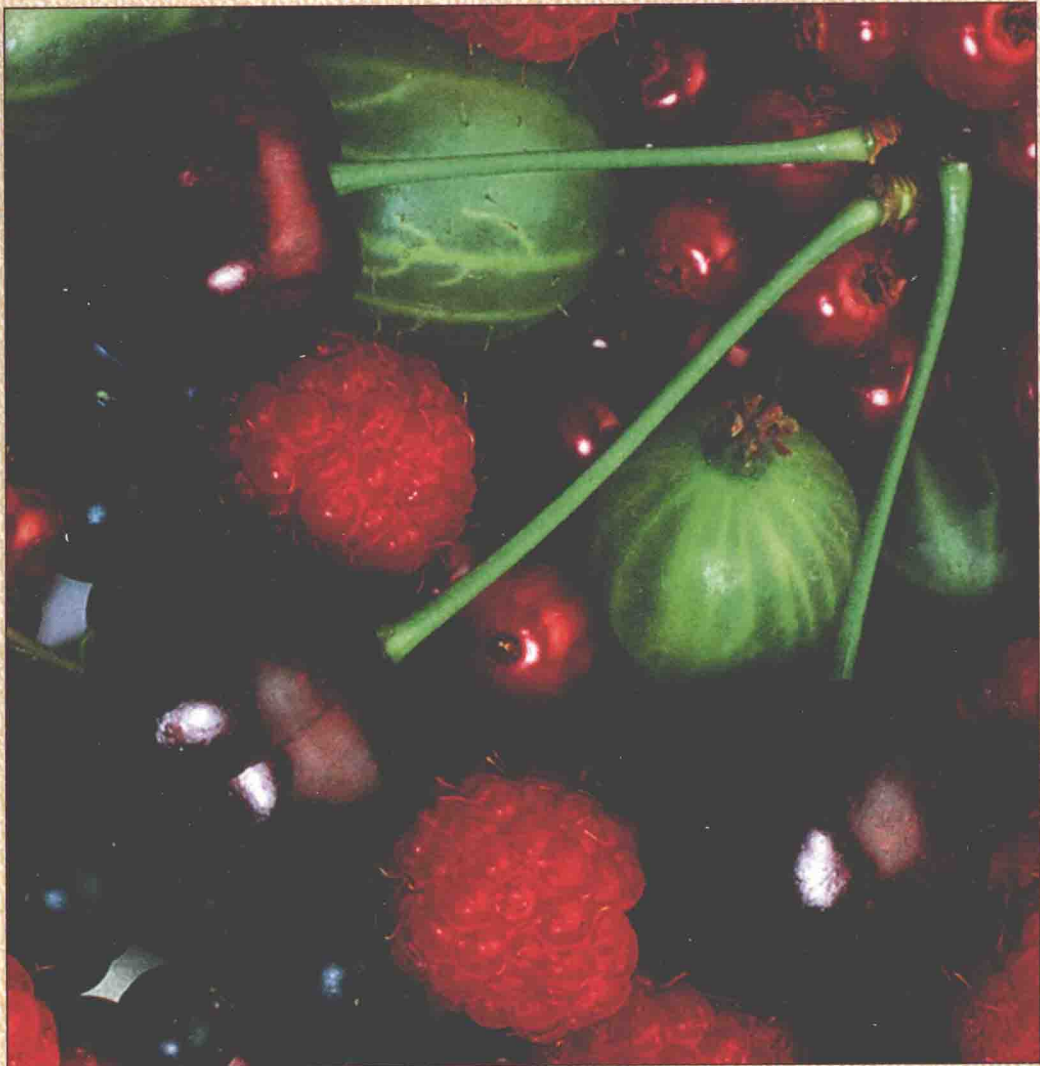


# NUTRITION

SCIENCE & APPLICATIONS



Smolin & Grosvenor

# **NUTRITION**

## **Science and Applications**

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## Recommended Dietary Allowances,<sup>a</sup> Revised 1989

*Designed for the maintenance of good nutrition of practically all healthy people in the United States*

