NUTRITION FUNDAMENTALS AND MEDICAL NUTRITION THERAPY

THIRD EDITION

ANFP® | Association of Nutrition & Foodservice Professionals


ANFP®
Association of
Nutrition & Foodservice
Professionals

NUTRITION FUNDAMENTALS AND MEDICAL NUTRITION THERAPY

THIRD EDITION

ANFP® | Association of Nutrition & Foodservice Professionals

Julie Zikmund, MPH, RDN, LRD

ANFP® | Association of Nutrition & Foodservice Professionals

Association of Nutrition & Foodservice Professionals
406 Surrey Woods Dr.
St. Charles, IL 60174
800.323.1908
www.ANFPonline.org

ISBN: 978-0-578-78016-0

Printed in the United States of America

Dedication

I dedicate this book to those dietitians on whose shoulders I firmly stand and from whom I have had the privilege of learning, for without your gift of shared knowledge, I would not be who I am today.

To my University of North Dakota Nutrition Sherpas: Becky Rude, Jean Hartl, Lynette Borth, Mary Russell, and Brenda Rubash—thank you for always keeping me grounded and yet reaching for new heights.

To the future Certified Dietary Manager,® Certified Food Protection Professional® (CDM®, CFPP®) who does not yet realize the potential and importance of the career they have chosen, and to those CDM, CFPPs who work every day at making their career a success and our world a much better place in which to live, I extend my gratitude.

Finally, and most of all, I dedicate this book to my family (Kevin, Zach, Andrew, Mom, Dad, and Augie) and friends, with all my love and appreciation. I could not have done it without you. I am truly blessed!

—Julie Zikmund, MPH, RDN, LRD

Table of Contents

The chapters are color coded based on CDM, CFPP professional competencies. This book includes two areas. The first six chapters include fundamentals of nutrition. The next 11 chapters include nutrition fundamentals related to the daily practice of the CDM, CFPP.

CHAPTER

APPENDIX

Preface

Nutrition is a science that has been studied for centuries and continuously evolves related to new evidence. Research results may often change or modify practice applications. Food and nutrition are critical to human beings across the lifespan. From prenatal care through death, the Certified Dietary Manager®, Certified Food Protection Professional® (CDM®, CFPP®) plays an important role in providing proper nutrition and nutrition care.

The CDM, CFPP faces many opportunities and challenges in providing clinical nutrition care. At one time, health care involved just the physician and the client; however, times have changed. Health care includes many allied health professionals. How many different types of healthcare professionals will the CDM, CFPP work with daily? That list will likely include a/an: Registered Dietitian Nutritionist; Dietetic Technician, Registered; Nutrition and Dietetic Technician, Registered; Registered Nurse; Licensed Practical Nurse; Pharmacist; Licensed Social Worker; Medical Technologist; Respiratory Therapist; Physical Therapist; Occupational Therapist; Speech-Language Pathologist; and Activities Director. All are members of the healthcare team. A healthcare or interdisciplinary team is a group of specialists, in their respective areas, that work together to provide client care.

One component of the healthcare team is the nutrition care team. This may be comprised of some combination of the following: Registered Dietitian Nutritionist (RD/RDN); Nutrition and Dietetics Technician, Registered (NDTR); Certified Dietary Manager, Certified Food Protection Professional (CDM, CFPP); and foodservice staff. These members work together to provide optimal nutrition services to patients or residents. These leaders also recognize the importance and value of the entire department as additional team members.

Nutrition care for the client will include the selection and recommendation of foods based on nutrition science, application of food guides and tools to assess nutritional adequacy, planning menus based on nutrition needs of clients or populations, implementation and service of menus that meet guidelines, management of food allergies, and participation in the nutrition care process including: nutrition screening, documenting in the electronic health record, implementing medical nutrition therapy, and providing feedback and evaluation to the healthcare team as well as to other regulatory agencies.

The author's roadmap in writing this textbook is based on the Professional Standards of Practice for the CDM, CFPP and the role of nutrition care as a critical component of client care. These tasks represent current practice in the United States. Evidence-based nutrition science is the foundation of nutrition care and practice for the future CDM, CFPP. This textbook is intended for students learning to become a CDM, CFPP and as a reference for CDM, CFPPs working in the industry. In addition, this textbook integrates the 2021 Detailed Content Outline.

An additional online resource, *Nutrition Supplemental Materials,* is included for the student. This supplement offers documents, articles, and other information to assist in the learning and practice to become a CDM, CFPP.

Acknowledgements

We want to recognize the contribution of the review team who generously invested their professional expertise and valuable time:

Jill Braten, RD

Jolene Campbell, MEd, RD, LDN

Sona Donayan, MS, RDN

Catherine Kling Nourse, MPH, RDN, LD

Barbara Thomsen, CDM, CFPP, RAC, QCP

We would like to express our appreciation to the individuals who contributed as content editors of this textbook throughout the past few years:

Content Editors:

Melissa Baron, MS, RDN

Dorothy Chen-Maynard, PhD, RDN, FAND

Casey Colin, MS, RDN

Dr. Terri Lisagor, EdD, MS, RDN

Lauri Wright, PhD, RDN

ANFP® | Association of Nutrition & Foodservice Professionals

Technical Editor: Diane Everett

ANFP Staff: Cindy Zemko, BS, CDM, CFPP

Art Direction/Graphic Design: Mercy Ehrler

A Personal Invitation

As a student enrolled in the Nutrition & Foodservice Professional Training Program, we invite you to join the Association of Nutrition & Foodservice Professionals (ANFP) as a Pre-Professional member.

ANFP is the premier resource for foodservice managers, directors, and those aspiring towards careers in foodservice management, with more than 14,000 professionals dedicated to the mission of providing optimum nutritional care through foodservice management and food safety.

Pre-Professional membership is a stepping stone for professional growth. Network and connect with members in all practice areas, understand the profession, and gain valuable tools and resources at your fingertips.

Enjoy benefits such as:

- 24/7 Members-only access to website, online community, and social media
- An electronic version of *Nutrition & Foodservice Edge* magazine
- Scholarship opportunities
- eNews monthly online newsletter
- Special discounted member pricing for ANFP products and services
- Network nationally, locally, and even globally with peers

ANFP® | Association of Nutrition & Foodservice Professionals

You are the future of our profession. Take the first step in nourishing your career. Join ANFP today! For more information, visit www.ANFPonline.org or call 800-323-1908.

ANFP® | Association of Nutrition & Foodservice Professionals


ANFP®
Association of
Nutrition & Foodservice
Professionals

Translate Nutrition Science into Food Intake

Overview and Objectives

A Certified Dietary Manager®, Certified Food Protection Professional® (CDM®, CFPP®) needs to select and recommend food according to established science-based nutrition guidelines. In addition, a CDM, CFPP needs to be able to use guides to assess nutritional adequacy. After completing this chapter, you should be able to:

- Discuss the importance of good nutrition and physical activity for a healthy lifestyle
- Discuss dietary recommendations for simple carbohydrates (sugars) and complex carbohydrates (fiber)
- Discuss dietary recommendations for fats (total fat, saturated fat, and cholesterol)
- Explore health effects of protein
- Distinguish between vitamins and minerals
- Identify the role of water as a nutrient
- Define phytochemicals and functional foods
- Select the best food sources of specific vitamins and minerals
- Define daily fluid requirement
- Differentiate between different food guides
- Analyze dietary intake compared to MyPlate

1

This chapter will help you understand the relationship between overall dietary intake and nutrition status. Nutrition status and "total diet" have to do with consuming food and the body utilizing that food for growth, regulation, and maintenance. The Dietary Guidelines Advisory Committee (DGAC) defines "total diet" as "the combination of foods and beverages that provide energy and nutrients and constitute an individual's complete dietary intake, on average, over time. This encompasses various foods and food groups, their recommended amounts and frequency (to be eaten) and the resulting eating pattern." With so many foods to choose from, what is the best combination of foods that provide a balance of nutrients?

Sound nutrition advice combined with food consumption advice is available from both government and private agencies.

This chapter will explore:

- Healthy People Initiative
- Dietary Reference Intakes (DRIs)
- Dietary Guidelines for Americans
- USDA Food Plans
- MyPlate

Nutrition as a Science

Nutrition is based in science—biology, chemistry, anatomy, physiology, psychology, anthropology—just to name a few. Nutrition has been observed and studied since ancient times, with early observations written by Aristotle and Socrates. Nutrition investigation and scientific discovery continued until the late 1700-1800s when the ability to identify nutrients in food became possible. In those years of "rapid discovery," early nutrition research focused on identifying essential nutrients. During the last century, the 1900s, nutrition advice centered on encouraging intake of certain foods to prevent deficiencies and enhance growth. In recent years, however, the focus has changed, as nutrition scientists devote a great deal of research to the opposite problem: nutritional excess and imbalance. The first Surgeon General's Report on Nutrition and Health in 1988 was a turning point for nutritional planning. The report concluded that over-consumption of certain nutrients—not deficiency—should be the primary nutritional concern for Americans. Generally, the over-consumed nutrients are macronutrients, like fats (certain types), protein and carbohydrates, as well as overall caloric-intake.

The Health Status of the United States

In the early 1990s, the United States Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (HHS) focused attention on the issue of nutrition excess and imbalance. The USDA and HHS were charged with tracking what Americans eat, the nutritional content of the food, and the related health concerns connected with consumption of these foods. These two agencies and the Centers for Disease Control and Prevention (CDC) conduct ongoing national food surveys: USDA's Continuing Survey of Food Intakes by Individuals (CSFII) and CDC's National Health and Nutrition Examination Survey (NHANES). The results of these two surveys give us insight into the eating patterns of Americans.

The NHANES survey results showed that Americans eat excess calories, fats, added sugars, refined grains, and sodium. Conversely, Americans do not consume enough dietary fiber, vitamin D, calcium, potassium, unsaturated fatty acids (specifically omega-3s), and other important nutrients. Many of these nutrients are found in vegetables, fruits, whole grains, low-fat milk and dairy products, and seafood.

Obesity is a major public health challenge, not only in the United States, but worldwide. According to the Surgeon General's Report in 2010, "obesity contributes to an estimated 112,000 preventable deaths in the U.S. annually." Figure 1.1 shows obesity trends for individuals aged 18 and older. This obesity trend is a concern not just for adults, but also youth of all ages. Due to the dramatic increase in childhood obesity, the White House convened a Task Force on Childhood Obesity (including 12 federal agencies) in 2010 to make recommendations to address childhood obesity.

Overweight is calculated by figuring **body mass index (BMI)**. BMI is used to express weight adjusted for height. BMI is calculated as weight in kilograms divided by height in meters squared. There are many charts available where one can just enter height in inches and weight in pounds to pinpoint BMI. **Overweight** is defined as being at a BMI of 25-29.9. **Obesity** is defined as being at a BMI of 30 or greater.

According to the Dietary Guidelines Advisory Committee Report on Energy Balance and Weight Management, 2010, the conditions listed in Figure 1.2 are health risks associated with overweight and obesity and with a sedentary lifestyle. Note the health risks that are the same.

Obesity is influenced by many factors. For each individual, body weight is the result of a combination of genetic, metabolic, behavioral, environmental, cultural, and socioeconomic influences. However, based on a growing amount of evidence provided by the Dietary Guidelines Advisory Committee, there are two factors that have a significant impact on the obesity epidemic:

- The food environment
- Amount of physical activity

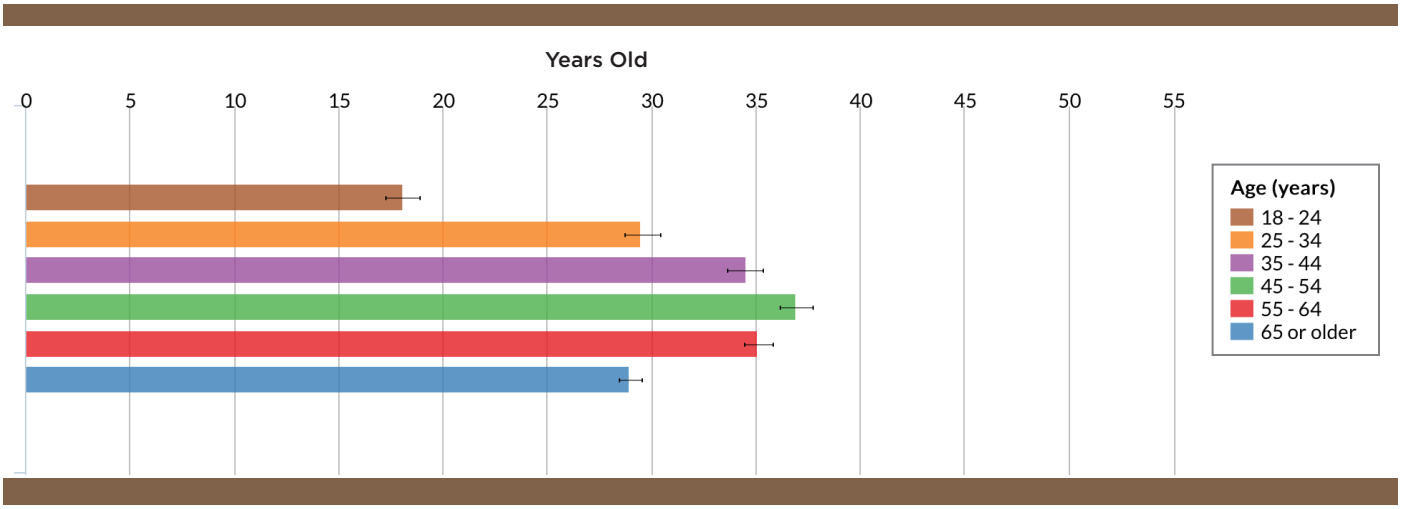
GLOSSARY

Body Mass Index (BMI)
A proportion of weight to height

Overweight
Having a BMI of 25.0-29.9 Kg/m^2

Obesity
Having a BMI of 30.0 Kg/m^2 or greater

Figure 1.1
2018: Percent of Adults Aged 18 Years and Older Who Have Obesity



Source: Centers for Disease Control and Prevention

Figure 1.2
Health Risks Associated with Overweight, Obesity, and Sedentary Lifestyles

Overweight and Obesity Associated Health Risks	Sedentary Lifestyle Associated Health Risks
• Type 2 Diabetes • Hypertension • Cardiovascular Disease (CVD) • Stroke • Certain Kinds of Cancer • Osteoarthritis • Gallbladder Disease • Sleep Apnea • Dyslipidemia	• Type 2 Diabetes • Hypertension • Coronary Artery Disease • Stroke • Certain Kinds of Cancer • Osteoporosis • Depression • Decreased Health-Related Quality of Life • Overweight and Obesity • Decreased Overall Fitness

Note that some of the health risks are the same in both categories.
Source: Centers for Disease Control and Prevention and Healthy People 2020

The food environment is associated with a lower intake of fruits and vegetables and an increased body weight. Food environment includes the distance from a supermarket that offers a large variety of fruits and vegetables, and the density of fast food restaurants in the area where a person lives. The strongest documented relationship between fast food and obesity is when one or more fast food meals are consumed in a week. There is also a direct relationship between portion size and body weight. Discussions of food environment must also include "screen time" (amount of time spent on watching TV, the computer, or video games) for both adults and children. The strongest association with overweight and obesity is with television screen time.

Research indicates that there is an imbalance with excess energy intake when compared to energy expenditure at the current level of physical activity. While food alone does not cause, cure, or control obesity, weight control is an important nutrition issue. When consuming more than what is expended, weight gain can be seen. Exercise is a key component in disease prevention and weight management. Regular (daily) exercise helps a person:

- Balance energy intake and energy expenditure (see Figure 1.3)
- Prevent heart disease by strengthening the heart and cardiovascular system
- Achieve a healthy weight and reduce the risk of developing certain types of cancer (breast, colon, and other forms linked to obesity)

It is obvious from the information above that both dietary intervention and regular physical activity are needed in order to reach goals of maintaining energy balance and preventing disease. Figure 1.4 provides physical activity goals and facts on inactivity.

Putting It Into Practice

1. What would BMI be for an individual who is 5'6" tall and weighs 175 lbs.?

Figure 1.3
Energy Balance

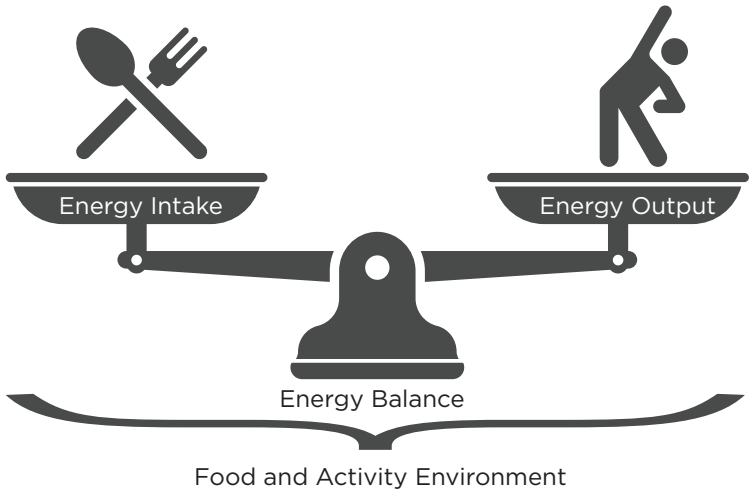


Figure 1.4
Physical Activity Goals and Facts on Inactivity

- It is recommended that Americans accumulate at least 30 minutes (adults) or 60 minutes (children) of moderate physical activity most days of the week. More may be needed to prevent weight gain, to lose weight, or to maintain weight loss.
- Less than 1/3 of adults engage in the recommended amounts of physical activity.
- Many people live sedentary lives; in fact, 40 percent of adults in the United States do not participate in any leisure time physical activity.
- 43 percent of adolescents watch more than 2 hours of television each day.
- Physical activity is extremely helpful in maintaining weight loss, especially when combined with healthy eating.

Source: US Surgeon General and American Cancer Society

Healthy People Initiative

For the past three decades, the U.S. Department of Health and Human Services (HHS) has set science-based, 10-year national objectives for promoting health and preventing disease. Healthy People 2020 is the current edition. Healthy People Initiatives have established benchmarks for the United States population and monitor progress made towards achieving these goals. Healthy People 2020 national objectives are aimed at improving the health of all Americans. The focus of Healthy People 2020 is to encourage collaborations across communities and sectors, empower individuals toward making informed health decisions, and to measure the impact of prevention activities.

Healthy People 2020 was launched in December 2010. It is an ambitious, yet achievable, 10-year agenda for improving the nation's health. Healthy People 2020 is the result of a multiyear process that reflects input from a diverse group of individuals and organizations. The vision of Healthy People 2020 is stated as "A society in which all people live long, healthy lives."

View the Supplemental Material to see the latest Healthy People 2030.

Here is a bit more background information on the overarching activities to support the vision of Healthy People 2020:

- Identify nationwide health improvement priorities.
- Increase public awareness and understanding of the determinants of health, disease and disability, and the opportunities for progress.
- Provide measurable objectives and goals that are applicable at the national, state, and local levels.
- Engage multiple sectors to take actions to strengthen policies and improve practices that are driven by the best available evidence and knowledge.
- Identify critical research, evaluation, and data collection needs.

Overarching Goals: Healthy People 2020 is working to:

- Attain high-quality, longer lives free of preventable disease, disability, injury, and premature death.
- Achieve health equity, eliminate disparities, and improve the health of all groups.
- Create social and physical environments that promote good health for all.
- Promote quality of life, healthy development, and healthy behaviors across all life stages.

There are 38 categories of objectives that range from A (Access to Health Services) to V (Vision). Many categories have a tie to nutrition and the role of nutrition in disease prevention. Figure 1.5 shows the objectives for the Nutrition and Weight Status category.

The purpose of these objectives is to provide direction for diverse groups of people to combine their efforts and work as a team. All parts of health care should address these objectives, and as an organization work towards improving health, as set forth in Healthy People 2020. Remember, the Healthy People Initiative is a population-based approach to improve the health status of all Americans.

Dietary Reference Intakes (DRIs)

Since 1941, the Food and Nutrition Board of the National Academy of Sciences has been preparing recommendations on nutrient intakes for Americans. Contemporary studies address topics ranging from the prevention of classical nutritional deficiency diseases to the reduction of risk of chronic diseases such as osteoporosis, cancer, and cardiovascular disease. In partnership with Health Canada, the Food and Nutrition Board has responded to these developments by making fundamental changes in its approach to setting nutrient reference values. This partnership issued the first of its new standards in 1997, replacing Recommended Dietary Allowances (RDAs). Dietary Reference Intakes is the inclusive name given to the new approach.

Dietary Reference Intakes (DRIs) is a generic term used to refer to four types of reference values: **Estimated Average Requirement, Recommended Dietary Allowance, Adequate Intake,** and **Tolerable Upper Intake Level**. Dietary reference intakes are designed for various age and gender groups, because nutrient needs vary from childhood through adulthood and some vary between males and females.

