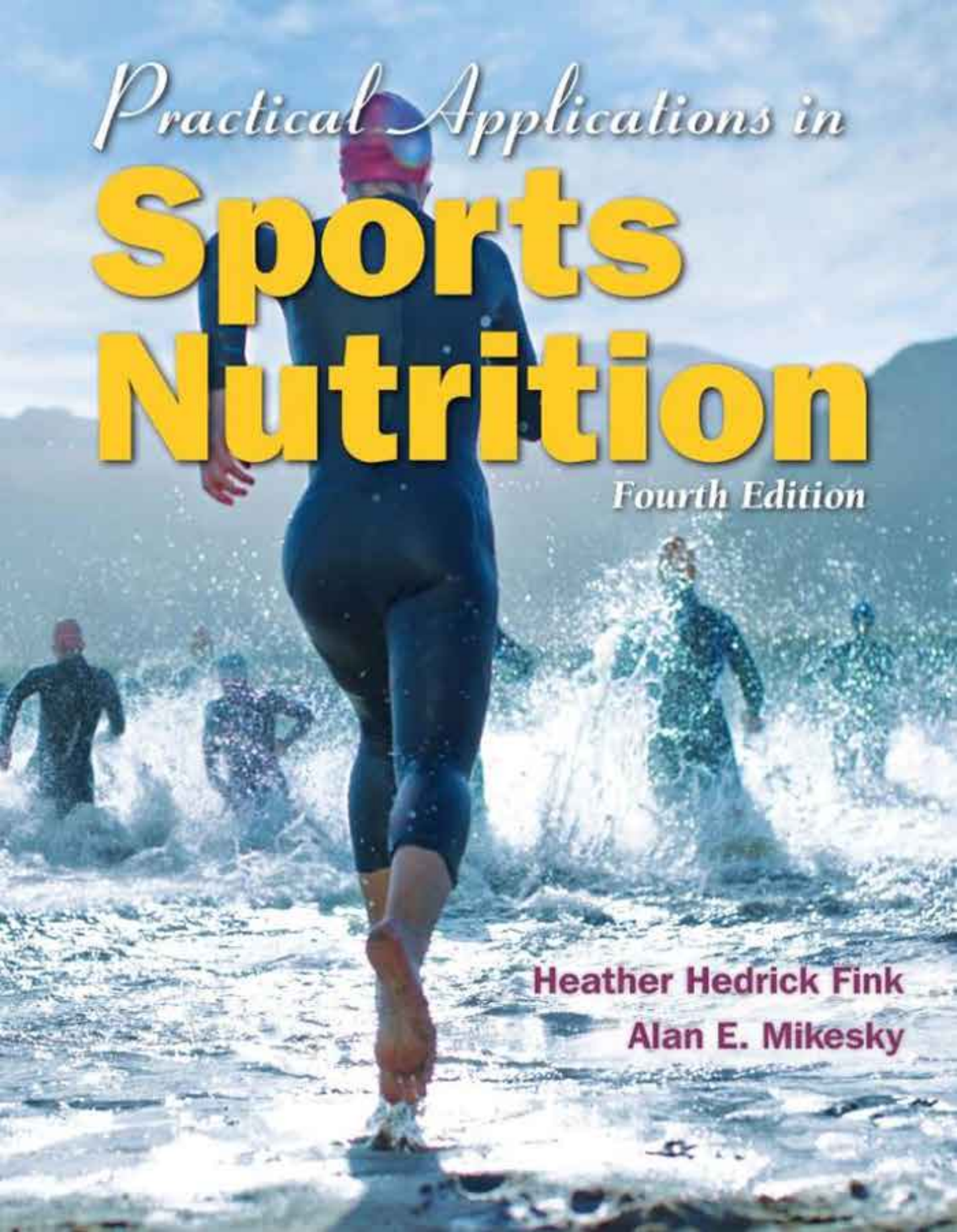
Practical Applications in
Sports Nutrition
Fourth Edition
Heather Hedrick Fink
Alan E. Mikesky

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Sports Nutrition

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Brief Contents

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Preface

Sports nutrition is an exciting field that combines the sciences of nutrition and exercise physiology. The generally accepted notion that proper nutrition can positively impact athletic performance has created the need for exercise and nutrition professionals to acquire knowledge that goes beyond the basics of general nutrition.

In addition, emerging career opportunities in sports nutrition require that academic programs preparing registered dietitians expand the application of nutrition beyond the clinical population. Strength coaches and personal trainers also need to go beyond the nutrition basics to help their athletes achieve optimal performance. The growing research base supporting the importance of sports nutrition and the inherent interest of athletes seeking a nutritional edge has created an increased demand for sports nutrition courses in dietetic and exercise science programs.

In order to obtain a job in the sports nutrition field, readers need to understand current nutrition guidelines, be aware of the results of emerging research, and be able to practically apply sports nutrition knowledge to athletes of all ages, sports, and abilities. This text has been developed to meet these needs, providing readers with an opportunity to learn the most up-to-date information related to diet and athletic performance while also addressing consultation skills and giving readers the tools they need to educate others properly. The focus on research, current guidelines, and practical application of information makes this sports nutrition textbook unique among other texts currently on the market.

Undergraduate and graduate students as well as professionals from several different backgrounds will benefit from this textbook. Students in dietetics, exercise science, and athletic training programs will enhance their education with an understanding of the relationship among essential nutrients, energy metabolism, and optimal sports performance. Dietetics students seeking the registered dietitian (RD) credential will appreciate the thorough explanations and many helpful tips on how to guide an athlete through nutrition consultations. Exercise science and athletic training students will learn how to educate athletes regarding public domain sports nutrition guidelines as well as how to work together as a team with a registered dietitian and physician. Current professionals in the field of sports nutrition will benefit from adding this text to their reference library due to the straightforward and complete presentation of current sports nutrition recommendations and examples of practical applications for athletes participating in endurance, strength/power, and team sports.

Fourth Edition Enhancements

The fourth edition of *Practical Applications in Sports Nutrition* is divided into two sections. Chapters 1–9 provide an introduction to sports nutrition, including the definition of sports nutrition and an explanation of general nutrition concepts; a review of digestion and energy metabolism; a thorough explanation of macronutrients, micronutrients, and water and their relation to athletic performance; and, finally, an overview of nutritional ergogenics. Enhancements within Chapters 1–9 in this *Fourth Edition* include a new feature entitled "Food for Thought"; updated figures, tables, and recipes throughout; Chapter 2 reorganization; recent carbohydrate recommendations and research findings; condensed glycemic index section with new table; new tables on carbohydrate and fiber content of foods along with carbohydrate recommendations based on training level; new tables on daily fat intake recommendations and omega-3 fatty acid content of foods; updated vitamin D recommendations; new 2013 World Anti-Doping Association Prohibited Substances List; condensed section on Ephedra removal from the market; and new information on researching ergogenic aids and energy drinks.

Several of this textbook's unique features appear in the second half of the text, within the practical application section. Chapter 10 focuses on how to educate, communicate with, and empower athletes to make behavior changes through nutrition consultations. Chapter 11 covers enhancing athletic performance through nutrition while also focusing on weight management, including weight loss, weight gain, and eating disorders. The *Fourth Edition* changes to Chapter 11 include updated statistics and graphs on obesity and condensed sections regarding body composition measurement and weight loss.