Category	Age (years) or Condition	Weight <sup>b</sup>		Height <sup>b</sup>		Protein (g)	Fat-Soluble Vitamins			
		(kg)	(lb)	(cm)	(in)		Vitamin A (μg RE) <sup>c</sup>	Vitamin D (μg) <sup>d</sup>	Vitamin E (mg α-TE) <sup>e</sup>	Vitamin K (μg)
Infants	0.0–0.5	6	13	60	24	13	375	7.5	3	5
	0.5–1.0	9	20	71	28	14	375	10	4	10
Children	1–3	13	29	90	35	16	400	10	6	15
	4–6	20	44	112	44	24	500	10	7	20
	7–10	28	62	132	52	28	700	10	7	30
Males	11–14	45	99	157	62	45	1,000	10	10	45
	15–18	66	145	176	69	59	1,000	10	10	65
	19–24	72	160	177	70	58	1,000	10	10	70
	25–50	79	174	176	70	63	1,000	5	10	80
	51+	77	170	173	68	63	1,000	5	10	80
Females	11–14	46	101	157	62	46	800	10	8	45
	15–18	55	120	163	64	44	800	10	8	55
	19–24	58	128	164	65	46	800	10	8	60
	25–50	63	138	163	64	50	800	5	8	65
	51+	65	143	160	63	50	800	5	8	65
Pregnant						60	800	10	10	65
Lactating	1st 6 months					65	1,300	10	12	65
	2nd 6 months					62	1,200	10	11	65

<sup>a</sup> The allowances, expressed as average daily intakes over time, are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well defined.

<sup>b</sup> Weights and heights of Reference Adults are actual medians for the U.S. population of the designated age, as reported by NHANES II. The median weights and heights of those under 19 years of age were taken from Hamill et al. (1979). The use of these figures does not imply that the height-to-weight ratios are ideal.

## Median Heights and Weights and Recommended Energy Intake from the RDA

Category	Age (years) or Condition	Weight		Height		REE <sup>a</sup> (kcal/day)	Average Energy Allowance (kcal) <sup>b</sup>		
		(kg)	(lb)	(cm)	(in)		Multiples of REE	Per kg	Per day <sup>c</sup>
Infants	0.0–0.5	6	13	60	24	320		108	650
	0.5–1.0	9	20	71	28	500		98	850
Children	1–3	13	29	90	35	740		102	1,300
	4–6	20	44	112	44	950		90	1,800
	7–10	28	62	132	52	1,130		70	2,000
Males	11–14	45	99	157	62	1,440	1.70	55	2,500
	15–18	66	145	176	69	1,760	1.67	45	3,000
	19–24	72	160	177	70	1,780	1.67	40	2,900
	25–50	79	174	176	70	1,800	1.60	37	2,900
	51+	77	170	173	68	1,530	1.50	30	2,300
Females	11–14	46	101	157	62	1,310	1.67	47	2,200
	15–18	55	120	163	64	1,370	1.60	40	2,200
	19–24	58	128	164	65	1,350	1.60	38	2,200
	25–50	63	138	163	64	1,380	1.55	36	2,200
	51+	65	143	160	63	1,280	1.50	30	1,900
Pregnant	1st trimester								+0
	2nd trimester								+300
	3rd trimester								+300
Lactating	1st 6 months								+500
	2nd 6 months								+500

<sup>a</sup> Calculation based on FAO equations, then rounded.

<sup>b</sup> In the range of light to moderate activity the coefficient of variation is  $\pm 20\%$ .

<sup>c</sup> Figure is rounded.



## Recommended Dietary Allowances,<sup>a</sup> Revised 1989 (continued)

Designed for the maintenance of good nutrition of practically all healthy people in the United States