Estimated Average Requirement

The Estimated Average Requirement (EAR) is the intake value that is estimated to meet the requirement defined by a specified indicator of adequacy in 50 percent of a specific group (age and gender group). A requirement is how much is needed in the

GLOSSARY

Dietary Reference Intakes (DRIs)
A generic term that encompasses four types of reference values: Estimated Average Requirement, Recommended Dietary Allowance, Adequate Intake, and Tolerable Upper Intake Level

Estimated Average Requirement (EAR)
Intake value that is estimated to meet the requirements defined by a specific indicator of adequacy in 50 percent of a specific group (age/gender)

Recommended Dietary Allowance (RDA)
The amount of a nutrient adequate to meet the known nutrient needs of practically all healthy persons

Adequate Intake (AI)
A specific judgment or the amount of some nutrients for which a specific RDA is not known

Tolerable Upper Intake Level (UL)
The maximum level of a daily nutrient that is considered safe

Figure 1.5
Healthy People 2020 Nutrition and Weight Status Objectives

- Increase the proportion of adults who are at a healthy weight.
- Reduce the proportion of adults who are obese.
- Reduce iron deficiency among young children and females of childbearing age.
- Reduce iron deficiency among pregnant females.
- Reduce the proportion of children and adolescents who are overweight or obese.
- Increase the contribution of fruits to the diets of the population aged 2 years and older.
- Increase the variety and contribution of vegetables to the diets of the population aged 2 years and older.
- Increase the contribution of whole grains to the diets of the population aged 2 years and older.
- Reduce consumption of saturated fat in the population aged 2 years and older.
- Reduce consumption of sodium in the population aged 2 years and older.
- Increase consumption of calcium in the population aged 2 years and older.
- (Developmental) Increase the proportion of worksites that offer nutrition or weight management classes or counseling.
- Increase the proportion of physician office visits that include counseling or education related to nutrition or body weight.
- Eliminate very low food security among children in U.S. households.
- (Developmental) Prevent inappropriate weight gain in youth and adults.
- Increase the proportion of primary care physicians who regularly measure the body mass index of their patients.
- Reduce consumption of calories from solid fats and added sugars in the population aged 2 years and older.
- Increase the number of States that have State-level policies that incentivize food retail outlets to provide foods that are encouraged by the Dietary Guidelines.
- Increase the number of States with nutrition standards for foods and beverages provided to preschool-aged children in childcare.
- Increase the percentage of schools that offer nutritious foods and beverages outside of school meals.

Source: Centers for Disease Control and Prevention and Healthy People 2020

diet to prevent symptoms of deficiency. A deficiency is the illness that occurs over time when a nutrient is not present in adequate amounts. For example, not eating enough vitamin C causes the deficiency disease scurvy. Not having enough vitamin D causes the deficiency disease rickets. Scurvy and rickets are examples of nutrient deficiency illnesses. At the EAR level of intake, 50 percent of the specified group would not have its needs met. In other words, if everyone consumed exactly the EAR levels of nutrients, some people would actually develop nutrient deficiencies. Thus, the EAR is designed only for setting a benchmark for baseline nutrient requirements. An EAR is not intended for use in evaluating an individual's dietary intake.

Recommended Dietary Allowance

A Recommended Dietary Allowance (RDA) is the amount of a nutrient that is adequate to meet the known nutrient needs of practically all healthy persons. Contrary to popular belief, an RDA is not a minimum daily requirement. It is a dietary recommendation. To develop RDAs, scientists first review research studies that indicate what minimum levels of nutrients might be required to prevent nutrient

deficiencies. Then, they adjust the requirements to account for additional factors that might affect requirements. They also consider the numbers to account for the difference between the amount of a nutrient consumed and the amount the body can actually use. The scientists use statistics to calculate individual variations in nutrient needs and project figures that address the needs of most healthy people. Thus, an RDA is truly a recommendation about how much of a nutrient to consume through food. If everyone consumed exactly the RDA levels of nutrients, very few people in that group would develop nutrient deficiencies. Also, RDAs are for healthy individuals. RDAs do not always apply to someone who is suffering from a chronic illness or who has special medical conditions. Unlike the EAR, an RDA is a goal for groups of individuals.

Adequate Intake

For some nutrients, there is simply not enough science to set a meaningful RDA. Currently, the scientific research that backs up the calculation of requirements has not been done. When this is the case, an Adequate Intake (AI) value is issued. For example, there is no information about the physiological requirements for choline. Instead of setting an RDA, experts have designated an AI for choline. An AI represents a scientific judgment. An AI covers the nutrient needs of groups or individuals, but the AI value seems to be a reasonable point of reference based on what is currently available in the research. When the only standard available for a nutrient is an AI, it is fine to apply the AI to both groups and individuals.

Tolerable Upper Intake Level

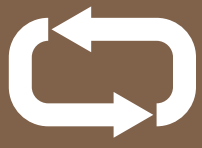
The Tolerable Upper Intake Level (UL) is the maximum level of daily nutrient intake that is unlikely to pose risks of adverse health effects. ULs have been developed for some nutrients as safety guidelines. For example, these points of reference are helpful in determining whether the doses of nutrients contained in nutritional supplements represent safe intakes.

Setting dietary reference intakes is a complex task. Scientists are working to develop figures that can be referred to when assessing individuals' diets and planning menus. Due to the enormity of this undertaking, the Dietary Reference Intake project has been divided into seven nutrient groups, which are updated intermittently based on the latest scientific findings.

How Should the Dietary Reference Intakes be Used?

The RDAs were developed to assess the diets of groups of people rather than individuals. Be sure to use the DRIs to plan and evaluate the diets of clients. Because the body stores nutrients for later use, it is not necessary to eat the RDAs every day. The USDA has a website that lists the current DRI tables (http://fnic.nal.usda.gov/interactiveDRI/). Log on to use the interactive tool to calculate daily nutrient recommendations for a client and for dietary planning based on the Dietary Reference Intakes (DRIs).

Putting It Into Practice



2. Which would be a more appropriate DRI for someone planning a menu in a facility: EAR or RDA?

Nutrition Guidance for Americans

With so much nutrition information, so many recommendations, and plenty of health and nutrition goals, how can a person make sense of it all? How can one evaluate diets, plan adequate menus, or advise others about how to choose the "right" foods?

The Center for Nutrition Policy and Promotion, under the umbrella of the United States Department of Agriculture, was established in 1994 to improve the nutrition and wellbeing of Americans. The Center has two primary objectives:

1. Advance and promote dietary guidance for all Americans, and
2. Conduct applied research and analyses in nutrition and consumer economics.

The Center has six core initiatives to reach its objectives: (those starred below will be addressed in this chapter)

1. Dietary Guidelines for Americans*
2. USDA Food Patterns
3. MyPlate*
4. Healthy Eating Index
5. Nutrient Content of the U.S. Food Supply
6. Expenditures on Children by Families

Dietary Guidelines for Americans

The *2015-20 Dietary Guidelines for Americans* (*Dietary Guidelines* for short) support a total diet approach to achieving dietary goals. The *Dietary Guidelines* are issued jointly by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (HHS). According to the USDA, "The *Dietary Guidelines* is designed for professionals to help all individuals ages 2 years and older and their families consume a healthy, nutritionally adequate diet. The information in the *Dietary Guidelines* is used in developing Federal food, nutrition, and health policies and programs. It also is the basis for Federal nutrition education materials designed for the public and for the nutrition education components of HHS and USDA food programs."

According to the USDA and HHS, the *2015-20 Dietary Guidelines for Americans (8th Edition)* focuses on healthy eating patterns and regular physical activity to help people achieve and maintain good health and reduce the risk of chronic disease throughout all stages of the lifespan. The 2015-20 Dietary Guidelines encourages healthy eating patterns and healthy food and beverage choices focusing on variety, nutrient density, and amount, and supports healthy eating patterns.

Helping Americans incorporate these Guidelines into their everyday lives is important to improving the overall health of the American people. The *2015-20 Dietary Guidelines for Americans* includes 5 general guidelines that encourage healthy eating patterns for the general population and additional Key Recommendations for specific population groups, such as women who are pregnant. Key Recommendations are the most important messages within the Guidelines in terms of their implications for improving public health and reducing development of chronic diseases. The recommendations are intended as advice to achieve an overall healthy eating pattern. To get the full benefit, all Americans should achieve all of the Dietary Guidelines' recommendations in their entirety. Find it at: https://www.dietaryguidelines.gov/current-dietary-guidelines/2015-2020-dietary-guidelines.

View supplemental material for more information on Dietary Guidelines

The USDA solicits the foremost nutrition experts in the country to serve on the Dietary Guidelines Advisory Committee. These experts convene to examine the most current research surrounding nutrition outcomes, and use this updated research to revise

and publish the newest Dietary Guidelines every five years. The Dietary Guidelines Advisory Committee also takes into account feedback from professionals and consumers when formulating the newest guidelines. The latest *Dietary Guidelines* can be found in the Supplemental Material.

The USDA and HHS also developed more consumer-friendly advice and tools, such as MyPlate. Below is a preview of some of the tips to help consumers translate the Dietary Guidelines into their everyday lives:

Balance the Energy Intake

- Enjoy your food, but eat less.
- Avoid oversized portions.

Foods to Increase

- Make half your plate fruits and vegetables.
- Switch to fat-free or low-fat (1%) milk.
- Make at least half your grains whole grains.

Foods to Reduce

- Compare sodium in foods like soup, bread, and frozen meals—and choose the foods with lower numbers.
- Drink water instead of sugary drinks.

The *Dietary Guidelines* "summarize and synthesize knowledge regarding individual nutrients and food recommendations into a pattern of eating that can be adopted by the public." They are updated every five years based on new scientific information.

Dietary Guidelines generally categorize and make recommendations under topic areas/groups. Each topic area or group contains a series of key recommendations, including some for specific population groups. The *Dietary Guidelines* are full of the science, recommendations, and goals for healthy eating. Even with all of that information, it seems an average American is not any closer to understanding what foods need to be eaten to attain good health.

Healthy Eating Plans

GLOSSARY

Eating Plan or Eating Pattern
Translation of the dietary recommendations and research into a healthy way of eating for most individuals

An **eating plan** or **eating pattern** translates dietary recommendations and current research into a healthy way of eating for most individuals. The plans or patterns are examples of how to eat in accordance with the Dietary Guidelines. Three eating plans based on the Dietary Guidelines are:

- USDA Food Patterns
- MyPlate
- DASH Diet (covered in Chapter 6)

USDA Food Patterns

The USDA Food Patterns, based on the *Dietary Guidelines*, were developed to translate the science into a workable form for individuals to make food choices. They identify daily amounts of foods from each food group. Individuals need to eat from five major food groups, as well as specific amounts of foods from subgroups from the major food groups. In addition, the patterns also include an allowance for oils and limits on the maximum number of calories that should be consumed from solid fats and added sugars (empty calories or low nutrient density food).

Recommended amounts and limits in the USDA Food Patterns at 12 calorie levels, ranging from 1,000 calories to 3,200 calories, are shown in Figure 1.7 USDA Food Patterns. Food Patterns at 1,000, 1,200 and 1,400 calorie levels meet the nutritional needs of children ages 2 to 8 years. Patterns at 1,600 calories and above meet the needs for adults and children ages 9 years and older. Individuals should follow a pattern that meets their estimated calorie needs—shown in the "Estimated Calorie Needs per Day" table.

The USDA Food Patterns (see Figure 1.7a and 1.7b) are the recommended daily intake amounts from each food group or subgroup at all calorie levels. Recommended intakes from vegetable subgroups are per week. This food pattern can be used to plan menus for school foodservice, correctional facilities, and healthcare facilities. Additional food patterns are available online at: www.fns.usda.gov/cnd/menu/menu_planning.doc

The USDA Food Patterns help simplify the *Dietary Guidelines* for Americans into a form that can be quantified or measured daily or weekly. For most, this is still a complex system to ensure that our bodies get the nutrition we need. Let's look at MyPlate, which helps clarify what should be eaten at each meal.

MyPlate

For the past 100 years or so, the United States Department of Agriculture (USDA) has been providing food guidance to the public. The USDA has had many different food guidance systems based on the nutrition science of the time. There have been as few as 4 food groups. There have also been as many as 9 different food groups. The basis for all of these food guidance systems is to attempt to help people *visualize* what should be on our plates and ultimately in the body to help it grow and be healthy.

In addition to the food guidance systems, there have been many attempts by USDA to help us understand "how much" food should be eaten (portion sizes). Many figures discuss how to select foods, what protection or health benefits they may have, and to focus primarily on eating foods rather than eating "nutrients." Some of the other key messages include variety, consistency ("eat this way every day" for example), moderation, and nutrition adequacy.

When taking a look at the history of the food guidance systems, many focus on the reduction of certain foods to make Americans aware of dietary excesses. This is true when focusing on the concepts of eating fats, oils, and sweets less often to maintain energy balance. When looking at the messages over time, the shift in attention to the rise in obesity in the United States is quite evident. As America has become heavier, the messages found in the food guidance system also reflect a similar message. More recently, an increase in the physical activity messages and its role in maintaining health have been added. Glimpses of this message appeared in the 1940s through the 1970s, then it reappeared with a strong emphasis in 2005.

Fast forward to the newest Food Guidance from USDA: MyPlate. In the summer of 2011, MyPlate became the newest in a long line of Food Guidance Systems that helps people visualize what should be put on the plate at each meal. Here are some features about 2011 MyPlate:

- Introduced along with updated USDA food patterns for the 2020 *Dietary Guidelines for Americans*
- Different shape to help grab consumers' attention with a new visual cue
- Icon that serves as a reminder for healthy eating, not intended to provide specific messages

Figure 1.6
MyPlate—Estimated Calorie Needs per Day by Age, Gender, and Activity Level

Estimated amounts of calories [a] needed to maintain calorie balance for various gender and age groups at three different levels of physical activity. The estimates are rounded to the nearest 200 calories for assignment to a USDA Food Pattern. An individual's calorie needs may be higher or lower than these average estimates. *(Source: USDA)*

	MALE			FEMALE [c]		
ACTIVITY LEVEL [b]	Sedentary	Moderately Active	Active	Sedentary	Moderately Active	Active
2	1,000	1,000	1,000	1,000	1,000	1,000
3	1,200	1,400	1,400	1,000	1,200	1,400
4	1,200	1,400	1,600	1,200	1,400	1,400
5	1,200	1,400	1,600	1,200	1,400	1,600
6	1,400	1,600	1,800	1,200	1,400	1,600
7	1,400	1,600	1,800	1,200	1,600	1,800
8	1,400	1,600	2,000	1,400	1,600	1,800
9	1,600	1,800	2,000	1,400	1,600	1,800
10	1,600	1,800	2,200	1,400	1,800	2,000
11	1,800	2,000	2,200	1,600	1,800	2,000
12	1,800	2,200	2,400	1,600	2,000	2,200
13	2,000	2,200	2,600	1,600	2,000	2,200
14	2,000	2,400	2,800	1,800	2,000	2,400
15	2,200	2,600	3,000	1,800	2,000	2,400
16	2,400	2,800	3,200	1,800	2,000	2,400
17	2,400	2,800	3,200	1,800	2,000	2,400
18	2,400	2,800	3,200	1,800	2,000	2,400
19-20	2,600	2,800	3,000	2,000	2.200	2,400
21-25	2,400	2,800	3,000	2,000	2,200	2,400
26-30	2,400	2,600	3,000	1,800	2,000	2,400
31-35	2,400	2,600	3,000	1,800	2,000	2,200
36-40	2,400	2,600	2,800	1,800	2,000	2,200
41-45	2,200	2,600	2,800	1,800	2,000	2,200
46-50	2,200	2,400	2,800	1,800	2,000	2,200
51-55	2,200	2,400	2,800	1,600	1,800	2,200
56-60	2,200	2,400	2,600	1,600	1,800	2,200
61-65	2,000	2,400	2,600	1,600	1,800	2,000
66-70	2,000	2,200	2,600	1,600	1,800	2,000
71-75	2,000	2,200	2,600	1,600	1,800	2,000
76+	2,000	2,200	2,400	1,600	1,800	2,000

a. Based on Estimated Energy Requirements (EER) equations, using reference heights (average) and reference weights (healthy) for each age-gender group. For children and adolescents, reference height and weight vary. For adults, the reference man is 5 feet 10 inches tall and weighs 154 pounds. The reference woman is 5 feet 4 inches tall and weighs 126 pounds. EER equations are from the Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids. Washington (DC): The National Academies Press; 2002.

b. Sedentary means a lifestyle that includes only the light physical activity associated with typical day-to-day life. Moderately active means a lifestyle that includes physical activity equivalent to walking about 1.5 to 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life. Active means a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.

c. Estimates for females do not include women who are pregnant or breastfeeding.

Source: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion

Figure 1.7a
USDA Food Patterns

The Food Patterns suggest amounts of food to consume from the basic food groups, subgroups, and oils to meet recommended nutrient intakes at 12 different calorie levels. Nutrient and energy contributions from each group are calculated according to the nutrient-dense forms of foods in each group (e.g., lean meats and fat-free milk). The table also shows the number of calories from solid fats and added sugars (SoFAS) that can be accommodated within each calorie level, in addition to the suggested amounts of nutrient-dense forms of foods in each group.

Daily Amount of Food from Each Group

Calorie Level[1]	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600	2,800	3,000	3,200
Fruits[2]	1 cup	1 cup	1-1/2 cups	1-1/2 cups	1-1/2 cups	2 cups	2 cups	2 cups	2 cups	2-1/2 cups	2-1/2 cups	2-1/2 cups
Vegetables[3]	1 cup	1-1/2 cups	1-1/2 cups	2 cups	2-1/2 cups	2-1/2 cups	3 cups	3 cups	3-1/2 cups	3-1/2 cups	4 cups	4 cups
Grains[4]	3 oz.-eq.	4 oz-eq.	5 oz-eq.	5 oz-eq.	6 oz-eq.	6 oz-eq.	7 oz-eq.	8 oz-eq.	9 oz-eq.	10 oz-eq.	10 oz-eq.	10 oz-eq.
Protein Foods[5]	2 oz-eq.	3 oz-eq.	4 oz-eq.	5 oz-eq.	5 oz-eq.	5-1/2 oz-eq.	6 oz-eq.	6-1/2 oz-eq.	6-1/2 oz-eq.	7 oz-eq.	7 oz-eq.	7 oz-eq.
Dairy[6]	2 cups	2-1/2 cups	2-1/2 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups
Oils[7]	15 g	17 g	17 g	22 g	24 g	27 g	29 g	31 g	34 g	36 g	44 g	51 g
Limit on calories from SoFAS[8]	137	121	121	121	161	258	266	330	362	395	459	596

Vegetable Subgroup Amounts Per Week

Calorie Level	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600	2,800	3,000	3,200
Dark-green Vegetables	1/2 c./wk.	1 c./wk.	1 c./wk.	1-1/2 c./wk.	1-1/2 c./wk.	1-1/2 c./wk.	2 c./wk.	2 c./wk.	2-1/2 c./wk.	2-1/2 c./wk.	2-1/2 c./wk.	2-1/2 c./wk.
Red and Orange Vegetables	2-1/2 c./wk.	3 c./wk.	3 c./wk.	4 c./wk.	5-1/2 c./wk.	5-1/2 c./wk.	6 c./wk.	6 c./wk.	7 c./wk.	7 c./wk.	7-1/2 c./wk.	7-1/2 c./wk.
Beans and Peas (e.g. pintos, lentils, split peas)	1/2 c./wk.	1/2 c./wk.	1/2 c./wk.	1 c./wk.	1-1/2 c./wk.	1-1/2 c./wk.	2 c./wk.	2 c./wk.	2-1/2 c./wk.	2-1/2 c./wk.	3 c./wk.	3 c./wk.
Starchy Vegetables	2 c./wk.	3-1/2 c./wk.	3-1/2 c./wk.	4 c./wk.	5 c./wk.	5 c./wk.	6 c./wk.	6 c./wk.	7 c./wk.	7 c./wk.	8 c./wk.	8 c./wk.
Other Vegetables	1-1/2 c./wk.	2-1/2 c./wk.	2-1/2 c./wk.	3-1/2 c./wk.	4 c./wk.	4 c./wk.	5 c./wk.	5 c./wk.	5-1/2 c./wk.	5-1/2 c./wk.	7 c./wk.	7 c./wk.

Protein Foods Subgroup Amounts Per Week

Calorie Level	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600	2,800	3,000	3,200
Seafood	3 oz./wk.	5 oz./wk.	6 oz./wk.	8 oz./wk.	8 oz./wk.	8 oz./wk.	9 oz./wk.	10 oz./wk.	10 oz./wk.	11 oz./wk.	11 oz./wk.	11 oz./wk.
Meats, Poultry, Eggs	10 oz./wk.	14 oz./wk.	19 oz./wk.	24 oz./wk.	24 oz./wk.	26 oz./wk.	29 oz./wk.	31 oz./wk.	31 oz./wk.	34 oz./wk.	34 oz./wk.	34 oz./wk.
Nuts, Seeds, Soy	1 oz./wk.	2 oz./wk.	3 oz./wk.	4 oz./wk.	4 oz./wk.	4 oz./wk.	4 oz./wk.	5 oz./wk.	5 oz./wk.	5 oz./wk.	5 oz./wk.	5 oz./wk.

1 **Calorie Levels** are set across a wide range to accommodate the needs of different individuals. The table "Estimated Daily Calorie Needs" can be used to help assign individuals to the food pattern at a particular calorie level.

2 **Fruit Group** includes all fresh, frozen, canned and dried fruits and fruit juices. In general, 1 cup of fruit or 100% fruit juice, or ½ cup of dried fruit can be considered as 1 cup from the fruit group.