In Chapters 12–14, sports are divided into three categories: endurance, strength/power, and team, each covered separately. Each chapter reviews the

most current research as it relates to the energy systems and specific nutrition needs of athletes in these various categories of sports. Chapters 12–14 are examples of one of the main objectives of this book—to empower individuals to excel in the sports nutrition field by teaching sports nutrition guidelines and showing how to apply the concepts to athletes in various sports. These chapters demonstrate how to give advice that is practical and easy to follow. Chapters 12–14 have been the favorites of many reviewers; however, a few changes have been made in this *Fourth Edition* such as updated macronutrient recommendations and clarifications as well as a new case study.

Due to the increased occurrence of athletes with special medical or nutritional considerations, including those who are pregnant, vegetarian, masters athletes, or have chronic diseases, Chapter 15 targets the unique nutrition requirements of these special populations. The text concludes with a chapter dedicated to helping readers discover and understand the pathway to becoming a sports dietitian through education and experience. *Fourth Edition* enhancements to Chapters 15 and 16 include updated tables, references, resources, and websites.

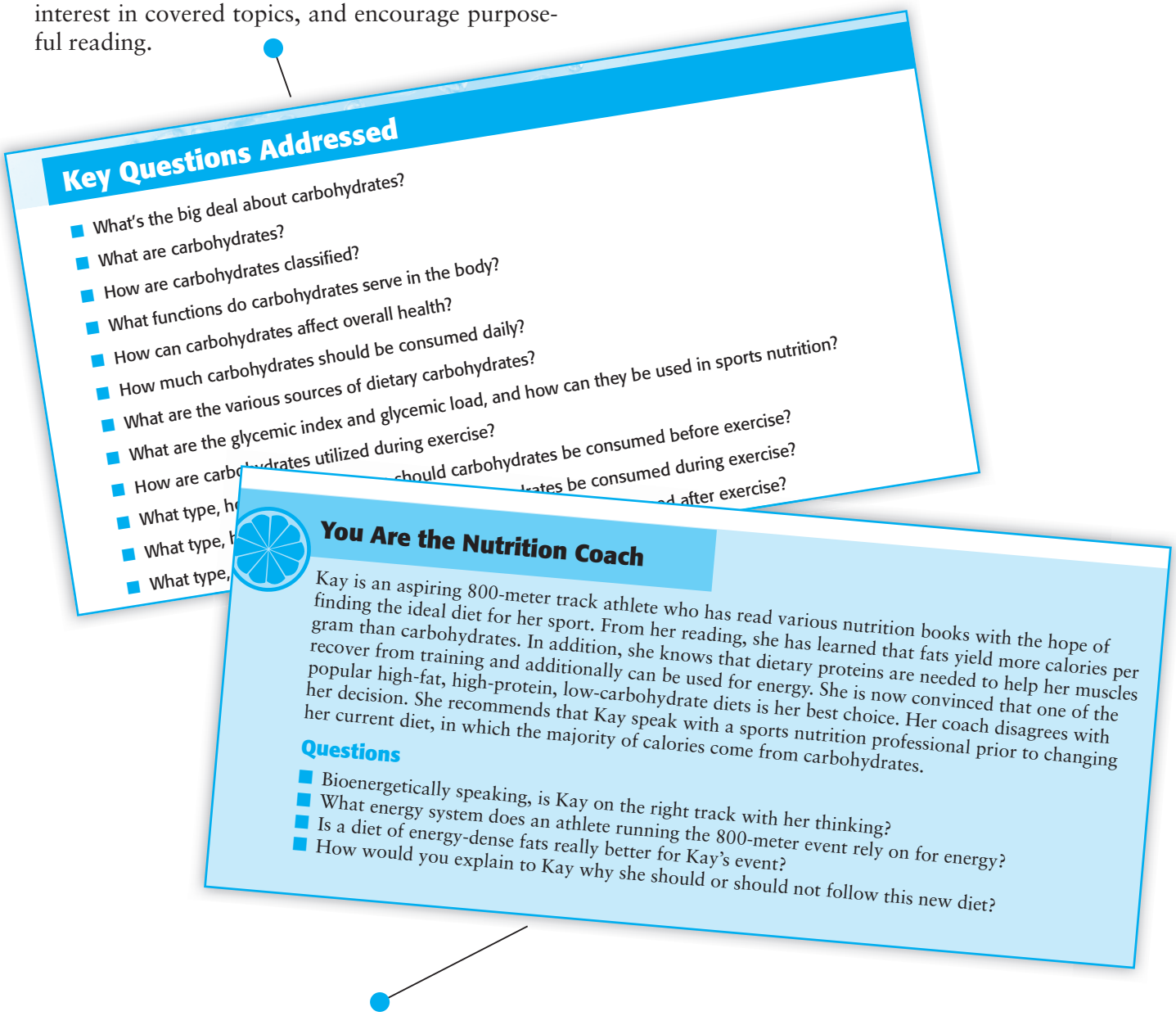
The Pedagogy

Throughout the text the primary, secondary, and tertiary section headings are phrased as questions. We formatted the section headings as questions to help readers focus their attention and to foster interest in the topic before they begin to read. In other words, they are "directed" to read about topics with the specific purpose of obtaining an answer to a question. This is an effective way of reading and borrows from the work of Francis Robinson, who developed the widely used "preview-question-read-recite-review" (PQ3R) reading technique. The goal is to prevent "hollow reading," in which a person reads the words on the pages but without a specific understanding or perspective of why he or she is reading.

Our mission is for readers to become engrossed in their reading with the hope that they will be inspired to learn more about the relatively new and growing field of sports nutrition. After all, regardless of where a reader's academic and career paths may lead, knowledge of good nutrition is universally applicable to one's personal health and well-being, to enjoyment of recreational and sports activities, and, in the case of dietitians and fitness professionals, to career success.

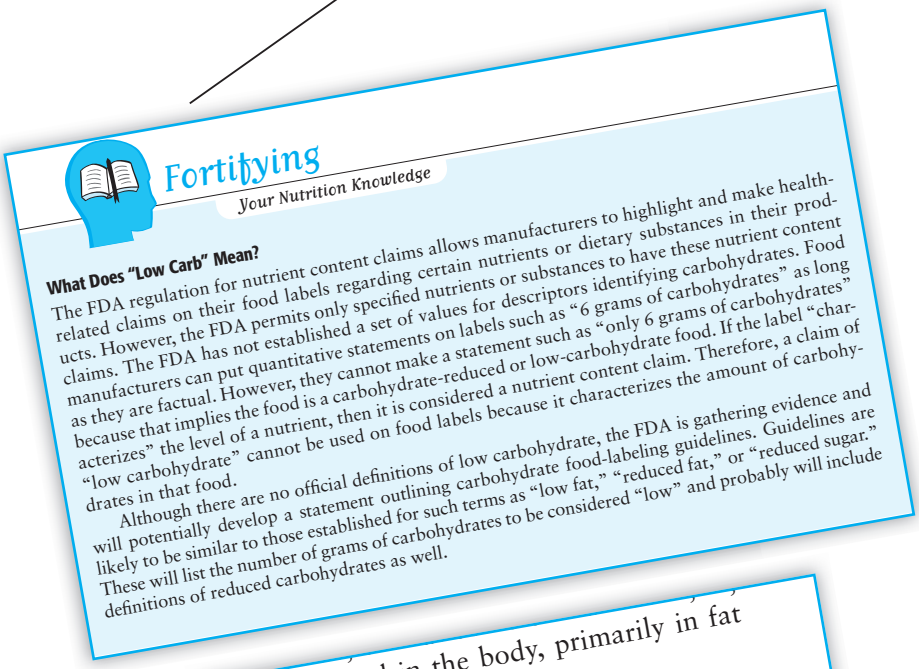
How to Use This Book

Key Questions Addressed sections open each chapter and introduce students to key material, pique their interest in covered topics, and encourage purposeful reading.