Category	Water-Soluble Vitamins							Minerals						
	Vita- min C (mg)	Thia- min (mg)	Ribo- flavin (mg)	Niacin (mg NE) <sup>f</sup>	Vita- min B <sub>6</sub> (mg)	Folate (μg)	Vita- min B <sub>12</sub> (μg)	Cal- cium (mg)	Phos- phorus (mg)	Mag- nesium (mg)	Iron (mg)	Zinc (mg)	Iodine (μg)	Sele- nium (μg)
Infants	30	0.3	0.4	5	0.3	25	0.3	400	300	40	6	5	40	10
	35	0.4	0.5	6	0.6	35	0.5	600	500	60	10	5	50	15
Children	40	0.7	0.8	9	1.0	50	0.7	800	800	80	10	10	70	20
	45	0.9	1.1	12	1.1	75	1.0	800	800	120	10	10	90	20
	45	1.0	1.2	13	1.4	100	1.4	800	800	170	10	10	120	30
Males	50	1.3	1.5	17	1.7	150	2.0	1,200	1,200	270	12	15	150	40
	60	1.5	1.8	20	2.0	200	2.0	1,200	1,200	400	12	15	150	50
	60	1.5	1.7	19	2.0	200	2.0	1,200	1,200	350	10	15	150	70
	60	1.5	1.7	19	2.0	200	2.0	800	800	350	10	15	150	70
	60	1.2	1.4	15	2.0	200	2.0	800	800	350	10	15	150	70
Females	50	1.1	1.3	15	1.4	150	2.0	1,200	1,200	280	15	12	150	45
	60	1.1	1.3	15	1.5	180	2.0	1,200	1,200	300	15	12	150	50
	60	1.1	1.3	15	1.6	180	2.0	1,200	1,200	280	15	12	150	55
	60	1.1	1.3	15	1.6	180	2.0	800	800	280	15	12	150	55
	60	1.0	1.2	13	1.6	180	2.0	800	800	280	10	12	150	55
Pregnant	70	1.5	1.6	17	2.2	400	2.2	1,200	1,200	320	30	15	175	65
Lactating	95	1.6	1.8	20	2.1	280	2.6	1,200	1,200	355	15	19	200	75
	90	1.6	1.7	20	2.1	260	2.6	1,200	1,200	340	15	16	200	75

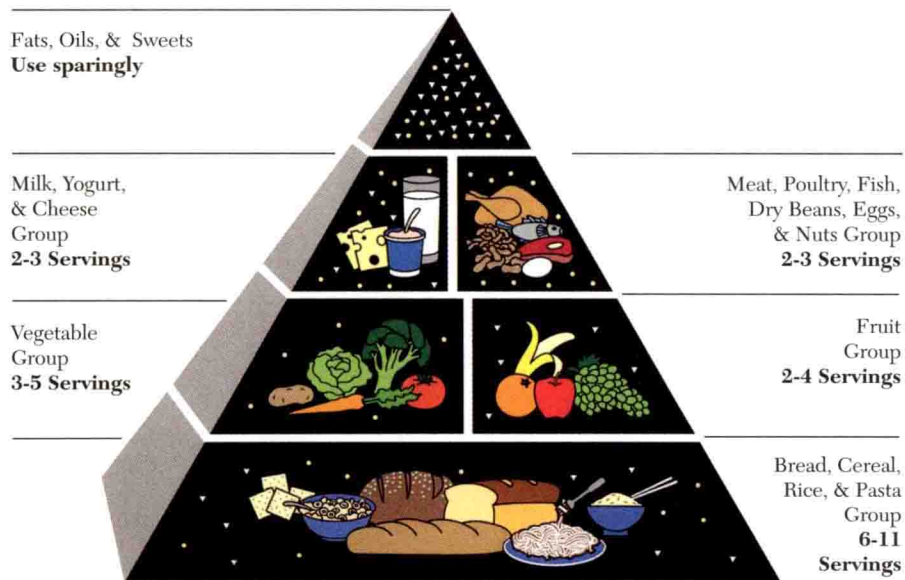
<sup>a</sup>Retinol equivalents. 1 retinol equivalent = 1 μg retinol or 6 μg β-carotene.

<sup>d</sup>As cholecalciferol. 10 μg cholecalciferol = 400 IU of vitamin D.

<sup>e</sup>α-Tocopherol equivalents. 1 mg d-α tocopherol = 1 α-TE.

<sup>f</sup>1 NE (niacin equivalent) is equal to 1 mg of niacin or 60 mg of dietary tryptophan.