3 **Vegetable Group** includes all fresh, frozen, canned and dried vegetables and vegetable juices. In general, 1 cup of raw or cooked vegetables or vegetable juice, or 2 cups of raw leafy greens can be considered as 1 cup from the vegetable group.

4 **Grains Group** includes all foods made from wheat, rice, oats, cornmeal, barley, such as bread, pasta, oatmeal, breakfast cereals, tortillas and grits. In general, 1 slice of bread, 1 cup of ready-to-eat cereal, or ½ cup of cooked rice, pasta, or cooked cereal can be considered as 1 ounce-equivalent from the grains group. At least half of all grains consumed should be whole grains.

5 **Proteins Group** includes meat, poultry, seafood, eggs, processed soy products and nuts and seeds. In general, 1 ounce of lean meat, poultry, or seafood, 1 egg, 1 Tbsp. peanut butter, or 1/2 ounce of nuts or seeds can be considered as 1 ounce equivalent from the protein group. Also, 1/4 cup of beans or peas may be counted as a 1 ounce equivalent in this group.

6 **Dairy Group** includes all milks, including lactose-free products and fortified soy milk (soy beverage) and foods made from milk that retain their calcium content, such as yogurt and cheese. Foods made from milk that have little to no calcium, such as cream cheese, cream and butter, are not part of the group. Most dairy group choices should be fat-free or low-fat. In general, 1 cup of milk or yogurt, 1½ ounces of natural cheese, or 2 ounces of processed cheese can be considered as 1 cup from the dairy group.

7 **Oils** include fats from many different plants and from fats that are liquid at room temperature, such as canola, corn, olive, soybean and sunflower oil. Some foods are naturally high in oils, like nuts, olives, some fish and avocados. Foods that are mainly oil include mayonnaise, certain salad dressings and soft margarine.

8 **SoFAs** are solid fats and added sugars. The limits for calories from SoFAS are the remaining amount of calories in each food pattern after selecting the specified amounts in each food group in nutrient-dense forms (forms that are fat-free or low-fat and with no added sugars).

Source: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion

Figure 1.7b
USDA Food Patterns

Estimated Daily Calorie Needs

To determine which food intake pattern to use for an individual, the following chart gives an estimate of individual calorie needs. The calorie range for each age/sex group is based on physical activity level, from sedentary to active.

	CALORIE RANGE	
Children	**Sedentary**	**Active**
2-3 years	1,000	1,400
Females	**Sedentary**	**Active**
4-8 years	1,200	1,800
9-13	1,600	2,200
14-18	1,800	2,400
19-30	2,000	2,400
31-50	1,800	2,200
51+	1,600	2,200
Males	**Sedentary**	**Active**
4-8 years	1,400	2,000
9-13	1,800	2,600
14-18	2,200	3,200
19-30	2,400	3,000
31-50	2,400	3,000
51+	2,200	2,800

Sedentary means a lifestyle that includes only the light physical activity associated with typical day-to-day life.

Active means a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3 to 4 miles per hour, in addition to light physical activity associated with typical day-to-day life.

Source: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion

- Visual is linked to food and is a familiar mealtime symbol in consumers' minds, as identified through testing
- "My" continues the personalization approach from USDA

Upon the announcement of the 2015-20 Dietary Guidelines for Americans, the United States Department of Agriculture (USDA) and the Department of Health and Human Services (HHS) said, "The *2015-20 Dietary Guidelines* provides guidance for choosing a healthy diet and focuses on preventing the diet-related chronic diseases that continue to affect our population. Its recommendations are ultimately intended to help individuals improve and maintain overall health and reduce the risk of chronic disease. Its focus is disease prevention, not treatment."

Because more than one-third of children and more than two-thirds of adults in the United States are overweight or obese, the 2015-2020 version of the *Dietary Guidelines* placed stronger emphasis on the overall eating pattern and increasing physical activity.

When the *2015-20 Dietary Guidelines for Americans* were released, the majority of adults were overweight. In addition, one in three children were also overweight or obese. This was a crisis that could no longer be ignored. These new and improved dietary recommendations give individuals the information to make thoughtful choices of healthier foods in the right portions and to complement those choices with physical activity. The bottom line is that most Americans need to trim our waistlines to reduce the risk of developing diet-related chronic disease. Improving our eating habits is not only good for every individual and family, but also for our country.

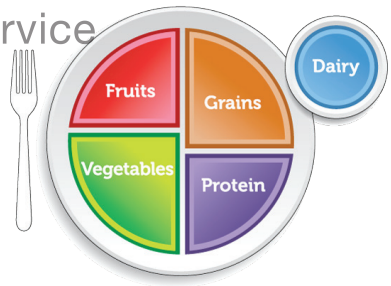
MyPlate was developed to provide a visual and practical guidance about how to eat at each meal. It is a concrete example of how the plate should look, in spite of gender, age or caloric requirements. It offers a way of making dietary choices, based on sound nutrition principles. For the general healthy public over the age of two, it represents solid "basic nutrition" advice that can help individuals choose healthy foods that will contribute to health, balance calorie intake with physical activity and provide nutrient-dense food choices.

MyPlate can be found at www.ChooseMyPlate.gov. The site is an interactive nutrition resource to explore and design a personal eating plan.

Ten Tips—MyPlate

The MyPlate plan illustrates 10 recommendations/categories as follows:

1. **Balance Calories**—Find out how many calories *you* need for a day as a first step in managing your weight. Go to www.ChooseMyPlate.gov to find your calorie level. Being physically active also helps you balance calories.
2. **Enjoy Your Food, But Eat Less**—Take the time to fully enjoy your food as you eat it. Eating too fast or when your attention is elsewhere may lead to eating too many calories. Pay attention to hunger and fullness cues before, during, and after meals. Use them to recognize when to eat and when you've had enough.
3. **Avoid Oversized Meals**—Use a smaller plate, bowl, and glass. Portion out foods before you eat. When eating out, choose a smaller size option, share a dish, or take home part of your meal.
4. **Foods to Eat More Often**—Eat more vegetables, fruits, whole grains, and fat-free or 1% milk and dairy products. These foods have the nutrients you need for health, including potassium, calcium, vitamin D, and fiber. Make them the basis for meals and snacks.
5. **Make Half Your Plate Fruits and Vegetables**—Choose red, orange, and dark-green vegetables like tomatoes, sweet potatoes, and broccoli, along with other vegetables for your meals. Add fruit to meals as part of main or side dishes or as dessert.
6. **Switch to Fat-Free or Low-Fat (1%) Milk**—They have the same amount of calcium and other essential nutrients as whole milk, but fewer calories and less saturated fat.
7. **Make Half Your Grains Whole Grains**—To eat more whole grains, substitute a whole-grain product for a refined product—such as eating whole wheat bread instead of white bread or brown rice instead of white rice.



MyPlate

Figure 1.8
MyPlate Overview of Messages

Food Group	MyPlate Message	What Foods Are Included	Amounts Measured In...	Other Messages
Fruit 	Focus on fruit	Any fruit or 100% fruit juice counts as part of the fruit group. Fruits may be fresh, canned, frozen, or dried and may be whole, cut-up, or puréed.	Cups per day	Limit juice to 6 ounces or less per day.
Vegetables 	Vary your veggies	Any vegetable or 100% vegetable juice counts as a member of the vegetable group. Vegetables may be raw, cooked, fresh, frozen, canned, dried, or dehydrated and may be whole, cut-up, or mashed.	Cups per day	Based on their nutrient content, vegetables are organized into 5 subgroups: dark green vegetables, red and orange vegetables, starchy vegetables, beans and peas, and other vegetables.
Protein 	Go lean with protein	All foods made from meat, poultry, seafood, beans, peas, eggs, processed soy products, nuts, and seeds are considered part of the protein foods group.	Ounces per day	Select a variety of protein foods to improve nutrient intake and health benefits, including at least 8 ounces of cooked seafood per week.
Grains 	Make half your grains whole	Any food made from wheat, rice, oats, cornmeal, barley, or another cereal grain is a grain product. Bread, pasta, oatmeal, breakfast cereals, tortillas, and grits are examples of grain products.	Ounces per day	Grains are divided into 2 subgroups: whole grains and refined grains. Whole grains contain the entire grain kernel—the bran, germ, and endosperm.
Dairy 	Get your calcium-rich foods	All fluid milk products and many foods made from milk are considered part of the dairy food group. Most dairy group choices should be fat-free or low-fat. Foods made from milk that retain their calcium content are part of the group. Foods made from milk that have little to no calcium, such as cream cheese, cream, and butter, are not. Calcium-fortified soymilk (soy beverage) is also part of the dairy group.	Cups per day	

Source: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion

8. **Foods to Eat Less Often**—Cut back on foods high in solid fats, added sugars, and salt. They include cakes, cookies, ice cream, candies, sweetened drinks, pizza, and fatty meats like ribs, sausages, bacon, and hot dogs. Use these foods as occasional treats, not everyday foods.
9. **Compare Sodium in Foods**—Use the Nutrition Facts label to choose lower sodium versions of foods like soup, bread, and frozen meals. Select canned foods labeled "low sodium," "reduced sodium," or "no salt added."
10. **Drink Water Instead of Sugary Drinks**—Cut calories by drinking water or unsweetened beverages. Soda, energy drinks, and sports drinks are a major source of added sugar and calories in American diets.

Ounce or Ounce Equivalent for Grains and Protein Groups

What is an **ounce** or ounce equivalent? An ounce is a measurement of weight. The weight of one ounce is 28 grams. But still, what does that mean?

GLOSSARY

Ounce
A measurement of weight. One ounce = 28 grams

In general, 1 ounce of meat, poultry or fish, ¼ cup cooked beans, 1 egg, 1 tablespoon of peanut butter, or ½ ounce of nuts or seeds can be considered as 1 ounce equivalent from the Protein Foods Group. In general, 1 slice of bread, ½ bun, 1 cup of ready-to-eat cereal, or ½ cup of cooked rice, cooked pasta, or cooked cereal can be considered as 1 ounce equivalent from the Grains Group. Let's look at an example: consider the MyPlate guide for a person targeting 2,200 calories per day. The suggested intake from the Grains group is 7 ounces. To meet that total, a person may choose many different combinations and amounts of grain foods, such as:

- 1/2 cup oatmeal at breakfast (1 ounce), plus
- 2 slices of rye bread at lunch in a sandwich (2 ounces), plus
- 1 small bag of corn tortilla chips (1 ounce) for a snack, plus
- 1-1/2 cups of rice or pasta at dinner (3 ounces)

This would provide a total of seven ounces from this group for a day.

For mixed foods, estimate food groups based on the main ingredients. For example, a generous serving of pizza would count in the Grains group (crust), the Dairy group (cheese), and the Vegetable group (tomato). A serving of beef stew would count in the Protein and the Vegetable groups. Figure 1.9 provides examples of counting mixed dishes with MyPlate.

The MyPlate approach provides a simple tool that is readily understood. Most people can select their own food choices from within each food group and make personal dietary choices that contribute to good health. The image is easy to conceptualize and makes a good educational tool as well.

Please note that MyPlate, like other food guides, is not absolute. As will be learned in later chapters, an individual's nutritional needs vary throughout the stages of life. In addition, medical conditions can affect what constitute "ideal" dietary choices for any

Putting It Into Practice

3. How could the following meal be modified to better fit MyPlate guidelines?

- Roast beef
- Mashed potatoes
- Corn
- Bread
- Milk

Figure 1.9
Examples of Counting Mixed Dishes

FOOD AND SAMPLE PORTION	AMOUNT FROM FOOD GROUP IN THIS PORTION					
	Grains Group	Vegetable Group	Fruit Group	Dairy	Protein	Estimated Total Calories
Cheese Pizza—Thin Crust (1 slice from medium pizza)	1 oz.-eq.	1/8 cup	0	1/2 cup	0	215
Macaroni and Cheese (1 cup made from package mix)	2 oz.-eq.	0	0	1/2 cup	0	260
Tuna Noodle Casserole (1 cup)	1-1/2 oz.-eq.	0	0	1/2 cup	2 oz.-eq.	260
Chicken Pot Pie (8 oz. pie)	2-1/2 oz.-eq.	1/4 cup	0	0	1-1/2 oz.-eq.	500
Beef Taco (2 tacos)	2-1/2 oz.-eq.	1/4 cup	0	1/4 cup	2 oz.-eq.	370
Egg Roll (1)	1/2 oz.-eq.	1/8 cup	0	0	1/2 oz.-eq.	150
Chicken Fried Rice (1 cup)	1-1/2 oz.-eq.	1/4 cup	0	0	1 oz.-eq.	270
Stuffed Peppers with Rice and Meat (1/2 pepper)	1/2 oz.-eq.	1/2 cup	0	0	1 oz.-eq.	190
Clam Chowder-New England (1 cup)	1/2 oz.-eq.	1/8 cup	0	1/2 cup	2 oz.-eq.	165
Cream of Tomato Soup (1 cup)	1/2 oz.-eq.	1/2 cup	0	1/2 cup	0	160
Large Cheeseburger	2 oz.-eq.	0	0	1/3 cup	3 oz.-eq.	500
Peanut Butter & Jelly Sandwich (1)	2 oz.-eq.	0	0	0	2 oz.-eq.	375
Tuna Salad Sandwich (1)	2 oz.-eq.	1/4 cup	0	0	2 oz.-eq.	290
Chef Salad (3 cups—no dressing)	0	1-1/2 cups	0	0	3 oz.-eq.	230
Pasta Salad with Vegetables (1 cup)	1-1/2 oz.-eq.	1/2 cup	0	0	0	140
Apple Pie (1 slice)	2 oz.-eq.	0	1/4 cup	0	0	280

Source: U.S. Department of Agriculture and U.S. Department of Heath and Human Services

individual. In later chapters, the focus will be to learn more about how diets may need to be modified for certain disease states.

Other Significant Dietary Recommendations

Today's nutrition advice indicates a need to make some adjustments to the usual American diet. Here are more tips for making healthy choices based on the Dietary Guidelines for Americans, the USDA Food Plans, and MyPlate.

Carbohydrate: Limit Sugar

The Dietary Guidelines for Americans recommend using sugars only in moderation. Foods containing large amounts of refined sugars should be eaten in moderation by most healthy people, and sparingly by people with low calorie needs. For very active people with high calorie needs, sugars can be an additional source of calories. The following tips can help reduce sugar in the diet:

- Instead of regular soft drinks or powdered drink mixes, choose diet soft drinks, 100 percent fruit juices, bottled waters such as seltzer, or iced tea made without added sugar or with non-nutritive sweeteners.
- Instead of desserts such as cake, emphasize fruits. Fresh fruit can be baked (baked apples), poached (poached pears), broiled, or made into compote. Choose canned fruits that are packed in fruit juice or water and avoid those packed in syrup.
- Make cakes, cookies, pies, and other baked goods from scratch and reduce the sugar by one-quarter to one-third. It usually does not affect the quality of the product. Use recipes that contain fruits to sweeten and sweet spices such as cinnamon, nutmeg, and cloves.
- Try a cookie that uses less sugar, such as graham crackers, vanilla wafers, ginger snaps, or fig bars.
- Choose 100 percent pure fruit juices. They do not contain added sugars. Products labeled as fruit drinks, fruit beverages, or flavored drinks usually contain only small amounts of fruit juice, with added water and much refined sugar.
- Choose whole grain, unsweetened breakfast cereals with less than four grams of sugar per serving (unless the sugar comes from a dried fruit such as raisins) and top with fresh fruit.
- Jams, jellies, and pancake syrup contain considerable amounts of refined sugar. Select jams and jellies made without (or with less) sugar and pancake syrup labeled "reduced calorie." Other suggested toppings for toast or pancakes are chopped fresh fruit, applesauce, part-skim ricotta cheese, peanut and other nut butters, and fruit.

Mixed Dishes: Look for Fats and Sugar

Some mixed foods contain a lot of fat, oil, or sugar, which adds calories (see Figure 1.10).

SoFAs is a term that refers to the addition of solid fats (like butter, shortening, margarine, and the like) and added sugars. The addition of SoFas on a regular basis in the American diet is significant. Look again at the foods listed in Figure 1.10. Hidden

Putting It Into Practice

4. Which foods and beverages contain natural sugars, and which contain added sugars?
   - Canned fruit
   - Plain milk
   - Eggs
   - Bread
   - Soda
   - Chocolate milk
   - Fresh fruit
   - Flavored oatmeal packets
   - Sweet potatoes

fats, sugars, and calories are in common foods. These foods (like cheese, for example) are often added to other foods, thus increasing the fat of an entrée. Make some healthier substitutions. Consider these easy substitutions:

- Instead of sweetened breakfast pastries such as Danish, try a bagel, English muffin, roll, or fruited muffin and make them whole grain.
- Use less table (refined) sugars in coffee, tea, cereals, etc., or use sugar substitutes.
- Try fresh or dried fruit for a sweet snack instead of candy.
- Cut back on the fat in a baked product by substituting applesauce for some of the butter or margarine in the recipe.

Figure 1.10
Examples of Solid Fats and Added Sugars in Current American Diets

SOLID FATS	ADDED SUGARS
• Grain-based desserts, including cakes, cookies, pies, doughnuts, and granola bars • Regular cheese • Sausage, franks, bacon, and ribs • Pizza • Dairy-based desserts such as ice cream	• Soda • Grain-based desserts • Fruit drinks • Dairy-based desserts • Candy

Source: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. Dietary Guidelines for Americans, 2015-2020

Figure 1.11
Good Sources of Fiber

FOOD	GRAMS	FOOD	GRAMS
Breakfast Cereals (1 cup)		**Breads and Pastas (1 ounce)**	
Bran-type Cereals	10	Whole Wheat Bread	2
Raisin Bran-type Cereals	8	Bran Muffin	5
Whole Wheat Breakfast Cereals	4	Whole Wheat Pasta	1-6
Whole Oat Breakfast Cereals	2	**Fruits**	
Dried Beans and Peas (1/2 cup)		Apple	3
All Cooked Beans and Peas	7	Banana	3
Vegetables (1/2 cup)		Blackberries (1 cup)	8
Broccoli	3	Cherries (10 each)	2
Brussels Sprouts	3	Figs (10 each)	2
Carrots	3	Grapefruit	2
Peas	4	Kiwi Fruit	3
Potatoes with Skin (1 each)	5	Orange	3
Spinach, Raw	< 1	Pear	4
Sweet Potatoes (1 each)	3	Prunes (1 cup)	16
		Raspberries (1 cup)	8
		Strawberries (1 cup)	3

Source: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, www.ChooseMyPlate.gov

Increase Your Fiber: Eat Fiber-Rich Foods

General recommendations for fiber intake are from 20 to 35 grams daily. The Daily Value used for Nutrition Facts Labeling is 25 grams. For children, use the "age + 5" rule, which recommends that children consume an amount of fiber equal to their age plus an additional 5 grams of fiber. Unfortunately, the average American takes in less than 20 grams of fiber a day. Figure 1.11 lists good sources of fiber. When increasing fiber intake, do so slowly to avoid problems with cramps, diarrhea, and excessive gas. Also, it's important to chew foods well and drink at least 8 to 10 glasses of water each day, because fiber takes water out of the body. Make at least half of your grains whole grains.

Fat: Limit Solid Fats, Saturated Fats, Trans-Fat, and Cholesterol

The Dietary Guidelines for Americans recommend a diet moderate in total fat and low in saturated fat and cholesterol. Guidelines generally suggest that no more than 30 percent of daily calories should come from fat. Figure 1.12 gives the recommendations for saturated fat intake according to various calorie levels.

Additional recommendations for Americans without cardiovascular disease include:

- No more than 10 percent of total calories should be in the form of saturated fat with an eventual goal of <7 percent.
- Avoid trans-fatty acids (trans-fat) from processed food sources.
- Cholesterol intake should be less than 300 milligrams daily.
- Increase total amount of fish consumption to two times per week, especially those fish high in omega-3 fatty acids.

This advice does not apply to infants and toddlers below the age of two years. After age two, children should gradually adopt a diet that, by about five years of age, contains no more than 30 percent of calories from fat. As they begin to consume fewer calories

Figure 1.12
Recommended Saturated Fat intake

Total Daily Calories	Saturated Fat @ 10%
1600	18 grams or less
2000	20 grams or less
2200	24 grams or less
2400	25 grams or less
2800	31 grams or less

Source: U.S. Department of Health and Human Services and U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, Dietary Guidelines for Americans, 2010

Putting It Into Practice

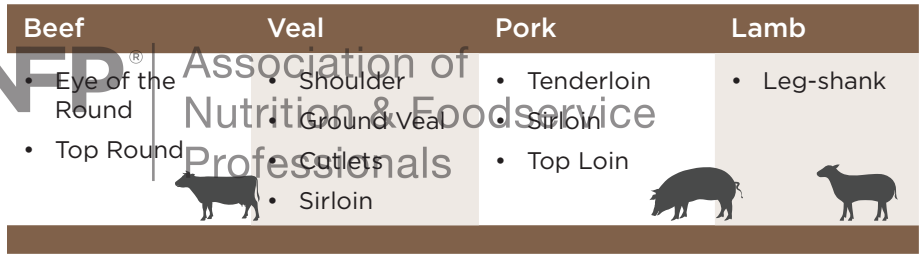
5. Which foods or beverages have more fiber:
   - A bagel or a vegetable omelet?
   - Vegetable juice or a baked potato?
   - White rice or pinto beans?

from fat, children should replace these calories by eating more grain products, fruits, vegetables, low-fat milk products or other calcium-rich foods, beans, lean meat, poultry, fish, or other protein-rich foods.