You Are the Nutrition Coach case studies at the beginning of the chapter provide context to chapter material. Students are urged to carefully consider the case study prior to reading the chapter and reconsider it after completing their reading.

Fortifying Your Nutrition Knowledge boxes expand on timely topics with the intent of providing information that is beyond the basics of the sports nutrition topic being discussed.



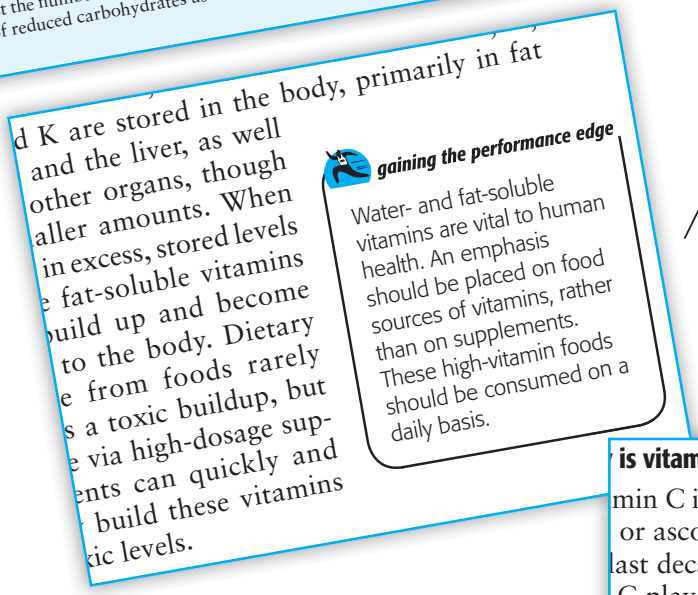
Fortifying
Your Nutrition Knowledge

What Does "Low Carb" Mean?

The FDA regulation for nutrient content claims allows manufacturers to highlight and make health-related claims on their food labels regarding certain nutrients or dietary substances in their products. However, the FDA permits only specified nutrients or substances to have these nutrient content claims. The FDA has not established a set of values for descriptors identifying carbohydrates. Food manufacturers can put quantitative statements on labels such as "6 grams of carbohydrates" as long as they are factual. However, they cannot make a statement such as "only 6 grams of carbohydrates" because that implies the food is a carbohydrate-reduced or low-carbohydrate food. If the label "characterizes" the level of a nutrient, then it is considered a nutrient content claim. Therefore, a claim of "low carbohydrate" cannot be used on food labels because it characterizes the amount of carbohydrates in that food.

Although there are no official definitions of low carbohydrate, the FDA is gathering evidence and will potentially develop a statement outlining carbohydrate food-labeling guidelines. Guidelines are likely to be similar to those established for such terms as "low fat," "reduced fat," or "reduced sugar." These will list the number of grams of carbohydrates to be considered "low" and probably will include definitions of reduced carbohydrates as well.

Gaining the Performance Edge boxes provide insightful tips on how to apply sports nutrition knowledge when working with athletes.

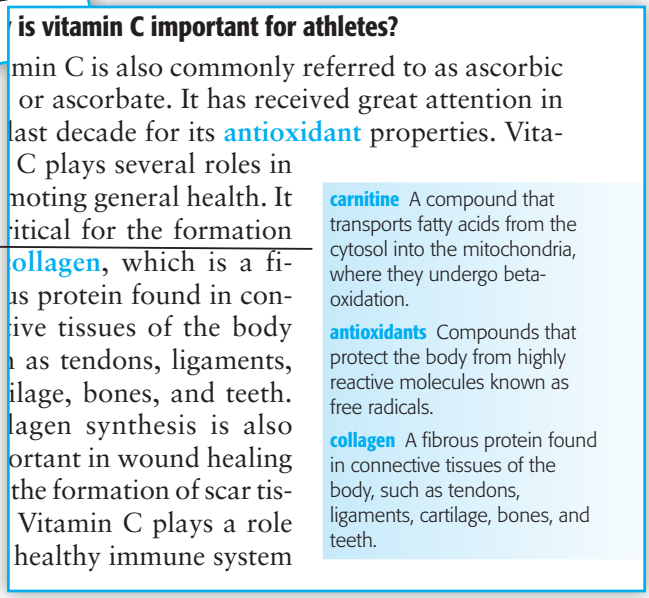


d K are stored in the body, primarily in fat
and the liver, as well
other organs, though
aller amounts. When
in excess, stored levels
e fat-soluble vitamins
uild up and become
to the body. Dietary
e from foods rarely
s a toxic buildup, but
e via high-dosage sup-
nts can quickly and
build these vitamins
ic levels.

gaining the performance edge

Water- and fat-soluble vitamins are vital to human health. An emphasis should be placed on food sources of vitamins, rather than on supplements. These high-vitamin foods should be consumed on a daily basis.

Key Terms are bolded within the text and defined in a sidebar to help students quickly identify and understand new terms.



is vitamin C important for athletes?

min C is also commonly referred to as ascorbic
or ascorbate. It has received great attention in
last decade for its **antioxidant** properties. Vita-
C plays several roles in
moting general health. It
itical for the formation
ollagen, which is a fi-
us protein found in con-
ive tissues of the body
as tendons, ligaments,
ilage, bones, and teeth.
lagen synthesis is also
ortant in wound healing
the formation of scar tis-
Vitamin C plays a role
healthy immune system

carnitine A compound that transports fatty acids from the cytosol into the mitochondria, where they undergo beta-oxidation.

antioxidants Compounds that protect the body from highly reactive molecules known as free radicals.

collagen A fibrous protein found in connective tissues of the body, such as tendons, ligaments, cartilage, bones, and teeth.

Detailed **Figures and Tables** help students grasp difficult concepts and clarify information.

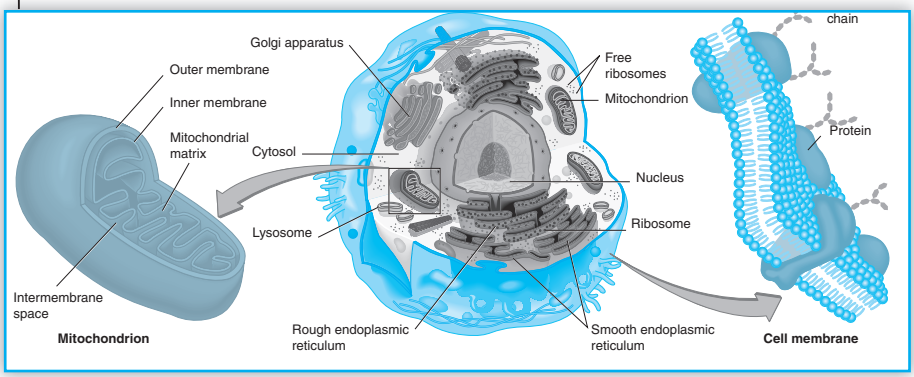
New **Food for Thought** callouts refer students to web-based workbook activities to further their understanding or engagement in nutritional topics.