**Food Guide Pyramid**  
A Guide to Daily Food Choices



### Key

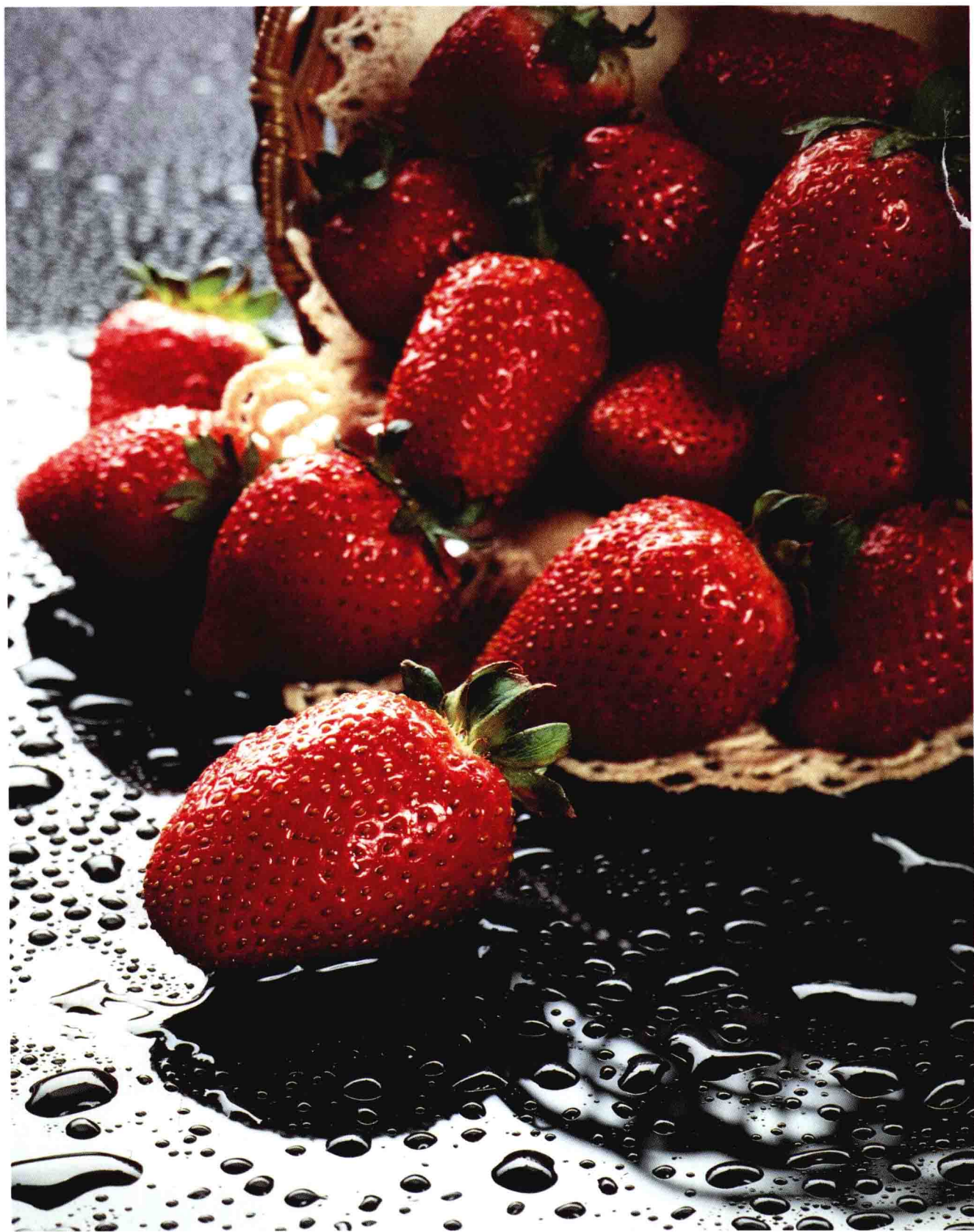
- Fat (naturally occurring and added) ▼ Sugars (added)
- These symbols show fats, oils, and added sugars in foods.

USDA, 1992

# **NUTRITION**

## Science and Applications

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To Edwin M. Smolin, whose life inspired me and all who knew him.

To our husbands and families for their patience and forbearance.