Meat, poultry, fish, and shellfish contain saturated fat and/or cholesterol. Luckily, some choices are quite low in saturated fat. In general, poultry is low in saturated fat, especially when the skin is removed. When buying fresh ground turkey or chicken, find a product that says "light meat" or "breast" on the label. Poultry products that include the skin and/or dark meat are much higher in fat. Goose and duck are also high in fat. Most fish is lower in saturated fat and cholesterol than meat and poultry. Fatty fish (such as salmon and tuna) are rich in omega-3 fatty acids, which may protect against heart disease and certain forms of cancer. Shellfish varies in cholesterol content.

Figure 1.13 lists lean cuts of meat. High-fat processed meats, such as many luncheon meats and sausages, provide a hefty 60 to 80 percent of their calories from fat, much of which is saturated. Other examples of processed meats are bacon, bologna, salami, hot dogs, and sausage. In some cases, processed meats are made from turkey or chicken and are lower in fat. Look for low-fat processed meats. Organ meats, like liver and kidneys, are relatively low in fat. However, these meats are high in cholesterol.

Figure 1.13
Lean Cuts of Meat



Source: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion

When cooking meats, poultry, and fish, use cooking methods that use little or no fat, such as roasting, baking, broiling, grilling, boiling, stir frying, or poaching. Do not fry. When making pan gravy, refrigerate the drippings first so the fat will solidify and can be removed. One may also extend meat with pasta, beans, or vegetables for hearty dishes. For less saturated fat and cholesterol and more variety, dried beans or legumes are an excellent meat alternative.

Although many people believe that meats have the highest cholesterol and saturated fat content, dairy products can also be high in saturated fat and cholesterol. As dairy products are often added to foods like casseroles, cakes, or pies, it's easy to eat a significant amount of them without knowing it. Both 1 percent and skim milk provide much less saturated fat and cholesterol and fewer calories than whole milk, as shown in Figure 1.14.

Putting It Into Practice

6. What could be a better choice when limiting saturated fats:
   - Bologna sandwich or tuna sandwich?
   - Ribeye steak or sirloin steak?

Figure 1.14
Comparison of Milk, Poultry, Meat, and Cheese

MILK	TOTAL FAT	SATURATED FAT	CHOLESTEROL	CALORIES
Skim Milk	0.4 g	0.3 g	4 mg	86
1% Milk	2.6 g	1.6 g	10 mg	102
2% Milk	4.7 g	2.9 g	18 mg	121
Whole Milk	8.2 g	5.1 g	33 mg	150
CHICKEN				
Roasted Chicken (no skin, light meat, 3 oz.)	3.1 g	.9 g	72 mg	140
MEAT				
Beef (top round, broiled, 3 oz.)	4.8 g	1.7 g	65 mg	158
CHEESE				
Natural Cheddar (1 oz.)	9.4 g	6.0 g	30 mg	110

Source: National Institutes of Health

Often, when people cut back on meat, they replace it with cheese, thinking they are cutting back on their saturated fat and cholesterol. However, most cheeses are prepared from whole milk or cream, which are also high in saturated fat and cholesterol. Cheeses are particularly high in saturated fat (Figure 1.14). Fortunately, manufacturers offer low-fat versions of cheese favorites like cheddar, Swiss, and mozzarella. They use skim milk and vegetable oils to replace some of the cream and other fat. The result is reduced-fat or fat free cheese.

Americans love ice cream. Ice cream is made from whole milk and cream, and therefore contains a considerable amount of saturated fat and cholesterol. Some frozen desserts such as ices, popsicles, and sorbet are generally made without fat. Ice milk contains less fat and saturated fat than regular ice cream, as does frozen low-fat yogurt. With the wide variety of frozen desserts, it's a good idea to read nutrition labels.

Egg yolks are high in cholesterol. The average large egg yolk contains 185 milligrams of cholesterol, about two-thirds of the suggested daily intake. To lower cholesterol and fat content, use egg substitutes with less than 60 calories per one-quarter cup serving, or egg whites, which contain no cholesterol. Two egg whites can be substituted for one whole egg in most recipes.

Most breads and bread products contain only small amounts of fat, with less than two grams per slice or serving—that is, if margarine or mayonnaise is not spread on them. Some breads typically have significant fat added in their preparation. Examples include biscuits, croissants, cornbread, dinner rolls, scones, and muffins. Also note that most granolas are high in fat. Commercial cakes, pies, cookies, donuts, and pastry are often high in fat, saturated fat, and calories. In addition, some are quite high in cholesterol. Tasty alternatives include angel food cake, sponge cake, fig bars, ginger snaps, and baked goods made with little or no fat. Recipe substitution ideas appear in Figure 1.15. Many desserts can also be made with less fat. Simply reduce the fat called for by one-fourth to one-third the original amount. When decreasing the fat in a recipe, it is important to note that the quality of the product may be affected. Be sure to test recipes prior to serving.

Figure 1.15
Lower Fat Baking Substitutions

INSTEAD OF...	...USE THIS
1 cup shortening, butter, or margarine	1/2 cup oil and 1/2 cup applesauce
1 whole egg	2 egg whites
1 cup sour cream	1 cup reduced-fat sour cream
1 cup whole milk	1 cup skim milk
1 Tbsp. cream cheese	1 Tbsp. fat-free or light cream cheese
1 cup cream	1 cup low-fat yogurt
1 oz. baking chocolate	3 Tbsp. cocoa and 1 Tbsp. vegetable oil

Source: U.S. Department of Agriculture, Food and Nutrition Service

Protein

Proteins are especially important because they provide both energy and essential amino acids, which will be discussed in the next chapter. Unlike fats, the amount required per day is based on grams of protein per kilogram of body weight. The Recommended Dietary Allowance (RDA) for protein is 0.8 g protein/kg body weight/day for ages 19 and above. Average protein intake for most Americans is considered adequate. As Americans decrease their calorie intake to fight obesity, there is a shift in the percentage of calories from protein. Percent of proteins may need to increase. Figure 1.16 indicates how the percentage of calories from protein changes for a 150 lb. person based on the total daily calorie intake.

High quality protein sources are animal proteins. In the past few years, many consumers have adopted high-protein diets for weight-loss purposes. This has resulted in some Americans consuming diets high in protein, especially animal sources. According to the Report of the DGAC on the Dietary Guidelines for Americans 2020, "In shorter-term studies, low-calorie, high-protein diets may result in greater weight loss, but these differences are not sustained over time." Eating too much protein has no health benefits. In fact, eating excess protein from animal products may add excessive fat and calories.

Lower quality protein sources are plant-based. Review the complementary protein sources in Chapter 2. Consuming lower-quality proteins is of greater concern when protein needs are high, such as pregnancy, lactation, childhood, and during illness

Putting It Into Practice

7. What are some ways to reduce saturated fat intake to 7% of total calories while also increasing the meal's nutrient value?
   - 4 oz. ribeye steak
   - Small baked potato with 1 Tbsp. butter and 1 tsp. sour cream
   - 1/2 cup green beans with 1 tsp. butter
   - 1 cup whole milk
   - 1/2 cup ice cream

Figure 1.16
Changes in Protein Needs by Calorie Level

CALORIE LEVEL	% OF CALORIES
1200	18%
1500	14.4%
1800	12%
2000	10.8%
2500	8.5%

Protein needs for 150 lb. person @ 0.8gm/kg = 54 grams. That amount stays the same regardless of the different level of energy intake.

Source: U.S. Department of Agriculture and U.S. Department of Health and Human Services

or injury. The Report of the DGAC on the Dietary Guidelines for Americans 2010, indicated moderate evidence linking a plant-protein diet to lower blood pressure.

The best way to manage protein intake is to follow the Dietary Guidelines and MyPlate. Also, note that many of the recommendations for reducing dietary fat and saturated fat are based on following recommended portion sizes.

Drink Enough Water: Meeting Daily Fluid Requirements

Water is an essential nutrient. In the past, there was no dietary guideline or Dietary Reference Intake for water. Some people have even referred to it as the "forgotten nutrient." Since nearly all bodily systems depend on water and proper hydration, let's look at the recommendation for water and how to calculate daily fluid requirement. How much is needed depends upon health, physical activity, and even where a person lives. Humans lose about 10 cups of water each day through breathing, sweating, and urine and bowel movements. Most physicians recommend drinking 8-10, 8-ounce glasses of water each day. Approximately 20 percent of fluid needs come from food that is consumed, and the other 50 percent from beverage consumption (which will be discussed at length in other chapters).

Sources of water from food plus the 8-10 glasses of water would help to replace what is lost each day. Additional water may be needed for high temperature and humidity. In the effort to fight the obesity epidemic, replacing other fluids such as soda, sports drinks, and juice with water will help reduce calories. On average, Americans consume over 130 calories each day from soda, sports drinks, and juice.

Food or Supplements? Real Food First

A common nutritional question concerns multivitamin preparations or supplements. Should one rely on a balanced diet or pills to ensure good nutrition? While nutrition science is quite advanced, scientists are only beginning to understand the many components of foods that are active in the human body. The emerging concept of functional foods makes this quite evident. Beyond vitamins, minerals, protein, lipids, and carbohydrates, foods provide other compounds. Some appear to offer health benefits. Already, some functional ingredients in foods have been incorporated into nutritional supplements. But this is not a complete answer for sound nutrition. The bottom line is that real food is preferred. With real food, provided through a balanced diet and based on established dietary guidance, one can obtain necessary nutrients, as well as compounds that may not be fully understood. Real food also gives people pleasure, offers fiber (not present in all supplemental products), and water. It provides a sense of satiety or fullness when eaten.

Real Food First is a concept that has gotten much notice in long-term care. With liberalized diets in long-term care, real food should always be the first food offered between meals, prior to beginning any nutritional supplements.

Multivitamins or nutritional supplements can be important for an individual who wishes to ensure adequate nutrition, or who needs to correct a deficiency. Iron supplements, for example, may be important to supplement dietary intake of iron. Iron-deficiency anemia is common in the U.S. and it is not easy for everyone to consume adequate iron through food. Calcium is another nutrient that may be worth supplementing—especially for adult women. The AI level is not easy for every woman to achieve and calcium plays a role in preventing osteoporosis. These are just examples of situations in which supplementation may be useful. However, it's prudent to consider supplements for what they are— supplements—not replacements for healthy eating habits. It is also important to review DRIs for nutrients and pay particular attention to the UL levels for nutrients. Excessive supplementation of some nutrients can cause health problems.

The Dietary Guidelines emphasize real foods over nutrition supplements, saying, "A basic premise of the Dietary Guidelines is that nutrient needs should be met primarily through consuming foods. Foods provide an array of nutrients and other compounds that may have beneficial effects on health. In certain cases, fortified foods and dietary supplements may be useful sources of one or more nutrients that otherwise might be consumed in less than recommended amounts. However, dietary supplements, while recommended in some cases, cannot replace a healthful diet." Figure 1.17 provides guidelines for minimizing nutrient loss during cooking. The human diet is complex. So much nutrition information bombards a person that sorting through it all can be challenging. Looking to the Dietary Guidelines for Americans, the USDA Food Plans, and MyPlate to translate the science to what is consumed is the best way to ensure a healthy diet. Remember, for menu planning and in-depth assessment, the DRIs offer a science-based standard of reference.

Putting It Into Practice

8. Why might a nutritional shake, such as an oral nutrition supplement or a smoothie, not align with the Real Food First concept?

Figure 1.17
Tips for Protecting Nutrients

- Minimize storage time. Do not store foods longer than necessary.
- Keep foods wrapped or covered for storage.
- Do not soak foods in water unless absolutely necessary. If you need to soak a food, use as little water as possible. If practical, add the water to the product (e.g. boiling vegetables, if possible, use the water in soups instead of throwing it away).
- Cut and cook vegetables in large pieces to minimize contact between surface area and air.
- To cook vegetables, steam rather than boil. This helps them retain nutrients.
- Cook vegetables as soon as possible after cutting. If preparing for later use, keep in airtight bag or container and keep in the refrigerator.
- Use raw vegetables (rather than boiled) whenever possible.
- Avoid adding baking soda to vegetables during cooking. Some people use this practice to retain color. However, it destroys thiamin and vitamin C.
- Avoid overcooking food, as heat can destroy vitamins (especially vitamin C). Cook just until tender and serve as soon as possible.
- Do not rinse enriched rice before cooking and do not discard the water during cooking.
- Do not brown undercooked rice before adding water. This destroys thiamin.
- After cooking rice, pasta, or other grain-based foods, do not rinse; just drain.
- Store food away from light or in dark containers. This is important for milk, since riboflavin and B vitamin in milk is destroyed by light.
- In foodservice operations, cook food as close to service times as possible. Cook in small batches as appropriate. For example, steamed vegetables may be prepared in small batches throughout an extended meal service time.

Source: U.S. Department of Agriculture

Chapter References

RESOURCES	
American Cancer Society*	http://www.cancer.org
Centers for Disease Control and Prevention*	https://www.cdc.gov/
Centers for Disease Control and Prevention. Survey Results and Products from the National Health and Nutrition Examination Survey. National Center for Health Statistics. Updated February 13, 2018.*	https://www.cdc.gov/nchs/nhanes/nhanes_products.htm
International Food Information Council Foundation*	https://foodinsight.org
Office of Disease Prevention and Health Promotion. Healthy People 2020.*	https://www.healthypeople.gov
U.S. Department of Agriculture*	https://www.usda.gov/
U.S. Department of Agriculture. Food and Human Nutrition. National Agricultural Library.*	https://www.nal.usda.gov/food-and-human-nutrition
U.S. Department of Agriculture. MyPlate.*	https://www.choosemyplate.gov
U.S. Department of Agriculture. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. Published February, 2015. Accessed September 16, 2020.*	https://health.gov/sites/default/files/2019-09/Scientific-Report-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf
U.S. Department of Agriculture. What We Eat in America, Agricultural Research Service. Updated August 15, 2019.*	https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/wweia-usual-intake-data-tables/
U.S. Department of Health and Human Services*	https://www.hhs.gov/
U.S. Department of Health and Human Services. DASH Eating Plan. National Heart, Lung, and Blood Institute.*	https://www.nhlbi.nih.gov/health-topics/dash-eating-plan
U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015–2020 Dietary Guidelines for Americans, 8th Edition. Office of Disease Prevention and Health Promotion. Published December 2015.*	https://health.gov/dietaryguidelines/2015/resources/2015-2020_Dietary_Guidelines.pdf.
U.S. Department of Health and Human Services and U.S. Department of Agriculture. Dietary Guidelines for Americans, 2010. 7th Edition. Office of Disease Prevention and Health Promotion. Published December 2010*	https://health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf
U.S. Department of Health & Human Services. Nutrient Recommendations: Dietary Reference Intakes (DRI). National Institutes of Health Office of Dietary Supplements.*	https://ods.od.nih.gov/Health_Information/Dietary_Reference_Intakes.aspx
U.S. Department of Health and Human Services. USDA Food Patterns. National Institute on Aging. Updated April 29, 2019.*	https://www.nia.nih.gov/health/usda-food-patterns

**Accessed September 18, 2019*

The Building Blocks of Nutrition

Overview and Objectives

In order to plan and implement menus, a Certified Dietary Manager®, Certified Food Protection Professional® (CDM®, CFPP®) needs to master nutrition concepts. An understanding of basic nutrients is also essential for planning modified diets. CDM, CFPPs apply information from the six nutrient categories. After completing this chapter, you should be able to:

- Identify six groups of nutrients
- Define calorie
- List the energy content of nutrients
- Differentiate between simple and complex carbohydrates
- Explain nutrient density of foods
- Calculate energy content of a simple food

2

People eat foods for many different reasons. Many people have feelings and beliefs regarding the foods they choose. Most people care about their body…how they feel and look. Each person has a relationship with nutrition. Nutrition is all about how food nourishes the body. When properly combined, nutrients from the foods that are eaten help to provide optimum health.

Nutrition is also about food energy, which affects how a person looks and feels. Energy is needed every day to work and play. That energy comes either directly or indirectly from the sun in the form of nutrients in food. Plants convert the sun's rays into stored energy and when plants become food, the body releases that stored energy from the plants. Animals that eat plant foods get their energy in the same way, so both plant and animal foods provide energy.

GLOSSARY

Nutrients
Food components that supply the body with energy, promote growth and maintenance of tissues, and regulate body processes

Essential Nutrients
Nutrients that cannot be made in the body or cannot be made in the quantity needed by the body. Humans must get them via food

Nutrients, or food components, supply the body with energy, promote the growth and maintenance of tissues, and regulate body processes. There are about 50 known nutrients that are categorized into six groups:

- Carbohydrates
- Fats (lipids)
- Proteins
- Vitamins
- Minerals
- Water

The functions of each group of nutrients are shown in Figure 2.1.

Most foods are a mixture of carbohydrates, proteins, and fats and contain smaller quantities of other nutrients, such as vitamins, minerals, and water. It's been said many times: "You are what you eat." Indeed, the nutrients within the foods we eat, once eaten, are in the body. Water accounts for about 50-70 percent of body weight. Fats (lipids) account for about 4-27 percent of body weight, and protein accounts for about 14-23 percent of body weight. Carbohydrates comprise only 0.5 percent. (Even though carbohydrates are important nutrients, most do not remain as carbohydrates in the body.) The remainder of body weight includes minerals, like calcium (in bones, teeth) and vitamins.

Most, but not all, nutrients are considered **essential nutrients.** Essential nutrients either cannot be made in the body or cannot be made in the quantities needed by the body; therefore, they must be obtained through food. Thus, "essential" in this term

Figure 2.1
Functions of Each Group of Nutrients

NUTRIENT GROUP	FUNCTION
• Carbs, Fats, Protein	• Provide energy
• Fats, Protein	• Promote growth and maintenance of tissue and bone
• Minerals, Water, Vitamins	• Maintain and regulate body processes
• Minerals	• Provide structural function

means it is essential (necessary) that these nutrients be consumed; they are essential components of the diet. Carbohydrates, vitamins, minerals, water, and some parts of lipids and proteins are considered essential. Remember, the nutrients are not usually eaten by themselves, nutrients are components of foods.

SECTION A MACRONUTRIENTS

The Energy Nutrients

The macronutrients ("macro" means "big") are the nutrients that are found in the greatest amounts in the diet and in the body. In addition, macronutrients are those that provide the fuel that the body needs to function. These are called **energy-yielding nutrients**—carbohydrates, lipids (fats), and protein. All of the energy a human uses in a day are one of these energy-yielding nutrients that are metabolized by the body, yielding energy in the form of Adenosine Triphosphate (ATP). ATP is the form of energy the body uses as fuel. The other three nutrient groups—vitamins, minerals, and water—do not provide any calories, but do promote other important functions, which will be discussed later in this chapter.

GLOSSARY

Energy-Yielding Nutrients
Nutrients that provide energy or calories to the body, such as carbohydrates, fats, and protein

Calorie
A measurement of heat or energy

A **calorie** is a unit of measurement of heat or energy. Although the term "calorie" is commonly used, a calorie is actually a shortened form of the term "kilocalorie," which means 1,000 calories. Of the six categories of nutrients, only carbohydrates, lipids, and protein provide energy, as follows:

- Carbohydrates: 4 calories per gram
- Lipids (Fat and Oils): 9 calories per gram
- Protein: 4 calories per gram

View the Supplemental Material for the Focus on Formulas video: Calorie Exchange.

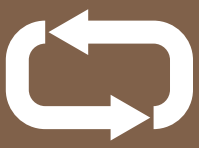
Remember from chapter one, a gram is a unit of weight; there are 28 grams in one ounce. To determine calories from grams, this is how it is done: Let's say we needed to calculate the calories in 1 pat of butter (about 5 grams by weight). How would we do that?

- 1 pat of butter = 5 grams of fat
- 5 grams of fat x 9 calories per gram = 45 calories

There are 3500 calories in a pound. So when an extra 3500 calories are consumed, one could gain one pound of body weight. Another calorie-contributor is alcohol. While it is definitely not a macronutrient, alcohol contributes seven calories per gram of alcohol consumed.

As can be seen in Figure 2.1, energy-yielding nutrients can also serve as building blocks for body tissue and bone. This is particularly true of proteins and lipids (fats). Because these nutrients give the body energy and are used for building body tissue and bone, a large amount of these nutrients are needed. Now, let's take a closer look at the macronutrients—carbohydrates, lipids, and protein.

Putting It Into Practice



1. Describe which of the six nutrient categories are found in a snack consisting of an apple. Are all six nutrient categories present? If not, what could be included in this snack to account for the remaining nutrient categories?

GLOSSARY

Carbohydrates
Nutrients made up of carbon, hydrogen, and oxygen that primarily provide energy to fuel the body

Simple Carbohydrates
Carbohydrates with a simple chemical structure, commonly called sugars

Complex Carbohydrates
Carbohydrates with a complex chemical structure that is more difficult to break down, such as starch and fiber

Monosaccharide
Simple carbohydrate containing one sugar molecule

Glucose
A simple sugar used for energy—also called blood sugar or blood glucose

Disaccharide
Simple carbohydrate containing two sugar molecules

Carbohydrates

Carbo means carbon and *hydrate* means water. **Carbohydrates** (CHO) contain carbon and the two chemical elements that make up water: hydrogen and oxygen. The main function of carbohydrates is to provide energy or fuel to the body. In fact, the central nervous system, including the brain and nerve cells, relies almost exclusively on a form of carbohydrate called glucose for energy.

