Nutrition

Science and Applications

4th Edition

LORI SMOLIN
University of Connecticut

MARY GROSVENOR

WILEY

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LORI A. SMOLIN received a bachelor of science degree from Cornell University, where she studied human nutrition and food science. She received a doctorate from the University of Wisconsin at Madison, where her doctoral research focused on B vitamins, homocysteine accumulation, and genetic defects in homocysteine metabolism. She completed postdoctoral training both at the Harbor–UCLA Medical Center, where she studied human obesity, and at the University of California–San Diego, where she studied genetic defects in amino acid metabolism. She has published articles in these areas in peer-reviewed journals. Dr. Smolin is currently at the University of Connecticut, where she has taught both in the Department of Nutritional Science and in the Department of Molecular and Cell Biology. Courses she has taught include introductory nutrition, life cycle nutrition, food preparation, nutritional biochemistry, general biochemistry, and introductory biology. In her spare time Dr. Smolin enjoys bicycling and watercolor painting.

MARY B. GROSVENOR holds a bachelor of arts in English from Georgetown University and a master of science in Nutrition Science from the University of California at Davis. This combination provides her an ideal background for nutrition writing. She is a registered dietitian and has worked in clinical as well as research nutrition, in hospitals and communities, large and small, in the western United States. She teaches at the community college level and has published articles in peer-reviewed journals in nutritional assessment and nutrition and cancer. Her training and experience provide practical insights into the application and presentation of the science in this text.

Dedication

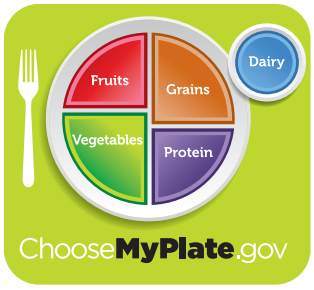
To my sons, Zachary and Max, and my husband David, for their love, support, and humorous outlook on life. To my mother, Shirlee Smolin, who is a testament to the health benefits of eating well and staying physically and mentally active.

LAS

To Peter, David, and John for their advice, patience, and editorial services, but most of all for continuing to remind me what is important in life.

MBG

Preface



Courtesy USDA

2011

Nutrition: Science and Applications, Fourth Edition, is intended as an introductory text for a science-driven and application-oriented nutrition course. The material is appropriate for a college student at any level, freshman to senior, taking this course to fulfill a science requirement. The clear, concise writing style—reinforced visually with colorful, engaging illustrations and photographs—makes the science accessible. The strong metabolism coverage, clinical flavor, and critical-thinking approach to understanding science and nutrition research make this a text that will also prepare nutrition majors and other science majors for their future studies and careers. These students will discover that this text ties together information that they have studied in chemistry, physiology, biology, and biochemistry courses.

This up-to-date text includes the most recent recommendations from the DRIs, Dietary Guidelines, and MyPlate, as well as coverage of the new Nutrition Facts food label that now appears on many food packages. The text is extensively referenced from current literature. Recent concerns in nutrition science, such as nutritional genomics, the role our food environment plays in the dual epidemics of obesity and diabetes, controlling world hunger, the risks and benefits of genetically modified foods, and the nutritional impact of dietary supplements, are discussed. The examples used throughout the text reflect the diverse ethnic and cultural mix of the American population.

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Critical Thinking Enhances Problem-Solving Skills

Nutrition: Science and Applications takes a critical-thinking approach to understanding and applying human nutrition. Like other introductory texts, it offers students the basics of nutrition by exploring the nutrients, their functions in the body, and sources in the diet. But its unique critical-thinking approach gives students an understanding of the "whys" and "hows" behind nutrition processes and explores the issues that surround nutrition controversies. Within each chapter, separate Critical Thinking exercises introduce nutrition-related problems. They then walk students through the process of first finding the facts, and then applying the logic needed to find solutions to the problems and to make healthy food and nutrition decisions. Application exercises, which accompany each chapter, ask students to use this same process of logical scientific inquiry, along with the information in the chapter, to analyze, modify and/or plan diets that promote health and reduce the risk of nutrient deficiencies and nutrition-related chronic diseases. "Think Critically" and "Analyze the Data" questions accompany many of the illustrations and photographs in the text and appear at the end of special features such as Debate, Off the Label, and Science Applied. These are designed to promote critical thought and focus student attention on the information in visuals or discussed in the features. This critical-thinking approach gives students the tools they need to bring nutrition out of the classroom and apply the logic of science to their own nutrition concerns—both as consumers and as future scientists and health professionals.