And to the four children born during the writing of this book.

They will be glad to have their mothers back.



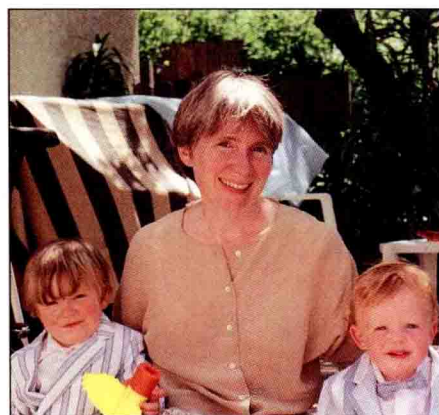
## About the Authors



**Lori A. Smolin** received her B.S. at Cornell University, where she studied Human Nutrition and Food Science, and her Ph.D. in Nutritional Sciences at the University of Wisconsin–Madison. Her doctoral research focused on protein and amino acid metabolism with an emphasis on sulfur amino acids and genetic diseases of amino acid metabolism. She completed extensive postdoctoral research at Harbor-UCLA Medical Center as well as the University of

California at San Diego, where she studied the genetic disease cystinosis.

Lori teaches nutrition at Tunxis Community College and is a Biology and Biochemistry instructor at the University of Connecticut. She has published extensively in peer-review journals but currently devotes most of her time to teaching.



**Mary B. Grosvenor** received a B.A. in English from Georgetown University and a M.S. in Nutrition Science from University of California at Davis.

Currently, Mary is a Registered Dietician and a Senior Research Nutritionist at the General Clinical Research Center at Harbor-UCLA Medical Center, where she and Lori Smolin first met and collaborated on an obesity research project. In her clinical research, she studies the latest

developments in the relationships between nutrition and disease. She is currently studying nutrition implications of HIV infection. Independently, Mary has conducted considerable research and published numerous journal articles in the area of nutrition and cancer.

## Preface

As nutritionists, we are frequently asked questions about popular nutrition fads and fallacies. Students don't ask us to explain the chemical properties of fiber but rather what foods they should eat to avoid getting colon cancer. Should they be eating a lowfat diet? Should they buy a protein supplement to improve their athletic performance? How can they lose weight? In teaching nutrition science, we sometimes forget that it is these personal concerns that trigger student interest in nutrition. As a result, introductory nutrition classes and textbooks present the basics—what is carbohydrate, protein, fat?—but fail to address popular nutrition issues. Whether students are making decisions about nutritional supplements and weight-loss diets or selecting a healthy diet, they often find themselves unable to use the basic nutrition content of introductory texts to make personal nutrition decisions. The goal of this book is to present students with complete nutrition information and teach them how to use a scientific approach in making important daily decisions about nutrition.

### Approach

To apply the science of nutrition to everyday life, *Nutrition: Science and Applications* presents basic nutrition science principles in simple understandable terms and then relates these to nutrition issues and topics of interest to the student. Relevant issues such as the connections between nutrition and disease are integrated throughout the book. This approach allows students to learn basic science principles within the context of topics of interest to them. They learn not only that a nutrient has an effect on the body but also why it has that effect, what scientific studies have been done to support the role of this nutrient, and how this information affects the food choices in their daily diet.

Our approach is to teach students how to apply the logic of science to their own nutrition concerns. We present the process of scientific inquiry and demonstrate how it is used to evaluate the role of nutrition in health. Critical thinking exercises, which are included in each chapter, guide students step by step through a logical approach to solving the problems. These exercises are unique to this text and introduce real world nutrition problems and potential solutions. Each chapter also includes application exercises that ask the students to follow the model of the critical thinking exercises and answer questions about their own diets, nutrition fads, and nutrient supplements.

We have tried to address topics relevant to the diverse student population, comprising individuals of different ages, of both sexes, and in many stages and circumstances of life. This information is incorporated throughout the text (highlighted by lifecycle icons) as well as included in separate chapters. By integrating lifecycle information, the students are exposed to the important differences in nutrition in various stages and circumstances of life. This integrated approach acknowledges how difficult it can be to cover all of these chapters in a one-semester course. Human diversity is also emphasized in the critical thinking exercises, which present the nutrition challenges faced by college students, working parents with children, athletes, pregnant women, and so on.