Carbohydrates (CHO) fall into two categories: **simple carbohydrates** (commonly called sugars) and **complex carbohydrates** (commonly called starch and fiber). All digestible forms of CHO are converted to glucose in the body. The number of molecules of glucose linked together determines the type of carbohydrate. If a food is a simple carbohydrate, it "melts" or dissolves in the mouth. Simple CHO also have fewer glucose molecules linked together and the chemical bonds are easily broken. Think of foods that are high in sugar (i.e. frostings, marshmallows, hard candy). Complex carbohydrates include nutritious foods such as whole grain breads and cereals, fruits and vegetables, dried beans and peas. They are complex because there are many carbohydrate molecules linked together. To better understand carbohydrates, let's take a closer look at simple and complex carbohydrates.

Simple Carbohydrates: Sugars

Simple carbohydrates are so named because their chemical structure is fairly simple. In fact, the simple carbohydrates are building blocks for the complex carbohydrates. There are six forms of simple carbohydrates, or sugars, that are nutritionally important (see Figure 2.2).

Mono means one and *saccharide* means sugar. A **monosaccharide**, like a **glucose** molecule is absorbed without further breakdown when eaten. In the body, glucose is called "blood sugar" or "blood glucose" because it circulates in the blood at a relatively constant level. Glucose (also known as dextrose) is the most common form of sugar in the body. It is the preferred energy source for brain functions, the central nervous system, and for performing physical activity.

Di means two and *saccharide* means sugar. A **disaccharide** is two monosaccharides linked by a chemical bond. When disaccharides are eaten, the body must break them down (digest) them first. Enzymes split the two sugar molecules apart so they can be more easily absorbed into the bloodstream. Because of the need for every cell to use glucose and because our bodies can't make them, carbohydrate is an essential nutrient. There is no substitute for carbohydrate in the body.

Sugar in Food

The sugars listed in Figure 2.2 have differing levels of sweetness. Fructose is more than twice as sweet as glucose. Fructose, also known as fruit sugar, is found in ripe fruits and honey; it is also found in other foods. There are two primary types of simple carbohydrates in food. There are naturally-occurring sugars in fruits (fructose) and

Putting It Into Practice

2. If there are about 7 grams of protein in one ounce of meat, how many calories are in a 4 ounce portion of meat?

Figure 2.2
Six Sugar Molecules Important in Nutrition

Molecule	Characteristics	Known As
Glucose	Mono (one) saccharide	Blood sugar in the body; commonly found in nature and used for energy
Fructose	Mono (one) saccharide	Fruit sugar or the sugar in honey
Galactose	Mono (one) saccharide	Combines with glucose to make lactose or milk sugar
Sucrose	Di (two) saccharide comprised of glucose and fructose	Table sugar
Lactose	Di (two) saccharide comprised of glucose and galactose	Milk sugar
Maltose	Di (two) saccharide comprised of two molecules of glucose	Malt sugar

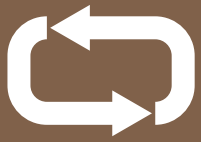
dairy products (lactose), and there are added sugars, such as sucrose. Sweeteners come in different forms, from powdered and crystalline to syrup (see Figure 2.3).

Some compounds used to sweeten foods are not sugars at all. Instead, they are "artificial sweeteners." Sucralose and aspartame, for example, are artificial sweeteners, not sugars. However, they can substitute for sugars in food by providing a sweet taste.

In addition to sweetening foods, sugars help to prevent spoilage in jams and jellies and perform several functions in baking. These include browning the crust and retaining moisture in baked goods. Sugar also acts as a food for yeast in breads. When yeast "eats" sugar, carbon dioxide (a gas) is produced. Carbon dioxide makes bread rise and gives it an airy texture.

As well as occurring naturally in some foods, sugar is often added to foods to sweeten them. Some of the added sugars include table sugar, high fructose corn syrup, and corn syrup. Although a natural sugar, honey is primarily made of fructose and glucose, the same two components as table sugar. Honey and table sugar both contribute only energy (calories), but no other significant amounts of nutrients. However, because honey is more concentrated, it has more calories than an equal amount of table sugar. Fruits are an excellent source of natural sugar (fructose). Canned fruits are packed in four different ways: in water, fruit juice, light syrup, and/or heavy syrup. Both light syrup and heavy syrup have sugar added (usually sucrose or high fructose corn syrup), with heavy syrup containing more added sugar, and thus, more calories. Dried fruits,

Putting It Into Practice



3. Explain which would affect diabetes management more, consuming honey in coffee or regular sugar. Why?

Figure 2.3
Common Forms of Added Sugars

Table Sugar (granulated sugar, sucrose)	Obtained in crystalline form from cane and beets; is about 99.9% pure; is sold in granulated or powdered form.
Corn Syrup	Made from cornstarch; mostly glucose. Only 75% as sweet as sucrose; less expensive than sucrose. Used extensively in baked goods; also used in canned goods.
High Fructose Corn Syrup	Corn syrup treated with an enzyme that converts glucose to fructose, which results in a sweeter product. Used in soft drinks, baked goods, jelly, syrups, fruits, and desserts.
Brown Sugar	Sugar crystals contained in a molasses syrup with natural flavor and color; 91 to 96% sucrose.
Molasses	Thick syrup left over after making sugar from sugar cane. Brown in color with a high sugar concentration.
Turbinado Sugar	Sometimes viewed incorrectly as raw sugar. Produced by separating raw sugar crystals and washing them with steam to remove impurities.

Nutrition Facts
Serving Size 1 Container (150g)

Calories 120	**Calories from Fat** 0
Amount/Serving	**%DV***
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 5mg	2%
Sodium 50mg	2%
Total Carbohydrate 19g	6%
Dietary Fiber 0g	0%
Sugars 18g	
Added Sugars 0g	
Protein 12g	24%

Vitamin A 0% • **Vitamin C** 0% • **Vitamin D** 15%
Calcium 15% • **Iron** 0%

INGREDIENTS: CULTURED GRADE A NON FAT MILK, WATER, STRAWBERRY, SUGAR, FRUCTOSE, CONTAINS LESS THAN 1% OF MODIFED CORN STARCH, NATURAL FLAVOR, CARRAGEENAN, CARMINE AND BLACK CARROT JUICE CONCENTRATE (FOR COLOR), SODIUM CITRATE, POTASSIUM SORBATE (TO MAINTAIN FRESHNESS), MALIC ACID, VITAMIN D_3.

CONTAINS ACTIVE YOGURT CULTURES.

having had much of their water removed, are much more concentrated sources of sugar than fresh fruits, and again, more calories for the same volume of fresh fruits. As seen in Figure 2.4, lactose, or milk sugar, is present in large amounts in milk, ice cream, ice milk, sherbet (which also contains sucrose and/or other forms of sugars), cottage cheese, cheese spreads and other soft cheeses, eggnog, and cream. Hard cheeses contain only traces of lactose.

In addition to the "artificial sweeteners" mentioned above, sugarless gums and many sugar-free products use sweeteners such as sorbitol, xylitol, and mannitol. These substances are called sugar alcohols. Sorbitol is 60 percent as sweet as sucrose, with about the same number of calories per gram. Sorbitol is used in such products as sugarless hard and soft candies, chewing gums, jams and jellies. Xylitol is about as sweet as table sugar and is absorbed very slowly. Finally, mannitol is poorly digested, so it does not contribute a full four calories per gram. Mannitol occurs naturally in pineapple, olives, sweet potatoes, and carrots, and is added to sugarless gums. Both mannitol and sorbitol, when taken in large amounts, may cause diarrhea. Products "whose reasonably foreseeable consumption may result in a daily ingestion of 20 grams of mannitol [or 50 grams of sorbitol] shall bear the labeling statement, 'Excess consumption may have a laxative effect'" (Code of Federal Regulations Title 21, April 2016, Section 180.25, [e]).

Putting It Into Practice

4. Using the food label above, how would we know if the 18 grams of sugar in this food is from added or natural sugars?

Figure 2.4
Sugar Content of Foods

FOOD/PORTION	TEASPOONS OF SUGAR
Dairy	
Skim Milk*, 1 cup	3
Swiss Cheese*, 1 ounce	Less than 1
Vanilla Ice Cream**, 1/2 cup	4
Meat, Poultry and Fish	
Meat, Poultry, or Fish, 3 ounces	0
Eggs	
Egg, 1	0
Grains	
White Bread*, 1 slice	Less than 1
English Muffin*, 1	Less than 1
White Rice*, Cooked, 1/2 cup	Less than 1
Circular-shaped Oat Cereal*, 1 cup	Less than 1
Honey-flavored, Circular-shaped Oat Cereal**, 1 cup	3
Square-shaped Oatmeal Cereal**, 1 cup	2
Fruits	
Apple*, 1 medium	4.5
Banana*, 1 medium	7
Orange*, 1 medium	3
Raisins*, 1/2 ounce	2.5
Vegetables	
Broccoli*, 1/2 cup raw, chopped	Less than 1 gram
Mixed Vegetables*, 1/3 cup, chopped	Less than 1 gram
Beverages	
Cola Soft Drink**, 12 fluid ounces	10
Cakes, Cookies, Candies, and Pudding	
Brownie**, 1 average	6
Chocolate Graham Crackers**, 8 squares	2
Chocolate Chip Cookies**, 3	3
Lemon Drops**, 4 pieces	2.5
Candy-coated Chocolate Pieces**, 70	7
Vanilla Pudding**, 1/2 cup	6
Sweeteners	
White Sugar*, 1 tablespoon	4
Honey*, 1 tablespoon	4
High Fructose Corn Syrup**, 1 tablespoon	4

*Source: U.S. Department of Agriculture * Naturally-occurring sugars ** Added sugars*

Sugar on the Food Label

Sugar content is listed on the nutrition label of food. Both the naturally-occurring sugars in food, such as the fruit sugar or milk sugar, as well as added sugars, such as table sugar, are reported on the food label. These are lumped together so it is difficult to determine the amount of added sugars. Read the food label carefully and look for any and all of the sugars listed in Figure 2.3. Limit foods that are high in added sugars. Be sure to read the food label and look at the ingredient list to see what types of sugars have been added.

Complex Carbohydrates: Starches

Whereas simple sugars are chemically made up of one or two units of monosaccharides, starch is much more complex. Chemically, starch and fiber—both forms of complex carbohydrates—consist of many glucose molecules strung together. This is why they are referred to as *complex*. Another term for complex carbohydrates is polysaccharides. *Poly* means many, *saccharide* means sugar [glucose] so a polysaccharide is made up of many glucose units. A single starch molecule (or chain) may contain 300 to 1,000 or more glucose molecules. The giant molecules are packed side by side in a plant root or seed, providing energy for the plant. All forms of starch are plant materials.

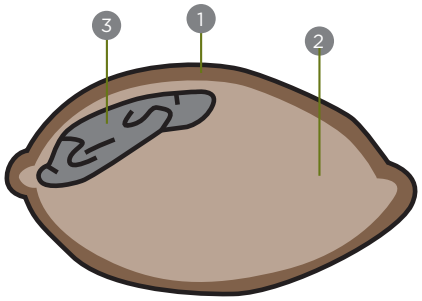
Cereal grains, which are the fruits or seeds of cultivated grasses, are rich sources of starch. Examples include wheat, corn, rice, rye, barley, and oats. Wheat and other grains consist of three parts: the starchy endosperm, the vitamin-rich germ, and the bran—the protective outer coat that contains fiber. Figure 2.5 is a diagram of a grain of rice. Cereal grains are used to make breads, breakfast cereals, and pastas. Starches are also found in potatoes, vegetables, and dried beans and peas. Figure 2.6 identifies common sources of starch in the diet.

Starch is a key component of a healthful diet. Some starch is broken down immediately after a meal and is used as sugar (glucose) to fuel body functions. If blood sugar goes too high, the body can take the excess and store it as **glycogen**, a readily available source of glucose. Glycogen is stored in muscles and in the liver. Glycogen is not really a food component; it is a special form of carbohydrate the body makes.

GLOSSARY

Glycogen
A particular form of carbohydrate storage found in animal tissue and used by the body for quick energy

Figure 2.5
Whole Grain Kernel



1. **Bran:** Outer shell protects seed (fiber, B vitamins, trace minerals)
2. **Endosperm:** Provides energy (carbohydrates, protein)
3. **Germ:** Nourishment for the seed (antioxidants, vitamin E, B vitamins)

Source: U.S. Department of Agriculture

Figure 2.6
Sources of Starch

Sources of Starch	Sources of Soluble Fiber	Sources of Insoluble Fiber
• Breads • Cereals • Flour • Grains • Legumes • Pasta • Starchy Vegetables	• Dried Beans and Peas • Some Grains (oats, barley) • Some Fruits and Vegetables (apples, grapes, citrus, and carrots)	• Whole Grains with Bran • Products Made with Whole Grains (whole wheat bread, brown rice) • Many Vegetables (corn, celery, green beans)

Complex Carbohydrates: Dietary Fiber

The term **dietary fiber** describes a variety of carbohydrate compounds from plants that are not digestible. Like starch, most fibers are chains of glucose units bonded together, but what's different is that the chains can't be broken down or digested. In other words, most fiber passes through the stomach and intestines unchanged and is excreted in the feces. Unlike sugars or starches, fiber does not give rise to blood sugar in the body. Fiber is found only in plant foods where it supports the plant's stems, leaves, and seeds.

There are two major types of fiber—soluble and insoluble. **Soluble fiber** simply means fiber that dissolves in hot water, forming a gel. **Insoluble fiber** is the tough, fibrous part of plants that is not digestible and does not dissolve in water.

Soluble fibers include gums, mucilages, pectin, and some hemicelluloses. Soluble fiber is found in foods like apples, oats, and dried beans (see Figure 2.6). In the body, soluble fiber slows down the movement of food through the lower part of the digestive tract. Fiber also slows down the release of glucose from other foods into the body, which may be beneficial to someone with diabetes who needs to control blood sugar. Soluble fibers also help control blood cholesterol levels.

Insoluble fibers include cellulose, lignin, and some hemicelluloses. Insoluble fiber is found in foods like bran (wheat bran, corn bran, whole grain breads) and vegetables. Insoluble fibers form the structures of plants, such as skins and the bran of the wheat kernel. Insoluble fiber can be seen in the skin of whole kernel corn and the strings of celery. Insoluble fibers speed up the movement of food through the lower digestive tract and can help prevent constipation. Like soluble fibers, they also help to slow down the release of glucose from other foods into the body. People need both types of dietary fiber for proper nutrition and digestion.

The amount of fiber in a plant varies from one kind of plant to another and may vary within a species or variety, depending on growing conditions and maturity of the plant at the time of harvest. Like starch, fiber is found abundantly in plants, especially in the outer layers of cereal grains and the fibrous parts of legumes (e.g. dried beans and peas), fruits, vegetables, nuts, and seeds. Fiber is not found in animal products such as meat, poultry, fish, dairy products, and eggs. Most plant foods contain both soluble and insoluble fibers.

Whenever the fiber-rich bran and the vitamin-rich germ are left on the endosperm of a grain, the grain is called whole grain. Examples of whole grains include whole

GLOSSARY

Dietary Fiber
A polysaccharide made up of many molecules of sugar; plant materials that are not digested by the body

Soluble Fiber
Fiber that forms a gel when combined with water (i.e., fruits, oats, and dried beans)

Insoluble Fiber
Outer covering (bran) of plants or fibrous inner parts that are not soluble in water (i.e., bran, celery, and corn)

wheat, whole corn, whole rye, bulgur (i.e. whole wheat grains that have been steamed and dried), oatmeal, whole cornmeal, whole hulled barley, popcorn, and brown rice. There are many others, but these are the most common. The milling of whole wheat to produce white flour removes the bran and germ and leaves behind mostly starch.

During the milling process, bran and germ are removed to produce **refined grains**. Much of the fiber and vitamins (especially the B vitamins) are lost in this process. By law, white flour and other refined grain products must be **enriched**, meaning that certain nutrients (thiamin, riboflavin, niacin, and iron) are added in amounts approximately equivalent to those originally present in the whole grain but were lost through milling. Enrichment does not replace the fiber removed by milling, it only replaces some of the other nutrients that were lost. Whole wheat flour retains most of the original nutrients and has more fiber, vitamin B6, magnesium, and zinc than enriched white flour.

As a general rule, *unrefined* (unprocessed) foods contain more fiber than *refined* foods because fiber is usually removed in processing. For example, raw apples contain much fiber in the skin (a whole, raw apple contains about 5 grams of fiber), but if the skin is removed to make applesauce or canned sliced apples, its fiber content drops to about 2-3 grams. When apples are processed further to make apple juice, all of the fiber is lost. Whole foods contain a greater variety of fibers, as well as many other nutrients.

Since insoluble fiber holds water and speeds the movement of waste through the intestines, stools produced by a high fiber diet tend to be bulkier and softer and pass more quickly and more easily through the intestines. A diet high in insoluble fiber helps reduce the risk of hemorrhoids; it is also important for those who have diverticulosis, a disease of the large intestine in which the intestinal walls become weakened and bulge out into pockets. Insoluble fibers may also reduce the risk of colon cancer.

Eating adequate soluble and insoluble fiber has many benefits, including increasing a sense of fullness (satiety), when part of an overall health plan that includes eating less dietary fat and cholesterol.

Fats

Lipid is the scientific name for a diverse family of compounds that are characterized by their insolubility in water. Lipids include fats, oils, and cholesterol. Except for cholesterol, these compounds are important for providing energy and for helping the body absorb fat-soluble vitamins (discussed later in this chapter). Fats and oils are the most plentiful lipids in nature. It is customary to call a lipid a *fat* if it is a solid at room temperature and an *oil* if it is a liquid at the same temperature. Fats from animal sources, such as butter, are usually solid, whereas oils are liquid and generally of plant origin (such as corn or canola oil). There are a few exceptions to this rule: Coconut oil and palm/palm kernel oil have a plant origin, but are solid at room temperature. It is common to hear the general category of fats referred to as "animal fats" and "vegetable oils." For the purposes of this book, the word "fat" will refer to both fats and oils.

In recent years, there has been much discussion about fats and cholesterol including what kind of fat is eaten and the relationship between dietary fats and cholesterol and cardiovascular (heart and artery) disease. A high level of blood cholesterol has been identified as one of the major risk factors for having a heart attack or a stroke. This is important because diet, particularly fat intake, influences blood cholesterol levels.

GLOSSARY

Refined Grain
A grain in which, during the milling process, the bran and germ are removed leaving behind the starchy endosperm

Enriched
Adding B vitamins and iron back into refined flour and grain products

Lipids
Nutrient category that includes both fats, such as butter, shortening, and oils (i.e. olive or canola oil)

Functions of Fats

Fat serves a variety of functions.

- Some fat is needed in the diet to provide the essential fatty acids. Fat in food also contains the fat-soluble vitamins (A, D, E, and K).
- Fat provides a concentrated source of energy (9 calories per gram). It is also a great way for the body to store extra calories. About 15-20 percent of the weight of healthy normal-weight men is fat; for women, it's about 18-25 percent.
- Fat cushions parts of our body for protection: At least half of fat deposits are located just beneath the skin, where they help to cushion body organs (acting like shock absorbers).
- Fat acts as insulation: fat provides insulation to help maintain a constant body temperature.
- Lipids are also an important component of cells, including the cell membrane (the outer layer of the cell).
- Because fats slow digestion and the emptying of the stomach, they help delay the onset of hunger.
- In addition to creating a feeling of fullness, fats increase the palatability of foods by enhancing their aroma, taste, flavor, juiciness, and tenderness.

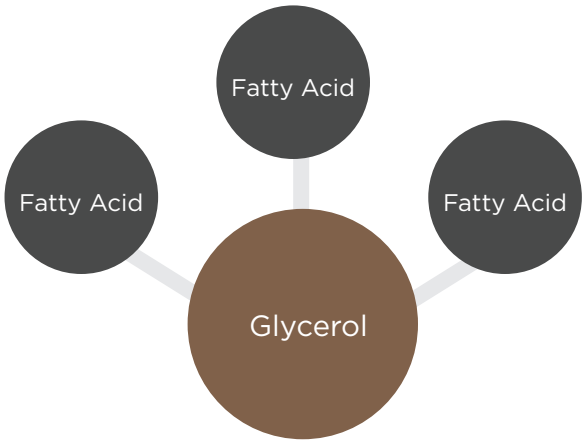
Triglycerides

The bulk of the body's fat tissue is in the form of **triglycerides**. Likewise, most of the fats found in foods are in the form of triglycerides. Figure 2.7 shows what a triglyceride molecule looks like. It is composed of three fatty acids attached to glycerol. Each fatty acid is made up of carbon atoms joined like links on a chain. The carbon chains vary in length, with most fatty acids containing 4 to 20 carbon atoms. Each carbon has hydrogen attached, much like charms on a charm bracelet.