Charles D. Winters/Photo Researchers, Inc.

Integrated Metabolism Reinforces Understanding

Nutrition: Science and Applications is distinctive in its integrated approach to the presentation of nutrient metabolism. Metabolism is one of the most challenging topics for students, but a knowledge of metabolism is critical for understanding how nutrients function and impact human health. The text includes a comprehensive discussion of metabolism as it applies to each of the energy-yielding nutrients, shows how the micronutrients are involved, and then ties it all together in discussions of energy balance and the energy sources needed to fuel physical activity. These discussions of metabolism are integrated throughout appropriate chapters. This approach makes metabolism more manageable and memorable for students because it presents material in smaller segments and highlights its relevance to the nutrient being discussed. It also reinforces understanding of metabolic processes by revisiting key concepts with each

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nutrient and adding relevant new information. *Nutrition: Science and Applications* introduces a simple overview of metabolism in Chapter 3 and then builds on this base with more complex discussions in Chapters 4 through 10. For example, the discussion of carbohydrate metabolism in Chapter 4 presents the basics of glucose metabolism. This information is reviewed and augmented in chapters on lipids, proteins, micronutrients, energy balance, and physical activity. To tie the concepts together, the illustrations use the same basic diagram with new information superimposed over familiar portions to demonstrate how each nutrient fits into the process. The nutrients and steps of metabolism are also color coded for easier recognition. Students or instructors who want to cover metabolism as a separate topic will find a slightly more in-depth summary online in Focus on Metabolism.

Integration of Health and Disease Relationships Holds Interest

Can I help my mom manage her blood cholesterol?

Why have I gained 10 pounds?

What should I eat to reduce my risk of cancer?

How can I change my diet to better support my athletic training?

© Mike Goldwater/Alamy Limited

These are some of the questions students want answered when they enroll in nutrition classes. To answer these and other health-related questions and to fuel student interest continuously, discussions of the relationships among nutrition, health, and disease are integrated throughout the text. The integration helps students recognize that a nutrient's function in the body is related to its role in health and disease. For example, just as discussing goiters in the section on iodine is logical and piques interest, so is discussing diabetes with carbohydrates, osteoporosis with calcium, and hypertension with sodium. Covering nutrition-related chronic conditions with the topic or nutrient most related to the issue continuously reinforces the applicability of nutrition science to the students' lives, and also helps them appreciate how and why their diet affects their health.

Healthy Eating Patterns, Not Individual Foods, Are the Focus

Nutrition: Science and Applications presents the message that each food choice makes up only a small part of your total diet and

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that it is the overall eating pattern that determines the healthfulness of your diet. Each of the macronutrient chapters begins with a section that discusses the role of that nutrient in the diet—factors that affect our intake and how different food sources of each nutrient may make very different contributions to the diet. For example, a less-processed choice, such as whole-wheat bread, provides a more nutrient-dense source of carbohydrate than a slice of chocolate cake. However, this does not mean you can never have chocolate cake. The text emphasizes that there are no "bad" foods as long as the sum of food choices over a period of days or weeks makes up a healthy overall dietary pattern. To reinforce this, these chapters end with a discussion of how to meet your need for that specific nutrient while taking into consideration other dietary recommendations that promote health.