Since the knowledge of nutrition science is expanding so quickly, new information is continually being developed. In response to this, we have been adding the most recent information, references, and applications even during the production of the text. The Food Guide Pyramid and the new food labeling regulations, two tools developed in the past few years to help consumers select a healthy diet, are discussed throughout the book.





*Nutrition: Science and Applications* is written for students with little or no science background but does provide the science necessary to understand the concepts involved in nutrition. The use of friendly language and relevant examples helps to explain difficult concepts and make them approachable to students from all backgrounds. The text is useful to students majoring in nutrition, health sciences, home economics, nursing, physical education, and pre-medicine.

## Learning Aids

**Chapter Concepts**—Each chapter opens with a list of the concepts to be explored in that chapter. These aid students in understanding up front how the material will be covered and serve as a study guide once the chapter is completed.

**Bold-faced Terms and Margin Definitions**—Bold face is used throughout the text to identify important terms and concepts. The margin definitions provided also serve as an important study aid for students. These terms and others are included in the glossary.

**Figures**—The illustrations help clarify concepts throughout the book. Some students learn better from visual examples. The illustrations were developed specifically for this text and so are geared to the level of understanding that will be gained from reading the text. The illustrations avoid using terminology that has not been explained. Many of these are also reproduced as overhead transparencies to accompany the text. The photographs were carefully chosen to enhance the student's understanding of and interest in the material.

**Lifecycle Icon**—In each chapter the lifecycle icon highlights issues and recommendations that apply to specific stages and circumstances of life. The diversity of the material contained in each chapter is thereby increased, offering information relevant to students in all phases of life.

**“Off the Label” and “Off the Shelf” Boxes**—“Off the Label” boxes present in-depth information on food labels as they apply to specific nutrients or issues. The most up-to-date information is included. “Off the Shelf” boxes discuss foods and nutritional supplements and the scientific research that supports or refutes claims made for these products. These boxes are a unique aspect of this text, briefly highlighting topics of special interest that deserve more explanation than the scope of a one-semester course allows. These can be read separately or in conjunction with the body of the text.

**Critical Thinking Exercises**—These exercises use case histories to direct student thinking and solve nutrition problems. They lead students through the logical thought processes needed to answer nutrition questions and act as a model to help students apply nutrition information to their own diet and as a guide for the “Applications” at the end of the chapter.

**Summary**—A summary at the end of each chapter follows the concepts used to introduce each chapter but provides more detail. This summary of important material covered in the chapter can be used by students as a study tool.

**Student Exercises**—At the end of each chapter, short answer “Self-Test” questions direct students to the most important concepts covered in the chapter. “Applications” help the student apply what they have learned to their own diet and lifestyle.



**References**—This text is extensively referenced, providing the most up-to-date information and interpretations available in the science.

**Appendices**—Extensive appendices are found at the end of the text. These include a comprehensive food composition table including fast foods and convenience foods; standards for nutritional indices, such as height and weight for infants through the elderly; normal blood values; dietary recommendations from the United States, Canada, and other countries; Canadian food labeling information; food exchange lists; and energy expenditure values.

**Glossary**—A glossary of terms at the end of the text provides a quick reference for terminology with which the students are unfamiliar or for which they require review.

## Organization

The book is divided into five parts. We have done our best to present the study of nutrition in a logical order that will capture the student's interest, but the chapters and sections can be taught in any order.

The first part, *Nutrition: Sorting Fact from Fantasy*, introduces the reader to the basic concepts in nutrition and the science necessary for understanding issues presented throughout the book. Chapter 1, "Nutrition: An Everyday Concern," provides an overview of the nutrients and their roles in the body, introduces nutritional assessment, discusses factors that determine food choices, and suggests sources of nutrition information, such as food labels, that are available to help consumers make informed decisions. Chapter 2, "Nutrition Science: The Basis for Nutrition Sense," focuses on identifying accurate nutrition information and distinguishing between factual and fictional nutrition information. It begins with the scientific method and demonstrates how this process is applied to nutrition research studies. It then discusses the types of nutrition studies used to develop dietary standards, such as the RDAs, and dietary guidelines for health and disease prevention, such as the *Dietary Guidelines for Americans*. Tools, such as the Food Guide Pyramid and Exchange Lists, are also presented so that students can begin applying these to their own diets. Chapter 3, "The Human Body: Meals, Molecules, and Humans," explains digestion and absorption by showing how a particular meal is digested, absorbed into the body, and transported to the cells, where metabolism takes place.