Food for Thought 2.2

Understanding Bioenergetics

In this exercise, your knowledge of how the energy systems work together to supply ATP during activity will be challenged.

the athlete, most of the proteins used in gluconeogenesis come from muscle.[10] This is one reason why carbohydrate intake is so important to the athlete. If carbohydrate intake is adequate to meet energy demands and carbohydrate stores are replenished after



Training Tables help students translate sports nutrition knowledge into actual meal planning ideas, recipes, or food selections.

Training Table 6.2: Slow Cooker Navy Bean Soup

1 lb dry navy beans
4 cups vegetable broth
4 cups water
1 cup carrots, chopped
3 celery stalks, chopped
2 garlic cloves, minced
1 cup onions, chopped
1 4-oz can chopped green chiles
1 15-oz can diced tomatoes

Rinse navy beans and put into large pot. Cover beans with 3 inches of water and soak overnight.

Rinse soaked beans and place in slow cooker. Add remaining ingredients and cook on low for 10 hours.

Serving size: 1.5 cups (Recipe makes 10 servings)

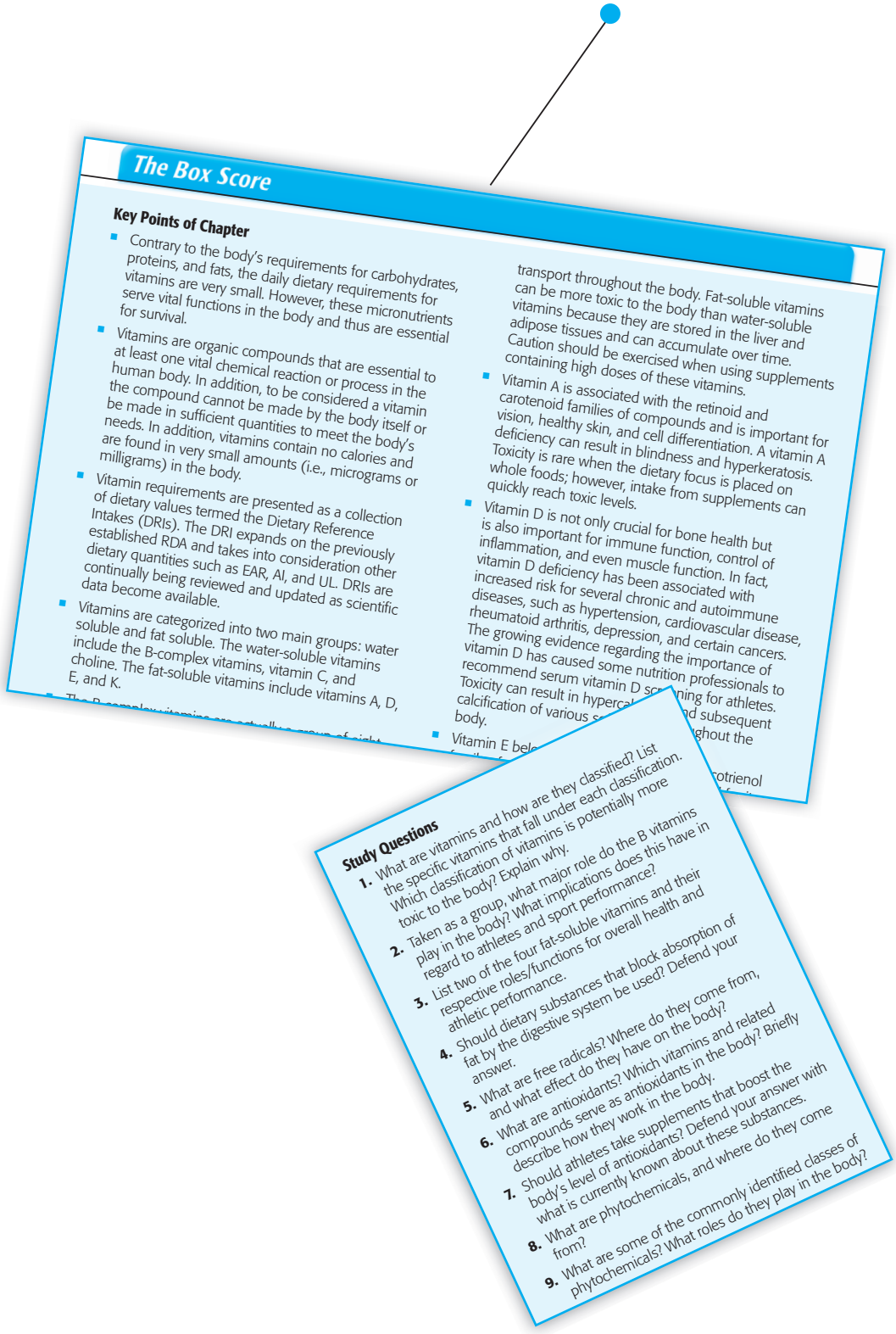
Calories: 186 kcals

Protein: 11 grams

Carbohydrate: 34 grams

Fat: 1 grams

The Box Score concludes each chapter with **Key Points**, numerous **Study Questions**, and **References**, which continue to engage students in thoughtful review of important chapter material.



The Box Score

Key Points of Chapter

- Contrary to the body's requirements for carbohydrates, proteins, and fats, the daily dietary requirements for vitamins are very small. However, these micronutrients serve vital functions in the body and thus are essential for survival.
- Vitamins are organic compounds that are essential to at least one vital chemical reaction or process in the human body. In addition, to be considered a vitamin the compound cannot be made by the body itself or be made in sufficient quantities to meet the body's needs. In addition, vitamins contain no calories and are found in very small amounts (i.e., micrograms or milligrams) in the body.
- Vitamin requirements are presented as a collection of dietary values termed the Dietary Reference Intakes (DRIs). The DRI expands on the previously established RDA and takes into consideration other dietary quantities such as EAR, AI, and UL. DRIs are continually being reviewed and updated as scientific data become available.
- Vitamins are categorized into two main groups: water soluble and fat soluble. The water-soluble vitamins include the B-complex vitamins, vitamin C, and choline. The fat-soluble vitamins include vitamins A, D, E, and K.

transport throughout the body. Fat-soluble vitamins can be more toxic to the body than water-soluble vitamins because they are stored in the liver and adipose tissues and can accumulate over time. Caution should be exercised when using supplements containing high doses of these vitamins.

- Vitamin A is associated with the retinoid and carotenoid families of compounds and is important for vision, healthy skin, and cell differentiation. A vitamin A deficiency can result in blindness and hyperkeratosis. Toxicity is rare when the dietary focus is placed on whole foods; however, intake from supplements can quickly reach toxic levels.
- Vitamin D is not only crucial for bone health but is also important for immune function, control of inflammation, and even muscle function. In fact, vitamin D deficiency has been associated with increased risk for several chronic and autoimmune diseases, such as hypertension, cardiovascular disease, rheumatoid arthritis, depression, and certain cancers. The growing evidence regarding the importance of vitamin D has caused some nutrition professionals to recommend serum vitamin D sc ning for athletes. Toxicity can result in hyperca nd subsequent calcification of various s ghout the body.
- Vitamin E bel

otrienol

Study Questions

1. What are vitamins and how are they classified? List the specific vitamins that fall under each classification. Which classification of vitamins is potentially more toxic to the body? Explain why.
2. Taken as a group, what major role do the B vitamins play in the body? What implications does this have in regard to athletes and sport performance?
3. List two of the four fat-soluble vitamins and their respective roles/functions for overall health and athletic performance.
4. Should dietary substances that block absorption of fat by the digestive system be used? Defend your answer.
5. What are free radicals? Where do they come from, and what effect do they have on the body?
6. What are antioxidants? Which vitamins and related compounds serve as antioxidants in the body? Briefly describe how they work in the body.
7. Should athletes take supplements that boost the body's level of antioxidants? Defend your answer with what is currently known about these substances.
8. What are phytochemicals, and where do they come from?
9. What are some of the commonly identified classes of phytochemicals? What roles do they play in the body?