New to This Edition

Most Current Information

As the science of nutrition continues to evolve *Nutrition Science and Applications* evolves with it, to include the most up-to-date information, terminology, and ways of thinking about nutrition. The entire text has been updated and re-referenced to reflect the most current nutrition science and guidelines. More information on the emerging science of nutritional genomics, nutritional programming, the recognition of non-celiac gluten sensitivities, and the role of the intestinal microbiota in human health has been included. Current recommendations in nutrition, such as choosing a plant-based diet and reducing added sugars, have been integrated into discussions of diet and health. Also addressed are advances in biotechnology and the impact of our food environment on the incidence of noncommunicable nutrition-related diseases. The most recent information is included on the prevalence of obesity and undernutrition as well as programs such as Healthy People and the United Nations Sustainable Development Goals that target improving health and nutrition.

2015–2020 Dietary Guidelines

The recommendations of the *2015–2020 Dietary Guidelines for Americans* are described in Chapter 2 and addressed in all applicable subsequent chapters.

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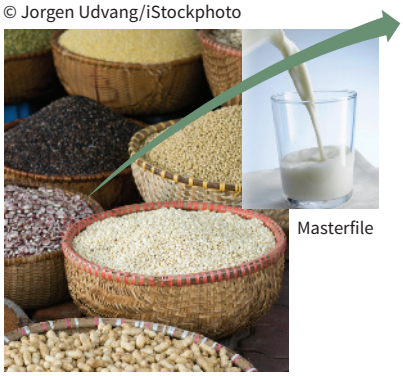

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The DASH Eating Plan

Food group	Servings
Grains	6–8/day
Vegetables	4–5/day
Fruits	4–5/day
Fat-free or low-fat milk and milk products	2–3/day
Lean meats, poultry, and fish	6 or less/day
Nuts, seeds, and legumes	4–5/week
Fat and oils	2–3/day
Sweets and added sugars	5 or less/week

USDA Food Patterns

Food group	Amount/day
Vegetables	2.5 cups
Fruit and juices	2.0 cups
Grains	6.0 ounces
Dairy products	3.0 cups
Protein foods	5.5 ounces
Oils	27 grams
Solid fats	16 grams
Added sugars	32 grams

Mediterranean Eating Pattern

Foods	How often
Fruits, vegetables, grains (mostly whole), olive oil, nuts, legumes and seeds, herbs and spices	Every meal
Fish and seafood	At least twice a week
Cheese and yogurt	Moderate portions daily or weekly
Poultry and eggs	Moderate portions every 2 days or weekly
Meats and sweets	Less often

USDA Vegetarian Adaptations

Food group and recommendation	Food choice examples	
	Lacto-Ovo	Vegan
Dairy products or dairy substitutes (3 cups/day)	Milk, calcium-fortified soymilk, yogurt, hard cheeses	Calcium-fortified soymilk, other fortified plant-based milks or yogurts
Protein foods (3.5 oz day)*		
Eggs	Eggs	
Beans and peas	Black, kidney, and pinto beans, chickpeas, hummus, peanut butter	Black, kidney, and pinto beans, chickpeas, hummus, peanut butter
Soy products	Tofu, tempeh, roasted soybeans	Tofu, tempeh, roasted soybeans
Nuts and seeds	Walnuts, almonds, pistachios, sunflower and pumpkin seeds	Walnuts, almonds, pistachios, sunflower and pumpkin seeds

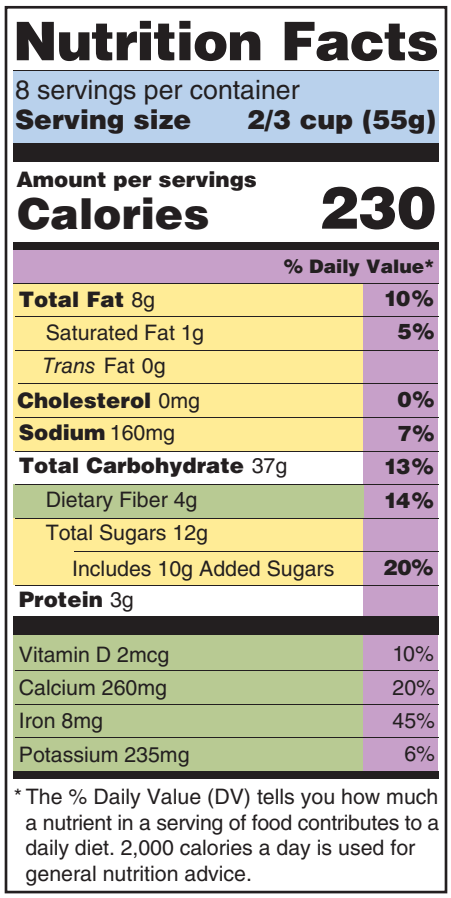
*The amount recommended here is less than for non-vegetarian diets because some of the protein in a vegetarian diet comes from beans and peas included in the vegetables group.

Food Labeling

The FDA has revised the format of the Nutrition Facts panel and updated the serving sizes and Daily Values used on these labels. The new format is presented in Chapter 2 along with the original Nutrition Facts panel, which will still be seen on some foods as manufacturers transition to the revised format. The new label is also addressed in all applicable subsequent chapters. Comparing the original to the new Nutrition Facts panel allows for student discussion and critical thinking regarding the purpose of food labels and the effectiveness of the original versus revised food labels in providing consumer guidance, and how best to present nutrition information about individual foods to consumers.

In addition to coverage of the new Nutrition Facts panel found on packaged foods, information on the calorie labeling of foods sold at restaurants and in vending machines is included as well as a discussion about new labeling standards for bioengineered foods.

New Format



Nutrition Facts

8 servings per container
Serving size **2/3 cup (55g)**

Amount per servings
Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 235mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

New Health Management Guidelines

Recently published guidelines for the management of cardiovascular disease, blood pressure, and overweight and obesity have been integrated into Chapters 5, 10, and 7, respectively. New diagnostic criteria for eating disorders are included in Focus on Eating Disorders and new diagnostic criteria for alcohol use disorder, commonly known as alcoholism, are included in Focus on Alcohol. Chapter 13 presents the most recent guidelines on nutrition and athletic performance, and includes the findings of the 2018 Physical Activity Guidelines Advisory Committee report. The World Health Organization's infant growth charts, which are now recommended for infants in the United States, are included in Chapter 14. The recommendations of the Healthy Hunger-Free Kids Act regarding school lunch standards are discussed in Chapter 15, and new recommendations on protein intake in older adults to minimize lean tissue loss are included in Chapter 16. Updated guidelines for fish consumption for children and pregnant women are discussed in Chapters 14 and 17.

Choice (Exchange) Lists

The Choice Lists, which update and replace the Exchange Lists, are discussed in Chapter 2, and revisited in Chapters 4, 5, and 6, which address the energy-yielding nutrients, and with energy balance in Chapter 7. The complete Food (Exchange) Lists are provided in the online appendices.

New and Updated Features

Many of the Debate, Off the Label, and Science Applied features in the Fourth Edition, have been amended and updated and new topics have been introduced. The chapter Case Study introductions and Outcome stories have been gently edited to make them more student friendly.

A few new Debate topics have been introduced and all have been revised to include the most up-to-date science. The Chapter 1 Debate, "Is There a 'Best' Diet for You?," which focuses on the new science of nutritional genomics, has been rewritten and new art added to enhance student understanding of this topic. The Chapter 3 Debate, "Should You Be Gluten Free?," has been updated to include a discussion of non-celiac gluten sensitivity. The Chapter 4 Debate, "Is Sugar Making Us Sick?," is new and focuses on the health impact of added sugars. A new Debate on coconut oil, "Coconut Oil: Does a Tablespoon a Day Keep the Doctor Away?," has been included in Chapter 5 to highlight the conflicting information about this type of lipid. The Chapter 12 Debate, "Antioxidant Supplements: Helpful or Harmful?," has been rewritten and new art added to explain the concept of oxidative stress. The Chapter 6 Debate, "The Highs and Lows of High-Protein Diets," has been revised to provide the most current information on the risks and benefits of high-protein diets.

A few of the Off the Label features are new, and most have been updated to include discussions and illustrations of the new Nutrition Facts panel. In Chapter 1, a new Off the Label, "Beware of Misleading Claims," focuses on how manufacturers use label claims to promote product sales. In Chapter 7, the Off the Label has been revised to highlight the changes made in serving sizes and how the number of calories is presented on the label and in Chapter 11, a new Off the Label, "How Much Calcium Is in Your Yogurt?," shows changes in the presentation of micronutrients on the revised label.

Where appropriate, the Science Applied features have been revised to include continued advances in science. For example, in Chapter 16, "Eat Less–Live Longer," has been updated to include the most recent research on calorie restriction. In Chapter 11, "Bones: Lost in Space," includes information on advances in nutrition and exercise regimens for astronauts aboard the International Space Station.

Improved Critical Thinking Exercises

Critical Thinking topics have been refined and the design modified to make it easier for students to follow stepwise the process of critically analyzing a problem. Critical thinking is a process that challenges an individual to use reflective, reasonable, rational thinking to gather, interpret, and evaluate information in order to derive a judgment. These exercises start by giving students background information and identifying a nutritional problem. Students then gather the data, such as blood cholesterol values, body weight, or diet records, needed to answer a series of critical-thinking questions and come to a conclusion about the problem presented in the exercise.

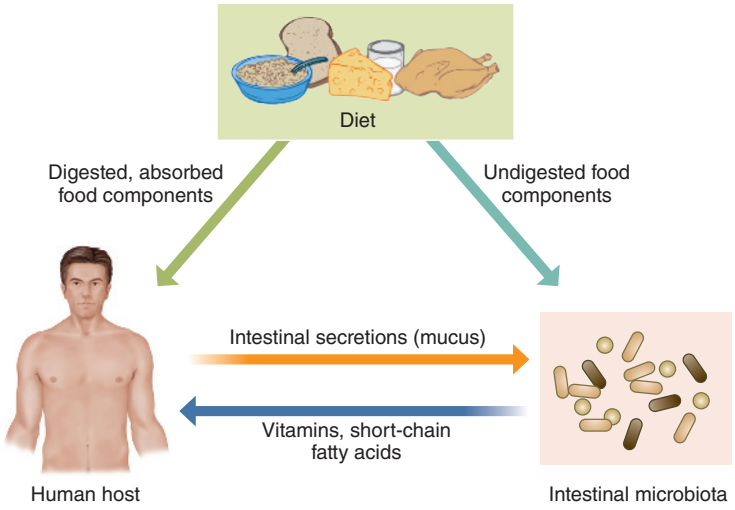
In addition to refining the critical thinking in these exercises, many of the Think Critically questions linked to art and special features have been refined and Analyze the Data questions have been added to enhance students' ability to analyze the information presented in graphs and charts.

New and Improved Art

In *Nutrition: Science and Applications*, Fourth Edition, the new art program introduced in the previous edition continues to be improved and refined to enhance clarity, understanding, and visual appeal. New illustrations and photographs have been added to enhance student understanding and make important visual points. For example, Chapter 1 includes two new graphs: one showing how the amount of time we spend cooking has changed since 1965 and another showing how eating breakfast away from home impacts overall diet quality. Additional new art in Chapter 1 helps illustrate the science of nutritional genomics. In Chapter 2, the figure on healthy dietary patterns has been updated to include vegetarian dietary patterns and the new Nutrition Facts label has been added and compared to the original label. In Chapter 3, new art helps students understand the role of the intestinal microbiota in overall health. Chapter 6 introduces an illustrated table to distinguish different types of vegetarian diets and a new illustration to show how to use MyPlate to plan vegetarian and vegan diets. Chapter 7 includes the most recent obesity map, a new figure to illustrate the role of nonexercise activity thermogenesis (NEAT) in regulating body weight, and a new decision tree illustration for determining who should lose weight based on the most recent guidelines for the treatment of overweight and obesity. Chapter 10 includes new art that illustrates the latest guidelines for assessing blood pressure and treating hypertension. New art in Chapter 13 highlights the relationship between the female athlete triad and relative energy deficiency in sport (RED-S) and new art in Chapter 18 illustrates the impact of infectious disease on child deaths and the impact of noncommunicable diseases on a population's productivity.