Part II, *Energy-Containing Nutrients*, includes chapters on carbohydrates, lipids, and proteins as well as a chapter on energy balance, weight control, and eating disorders. For each of the energy-providing nutrients, there is a discussion of nutrient function and metabolism, dietary sources, requirements and how they vary through life, the information provided by food labels, the use of the Food Guide Pyramid to select foods, and the types of and need for dietary supplements. Chapters 4 through 6 also discuss popular nutrition and health topics associated with each nutrient, such as the benefits of fiber consumption in Chapter 4, dietary cholesterol and heart disease in Chapter 5, and amino acid supplements in Chapter 6. Chapter 7, "Taking It In and Taking It Off: Energy Balance and Weight Control," then discusses the concept of energy balance and applies it to weight control. Overweight, underweight, and eating disorders are addressed here. Popular diets are reviewed, along with the recommended approach to weight control, which includes diet, exercise, and behavior modification.

Part III, *Micronutrients: From Deficiency to Excess*, examines the non-energy-containing nutrients: water, vitamins, and minerals. Chapter 8, “A Vitamin Primer and the Fat Soluble Vitamins,” begins with a vitamin primer that introduces vitamins in general, how they function, and where they are found in the diet. It then discusses each of the fat soluble vitamins. Chapter 9, “The Water Soluble Vitamins and Getting the Most from Your Diet,” presents each of the water soluble vitamins, their uses in the body, sources in the diet, deficiency symptoms, recommended intakes, supplement use, and potential for toxicity. The chapter closes with a discussion of reducing vitamin losses by proper food selection, handling, preparation, and storage. In Chapter 10, “The Internal Sea: Water and the Major Minerals,” water and the major minerals are presented. Popular issues such as fluid intake and exercise, sodium and hypertension, and calcium and osteoporosis are used to capture student interest. Practical information on food sources helps students apply this knowledge to their own diets. Chapter 11, “The Trace Minerals: Our Elemental Needs,” presents the trace elements in a format similar to that in Chapter 10. To engage the student’s interest, each chapter begins with the friendly topic of food. The sources of the nutrients and their metabolic role are then addressed. Again, health issues related to these nutrients help create interest, as do discussions of the pros and cons of vitamin and mineral supplements.

Part IV, *Applying Nutrition to Life*, applies the basics of nutrition to changes in development, age, and lifestyle. Exercise is presented in this section as a lifestyle factor that affects nutritional status and nutritional needs. Chapter 12, “Fueling Fitness: Nutrition and Exercise,” reviews metabolism, which was introduced in Part II in relation to energy production. Micronutrients, presented in Chapters 8 to 11, are also reviewed as they apply to energy production, athletic performance, and fitness in general. Practical aspects of selecting meals to maintain fitness throughout life as well as meals for the competitive athlete are included. Chapter 13, “In the Beginning: Nutrition for Mothers and Babies,” addresses the role of nutrition in development by discussing the nutritional needs of pregnancy and the first year of life. Current recommendations and practical information about feeding infants are given. Chapter 14, “The Growing Years: Toddlers to Teens,” continues this discussion with issues relating to nutrition for toddlers through teens. A discussion of nutrition and alcohol consumption is included in this chapter. Chapter 15, “Nutrition and Aging: The Adult Years,” addresses how nutrition affects aging and aging affects nutrition. Nutrient–drug interactions are discussed in this chapter. Nutrition policies that affect special groups, such as school lunch programs, Meals on Wheels, and WIC, are presented in appropriate chapters in this part.