Integrated Teaching and Learning Package

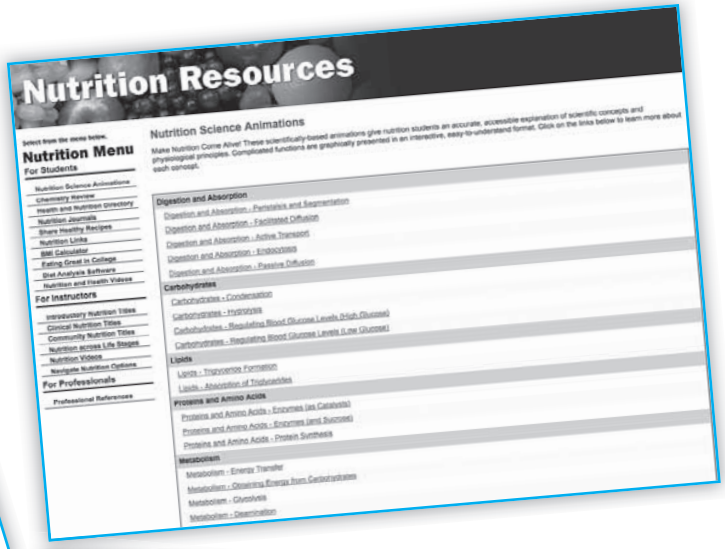
The **Navigate Companion Website, go.jblearning.com/Fink4e**, features numerous study aids and learning tools to help students get the most out of their course and prepare for class, including:

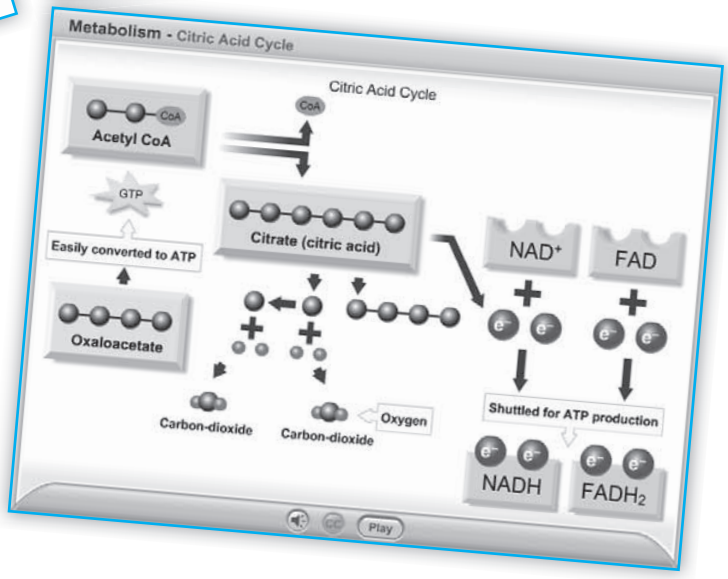
- Practice Quizzes
- Student Workbook
- Crossword Puzzles
- Animated Flashcards
- Interactive Glossary
- Chemistry Review
- And much more!

Nutrition Science Animations bring difficult processes to life with a graphically illustrated and interactive account of more than 30 key concepts. Animations can be found at **go.jblearning.com/NutritionResources**.

Instructor's Resources include:

- PowerPoint Lecture Slides
- PowerPoint Image Bank
- LMS-Ready Test Bank
- Instructor's Manual





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Heather Hedrick Fink, owner of Nutrition and Wellness Solutions, LLC, is a Registered Dietitian and Board Certified as a Specialist in Sport Dietetics. She completed her undergraduate degree in dietetics as well as her master of science degree in kinesiology at the University of Illinois, Urbana/Champaign. Heather is also certified by the American College of Sports Medicine as a Health/Fitness Specialist. Heather has been providing nutrition, fitness, and wellness programming to individuals, corporations, and athletic teams for more than 15 years.

Heather's interests and extensive experience are in the areas of wellness, disease prevention, weight management, exercise programming, vegetarian nutrition, and sports nutrition, ranging from the recreational to the ultra-endurance athlete. Her sports nutrition practice includes acting as the sports dietitian for the Indiana University-Purdue University Indianapolis athletic department, as well as working with club teams, individual athletes, trainers, and coaches to optimize their nutrition and hydration strategies. She has appeared on local NBC, CBS, and cable television shows and news broadcasts to educate central Indiana residents on the benefits of a healthy lifestyle. Heather is also the author of the *Absolute Beginner's Guide to Half Marathon Training*. She has been interviewed and quoted in *Women's Day, Ladies Home Journal*, and *Newsweek* magazines. Heather is also an accomplished triathlete, duathlete, and marathon runner who has qualified for and competed in the Hawaii Ironman and Boston Marathon.

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Alan E. Mikesky is a professor at the School of Physical Education and Tourism Management at Indiana University–Purdue University Indianapolis, and Director of the Human Performance and Biomechanics Laboratory. He also has an adjunct appointment with the School of Medicine, Department of Anatomy, and serves as research associate at the National Institute for Fitness and Sport in Indianapolis. Dr. Mikesky received his undergraduate degree in biology from Texas A&M University and his master of science degree in physical education with a specialization in exercise physiology from the University of Michigan. He received his doctorate in anatomy/cell biology from the University of Texas Southwestern Medical Center at Dallas where he studied the adaptations of skeletal muscle to heavy resistance exercise. He is a Fellow of the American College of Sports Medicine (ACSM) and was fitness editor for ACSM's quarterly newsletter, *Fit Society Page*. He has served as a member of the editorial board for the *National Strength and Conditioning Association's Journal of Strength and Conditioning Research* and *Strength and Conditioning Journal*. He is also coauthor of the *Sixth Edition* of *Physical Fitness: A Way of Life*, a textbook published by Cooper Publishing Group. His research focuses on the functional improvements and physiological adaptations to various forms of resistance exercise. He has investigated the impact of strength training on gait, balance, incidence of falls, joint proprioception, functional ability, and chronic diseases such as osteoarthritis. His most recent research interests involve exploring the effects of low-intensity, resistance exercise combined with blood flow restriction. Finally, his teaching responsibilities include both undergraduate and graduate exercise science courses and sports conditioning.

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Their thoughtful, constructive comments provided the feedback necessary to enhance our book with accurate and timely sports nutrition updates.

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SECTION 1

The Basics of Sports Nutrition

This section provides an introduction to sports nutrition, including a review of general nutrition concepts; an overview of digestion and energy metabolism; a thorough explanation of macronutrients, micronutrients, and water and their relation to athletic performance; and, finally, a discussion of nutritional ergogenics.