GLOSSARY

Triglycerides
Common form of fats in foods; comprised of three fatty acids and glycerol

Figure 2.7
Triglyceride Molecule



Putting It Into Practice

5. How would using a "fat-free" salad dressing affect how we use the nutrients from dark, leafy greens?

GLOSSARY

Saturated Fat
Fatty acid that is filled with hydrogen, making it solid or semisolid at room temperature

Unsaturated Fat
Fatty acid that contains one or more double bonds

Monounsaturated Fatty Acid
Fatty acid that contains one double bond and is found in foods like olive oil, almonds, and most hydrogenated margarines

Polyunsaturated Fatty Acid
A fatty acid that contains more than one double bond and is found in foods like corn oil, soybean oil, and soft margarines

Trans-Fatty Acid or Trans Fat
A fatty acid where hydrogen atoms have been added and chemically rearranged to make them more solid—found in hydrogenated oils, margarines, shortening, and many snack foods

Hydrogenated
A process of adding hydrogen to oils in order to make them more solid

Essential Fatty Acid
Fatty acids that cannot be made by the body, so much come from the diet

Types of Fatty Acids

Fatty acids may be one of three different types:

- Saturated
- Monounsaturated
- Polyunsaturated

The terms *saturated* and *unsaturated* relate to the chemistry and chemical structure of fats. "Saturated" means each carbon atom in the chain holds as many hydrogen atoms as it can (two). It is called a **saturated fatty acid** or saturated fat because it is filled or *saturated* with hydrogens. When a double bond forms between two neighboring carbons, two hydrogens are missing, so the carbons are not fully saturated. This type of fatty acid is called an **unsaturated fatty acid**. A fatty acid that contains one double bond in the chain is a **monounsaturated fatty acid** or unsaturated fat (mono means one). A fatty acid containing more than one double bond is a **polyunsaturated fatty acid** (PUFA). *Poly* means many, so this term means that the fatty acid is unsaturated in many places. Another fatty acid, **trans-fatty acid** (sometimes referred to as *trans fat*), has hydrogen atoms that have been added and chemically rearranged. Trans-fatty acids are made during the process in which vegetable oils are partially **hydrogenated** (adding hydrogen and saturation) to make them more solid at room temperature. Hydrogenated oils are used in margarines and shortening.

Hydrogenated oils in margarines and shortening extend the shelf life of the fat. The health risk of transfat has been widely publicized in the past decade. Consuming trans fat can increase your LDL "bad" cholesterol, and at the same time, decrease your HDL "good" cholesterol. This combination of increasing LDL and decreasing HDL cholesterol increases the risk of heart disease. In 2008, a law went into effect that requires trans fats to be listed on the Nutrition Facts Panel for all foods. In addition, some cities and states have banned all trans fat use in food products. Trans-fatty acids are found in vegetable shortenings and some margarines. Trans fats are also found in foods that contain shortening or margarines, such as crackers, cookies, canned frosting, and foods fried in partially hydrogenated fats.

Two of the fatty acids in food are considered to be **essential fatty acids** (EFA). Because the body can't make EFA, it is essential to get them from the diet. The names of the two essential fatty acids are linoleic acid and alpha-linolenic acid. Linoleic acid is polyunsaturated and is found in corn, cottonseed, soybean, and safflower oil. It is also found in nuts, seeds, and whole grain products. Alpha-linolenic acid is also polyunsaturated and appears in some vegetable oils such as canola, walnut, soybean oils, and in fatty fish.

Triglycerides in Foods

Fat in the diet is both visible and invisible. When thinking about fats, most think about only the visible fats—butter, margarine, and cooking oils. But much of the fat in the diet comes from less visible sources—the fatty streaks in meat (also known as marbling), the fat under the skin of poultry, the fat in milk and cheese, the fat in many baked goods, fried foods, nuts, and the fat contained in many processed foods such as candy, chips, crackers, canned soups, and convenience foods. Unprocessed cereal grains, fruits and vegetables (except avocados and olives), flour, pasta, breads, and most cereals have little or no fat.

All fats in foods are made up of mixtures of fatty acids. If a food contains mostly saturated fatty acids, it is considered a main source of saturated fat. If it contains mostly polyunsaturated fatty acids, it is a main source of polyunsaturated fat. Monounsaturated fats contain mostly monounsaturated fatty acids. Regardless of the type of fat used— saturated, monounsaturated, or polyunsaturated—all contain nine calories per gram.

Animal fats are generally more saturated than liquid vegetable oils. Saturated fat raises blood cholesterol more than anything else in the diet. Animal products are a major source of saturated fat in the typical American diet. The fat in whole dairy products (like butter, cheese, whole milk, ice cream, and cream) contains high amounts of saturated fat. Saturated fat is also concentrated in the fat that surrounds meat and in the white streaks of fat in the muscle of meat (marbling). Well-trimmed cuts from certain sections of the animal, such as the round and loin, are lower in saturated fat than well-marbled, untrimmed meat. Poultry without the skin and most fish are lower in saturated fat.

A few vegetable fats—coconut oil, cocoa butter, and palm oil—are high in saturated fat. These may be used for commercial deep-fat frying and in foods such as cookies and crackers, whipped toppings, coffee creamers, cake mixes, and even frozen dinners. Chocolate products, such as chocolate candy bars and baking chips, contain cocoa butter and sometimes also palm kernel oil or palm oil.

Recommendations for Daily Fat Intake

As discussed in chapter one, there are specific dietary recommendations for how much of these fats should be consumed. Total fat intake should be no more than 30 percent of total daily calories. Of that 30 percent, less than 7 percent should come from saturated fat. The American Heart Association recommends less than one gram per day of trans fat and less than 300 milligrams per day of dietary cholesterol. See Figure 2.8 for ways to choose healthy fats.

Cholesterol

Cholesterol is a type of sterol the body needs to function. Cholesterol is made in the liver of the human body, so it is technically not an essential nutrient. The body uses cholesterol to build cell membranes and brain and nerve tissues. It also helps the body produce steroid hormones needed for body regulation, bile acids needed for digestion, and for vitamin D synthesis.

Cholesterol is found only in foods of animal origin: egg yolks, meat, poultry, fish, milk, and milk products. Egg yolks and organ meats (liver, kidney, brain) are major sources of cholesterol. Cholesterol is found in both the lean and fat sections of red meat and the meat and skin of poultry. In milk products, cholesterol is mostly in the fat, so lower fat products contain less cholesterol. Egg whites and foods that come from plants have no cholesterol. Figure 2.9 shows the cholesterol content of selected foods.

Putting It Into Practice

6. A person following a vegan diet asks you what she can do to obtain omega-3 fats. What would you tell her?

Figure 2.8
Dietary Fats

TYPE OF FAT	INCREASE Your Intake of These Foods
Polyunsaturated Fats	Most low-fat or soft margarines, soybean oil, corn oil, sunflower oil, safflower oil, walnuts, sunflower seeds
Monounsaturated Fats	Peanuts and peanut oil, olive oil, canola oil, almonds, avocado, some seeds
Omega-3 Fatty Acids	Cold water finfish, flaxseed products, flaxseed oil, walnuts
TYPE OF FAT	**DECREASE Your Intake of These Foods**
Saturated Fats	Animal products, high-fat cheese and other dairy products, lard, butter, coconut and palm oil
Trans Fats	Foods fried in trans fat oils, foods made with partially hydrogenated oils, shortening, some margarines
Dietary Cholesterol	Eggs, animal products, shellfish

Figure 2.9
Cholesterol in Foods

FOOD	PORTION	CHOLESTEROL IN mg
Liver, braised	3 ounces	333
Egg	1 whole	185
Beef, Short Ribs, braised,	3 ounces	80
Beef, ground, lean, broiled	Medium, 3 ounces	74
Beef, Top Round, broiled	3 ounces	73
Chicken, roasted, no skin, light meat	3-1/2 ounces	75
Haddock, baked	3 ounces	63
Mackerel, baked	3 ounces	64
Swordfish, baked	3 ounces	43
Shrimp, moist heat	3 ounces	167
Milk, whole	8 ounces	33
Milk, 2% fat	8 ounces	18
Milk, 1% fat	8 ounces	10
Milk, skim	8 ounces	4
Cheddar Cheese	1 ounce	30
American Processed Cheese	1 ounce	27
Cottage Cheese, low-fat	1/2 cup	5

Source: National Institutes of Health

Protein

Carbohydrate and fat can both be independent food sources, such as sugar or butter, or they can be combined together to form other foods like cookies. Protein is rarely found by itself; it is usually found in combination with fat. The word *protein* comes from a Greek word that means "of prime importance." Protein has been considered to be "of prime importance" for centuries because of the essential functions in our bodies. In the United States, most people eat too much protein, which generally means a diet higher in fat.

To most Americans, the term "protein" means meat, poultry, or fish. These foods are all excellent sources of complete protein. In addition, there are other less well-known sources like dried beans and peas, whole grains, and vegetables. Protein-rich meats, poultry, and fish are the "main course" in the diets of Americans. In other parts of the world, plant-based protein sources are the foundation of the diet.

Like carbohydrates and fats, proteins contain carbon, hydrogen, and oxygen. But unlike these other nutrients, proteins contain the chemical element *nitrogen*. **Amino acids** are the nitrogen-containing building blocks of proteins. Proteins are strands of amino acids (Figure 2.10). This allows for an endless number of combinations and sequences in the amino acid chains and, therefore, a great variety of proteins in plants and animals.

Each protein has a unique sequence of amino acids, which are the *building blocks* of proteins. These amino acids build proteins and have a unique way of bending and coiling that is necessary for the protein to function normally. Different tissues in the body, such as hair and skin, each have their own characteristic proteins. Some amino acids, called **essential amino acids**, must be provided by the foods eaten, because the body can't make them. Other amino acids are considered **nonessential amino acids** because they can be made by the human body. If essential amino acids are not consumed regularly, the body isn't able to synthesize proteins.

GLOSSARY

Amino Acids
Building blocks of protein

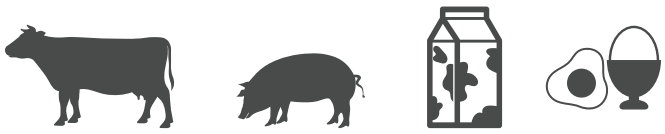
Essential Amino Acids
Amino acids that cannot be made in the body; must come from foods

Nonessential Amino Acids
Amino acids that can be made in the body

Figure 2.10
Complete and Incomplete Proteins

COMPLETE PROTEINS

Meat, Dairy Products, Eggs
Animal sources contain all essential amino acids.



INCOMPLETE PROTEINS

When combined foods from two or more of these categories make a complete protein and provide all of the essential amino acids. If eaten alone, they do not provide all of the essential amino acids.

Grains
Whole grain bread, barley, corn, cornmeal, oats, rice, pasta

Legumes
Dried beans and peas, peanuts, soy products

Seeds/Nuts
Nut butters, nuts, sunflower seeds, sesame seeds

Functions of Protein

Building Blocks. Amino acids are required by the body for building new cells. For instance, proteins are found in the skin, bone, cartilage, and muscles. The greatest amount of proteins are needed when the body is building new cells rapidly, like during pregnancy, infancy, or lactation. Building new cells is also important after burns, surgery, healing, and for growing new hair or nails (like after chemotherapy).

GLOSSARY

Enzymes
Catalysts that speed up chemical reactions in the body

Hormones
Chemical messengers that regulate metabolism—such as thyroid hormones

Antibodies
Blood proteins required for an immune response to foreign bodies

Amino acids are combined to build **enzymes**, some of the most important proteins formed in cells. Enzymes act as a catalyst that helps make the chemical reactions in the body. **Hormones** are also built from proteins and act as messengers that regulate metabolism.

Proteins build **antibodies** that fight infection. Antibodies travel in the blood, where it is their job to attack any foreign bodies that do not belong there. These foreign bodies could include viruses, bacteria, or toxins. Antibodies actually combine with these foreign bodies, producing an immune response that helps ward off harmful infections.

Maintaining

Besides building cells, proteins also maintain tissues by replacing worn-out cells. The body is constantly sloughing all kinds of cells (e.g. red blood cells, cells lining our intestinal tract, or skin cells), and these cells need to be replaced continually, thus maintaining balance.

Protein also assists in maintaining water and electrolyte balance. There must be a constant amount of fluid both inside and outside of the cells. Protein is important in the maintenance of fluid levels. Edema is a condition that occurs if this fluid balance fails.

Protein is also important in maintaining an acid-base (pH) balance within the body. Protein in the blood keeps the blood neutral, meaning that the blood is neither too acidic nor too basic. Normal processes of the body produce acids and bases that, if left unchecked, can cause major problems such as coma and death. Blood proteins buffer these acids and bases to keep the blood pH neutral.

Providing Energy

While protein does provide energy (four calories per gram), this is not one of its major functions. However, if the diet does not supply enough calories from carbohydrates or fats, proteins can be used for energy, though this would be at the expense of tissue building and maintenance functions. Some amino acids can be converted to glucose, the sole fuel of the brain.

Unlike fat, the body has few protein reserves, so we need to consume it daily. However, if more protein is eaten, and thus more calories than is needed by the body, the extra protein is used for energy, or converted to body fat and stored in fat cells. The recommended daily amount of protein is 0.8 grams per kilogram of body weight. That converts to about 40-60 grams of protein per day for a person weighing between 110 and 165 pounds. The average daily protein intake is about 1½ - 2 times more than we need.

During digestion, proteins are broken down into amino acids that are then absorbed into the blood. Amino acids travel through the blood into the body's cells. There is an amino acid pool in the body that provides the cells with a supply of amino acids for making protein. The amino acid pool refers to the overall amount of amino acids distributed in the blood, the organs (such as the liver), and the body's cells. Amino

acids from foods, as well as amino acids from body proteins that have been dismantled, stock these pools. In this manner, the body recycles its own proteins. If there is a shortage of a nonessential amino acid during production of a protein, the cell will make it and add it to the protein strand. If there is a shortage of an essential amino acid, the protein can't be completed.

Protein deficiency in the United States is usually due to illness, injury, or economic factors. Protein deficiency may cause wasting of muscles, weight loss, delayed wound healing, or lowered immunity due to fewer antibodies being made and edema. **Edema** is the abnormal pooling of fluid in the tissues, causing swelling of the part of the body where the pooling occurs. Edema is often seen with malnutrition because protein helps to maintain fluid balance. In protein deficiency, fluids collect outside the cells. With appropriate nutritional intervention, extra protein can be given where there is a loss of body protein due to burns, surgery, stress, infections, skin breakdown, and similar situations. Protein deficiency commonly occurs in developing countries where children do not have enough to eat. It is rarely seen without a deficiency of calories and other nutrients as well. **Protein-Calorie Malnutrition** is the name for a group of diseases characterized by both protein and energy deficiency. Protein-calorie malnutrition is also called Protein-Energy Malnutrition (PEM). Protein-deficiency disease is called kwashiorkor, and energy-deficiency disease is called marasmus. Kwashiorkor is characterized by retarded growth and development, a protruding abdomen due to edema, peeling skin, a loss of normal hair color, irritability, and sadness. Marasmus is characterized by gross underweight, no fat stores and wasting away of muscles, and apathy. There is no edema, as seen in kwashiorkor. Whereas marasmus is usually associated with severe food shortage, prolonged semi-starvation, or early weaning, kwashiorkor is associated with poor protein intake.

GLOSSARY

Edema
Abnormal pooling of fluid in the tissues causing swelling

Protein-Calorie Malnutrition
A name for a group of diseases characterized by protein and energy deficiency

Complete or High-Quality Protein
Protein that provides all of the essential amino acids

Incomplete Protein
Plant protein that lacks one or more essential amino acids

Sources and Quality of Protein

Protein is in all foods of animal origin, and in most foods of plant origin. Animal sources of protein in the American diet include meat, poultry, seafood, eggs, milk, and cheese. Plant sources include legumes, cereal grains, and products made with them, such as bread and ready-to-eat cereals, vegetables, nuts, and seeds. The legumes (beans, peas, and lentils) contain larger amounts and better quality proteins than other plant sources. Fruits and fat contain little-to-no protein. Animal sources of protein often also contain fat, especially saturated fat, while plant sources contain very little fat.

The quality of a particular protein depends on its content of essential amino acids. Food proteins providing all of the essential amino acids in the proportions needed by the body are called **complete or high-quality proteins**. Meat, poultry, fish, milk and milk products, and eggs are all sources of complete proteins. Animal proteins are more readily absorbed than plant proteins.

Complete proteins have a high *biological value* (BV). BV measures how effectively the body can use a particular protein source. Plant proteins are usually low, or lacking one or more of the essential amino acids, and are called **incomplete proteins**. The amino

Putting It Into Practice

7. A friend of yours mentions he read in a bodybuilding magazine that he should be eating 1 gram of protein per pound of body weight to be healthy. Is he right?

GLOSSARY

Complementary Proteins
The combination of two protein sources so that all of the essential amino acids are present

acid that is in short supply is called the *limiting amino acid*. Although plant proteins are incomplete proteins, they are the major source of protein for many people around the world. **Complementary proteins** combine either some animal protein (such as milk or eggs) with vegetable protein, or combine two plant sources, such as grains and legumes, so that the essential amino acids deficient in one are present in the other. See Figure 2.10 for examples of complete and incomplete proteins.

SECTION B VITAMINS

Vitamins are essential in small quantities for growth and good health. Vitamins are similar to each other because they are made of the same elements—carbon, hydrogen, oxygen, and sometimes nitrogen or cobalt. They are different in that their elements are arranged differently and each vitamin performs one or more specific functions in the body. In the early 1900s, scientists thought they had found the compounds needed to prevent two diseases caused by vitamin deficiencies: scurvy and pellagra. These compounds originally were believed to belong to a class of chemical compounds called *amines*. Their name comes from the Latin *vita*, or life, plus *amine*—vitamine. Later, the "e" was dropped when it was found that not all of the substances were amines. At first, no one knew what they were chemically and they were identified by letters. Later, because nutrition science is continuously emerging, what was thought to be one vitamin turned out to be many, and numbers were added instead. The vitamin B complex is the best example of this. The B complex vitamins are numbered from vitamin B1 to vitamin B12. When some were found unnecessary for human needs, they were removed from the list (e.g. B4 and B5). This accounts for some of the gaps in the numbers. Additionally, vitamin B8, adenylic acid, was later found not to be a vitamin, so it was removed from the numbered list. Others, originally designated as different from each other, were found to be one and the same. For example, vitamins H, M, S, W, and X were all shown to be biotin, now vitamin B7. Let's start with some basic facts about vitamins.

- Very small amounts of vitamins are needed by the human body and very small amounts are present in foods. Some vitamins are measured in international units (IUs), a measure of biological activity; others are measured by weight in micrograms (µg) or milligrams (mg). Some vitamins, such as vitamin D, can be measured in both IUs and micrograms. To illustrate how small these amounts are, remember that one ounce is 28 grams. A milligram is 1/1000 of a gram and a microgram is 1/1000 of a milligram.
- Although vitamins are needed in small quantities, the roles they play in the body are enormously important.
- Vitamins must be obtained through foods because they are either not made in the body or not made in sufficient quantities (i.e. they are essential).
- There is no perfect food that contains all the vitamins in just the right amounts. The best way to assure an adequate intake of vitamins is to eat a varied and balanced diet.
- Vitamins do not have any calories, so they do not directly provide energy to the body. However, they are involved in how the body uses energy and performs many of its necessary functions.
- Some substances considered to be vitamins in foods are not actually vitamins, but rather are precursors. In the body, the precursor chemically changes to the active form of the vitamin, under proper conditions.

Figure 2.11
Vitamins—Quick Glance

CATEGORY	VITAMIN NAME	
Fat-Soluble	Vitamin A	Vitamin E
	Vitamin D	Vitamin K
Water-Soluble	Vitamin C	B5 Pantothenic Acid
	B2 Riboflavin	B7 Biotin
	B3 Niacin	B9 Folate
		Vitamin B12

Vitamins are classified according to solubility; they are either fat-soluble or water-soluble. Figure 2.11 lists the fat-soluble and water-soluble vitamins. The fat-soluble vitamins generally are found in foods containing fat and can be stored in the body, in fat tissue. The water-soluble vitamins are not stored appreciably in the body.

Now let's take a closer look at 13 vitamins.

Vitamin A

Vitamin A is involved in many different functions. It plays a role in the formation and maintenance of healthy skin and hair, as well as in proper bone growth and tooth development in children. Vitamin A is also needed for the immune system to work properly (for fighting infections) and for maintenance of the protective linings of the lungs, intestines, urinary tract, and other organs. Vitamin A is essential for normal reproduction and, when eaten generously in the form of fruits and vegetables, may protect against certain forms of cancer. Vitamin A is well known for its part in helping us to see properly. Vitamin A is necessary for the health of the eye's *cornea*, the clear membrane that covers the eye. Without enough vitamin A, the cornea becomes cloudy and dry. Vitamin A is also necessary for night vision, the ability of the eyes to adjust after seeing a flash of bright light at night. With night blindness, it takes longer than normal to adjust to dim lights. This can be an early sign of vitamin A deficiency. If the deficiency continues, it can eventually lead to overall blindness.

The form of vitamin A found in fruits and vegetables is actually a precursor of vitamin A called *beta-carotene*. In the body, beta-carotene is converted to vitamin A. Beta-carotene often gives food an orange color. Vitamin A is abundant in deep orange fruits and vegetables, such as apricots, carrots, and sweet potatoes. It is also found in dark green vegetables, such as spinach, kale, and Romaine lettuce (see Figure 2.12).