The final part, *Nutrition in Today’s World*, addresses issues of food safety, food policy, and food practice in North America and the world. Chapter 16, “How Safe Is Our Food Supply,” discusses the safety of the food supply and includes information on microbial hazards, chemical toxins, and food additives and how each has an impact on the safety of the food we eat. Chapter 17, “The Global View: Feeding the World,” discusses nutrition policy and how it is used to help reduce malnutrition worldwide. The problems and causes of world hunger are examined, along with potential solutions. In addition, the impact of new technology on food availability and health status is discussed.

## Ancillaries

**Diet Simple Plus™ + Fit**—This educational version of the Nutritionist III includes a database of over 2000 foods and 58 nutrients and an exercise and



activity analysis. The nutrition recommendations included in the software match those found in the text.

**Overhead Transparencies**—This is a set of full color overheads to help instructors illustrate the more complicated concepts in the classroom.

**Instructor's Manual with Testbank**—This manual includes chapter concepts, critical thinking exercises, key terms, student pretests, self-assessment forms, suggested readings, and sources of supplementary materials. The Testbank includes multiple choice and short answer questions.

**Study Guide**—This guide reinforces concepts from the text through study activities such as reviewing key terms and answering test questions.

**ExaMaster™**—This is a computerized version of the printed Testbank that makes preparing clear, concise tests quick and easy. It is available for both Macintosh and IBM computers in either 5¼" or 3½" format.

**RequesTest™**—Instructors who do not have access to computers may request test masters through Saunders College Publishing RequesTest Call-in Testing Service.

**ExamRecord™**—This is a computerized gradebook program that enables instructors to record, curve, graph, and print grades.

**Quarterly Concerns Videos**—These include four easy-to-use video volumes that incorporate media footage on health-related topics into an instructional format. The objective is to promote critical thinking and encourage discussion of current events as they relate to nutrition.

**The Year in Review Videodisc**—This provides an extensive library of visual aids and film footage from the Quarterly Concerns on a compact and easy-to-access videodisc. The accompanying **LectureActive™** software makes it easy to customize lectures and presentations for exceptional impact. Images can be accessed sequentially, in a linear fashion, selected one by one via remote control or "called up" through the use of an ingenious barcode system. Videodisc images can be incorporated into innovative classroom presentations.

## Acknowledgments

We would like to acknowledge the endless hours of review time by over 120 reviewers involved in this project. The reviewers included individuals who teach introductory nutrition, experts in specific areas, and Canadian instructors who helped us make this text useful to Canadian students.

The reviewers, who offered comments and suggestions on both the presentation and the accuracy of this information include the following: Andrea Arquitt, Oklahoma State University; Gary Auld, Colorado State University; John Avens, Colorado State University; Lorraine Bailey, Cuesta College; Leon Barkman, Houston College; Kathy Beerman, Washington State University; Don Benardot, Georgia State University; Rebecca Benedict, St. Olaf College; Irene Berman-Levine, University of Pennsylvania; Barbara Bowman, Georgia State University; Ellen Brennan, San Antonio College; Peggy Caballero, Los Angeles Valley College; John Capeheart, University of Houston—Downtown; Nancy Ciosek, Chicago State University; Dorothy Coltrin, DeAnza College; Sally Daniel, Montgomery County Community College; Robert Doan, Bucks County Community College; Joan Downham, Normandale Community College; Marie Dunford, California State University—Fresno; Jill Emigh, Linn-Benton Community College; Art Gilbert, University of California—Santa Barbara; Mary Hadley, North Dakota State University; Margarette Harden, Texas Tech University; Deloy Hendricks, Utah



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## To the Student



In writing this book we are hoping to bridge the gap between popular nutrition and nutrition science. Our goal is not to tell you that nutritional supplements are good or bad, or that you should or should not eat potato chips. Instead, we want to provide you with the information you need to make informed decisions for yourselves. Our goal is to take nutrition science out of the classroom and apply it to the decisions you make daily—what foods to choose, what supplements to take, what diet and lifestyle factors are important for your health. We have included the latest tools for selecting a healthy diet, including the Food Guide Pyramid and product food labels. We hope this book will help you make healthy food selections every day while allowing you to enjoy the diversity of flavors, textures, and tastes that are available in today's food supply.