CHAPTER

1 Introduction to Sports Nutrition

Key Questions Addressed

- What is sports nutrition?
- Why study sports nutrition?
- What are the basic nutrients?
- How does the body produce energy?
- What are the Dietary Reference Intakes?
- What are enriched and fortified foods?
- What are the basic nutrition guidelines?
- How should athletes interpret the information on food labels?
- What are the factors to consider when developing an individualized sports nutrition plan for athletes?
- How can sports nutrition knowledge be converted into practical applications?

You Are the Nutrition Coach

Jennifer is a 42-year-old tennis player. She states that recently her energy levels have dropped and that she has had a hard time recovering from long tennis matches. She also complains of being "hungry all the time." The constant hunger has been frustrating because she is trying to maintain her current weight by attempting to control her total daily intake. She has been "eating well" since finding out 2 years ago that she has high cholesterol. She received counseling from a dietitian at the time of her diagnosis and subsequently made major changes in her diet, such as switching to nonfat foods and eliminating dairy. Her goals are to increase her energy levels, decrease recovery time, and create a meal plan that will also be healthy for her husband and three sons.

Question

- What should Jennifer's top priority be—her high cholesterol, struggle to maintain her weight, constant hunger, low energy levels, or long recovery time?

What is sports nutrition?

sports nutrition A specialty area of study and practice within the field of nutrition.

Sports nutrition is a specialization within the field of nutrition that partners closely with the study of the human body and exercise science. Sports nutrition can be defined as the application of nutrition knowledge to a practical daily eating plan focused on providing the fuel for physical activity, facilitating the repair and rebuilding process following hard physical work, and optimizing athletic performance in competitive events, while also promoting overall health and wellness. The area of sports nutrition is often thought to be reserved only for "athletes," which insinuates the inclusion of only those individuals who are performing at the elite level. In this text, the term *athlete* refers to any individual who is regularly active, ranging from the fitness enthusiast to the competitive amateur or professional. Differences may exist in specific nutrient needs along this designated spectrum of athletes, creating the exciting challenge of individualizing sports nutrition plans.

gaining the performance edge

The field of sports nutrition requires a command of general nutrition and exercise science, an understanding of their interrelationship, and the knowledge of how to practically apply sports nutrition concepts.

To fully understand and subsequently apply sports nutrition concepts, professionals instructing athletes on proper eating strategies first need to have a command of general nutrition as well as exercise science. The second step is to gain the knowledge of how nutrition and exercise science are intertwined, understanding that physical training and dietary habits are reliant on each other to produce optimal performance. The final step can be considered one of the most critical—the practical application of sports nutrition knowledge to individual athletes participating in a sport or physical activity.

Sports nutrition professionals must be able to teach athletes by putting "book" knowledge into practice with actual food selection and meal planning, while keeping in mind the challenges presented by busy schedules of exercise, competitions, work, school, and other commitments. It is this third step that many professionals lack after graduating from an undergraduate or graduate program in sports nutrition, dietetics, exercise science, or athletic training.

Our focus is to review sports nutrition concepts while also translating the information into specific meal plans, recipes, and case study scenarios. Students are encouraged to seek additional opportunities outside the classroom to work with recreational and elite athletes to gain more experience in applying sports nutrition concepts before searching for a job in the "real world."

Why study sports nutrition?

Sports nutrition has recently emerged as a recognized specialty area within the field of nutrition. Athletes challenge their bodies on a regular basis through physical training and competitions. To keep up with the physical demands of their activity or sport, athletes need to fuel their bodies adequately on a daily basis. This fueling process requires a specialized approach; therefore, athletes who want to make dietary changes should seek out professionals who are experts in sports nutrition and experienced in developing individualized plans.

gaining the performance edge

The field of sports nutrition is growing, increasing the demand for qualified sports nutrition professionals. To be considered an "expert" in sports nutrition, a professional must obtain the appropriate education and certification background as well as hands-on experience working with athletes.

Because of its relative infancy, sports nutrition research is providing new and exciting information on a regular basis. It is critical that sports nutrition professionals stay current so they can be evidence-based practitioners. Gone are the days of suggesting dietary practices based on anecdotal observations or experiences. Becoming an evidence-based practitioner requires use of nutrition guidelines and dietary practices that have been documented as being effective through peer-reviewed research. Professionals who have studied sports nutrition, have experience in the field, and continue to stay abreast of the latest nutrition research can prescribe individualized dietary plans that meet basic nutritional needs, enhance performance, and speed recovery in athletes of all sports. Becoming an evidence-based sports nutrition practitioner can lead to an exciting and fulfilling career.

evidence-based practitioner An individual whose professional practice is based upon information, guidelines, or interventions that have been shown through research to be safe and effective.

What are the basic nutrients?

Foods and beverages are composed of six nutrients that are vital to the human body for producing energy, contributing to the growth and development of tissues, regulating body processes, and preventing deficiency and degenerative diseases. The six nutrients are carbohydrates, proteins, fats, vitamins, minerals, and water and are classified as **essential** nutrients. The body requires these nutrients to function properly; however, the body is unable to endogenously manufacture them in the quantities needed daily, and therefore these nutrients must be obtained from the diet. Carbohydrates, proteins, and fats are classified as **macronutrients** because they have a caloric value and the body needs a large quantity of them on a daily basis. The **micronutrients** include vitamins and minerals; the prefix *micro* is used because the body's daily requirements for these nutrients are small. Water fits into its own class, and requirements for it vary greatly among individuals. These nutrients will be discussed briefly in this section.

essential A nutrition descriptor referring to nutrients that must be obtained from the diet.

macronutrients These include carbohydrates, proteins, and fats and are classified as such because they have caloric value and the body has a large daily need for them.

micronutrients Vitamins and minerals are classified as micronutrients because the body's daily requirements for these nutrients are small.

What are carbohydrates?

Carbohydrates are compounds constructed of carbon, hydrogen, and oxygen molecules. Carbohydrates are converted into glucose in the body, providing the main source of fuel (4 calories per gram of carbohydrate) for all physical activity. Carbohydrates are found in a wide variety of foods, including grains, fruits, and vegetables, as well as in the milk/alternative (soy, rice, nut, and other nondairy products) group.

What are proteins?

Amino acids are the building blocks of proteins, which are constructed of carbon, hydrogen, oxygen, and nitrogen molecules. Amino acids can be made within the body (**nonessential**) or obtained from dietary sources. Proteins are involved in the development, growth, and repair of muscle and other bodily tissues and are therefore critical for recovery from intense physical training. Proteins ensure that the body stays healthy and continues working efficiently by aiding in many bodily processes. Protein can also be used for energy, providing 4 calories per gram; however, it is not used efficiently and therefore is not a source of energy preferred by the body. Proteins are found in a variety of foods, including grains and vegetables, but are mainly concentrated in the milk/alternative as well as meat and beans/alternative (soy products, nuts, seeds, beans, and other nonanimal products) groups.

nonessential A nutrient descriptor referring to nutrients that can be made within the body.

What are fats?

Fats, like the other macronutrients, are compounds made up of carbon, hydrogen, and oxygen molecules. Fats are also known as lipids, and they come from both plant and animal sources in our diet. Triglycerides are the most common type of fat. Other fats include cholesterol and phospholipids. With 9 calories per gram, fats are a concentrated source of energy. Fat is primarily used as a fuel at rest and during low- to moderate-intensity exercise. Fats are also involved in providing structure to cell membranes, aiding in the production of hormones, forming the insulation that wraps nerve cells, and facilitating the absorption of fat-soluble vitamins. Fats are concentrated in butter, margarines, salad dressings, and oils, but they are also found in meats, dairy products, nuts, seeds, olives, avocados, and some grain products.