Other sources of vitamin A include animal products such as liver (a very rich source), egg yolk, butter, whole milk, and fortified cereals. Low-fat and skim milk are often fortified with vitamin A, because the vitamin is removed from the milk when the fat is removed. **Fortified** foods have one or more nutrients added. Most ready-to-eat and

GLOSSARY

Fortified
Foods that have one or more nutrients added

Putting It Into Practice

8. What would be the benefit of obtaining vitamin A from whole foods rather than from a supplement?

Figure 2.12
Vitamin A in Foods

FOOD	PORTION	RETINOL EQUIVALENTS
Liver, Beef	3 ounces	9,011
Sweet Potato, baked	1 small	2,488
Carrots, raw	1	2,025
Spinach, cooked	1/2 cup	875
Squash, Butternut	1/2 cup	857
Cantaloupe	1/4 melon	516
Fortified Milk, 2%	1 cup	140
Apricots, dried	4 large halves	127
Broccoli, cooked	1/2 cup	110
Egg Yolk	1	97
Cheese, Cheddar	1 ounce	86
Peach	1 medium	47
Orange	1 medium	27

Source: U.S. Department of Agriculture

instant-prepared cereals are also fortified with vitamin A. Retinol, the active form of vitamin A found in animal foods, is used in fortification.

Nutrient needs for vitamin A are expressed in *retinol equivalents* (REs). Retinol equivalents measure the amount of retinol the body will actually absorb and utilize from eating foods with various forms of vitamin A (e.g. retinol or beta-carotene).

Because the body stores vitamin A, it is not absolutely necessary to eat a good source every day. Vitamin A deficiency is not often seen in the United States. Unfortunately, it is of concern in third-world countries. Vitamin A deficiency may cause poor growth, infection, blindness, and death. Although there may not be agreement on exactly how much vitamin A can be considered a toxic dose, excessive use of vitamin A may cause dry, scaly skin, bone pain, soreness, stunted growth, liver damage, nausea, and diarrhea. Tolerable Upper Intake Levels (UL) have been established and vary with gender and age. Megadoses of supplemental vitamin A (more than 10 times the estimated nutrient need) are particularly dangerous for pregnant women and for children.

Vitamin D

Vitamin D differs from the other fat-soluble vitamins in that it can be made in the body and it acts more like a hormone than like a vitamin. Acting like a hormone or chemical messenger, vitamin D maintains blood calcium and phosphorus levels so that there is enough calcium and phosphorus present for building bones and teeth. Vitamin D also helps the body absorb calcium and phosphorus from the digestive tract. Only small amounts of vitamin D are found in most foods. For this reason, milk is usually fortified with vitamin D. Other significant food sources of vitamin D include liver, egg yolks, and fish liver oils. When ultraviolet rays shine on the skin, a cholesterol-like

compound is converted into a vitamin D precursor and absorbed into the blood. The precursor is then transformed into vitamin D. A light-skinned person needs only 10 to 15 minutes of sun each day to make enough vitamin D; a dark-skinned person may need several hours. Vitamin D deficiency causes *rickets* in children and infants. With rickets, bones are soft and pliable because they lack enough calcium and phosphorus to become strong. When this happens, several problems develop: bowlegs, knock knees, chest deformities, and curving of the spine. Deficiency may also occur in adults and is a condition known as *osteomalacia*. Adults at risk include those who have little exposure to the sun and low intakes of vitamin D, calcium, and phosphorus. Osteomalacia is seen most commonly in the Middle East and Asia. It is characterized by soft bones that break and/or bend easily, causing deformities of the spine.

New research over the past decade suggests that vitamin D may provide protection from osteoporosis, hypertension (high blood pressure), cancer, dementia, and several autoimmune diseases. Although further research is needed, vitamins D and E might help to protect against dementia and Parkinson's Disease. The Adequate Intake (AI) levels of vitamin D were established by the U.S. Institute of Medicine of the National Academy of Sciences: the Recommended Dietary Allowance (RDA) for vitamin D was established by the U.S. Institute of Medicine of the National Academy of Sciences. The RDA has been set at 600 IU (International Units) per day for all individuals (males, females, pregnant/lactating women, and children) from the age of 1 year up to the age of 70 years. For those over the age of 70, the RDA is 800 IU daily.

Vitamin D, when taken in excess from supplements, is the vitamin most likely to cause noticeable symptoms of toxicity. Symptoms include nausea, vomiting, diarrhea, fatigue, and thirst. Toxicity can lead to calcium deposits in the heart and kidneys, which can cause severe health problems. Megadoses of vitamin D in infants and young children can cause growth failure.

Vitamin E

Vitamin E has an important function in the body as an *antioxidant*. **Antioxidants** combine with the oxygen molecule so that it is not available to oxidize, or destroy, important substances. Vitamin E prevents the destruction of cells. Today, scientists suggest that antioxidants can slow down the normal aging process and provide important protections against cancer. Vitamins A (beta-carotene), E, and C are considered antioxidant vitamins. Vitamin E is also important for the health of the cell (especially the red blood cells), the proper functioning of the immune system, and the metabolism of vitamin A.

Vitamin E is widely distributed in plant foods. Rich sources include vegetable oils, margarine and shortening made from vegetable oils, and wheat germ. In oils, vitamin E acts like an antioxidant and thereby prevents the oil from going rancid or bad. Other good sources include whole grain cereals, green leafy vegetables, nuts, and seeds. Animal foods are poor sources, except for liver and egg yolk. Vitamin E deficiency is rare, as is toxicity.

GLOSSARY

Antioxidants
Anti means against and oxidant means oxygen—An antioxidant prevents oxygen from destroying important substances

Putting It Into Practice

9. Your elderly neighbor has been told by his doctor he is at risk for vitamin D deficiency What, besides supplements, are some ways to get vitamin D?

Vitamin K

Vitamin K has an important role in the production of the proteins that are involved in blood clotting. When the skin is broken, blood clotting is vital to prevent excessive blood loss. Vitamin K is also involved in calcium metabolism. Vitamin K appears in certain foods and is also made in the body. There are billions of bacteria that normally live in the intestines and some of these produce vitamin K. It is thought that the amount of vitamin K produced by the bacteria is significant and may meet about half of the body's need; food sources of vitamin K are needed to provide the rest. Excellent sources of vitamin K include green leafy vegetables such as kale, spinach, and cabbage. Other sources include liver, milk, and eggs. A deficiency of vitamin K is rare in adults. An infant is normally given this vitamin after birth to prevent bleeding, because the intestines do not yet have the bacteria to produce vitamin K.

Water-Soluble Vitamins

The water-soluble vitamins include vitamin C and the B-complex vitamins. The B vitamins work in every cell of the body where they function as *coenzymes*. A coenzyme works with an enzyme to make it active. An enzyme boosts chemical reactions in the body to support all kinds of body functions. The body stores only limited amounts of water soluble vitamins; excesses are excreted in the urine. However, many water-soluble vitamins taken in excess through massive supplementation can cause toxic side effects.

Vitamin C

Vitamin C (also called ascorbic acid) is important in forming collagen, a protein that gives strength and support to bones, teeth, muscle, cartilage, blood vessels, and skin tissue. It has been said that vitamin C acts like cement or glue, holding together our cells and tissues. Vitamin C also helps absorb iron into the body and strengthens resistance to infection. Like vitamins A (beta-carotene) and E, vitamin C is an important antioxidant, preventing the oxidation of vitamin A and polyunsaturated fatty acids in the intestine. Because of its antioxidant properties, vitamin C has been widely used in foods as an additive to help preserve freshness. It may appear on the food label as sodium ascorbate, calcium ascorbate, or simply ascorbic acid.

Foods rich in vitamin C include fruits (e.g. oranges, grapefruits, limes, lemons, as well as cantaloupe, strawberries, and tomatoes). Other good food sources include white potatoes, sweet potatoes, broccoli and other green and yellow vegetables, as well as cantaloupe and strawberries (See Figure 2.13). There is little or no vitamin C in meats or dairy foods. Some juices are fortified with vitamin C, as are most ready-to-eat cereals. Certain situations raise the body's need for vitamin C. These include pregnancy and nursing, growth, fevers, infections, burns, fractures, surgery, cancer, heavy alcohol intake, and cigarette smoking. Megadoses of supplemental vitamin C often cause nausea, abdominal cramps, and diarrhea; it can also interfere with clotting medications (such as warfarin and dicoumarol); and it can cause incorrect urine test results for diabetes. A deficiency of vitamin C can cause a disease called scurvy. Symptoms of

Putting It Into Practice

10. You overhear a new cook commenting to one of the more experienced trayline cooks about how his broccoli always looks so much more vibrantly green than what she cooks at home. He proudly mentions his secret, which is to sprinkle a little baking soda in the cooking water. Why might this be a problem?

Figure 2.13
Vitamin C in Foods

FOOD	PORTION	VITAMIN C (in mg)
Fruits		
Orange	1 medium	80
Kiwi	1 medium	75
Cranberry Juice Cocktail	3/4 cup	67
Orange Juice, from concentrate	1/2 cup	48
Papaya	1/2 cup cubes	43
Strawberries	1/2 cup	42
Grapefruit	1/2 each	41
Grapefruit Juice, canned	1/2 cup	36
Cantaloupe	1/2 cup cubes	34
Tangerine	1 medium	26
Mango	1/2 cup slices	23
Honeydew Melon	1/2 cup cubes	21
Banana	1 medium	10
Apple	1 medium	8
Nectarine	1 medium	7
Vegetables		
Broccoli, chopped, cooked	1/2 cup	49
Brussels Sprouts, cooked	1/2 cup	48
Cauliflower, cooked	1/2 cup	34
Sweet Potato, baked	1 small	28
Kale, cooked, chopped	1/2 cup	27
White Potato, baked	1 medium	26
Tomato, fresh	1 medium	22
Tomato Juice	1/2 cup	22
Cereals		
Corn Flakes (Fortified)	1 cup	15

Source: U.S. Department of Agriculture

scurvy include bleeding gums, weakness, growth failure, delayed wound healing, easy bruising, and iron-deficiency anemia. Many of these symptoms are due to the faulty formation of collagen.

Thiamin (B1), Riboflavin (B2), and Niacin (B3)

Thiamin (B1), riboflavin (B2), and niacin (B3) all play key roles as *coenzymes* in energy metabolism. Coenzymes are chemical compounds that help *enzymes* work. Enzymes are specialized proteins that speed up specific chemical reactions in the body. Vitamins B1, B2, and B3 help to release energy from glucose, fatty acids, and amino acids. B1 also plays a vital role in the normal functioning of the nervous system and appetite; B2 is important for healthy skin and normal functioning of the eyes; and B3 is needed for the maintenance of healthy skin and the normal functioning of the nervous system and digestive tract.

B1 is widely distributed in foods. Pork is an excellent source of this nutrient; other sources include liver, dry beans and peas, peanuts, peanut butter, seeds and whole grains, and enriched breads and cereals.

Milk is a major source of B2, as are yogurt and cheese. Other sources include organ meats like liver (very high), whole grain and enriched breads and cereals, and some meats.

The main sources of B3 are meat, including organ meats, poultry, and fish. Whole grains and enriched breads and cereals also supply vitamin B3. All foods containing complete proteins, including milk and eggs, are good sources of *tryptophan*, which is the precursor of vitamin B3.

Though vitamin B deficiencies are rare, they can occur with chronically reduced dietary intake. For example, B1 deficiency is linked to a disease called *beriberi*, which is characterized by poor appetite, depression, confusion, weakness, muscle wasting, heart problems, and deterioration of the nervous system. Most deficiencies of B vitamins include more than just one vitamin, so it is not surprising to find a B2 deficiency along with B1. Signs of a B2 deficiency include cracks at the corner of the mouth, skin rash, poor healing, burning and itching eyes. B3 deficiency first appears as fatigue, poor appetite, indigestion, and a skin rash. A chronic B3 deficiency can lead to a disease known as *pellagra*. Symptoms include diarrhea, *dermatitis* (skin inflammation), dementia, and ultimately death.

Toxicity is not a problem with these vitamins, except for megadoses of B3. Typical symptoms include flushing, rashes, tingling, itching, hives, nausea, diarrhea, and abdominal discomfort. More serious side effects of large doses include liver malfunction, high blood sugar levels, and abnormal heart rhythm. Whole grains and enriched breads and cereals supply the majority of the starch in many diets today. It is important to understand that grains are an excellent source of vitamins, but processing results in both vitamin and mineral losses. Processing removes the germ and the bran from the grain, taking with it many vitamins and minerals that are not replaced through enrichment or fortification (See Figure 2.14).

Pyridoxine (B6)

Vitamin B6 plays an important role as part of a coenzyme involved in carbohydrate, fat, and protein metabolism. It is particularly important in protein metabolism. Vitamin B6 is also used to make red blood cells, which transport oxygen around the body. And it helps convert the amino acid tryptophan to niacin (B3).

Figure 2.14
Processing Effects on Grain

Vitamins & Minerals Lost During Processing		
Thiamin (B1)	Pantothenic Acid (B5)	Copper
Riboflavin (B2)	Vitamin E	Calcium
Niacin (B3)	Fiber	Zinc
Pyridoxine (B6)	Iron	Manganese
Folate (B9)	Magnesium	Potassium

Vitamins & Minerals Replaced with Enrichment	
Thiamin (B1)	Niacin (B3)
Riboflavin (B2)	Iron

Good sources of vitamin B6 include organ meats, meat, poultry, and fish. Vitamin B6 also appears in plant foods, though it is not as well absorbed from these sources. Plant sources include whole grains, potatoes, some fruits (such as bananas and cantaloupe), and some green leafy vegetables (such as broccoli and spinach). Fortified ready-to-eat cereals are also good sources of B6. A chronic deficiency of B6 can lead to muscle twitching, rashes, greasy skin, and *microcytic* (small cell) anemia. Excessive intake (i.e. more than two grams daily for two months or more) of supplemental B6 can lead to irreversible nerve damage and symptoms such as numbness in hands and feet and difficulty walking.

Folate (B9)

Folate is part of a coenzyme used to make new cells, including red blood cells, white blood cells, and digestive tract cells. Folate occurs naturally in a variety of foods, including liver, dark-green leafy vegetables such as collards, turnip greens and Romaine lettuce, broccoli and asparagus, citrus fruits and juices, whole grain products, wheat germ, and dried beans and peas, such as pinto, navy, and lima beans, and chickpeas and black-eyed peas. Folic acid is the synthetic form of folate, which is used in fortified foods and supplements. By law, many grain products are fortified with folic acid.

A deficiency of folate can lead to *megaloblastic anemia*, a condition in which the red blood cells are oversized and function poorly. Other deficiency symptoms may include digestive tract problems (e.g. diarrhea) and depression. During pregnancy, the need for folate increases because of its vital role in producing new cells. Folate is needed both before and during pregnancy to help reduce the risk of certain serious and common birth defects called neural tube defects, which affect the brain and spinal cord. The tricky part is that neural tube defects can occur in an embryo before a woman realizes she's pregnant.

Cobalamin (B12)

Vitamin B12, also called cobalamin and cyanocobalamin, is present in all body cells. Along with folate, vitamin B12 is involved in making new cells in the body and in the growth of healthy red blood cells. It also helps in the normal functioning of the nervous system by maintaining the protective cover around nerve fibers. Vitamin B12 is found only in animal products such as meat, poultry, fish, shellfish, eggs, milk, and milk products. Plant foods do not contain any B12. *Vegans*, vegetarians who do not

consume any animal products, must include fortified foods, such as soy milk, or take supplements of B12, in order to meet this nutrient need.

In order to be absorbed, vitamin B12 requires a compound called *intrinsic factor* (IF), which is produced in the stomach. B12 deficiencies can be because of poor intake or poor absorption. A condition known as pernicious (macrocytic, megaloblastic) anemia can develop if there is a problem with the IF.

B12 deficiency can cause poor cell division, which leads to abnormally large cells (megaloblastic) and the condition of pernicious anemia. Pernicious anemia is also characterized by deterioration in the functioning of the nervous system that, if untreated, could cause significant and sometimes irreversible damage. Vitamin B12 toxicity rarely if ever occurs.

Pantothenic Acid (B5) and Biotin (B7)

Both pantothenic acid and biotin are involved in energy metabolism. Pantothenic acid is part of a coenzyme used in energy metabolism; biotin is part of a coenzyme used in energy metabolism, amino acid metabolism, fat synthesis, and glycogen synthesis. Both pantothenic acid and biotin are widespread in foods and deficiency is rare. There is no known toxicity of either pantothenic acid or biotin.

Vitamins and Food Preparation

Food preparation and storage techniques affect the vitamin content of food. Using too much water, too high a temperature, or too long a cooking time for vegetables significantly reduces the content of vitamins B and C. Too much acidity or base can also affect the nutrient content of fruits and vegetables. For example, some chefs use baking soda (a base) to enhance the green color of vegetables. This process significantly reduces the vitamin content of vegetables. To help decrease the loss of vitamins in vegetables, use *batch* cooking (cooking small amounts of vegetables) immediately prior to service. For dairy products, vitamin loss can be diminished during storage by keeping products at a constant, cold temperature and out of the light. Thawing and refreezing causes nutrient loss as well as loss of quality. Figure 2.15 summarizes the functions and food sources of vitamins.

SECTION C MACRO MINERALS

If one were to weigh all the minerals in the body, they would only amount to four or five pounds. The human body needs only small amounts of minerals in the diet, but they perform enormously important jobs—such as building bones and teeth, regulating heartbeat, and transporting oxygen from the lungs to tissues.

GLOSSARY

Macro or Major Minerals
Calcium, chloride, magnesium, phosphorous, potassium, sodium, and sulfur

Trace Minerals
Minerals needed in less than 100 mg a day

Some minerals are needed in relatively large amounts (macro or major minerals) in the diet—over 100 milligrams daily. (A paper clip weighs about 1 gram. A milligram is 1/1000 of a gram.) **Macro minerals** include calcium, chloride, magnesium, phosphorus, potassium, sodium, and sulfur. Other minerals, called **trace minerals** or trace elements, are needed in smaller amounts—less than 100 milligrams daily. Iron, fluoride, and zinc are examples of trace minerals. Figure 2.16 lists macro and trace minerals.

Minerals have some distinctive properties not shared by other nutrients. For example, whereas over 90 percent of the carbohydrate, fat, and protein in the diet is absorbed into the body, the percentage of minerals absorbed varies tremendously. Here are some

Figure 2.15
Vitamins—Functions and Food Sources

VITAMIN	FUNCTIONS	FOOD SOURCE
Vitamin A	Forming skin, hair, teeth, protective linings; immune function	Orange/yellow vegetables and fruits, dark green vegetables, dairy products
Vitamin D	Aids absorption of calcium and phosphorous; bone health; used in hormones	Fortified milk, liver, egg yolks, fish liver oil
Vitamin E	Antioxidant; protects red and white blood cells	Vegetable oils, margarine, shortening, seeds, nuts, wheat germ, whole grain and fortified breads and cereals, soybeans
Vitamin K	Blood clotting; makes protein used in making bones	Dark green leafy vegetables, cabbage
Vitamin C	Antioxidant; formation of collagen; wound healing; iron absorption; functioning of immune system	Citrus fruits, bell peppers, kiwifruit, broccoli, strawberries, tomatoes, potatoes, juices and cereals fortified with vitamin C
Thiamin (B1)	Coenzyme in energy metabolism; functioning of nervous system; normal growth	Pork, sunflower seeds, wheat germ, peanuts, dry beans, whole grain and enriched/fortified breads and cereals
Riboflavin (B2)	Coenzyme in energy metabolism; healthy skin; normal vision	Milk and milk products, whole grain and enriched/fortified breads and cereals, some meats, eggs
Niacin (B3)	Coenzyme in energy metabolism; healthy skin; normal functioning of nervous system	Meat, poultry, fish, whole grain and enriched/fortified breads and cereals, eggs
Pyridoxine (B6)	Coenzyme in carbohydrate, fat and protein metabolism; synthesis of blood cells	Meat, poultry, fish, fortified cereals, some leafy green vegetables, potatoes, bananas, watermelon
Folate (B9)	Formation of new cells	Green leafy vegetables, legumes, orange juice, enriched/fortified breads and cereals
Cobalamin (B12)	Activation of folate; normal functioning of the nervous system	Meat, poultry, seafood, eggs, dairy products, fortified breads and cereals
Pantothenic Acid (B5)	Energy metabolism	Widespread
Biotin (B7)	Energy metabolism; carbohydrate, fat and protein metabolism	Widespread

examples: only 5-10 percent of dietary iron is normally absorbed; about 30 percent of calcium is absorbed; yet almost all of dietary sodium is absorbed. Unlike some vitamins, minerals are not easily destroyed in storage or preparation. Like vitamins from dietary supplements, minerals from dietary supplements can be toxic when consumed in excessive amounts.

Figure 2.16
Minerals At-A-Glance

MACRO MINERALS			
Body contains approximately five teaspoons or 25 grams			
Calcium	Magnesium	Potassium	Sulfur
Chloride	Phosphorus	Sodium	
TRACE MINERALS			
Body contains less than 1/2 teaspoon or 3 grams			
Iron	Copper	Iodine	Zinc
Manganese	Fluoride	Selenium	

Calcium

Calcium, along with phosphorus, is used for building bones and teeth and are the most abundant minerals in the body. They give rigidity to the structures. Bone is being constantly rebuilt, with new bone being formed and old bone being taken apart, every day.

