

UNDERSTANDING NUTRITION

WHITNEY • ROLFES

14e

Dietary Reference Intakes (DRI)

The Dietary Reference Intakes (DRI) include two sets of nutrient intake goals for individuals—the Recommended Dietary Allowance (RDA) and Adequate Intake (AI). The RDA reflects the average daily amount of a nutrient considered adequate to meet the needs of most healthy people. If there is insufficient evidence to determine an RDA, an AI is set. In addition, the Estimated Energy Requirement (EER) represents the average dietary energy intake considered adequate to maintain energy balance in healthy people.

The DRI also include the Tolerable Upper Intake Level (UL) that represents the estimated maximum daily amount of a nutrient that appears safe for most healthy people to consume on a regular basis. Turn the page for a listing of the UL for selected vitamins and minerals. Note that the absence of a UL for a nutrient does not indicate that it is safe to consume in high doses, but only that research is too limited to set a UL. