                                       | 1 biscuit           | 2.7                           | Peach (with skin)           | 1 medium            | 2.3                                       |
| Whole wheat bread                                    | 1 slice             | 2.0                           | Strawberries                | 10 medium           | 2.1                                       |
| Bran (dry; wheat, oat)                               | 2 Tbsp              | 2.0                           |                             |                     |   |

(continued)

**Table 1.5** Food sources of carbohydrates (continued)

| C. Dietary Fiber (continued) |              |                |                             |                   |                |
|------------------------------|--------------|----------------|-----------------------------|-------------------|----------------|
|                              | Portion Size | Grams of Fiber |                             | Portion Size      | Grams of Fiber |
| <b>Vegetables</b>            |              |                | <b>Dried beans (cooked)</b> |                   |                |
| Lima beans                   | ½ cup        | 6.6            | Pinto beans                 | ½ cup             | 10.0           |
| Green peas                   | ½ cup        | 4.4            | Peas, split                 | ½ cup             | 8.2            |
| Potato (with skin)           | 1 medium     | 3.5            | Black beans (turtle beans)  | ½ cup             | 8.0            |
| Brussels sprouts             | ½ cup        | 3.0            | Lentils                     | ½ cup             | 7.8            |
| Broccoli                     | ½ cup        | 2.8            | Kidney or navy beans        | ½ cup             | 6.9            |
| Carrots                      | ½ cup        | 2.8            | Black-eyed peas             | ½ cup             | 5.3            |
| Green beans                  | ½ cup        | 2.7            | <b>Fast foods</b>           |                   |                |
| Collard greens               | ½ cup        | 2.7            | Big Mac                     | 1                 | 3              |
| Cauliflower                  | ½ cup        | 2.5            | French fries                | 1 regular serving | 3              |
| Corn                         | ½ cup        | 2.0            | Whopper                     | 1                 | 3              |
| <b>Nuts</b>                  |              |                | Cheeseburger                | 1                 | 2              |
| Almonds                      | ¼ cup        | 4.5            | Taco                        | 1                 | 2              |
| Peanuts                      | ¼ cup        | 3.3            | Chicken sandwich            | 2                 | 1              |
| Peanut butter                | 2 Tbsp       | 2.3            | Egg McMuffin                | 1                 | 1              |
|                              |              |                | Fried chicken, drumstick    | 1                 | 1              |

<sup>a</sup>4 grams sucrose = 1 teaspoon.

## Fats (Lipids)

Fats in food share the property of being soluble in fats but not in water. They are actually a subcategory of *lipids*, but this category of macronutrient is referred to as fat in the DRIs.<sup>10</sup> Lipids include fats, oils, and related compounds such as cholesterol. Fats are generally solid at room temperature, whereas oils are usually liquid. Fats and oils are made up of various types of triglycerides (triacylglycerols), which consist of three **fatty acids** attached to **glycerol** (Figure 1.4). The number of carbons contained in the fatty acid component of triglycerides varies from 8 to 22.

Fats and oils are a concentrated source of energy, providing 9 calories per gram. Fats perform a number of important functions in the body. They are needed for cholesterol and sex-hormone synthesis, components of cell membranes, vehicles for carrying certain vitamins that are soluble in fats only, and suppliers of the **essential fatty acids** required for growth and health.

**Essential Fatty Acids** There are two essential fatty acids: linoleic acid and alpha-linolenic acid. Because these fatty acids are essential, they must be supplied in the diet.

**fatty acids** The fat-soluble components of fats in foods.

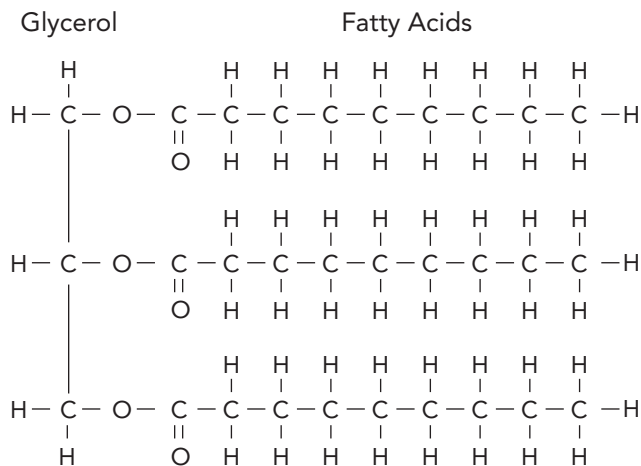
**glycerol** A component of fats that is soluble in water. It is converted to glucose in the body.

**essential fatty acids** Components of fat that are a required part of the diet (i.e., linoleic and alpha-linolenic acids). Both contain unsaturated fatty acids.

The central nervous system (CNS) is particularly rich in derivatives of these two fatty acids. They are found in phospholipids, which—along with cholesterol—are the

**Table 1.6** Food sources of protein

|                         | Portion Size | Grams of Protein |
|-------------------------|--------------|------------------|
| <b>Meats</b>            |              |                  |
| Beef, lean              | 3 oz         | 26               |
| Tuna, in water          | 3 oz         | 24               |
| Hamburger, lean         | 3 oz         | 24               |
| Chicken, no skin        | 3 oz         | 24               |
| Lamb                    | 3 oz         | 22               |
| Pork chop, lean         | 3 oz         | 20               |
| Haddock, broiled        | 3 oz         | 19               |
| Egg                     | 1 med        | 6                |
| <b>Dairy Products</b>   |              |                  |
| Cottage cheese, low fat | ½ cup        | 14               |
| Yogurt, low fat         | 1 cup        | 13               |
| Milk, skim              | 1 cup        | 9                |
| Milk, whole             | 1 cup        | 8                |
| Swiss cheese            | 1 oz         | 8                |
| Cheddar cheese          | 1 oz         | 7                |
| <b>Grain Products</b>   |              |                  |
| Oatmeal, cooked         | ½ cup        | 4                |
| Pasta, cooked           | ½ cup        | 4                |
| Bread                   | 1 slice      | 2                |
| Rice, white or brown    | ½ cup        | 2                |



**Figure 1.4** Basic structure of a triglyceride.

primary lipids in the brain and other nervous system tissue. Biologically active derivatives of essential fatty acids include **prostaglandins**, **thromboxanes**, and **prostacyclins**.

**Linoleic Acid** Linoleic acid is the parent of the omega-6 (or n-6) fatty acid family. One of the major derivatives of linoleic acid is arachidonic acid. Arachidonic acid serves as a primary structural component of the central nervous system. Most vegetable oils and meats, as well as human milk, are good sources of linoleic acid. American diets tend to provide sufficient to excessive levels of linoleic acid, and considerable amounts are stored in body fat.

**Alpha-Linolenic Acid** Alpha-linolenic acid is the parent of the omega-3 (n-3) fatty acid family. It is present in many types of dark-green vegetables, vegetable oils, and flaxseed. Derivatives of this essential fatty acid include eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Relatively small amounts of EPA and DHA are produced in the body from alpha-linolenic acid because the conversion is low.<sup>10</sup> EPA and DHA also enter the body through intake of fatty, cold-water fish, shellfish, and human milk. Regular consumption of fish (two or more servings per week) reduces chronic inflammation and the risk of heart disease and sudden cardiac death.<sup>13</sup> DHA is found in large amounts in the central nervous system, the retina of the eye, and the testes. The body stores only small amounts of alpha-linolenic acid, EPA, and DHA.<sup>14,15</sup> Recommended daily intakes for EPA and DHA have not been set, however, adequate intakes for different age groups have been published. On average, adults residing in the United States and Canada consume around 100 mg of EPA plus DHA daily, far short of the estimated need of 200 to 500 mg daily.<sup>16</sup> The National Health and Examination Study from 2003–2014 published in 2019 documented increasing intake of EPA, DHA, and EPA+DHA with age. Despite this increase, the authors noted EPA and DHA intake was inadequate in all age groups in the study regardless of gender, age, or pregnancy status.<sup>17</sup>

**Saturated and Unsaturated Fats** Fats (lipids) come in two basic types: **saturated** and **unsaturated**. Whether a fat is saturated or not depends on whether it has one or more double bonds between carbon atoms in one or more of its fatty acid components. If one double bond is present in one or more of the fatty acids, the fat is considered **monounsaturated**; if two or more are present, the fat is **polyunsaturated**.

Some unsaturated fatty acids are highly unsaturated. Alpha-linolenic acid, for example, contains three double bonds, arachidonic acid four, EPA five, and DHA six. These fatty acids are less stable than fatty acids with fewer double bonds, because double bonds between atoms are weaker than single bonds.

Saturated fats contain no double bonds between carbons and tend to be solid at room temperature. Animal products such as butter, cheese, and meats and two plant oils (coconut and palm) are rich sources of saturated fats. Fat we consume in our diets, whether it contains primarily saturated or unsaturated fatty acids, is generally in the triglyceride (or triacylglyceride) form.

Although most foods contain both saturated and unsaturated fats, animal foods tend to contain more saturated and less unsaturated fat than plant foods. Saturated fatty acids tend to increase blood levels of LDL cholesterol (the lipoprotein that is associated with heart-disease risk when present in high levels), whereas unsaturated fatty acids tend to decrease LDL cholesterol levels.<sup>3,18</sup>

**prostaglandins** A group of physiologically active substances derived from the essential fatty acids. They are present in many tissues and perform such functions as the constriction or dilation of blood vessels and stimulation of smooth muscles and the uterus.

**thromboxanes** Biologically active substances produced in platelets that increase platelet aggregation (and therefore promote blood clotting), constrict blood vessels, and increase blood pressure.

**prostacyclins** Biologically active substances produced by blood vessel walls that inhibit platelet aggregation (and therefore blood clotting), dilate blood vessels, and reduce blood pressure.

**saturated fats** Fats in which adjacent carbons in the fatty acid component are linked by single bonds only (e.g.,  $-\text{C}-\text{C}-\text{C}-\text{C}-$ ).

**unsaturated fats** Fats in which adjacent carbons in one or more fatty acids are linked by one or more double bonds (e.g.,  $-\text{C}-\text{C}=\text{C}-\text{C}=\text{C}-$ ).

**monounsaturated fats** Fats in which only one pair of adjacent carbons in one or more of its fatty acids is linked by a double bond (e.g.,  $-\text{C}-\text{C}=\text{C}-\text{C}-$ ).

**polyunsaturated fats** Fats in which more than one pair of adjacent carbons in one or more of its fatty acids are linked by two or more double bonds (e.g.,  $-\text{C}-\text{C}=\text{C}-\text{C}=\text{C}-$ ).