Calcium also circulates in the blood and appears in other body tissues, where it helps blood clot, muscles (including the heart muscle) contract, and nerves transmit impulses. Calcium also helps maintain normal blood pressure and immune defenses.

The major sources of calcium are milk and other dairy products. Not all dairy products are as rich in calcium as milk (see Figure 2.17). As a matter of fact, butter, cream, and cream cheese contain very little calcium. Other good sources of calcium include canned salmon and sardines (containing bones), oysters, calcium-fortified foods such as orange juice, and greens such as broccoli, collards, kale, and mustard and turnip greens. Other greens such as spinach, beet greens, Swiss chard, sorrel, and parsley are rich in calcium but also contain a binder (called oxalic acid) that prevents much of the calcium from being absorbed. Dried beans and peas and certain shellfish contain moderate amounts of calcium, but are usually not eaten in sufficient quantities to make a significant contribution. Meats and grains are poor sources.

Ordinarily, only about 30 percent of the calcium that is eaten is absorbed. However, the body is able to increase calcium absorption (up to 60 percent) during times when it is needed, such as during growth and pregnancy, and also when there is inadequate calcium in the diet. When there isn't enough calcium in the diet, calcium can be removed from the bones. However, one problem with relying on this process is that, over time, this will weaken the bone structure and increase the risk of developing a disease called osteoporosis, or bone loss. Many calcium supplements provide mixtures of calcium with other compounds, such as calcium carbonate. Research has also shown increased absorption when taken with vitamin D. Calcium supplements should not be taken without guidance from a physician or Registered Dietitian Nutritionist (RDN).

Phosphorus

Phosphorus is involved in the release of energy from fats, proteins, and carbohydrates during metabolism and in the formation of genetic material and many enzymes. Phosphorus also helps in the absorption and transport of fats, and assists in keeping blood chemistry neutral. Phosphorus has the ability to buffer or neutralize both acids and bases.

Phosphorus is widely distributed in foods and is not likely to be lacking in the diet. Milk and dairy products are excellent sources. Additional sources of phosphorus include meat, poultry, fish, eggs, legumes, and whole grain foods. Fruits and vegetables are generally low in this mineral.

Sodium

Sodium is a critical mineral that helps the body maintain water balance and acid-base balance. It also plays an important role in helping contract muscles and transmit nerve impulses. Meat, poultry, fish, eggs, and milk are high in natural sodium when compared to fruits and vegetables, but are still quite low compared to processed foods.

Deficiency of sodium is not a problem in the United States. The estimated minimum requirement is 500 mg per day, however an intake of ≤1500 mg per day is adequate. This may also be compared to the Tolerable Upper Limit of 2300 mg for those ≤14 years of age. The sodium intake of Americans is easily six times this amount—varying from 3000 mg to 8000 mg daily, much of it coming from processed foods. Overconsumption of sodium increases the risk of developing chronic diseases such as high blood pressure and cardiovascular disease.

Potassium

Potassium (one of three **electrolytes**, along with sodium and chloride) is found mainly inside the body's cells. All three electrolytes conduct electricity within the body. Potassium is also needed to release energy from carbohydrates, fats, and proteins. In the blood, potassium assists in muscle contraction, helps maintain a normal heartbeat, and helps send nerve impulses. Along with sodium and chloride, potassium helps maintain water balance and acid-base balance.

Potassium is distributed widely in foods, both plant and animal. Unprocessed, whole foods such as fruits and vegetables, as well as milk, grains, meat, poultry, fish, and legumes, are the best sources of potassium.

A potassium deficiency is very uncommon in healthy people, but may result from dehydration or from using a certain class of blood pressure medications called **diuretics**. Diuretics cause increased urine output. In addition, some diuretics cause an increased excretion of potassium. Symptoms of a deficiency include weakness, nausea, and abnormal heart rhythms that can be very dangerous, even fatal.

GLOSSARY

Electrolytes
Substances that produce an electrically conducting solution when dissolved in a polar solvent

Diuretic
A chemical that causes the body to increase urine output

Putting It Into Practice

11. A client tells you she is lactose intolerant; because she can't have dairy foods, she asks if she should take a calcium supplement. What are some food sources of calcium besides dairy?

Figure 2.17
Calcium in Selected Foods

FOOD	PORTION	CALCIUM CONTENT (mg)
Milk		
Skim	8 ounces	302
2%	8 ounces	297
Whole	8 ounces	291
Cheese		
Cottage Cheese, creamed	1 cup	147
Swiss	1 ounce	272
Parmesan	1 ounce	390
Cheddar	1 ounce	204
Mozzarella	1 ounce	183
American	1 ounce	174
Yogurt		
Low-Fat	1 cup	415
Low-Fat with Fruit	1 cup	345
Frozen	1 cup	200
Fish		
Sardines with Bones	3 ounces	372
Oysters	1 cup	226
Shrimp	3 ounces	98
Vegetables		
Turnip Greens, frozen and cooked	1 cup	249
Kale, frozen and cooked	1 cup	179
Mustard Greens	1 cup	104
Broccoli, frozen and cooked	1 cup	94
Miscellaneous		
Ice Cream	1 cup	176
Cheese Pizza	1/4 of 14" pie	332
Macaroni and Cheese	1/2 cup	181
Orange Juice, calcium-fortified	8 ounces	300
Tofu	3-1/2 ounces	128
Dried Navy Beans, cooked	1 cup	95

Source: U.S. Department of Agriculture

Excessive potassium is equally dangerous and megadoses of it can cause numbness, abnormal heart rhythms and cardiac failure, in which the heart stops beating. It is not recommended to take potassium supplements without the advice of a physician.

Chloride

Chloride is another important electrolyte in the body. It helps maintain water balance and acid-base balance. Chloride is also part of hydrochloric acid, found in high concentration in the juices of the stomach. Hydrochloric acid aids in protein digestion. The most important source of chloride in the diet is sodium chloride (NaCl), or table salt. If dietary sodium intake is adequate, there will be ample chloride as well.

Magnesium

Magnesium is found in all body tissues, with about 50-60 percent being in the bones and the remainder in the muscles and other soft tissues. It is an essential part of many enzyme systems responsible for energy conversions in the body. Magnesium is used in building bones and teeth and works with calcium, potassium, and sodium to contract muscles and transmit nerve impulses. Magnesium also has a role in making fatty acids and protein.

Magnesium is a part of the green pigment called chlorophyll that is found in plants. Good sources include dark green leafy vegetables, nuts (especially almonds and cashews), seeds, whole grain cereals, and legumes such as soybeans. Deficiency and subsequent symptoms are rare.

Sulfur

Sulfur is found in three of the amino acids (cysteine, homocysteine, and methionine). The protein in hair, skin, and nails is particularly rich in sulfur. Sulfur is also a part of two vitamins, thiamin and biotin. High protein foods supply adequate amounts of sulfur. A deficiency is not known to occur.

SECTION D TRACE MINERALS

Most of the trace minerals do not occur in the body in their free form, but are bound to organic compounds on which they depend for transport, storage, and function. The true understanding of many trace minerals is just starting to emerge.

Fluoride

Fluoride is the term used for the form of fluorine as it appears in drinking water and in the body. The terms fluoride and fluorine are used interchangeably. Fluoride contributes to solid tooth formation and results in a decrease of dental caries (cavities), especially in children. Although fluoride is not an essential element, there is also evidence that fluoride helps retain calcium in the bones of older people.

The major source of fluoride is drinking water. Some supplies of drinking water are naturally fluoridated; many have fluoride added, usually at a concentration of one part fluoride to one million parts water. In nearly all areas where **fluoridation** of water has been introduced, the incidence of dental caries in children has been reduced by at least 50 percent. In areas where there is too much natural fluoride in the water, teeth become discolored (mottled), but there are no undesirable health effects.

GLOSSARY

Fluoridation
The addition of fluoride to municipal water systems

Iodine

Iodine is required in extremely small amounts for the normal functioning of the thyroid gland. The thyroid gland is located in the neck and is responsible for producing important hormones that maintain a normal level of metabolism in the body. These hormones are essential for normal growth and development.

With a deficiency of dietary iodine, thyroid enlargement (called goiter) occurs. Iodine deficiency goiter used to be common in areas of the U.S. where the soil contains little iodine. Iodized salt was introduced in 1924 to combat iodine deficiencies.

Iron

Iron is an important part of compounds necessary for transporting oxygen to the cells and making use of the oxygen when it arrives. It is widely distributed in the body, where much of it is in the blood as the heme portion of hemoglobin. Hemoglobin is the oxygen carrier found in red blood cells. Iron is also part of the protein myoglobin in muscles, which makes oxygen available for muscle contraction. Iron works with many enzymes in energy metabolism.

Liver is an excellent source of iron. Other sources are meats, egg yolks, seafood, green leafy vegetables, legumes, dried fruits, and whole grain and enriched breads and cereals. The ability of the body to absorb and utilize iron from different foods varies from 3 percent for some vegetables to up to 30 percent for red meat. The iron in animal foods such as meat, poultry, and fish is absorbed and utilized more readily than iron in plant foods. The presence of these animal products in a meal increases the availability of iron from plant sources (non-heme iron) as well. The presence of vitamin C in a meal also increases iron absorption. Some foods actually decrease iron consumption: coffee, tea, calcium supplements, wheat bran, and other forms of fiber. The body adjusts its own iron absorption according to need.

Iron deficiency, which may be a result of inadequate dietary intake or from blood loss, can lead to **iron deficiency anemia**, a condition in which the size and number of red blood cells are reduced. Symptoms of iron deficiency anemia include fatigue, pallor, irritability, and lethargy. Iron deficiency anemia is a real concern in the U.S., more so for women than men. Iron requirements are higher for women of childbearing age than for men, because women have to replace menstrual blood losses.

GLOSSARY

Iron Deficiency Anemia
A condition resulting from insufficient dietary iron intake or blood loss

Selenium

It was not known that selenium was an essential mineral until 1979. Selenium is part of an enzyme that acts like an antioxidant and prevents oxidative damage to tissues, much like vitamins A, C, and E. Major food sources include Brazil nuts, seafood, meat, and liver. Because selenium is sometimes found in the soil, whole grains may be a good source of selenium as well, depending on where they are grown. Deficiency and toxicity in the U.S. are rare.

Putting It Into Practice

12. For clients who have an iron deficiency, what are two dietary practices that would improve iron absorption?

Zinc

Zinc is involved in enzymes that promote at least 50 metabolically important reactions in the body. Zinc assists in wound healing, bone formation, development of sexual organs, and general growth and maintenance of all tissues. Zinc is also important for taste perception and appetite.

Protein-containing foods are all good sources of zinc, particularly meat, shellfish, eggs, and milk. Whole grains and some legumes are good sources as well, but zinc is much more readily available in animal foods. In general, iron and zinc are both found in the same foods.

Children, pregnant and premenopausal women, and the elderly are most at risk for being deficient in zinc. Children who are deficient in zinc typically have poor growth and little appetite. Other symptoms of zinc deficiency include diarrhea, impaired immune response, slowed metabolism, loss of taste and smell, confusion, and poor wound healing. Though zinc toxicity is rare, excess supplemental intake can interfere with copper metabolism and can cause other serious problems.

Other Trace Minerals

Chromium participates in carbohydrate, protein, and fat metabolism. Chromium works with insulin to get glucose into the body's cells. Good sources of chromium are liver, meat, the dark meat of poultry, whole grains, and brewer's yeast. A chromium deficiency results in a condition much like diabetes, in which the glucose level in the blood is abnormally high.

Cobalt is a part of vitamin B12 and is, therefore, needed to form red blood cells. We take in the cobalt we need by eating vitamin B12-rich foods. (Remember that vitamin B12 is found only in animal foods.)

Copper is necessary along with iron for the formation of hemoglobin. As a part of many enzymes, it also helps make the protein collagen, assists in wound healing, and keeps nerves healthy. Good sources of copper include organ meats, meats, shellfish, whole grain cereals, nuts, and legumes. Copper deficiency is generally rare, except in cases of malnutrition or malabsorption diseases; excessive supplemental copper intake can be toxic.

Manganese is needed for blood formation and bone structure, and as part of many enzymes involved in energy metabolism. Manganese is found in many foods, especially whole grains, legumes, nuts and seeds, and green leafy vegetables. A deficiency is unknown.

Molybdenum is a cofactor in a number of enzyme systems and is possibly involved in the metabolism of fats. Deficiency does not seem to be a problem.

As time goes on, more trace minerals will probably be recognized as essential to human health. There are currently several trace minerals that are essential to animals and are likely to be essential to humans, as well. They include arsenic, nickel, silicon, and boron. Figures 2.18 and 2.19 summarize this section on minerals.

Figure 2.18
Macro Minerals—Function and Food Sources

MINERAL	FUNCTION	FOOD SOURCES
Calcium	• Mineralization of bones and teeth • Blood clotting muscle contractions • Transmission of nerve impulses	• Milk and milk products • Calcium-set to calcium-fortified foods • Collards, kale, mustard greens, turnip greens • Legumes • Whole wheat bread
Phosphorus	• Mineralization of bones and teeth • Energy metabolism • Formation of DNA and many enzymes • Buffer	• Milk and milk products • Meat and poultry • Eggs • Legumes
Magnesium	• Energy metabolism • Formation of bones and maintenance of teeth • Muscle contraction and nerve transmission • Immune system	• Green leafy vegetables • Potatoes • Nuts and legumes • Whole grain cereals
Sodium	• Water balance • Acid-base balance • Buffer, muscle contraction • Transmission of nerve impulses	• Salt • Processed foods • MSG
Potassium	• Water balance • Acid-base balance • Buffer, muscle contraction • Transmission of nerve impulses	• Many fruits and vegetables (oranges, grapefruit, potatoes) • Milk and yogurt • Legumes • Meats
Chloride	• Water balance • Acid-base balance • Part of hydrochloric acid in stomach	• Salt
Sulfur	• Part of some amino acids • Part of thiamin	• Protein foods

Figure 2.19
Trace Minerals—Function and Food Sources

MINERAL	FUNCTION	FOOD SOURCES
Copper	• Iron metabolism • Formation of hemoglobin • Collagen formation • Energy release	• Seafood • Whole-grain breads and cereal • Legumes, nuts, and seeds
Fluoride	• Strengthening of developing teeth	• Water (naturally or artificially fluoridated) • Tea • Seafood
Iodine	• Normal functioning of thyroid gland • Normal metabolic rate • Normal growth and development	• Iodized salt • Salt-water fish
Iron	• Part of hemoglobin and myoglobin • Part of some enzymes • Energy metabolism • Needed to make amino acids	• Red meats • Shellfish • Legumes • Whole-grain and enriched breads and cereals • Green leafy vegetables
Selenium	• Activation of antioxidant	• Seafood • Meat and liver • Eggs • Whole grains • Vegetables (if soil is rich in selenium)
Zinc	• Co-factor of many enzymes • Wound healing • DNA and protein synthesis • Bone formation • Development of sexual organs • General growth and maintenance • Taste perception and appetite	• Protein foods • Legumes • Dairy products • Whole-grain products • Fortified cereals

SECTION E WATER

Nothing survives without water and virtually nothing takes place in the body without water playing a vital role. While variations may be great, the average adult's body weight is generally 50 to 60 percent water—enough, if it were bottled, to fill 40 to 50 quarts. For example, in a 150-pound man, water accounts for about 90 pounds; fat about 30 pounds; with proteins, carbohydrates, vitamins, and minerals making up the balance. Men generally have a higher percentage of water than women. Some parts of the body have more water than others. Human blood is about 92 percent water; muscle and the brain are about 75 percent; and bone is about 22 percent.

The body uses water for virtually all its functions: digestion, absorption, circulation, excretion, transporting nutrients, building tissue, and maintaining temperature. Almost all of the body's cells depend on water to perform their functions; water carries nutrients to the cells and carries away waste materials to the kidneys; water is needed in each step of the process of converting food into energy and tissue; digestive secretions are mostly water, acting as a solvent for nutrients; water in the digestive secretions softens, dilutes, and liquefies the food to facilitate digestion; water also helps move food along the gastrointestinal tract.

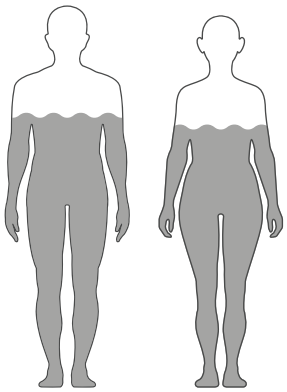
Additionally, water serves as an important part of lubricants, helping to cushion the joints and internal organs, keeping body tissues, such as the eyes, lungs, and air passages moist, and surrounding and protecting the fetus during pregnancy.

The body gets rid of the water it doesn't need through the kidneys (as urine) and skin (as perspiration) and, to a lesser degree, from the lungs and gastrointestinal tract. The largest amount of excess water, between 2-8 cups, is excreted as urine by the kidneys. The amount of urine reflects, to some extent, the amount of fluid intake of the individual, although no matter how little water one consumes, the kidneys will always excrete a certain amount each day to eliminate waste products generated by the body's metabolic actions. See Figure 2.20 for food sources of water. See Figure 2.21 for factors that upset water balance. Calculating fluid needs will be discussed as part of Nutrition Screening, found in Chapter 7.

Figure 2.20
Food Sources of Water

FOOD SOURCES	%
Coffee and tea (brewed)	100
Clear broth; boiled vegetables such as celery, cabbage, cauliflower, and broccoli; cucumber slices; iceberg lettuce; pumpkin; beer	95-99
Cider, cola drinks, lemonade, canned juice, skim milk, most broth-based soups, green peppers	90-94
Whole milk, wines, spaghetti canned in tomato sauce, boiled potatoes, canned grapefruit, fresh orange juice, strawberries, low-fat yogurt, eggplant, mango, cooked spinach, peas, stewed apples	80-89
Milkshake, yogurt, mashed potato, baked beans, sweet potato, cooked oatmeal, rice, poached fish, peaches, banana, boiled egg, cottage cheese	70-79
Pizza, fried and scrambled egg, tuna in oil, stewed prunes, roast beef and poultry, cheese spread, cream	50-69
Pork, lunch meat, cheddar cheese, processed cheese, hazelnuts	30-49
Most other nuts, salad dressings, honey syrup	10-29
Peanut butter, candy and sugar, oils, potato chips	< 10

Figure 2.21
Factors that Upset Water Balance



- Surgery
- Physical activity
- Illness with prolonged vomiting, diarrhea, or fever
- Amount of alcohol consumed
- Diuretic consumption
- Pregnancy or breastfeeding
- Hot weather or hot environments
- Increased intake of fiber, salt, protein, or sugar

SECTION F NUTRIENT DENSITY

Foods vary in how rich they are in nutrients. Foods that are nutrient-rich relative to their calorie (energy) content are said to be high in **nutrient density**. For example, one cup of broccoli has 25 calories and proportionally high levels of vitamins and minerals. Thus, it has a high nutrient density. In contrast, one cup of cola has 100 calories and no vitamins, thus low nutrient density. Think of these calories as a "price" paid for the lack of vitamins, minerals, and other essential nutrients. If a high calorie price was "paid" for a food that has little or no nutrients when eaten, that food is not nutrient-dense. Sometimes people use the term **empty calories** to describe a food that has low nutrient density. See the sample in Figure 2.22. In the "price" analogy, if you pay a low price (caloric intake) and receive many nutrients, the food you are consuming is nutrient-dense. Sound dietary habits rely on nutrient-dense foods for many of the daily food choices.

GLOSSARY

Nutrient Density
Foods that have many nutrients relative to their calorie or energy content

Empty Calories
Foods that are not nutrient-dense and may contain many calories

Figure 2.22
Example of Empty Calories

Homemade Cupcake with Icing

Information per Serving:
Serving Size = 1 Cupcake

Calories	170
Total Fat	5 grams
Sodium	110 milligrams
Carbohydrates	30 grams
Protein	2 grams
Vitamin A	*
Vitamin C	*
Calcium	*
Iron	*

There is a high calorie price for very little of the essential nutrients, Vitamins A and C, and minerals calcium and iron, with this cupcake.

Yogurt Parfait with Fruit and Granola

Information per Serving:
Serving Size = 1 Parfait

Calories	162
Total Fat	2 grams
Sodium	78 milligrams
Carbohydrates	31 grams
Protein	6 grams
Vitamin A	46 IU
Vitamin C	1.5 milligrams
Calcium	210 milligrams
Iron	75 milligrams

The yogurt parfait is a better dessert option, as it is lower in fat and sodium. It contains more protein, vitamins, and minerals while providing fewer calories.

Chapter References

RESOURCES	
Association of Nutrition & Foodservice Professionals	www.ANFPonline.org
U.S. Department of Agriculture. Food and Nutrition Information Center. National Agricultural Library*	https://www.nal.usda.gov/fnic
U.S. Department of Agriculture. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. Published February, 2015*	https://health.gov/dietaryguidelines/2015-scientific-report/pdfs/scientific-report-of-the-2015-dietary-guidelines-advisory-committee.pdf
U.S. Department of Agriculture. What We Eat in America. Agricultural Research Service. Updated August 15, 2019.*	https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/wweia-usual-intake-data-tables/
U.S. Department of Health & Human Services. History of Dietary Guidelines for Americans. Dietary Guidelines for Americans*	https://health.gov/dietaryguidelines/history.htm

**Accessed September 18, 2019*

ANFP® | Association of Nutrition & Foodservice Professionals