Eye on Science

This new online feature helps students look beyond the advertisements and news headlines they encounter every day by examining what science and experimentation actually tell us. Subjects covered in these features range from hot topics such as artificial sweeteners and weight gain, bacon consumption and cancer, and coconut water for hydration to more familiar themes like the benefits of locally grown food or drinking almond milk. Each feature includes questions that encourage students to think critically about the topic presented.



To the Student

Nutrition is a subject that all of you have a personal interest in, whether you are concerned about your own nutritional health, a parent with diabetes, or a friend with an eating disorder. You may enroll in a nutrition course to learn what to eat and how to choose healthy foods and then be surprised when the course talks about protein synthesis, lipid transport, and anaerobic metabolism. A good course and textbook should do both.

As authors, our goal is to provide you with tools that can be used throughout your life. We could tell you what to eat for breakfast, but if you didn't understand why these foods were healthy choices you would not be able to make your own healthy choices from a different set of breakfast foods, or use the same principles to choose a healthy dinner. On the other hand, for example, if you understand how your saturated fat intake can affect your risk for heart disease or your sodium intake affects your blood pressure, you will have the tools you need to choose a healthy dietary pattern.

The critical-thinking approach we have used in this text will help you understand the science of nutrition and give you the decision-making skills you need to navigate the scores of choices you face when deciding what to eat and which of the latest nutrition headlines to believe. By becoming a knowledgeable consumer, you will be able to make informed choices about diet and lifestyle, whether you use this information to improve your own health or to pursue a career in nutrition.

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We would like to add a special thank you to Laura Christoph for her many contributions. Laura played a key role in developing and writing the Eye on Science features, which are available for each chapter. These short features help students learn the difference between unsupported nutrition claims and science.

We also extend our thanks to John Ambrose, who worked tirelessly to write, direct, and produce Video Bites, a unique set of short videos that help students relate to key topics covered in the text.

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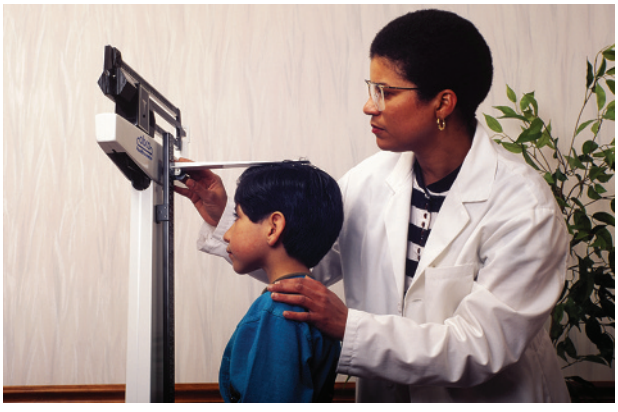

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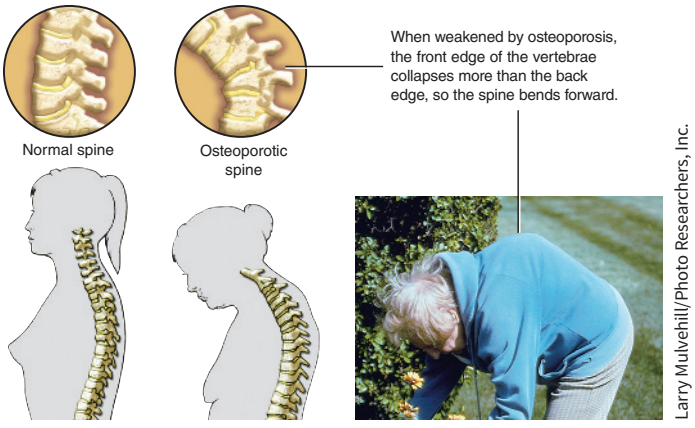

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