What are vitamins?

Vitamins are a large class of nutrients that contain carbon and hydrogen, as well as possibly oxygen, nitrogen, and other elements. There are two main requirements for a substance to be classified as a vitamin. First, the substance must be consumed exogenously because the body cannot produce it or cannot produce it in sufficient quantities to meet its needs. Second, the substance must be essential to at least one vital chemical reaction or process in the human body. Vitamins do not directly provide energy to the body; however, some vitamins aid in the extraction of energy from macronutrients. Vitamins are involved in a wide variety of bodily functions and processes that help to keep the body healthy and disease free. Vitamins are classified as either water soluble (B vitamins and vitamin C) or fat soluble (vitamins A, D, E, and K), depending on their method of absorption, transport, and storage in the body. Vitamins are found in nearly all foods, including fruits, vegetables, grains, meat and beans/alternative, milk/alternative, and some fats.

What are minerals?

Minerals are also a large group of nutrients. They are composed of a variety of elements; however, they lack carbon. Minerals have a role in the structural development of tissues as well as the regulation of bodily processes. Physical activity places demands on muscles and bones, increases the need for oxygen-carrying compounds in the blood, and increases the loss of sweat and electrolytes from the body, all of which hinge on the adequate intake and replacement of dietary minerals. Minerals are categorized into major minerals (calcium, sodium, potassium, chloride, phosphorus, magnesium, and sulfur) and trace minerals (iron, zinc, copper, selenium, iodine, fluoride, molybdenum, and manganese) based on the total quantity required by the body on a daily basis. Similar to vitamins, minerals are found in a wide variety of foods, but mainly are concentrated in the meat and beans/alternative and milk/alternative groups.

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Each of the six nutrients has a role in the health and proper functioning of the human body. Physical activity places extra demands on the body, increasing the importance of the nutrients' presence in the diet. Many of the nutrients are so critical to optimal athletic performance that the total daily requirements are increased to meet the demands placed on the body. The six basic nutrients each have distinct, but also intertwining, roles, making it critical to consume adequate amounts of each nutrient on a daily basis.

What is water?

Forming a category of its own, water deserves to be highlighted because of its vital roles within the body. The human body can survive for a much greater length of time without any of the macro- or micronutrients than without water. The body is 55–60% water, representing a nearly ubiquitous presence in bodily tissues and fluids. In athletics, water is important for temperature regulation, lubrication of joints, and the transport of nutrients to active tissues. In addition to plain water, water can be obtained from juices, milk, coffee, tea, and other beverages, as well as watery foods such as fruits, vegetables, and soups.

How does the body produce energy?

The body derives its energy from foods ingested daily. Carbohydrates, fats, and proteins are known as the **energy nutrients** because they serve as the body's source for energy. These energy nutrients are quite literally chemicals that have energy trapped within the bonds between the atoms of which they are made. The energy trapped within these nutrients is released when metabolic pathways within the cells break down the foods into their constituent parts, carbon dioxide and water. Some of the energy released is conserved or captured and used to make another high-energy chemical called **adenosine triphosphate (ATP)**. The rest of the energy is lost as heat. ATP is the body's direct source of energy for cellular work. Without a constant source of ATP, muscles would not be able to generate force, and thus athletes would not be able to move or perform any physical activity.

energy nutrients Carbohydrates, proteins, and fats serve as the body's source of energy and are considered the energy nutrients.

adenosine triphosphate (ATP) The molecule that serves as the body's direct source of energy for cellular work.

What are the Dietary Reference Intakes?

Several different terms are used to describe the recommendations for macronutrients and micronutrients. The **Recommended Dietary Allowances (RDAs)** were developed in 1941 by the U.S. National Academy of Sciences. The RDAs were the primary values health professionals used to assess and plan diets for individuals and groups and to make judgments about excessive intakes. The RDAs still exist for many nutrients; however, a newer way to quantify nutrient needs and excesses for healthy individuals has been developed and termed the **Dietary Reference Intakes (DRIs)**. The DRIs expand on the RDAs and take into consideration other dietary quantities such as **Estimated Average Requirement (EAR)**, **Adequate Intake (AI)**, and **Tolerable Upper Intake Level (UL)**. DRIs are continually being reviewed, and reports on various groups

Recommended Dietary Allowance (RDA) The average daily dietary intake level that is sufficient to meet the nutrient requirements of the overwhelming majority (i.e., 98%) of a healthy population.

Dietary Reference Intakes (DRIs) A newer way to quantify nutrient needs and excesses for healthy individuals. The DRI expands on the older Recommended Dietary Allowance (RDA) and takes into consideration other dietary quantities such as Estimated Average Requirement (EAR), Adequate Intake (AI), and Tolerable Upper Intake Level (UL).

Estimated Average Requirement (EAR) The estimated daily intake level of a vitamin or mineral needed to meet the requirements, as defined by a specified indicator of adequacy, of half of the healthy individuals within a given life stage or gender group.

Adequate Intake (AI) A reference intake for nutrients that is used instead of the Recommended Dietary Allowance. When insufficient scientific evidence is available to calculate an Estimated Average Requirement (EAR), then an AI is used. Similar to the EAR and the Recommended Dietary Allowance (RDA), the AI values are based on intake data of healthy individuals.

Tolerable Upper Intake Level (UL) The highest level of daily nutrient intake that poses no adverse health effects for almost all individuals in the general population.

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The DRIs encompass the EAR, RDA, AI, and UL for each macronutrient, vitamin, and mineral based on recent research and epidemiological data of healthy populations. As more information and data are discovered, these recommendations will be updated and revised.

of nutrients are published as scientific data are gathered. This comprehensive effort to develop all components of the DRIs is under the auspices of the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes of the Food and Nutrition Board, the Institute of Medicine, and the National Academy of Sciences of the United States, along with Health Canada.[1] The definitions of the various DRIs are reviewed in **Table 1.1**.

What are enriched and fortified foods?

When grains are milled, the germ and bran are removed. Because the germ and bran contain a majority of the vitamins and minerals in whole grains, the resulting refined product is less nutritious. Refined grain products include white flours, bread, pasta, rice, crackers, and cereals. To prevent deficiency diseases, the Food and Drug Administration (FDA) mandated in 1943 that the nutrients lost during the milling process of wheat, rice, and corn be replaced. The nutrients identified and thus added to refined grain products include thiamin, riboflavin, niacin, and iron. The addition of vitamins and minerals to refined products is termed **enrichment**.

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Enrichment and fortification of foods and beverages are intended to help individuals meet their daily nutrient needs.

enrichment The addition of vitamins and minerals to refined/processed products to increase their nutritional value.

fortification The process of adding vitamins or minerals to foods or beverages that did not originally contain them.

Fortification is the addition of a vitamin or mineral to a food or beverage in which it was not originally present. The first successful fortification program was the addition of iodine to salt in the 1920s to prevent goiter and other iodine deficiency conditions. In general, fortification is not required by the FDA, with the exception of folic acid in grains and vitamin D in milk. Other fortification programs are designed to enhance the quality of a product, such as the addition of vitamin A to milk and other dairy foods, as well as lysine to specific corn products to enhance protein quality. The food industry has the freedom to add any vitamin or mineral to a product. However, the FDA does require companies to show that a dietary insufficiency exists and therefore requires fortification in otherwise standardized products. Some products contain vitamins or minerals not naturally found in the food or beverage, such as added vitamin D and vitamin B_{12} in soy milk. Other products boost existing vitamin or mineral content, such as extra vitamin C added to orange juice. Sport supplements, such as bars and shakes, are highly fortified with a variety of vitamins and minerals. Athletes should check labels to ensure that their total daily consumption of any vitamin or mineral is not in excess of upper

TABLE 1.1 Review of the Nutrient Intake Descriptors

Descriptor	Definition
Dietary Reference Intake (DRI)	Umbrella term for all nutrient classifications, including RDA, EAR, AI, and UL.
Recommended Dietary Allowance (RDA)	Average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly an entire (i.e., 98%) healthy population. The established RDAs can vary based on life stage, including age; gender; and, if appropriate, pregnancy and lactation.
Estimated Average Requirement (EAR)	Daily intake level of a vitamin or mineral estimated to meet the requirements, as defined by a specified indicator of adequacy in half of the healthy individuals within a life stage or gender group.
Adequate Intake (AI)	Intake recommendation when insufficient scientific evidence is available to calculate an EAR/RDA. AI values are based on intake data of healthy individuals. However, the results of studies regarding the nutrient in question are not conclusive enough or more study is required before an EAR/RDA can be established.
Tolerable Upper Intake Level (UL)	The highest level of daily nutrient intake that poses no adverse health effects for almost all individuals in the general population. At intakes above the UL, the risk of adverse effects increases.

dietary limits. For more information about enrichment and fortification, visit the FDA's website at www.fda.gov.

What are the basic nutrition guidelines?

The keys to healthful eating are to consume a diet that provides adequate nutrients to maintain health, includes a variety of foods, is balanced, and is consumed in moderation. Government agencies have developed several tools that provide general healthful eating guidelines that include balance, variety, and moderation to help the American population maintain or improve health. The Dietary Guidelines for Americans and the MyPlate[2] food guidance system are two such tools that convert scientific evidence into practical applications that Americans can use to eat more healthfully. These general guidelines are applicable to sedentary and athletic individuals alike.

What are the Dietary Guidelines for Americans?

The Dietary Guidelines for Americans, developed jointly by the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA), are revised and published every 5 years. The first Dietary Guidelines were published in 1980. The most recent version of the Dietary Guidelines for Americans was published in 2010.[3] The guidelines provide science-based advice for people 2 years and older on dietary and physical activity habits that can promote health and reduce the risk for chronic illnesses and conditions such as cardiovascular disease, diabetes, and hypertension. A healthful diet that is not excessive in calories, follows the nutrition recommendations contained in the guidelines, and is combined with physical activity should enhance the health of most individuals.

The primary purpose of the Dietary Guidelines is to provide the public with information about nutrients and food components that are known to be beneficial for health and to provide recommendations that can be implemented into an eating and exercise plan. The 2010 Dietary Guidelines cover four interrelated focus areas. When the guidelines are implemented as a whole, they encourage Americans to: (1) maintain calorie balance over time to achieve and sustain a healthy weight and (2) focus on consuming nutrient-dense foods and beverages.

The four interrelated themes and the key recommendations from the 2010 Dietary Guidelines report are as follows (www.dietaryguidelines.gov):[3]

1. *Balance Calories to Manage Weight*
   - Prevent and/or reduce overweight and obesity through improved eating and physical activity behaviors.
   - Control total calorie intake to manage body weight. For people who are overweight or obese, this means consuming fewer calories from foods and beverages.
   - Increase physical activity (see Figure 1.1) and reduce time spent in sedentary behaviors.
   - Maintain appropriate calorie balance during each stage of life—childhood, adolescence, adulthood, pregnancy and breastfeeding, and older age.
2. *Reduce the Following Foods and Food Components*
   - Reduce daily sodium intake to less than 2300 milligrams (mg) and further reduce intake to 1500 mg among persons who are 51 and older and those of any age who are African

Figure 1.1 Exercising regularly, combined with a diet that does not exceed calorie needs, helps manage weight.

American or have hypertension, diabetes, or chronic kidney disease. The 1500 mg recommendation applies to about half of the U.S. population, including children, and the majority of adults.

- Consume less than 10% of calories from saturated fatty acids by replacing them with monounsaturated and polyunsaturated fatty acids.
- Consume less than 300 mg per day of dietary cholesterol.
- Keep trans fatty acid consumption as low as possible by limiting foods that contain synthetic sources of trans fats, such as partially hydrogenated oils, and by limiting other solid fats.
- Reduce the intake of calories from solid fats and added sugars.
- Limit the consumption of foods that contain refined grains, especially refined grain foods that contain solid fats, added sugars, and sodium.
- If alcohol is consumed, it should be consumed in moderation—up to one drink per day for women and two drinks per day for men—and only by adults of legal drinking age.

3. *Increase Intake of the Following Foods and Nutrients*

Individuals should meet the following recommendations as part of a healthy eating pattern while staying within their calorie needs.

- Increase vegetable and fruit intake.
- Eat a variety of vegetables, especially dark green, red, and orange vegetables and beans and peas.
- Consume at least half of all grains as whole grains. Increase whole grain intake by replacing refined grains with whole grains.
- Increase intake of fat-free or low-fat milk and milk products, such as milk, yogurt, cheese, or fortified soy beverages.
- Choose a variety of protein foods, which include seafood, lean meat and poultry, eggs, beans and peas, soy products, and unsalted nuts and seeds.
- Increase the amount and variety of seafood consumed by choosing seafood in place of some meat and poultry.
- Replace protein foods that are higher in solid fats with choices that are lower in solid fats and calories and/or are sources of oils.
- Use oils to replace solid fats where possible.
- Choose foods that provide more potassium, dietary fiber, calcium, and vitamin D, which are nutrients of concern in American diets. These foods include vegetables, fruits, whole grains, and milk and milk products.

Recommendations for specific population groups:

- *Women capable of becoming pregnant*
  a. Choose foods that supply heme iron (which is more readily absorbed by the body), additional iron sources, and enhancers of iron absorption such as vitamin C–rich foods.
  b. Consume 400 micrograms (mcg) per day of synthetic folic acid (from fortified foods and/or supplements) in addition to food forms of folate from a varied diet.
- *Women who are pregnant or breastfeeding*
  a. Consume 8 to 12 ounces of seafood per week from a variety of seafood types.
  b. Due to its high methyl mercury content, limit white (albacore) tuna to 6 ounces per week and do not eat the following four types of fish: tilefish, shark, swordfish, and king mackerel.
  c. If pregnant, take an iron supplement, as recommended by an obstetrician or other healthcare provider.
- *Individuals aged 50 years and older*
  a. Consume foods fortified with vitamin B12, such as fortified cereals, or dietary supplements.

4. *Build Healthy Eating Patterns*

- Select an eating pattern that meets nutrient needs over time at an appropriate calorie level.
- Account for all foods and beverages consumed and assess how they fit within a total healthy eating pattern.
- Follow food safety recommendations when preparing and eating foods to reduce the risk of foodborne illnesses.

Although the Dietary Guidelines listed here were developed with the American population's health in mind, athletes can benefit from implementing the guidelines in their daily nutrition planning. By selecting a variety of nutrient-dense foods, as dictated in the guidelines, athletes can meet their energy, macronutrient, and micronutrient needs for a high level of sport performance. The MyPlate food guidance system can be used to further plan an athlete's daily food intake by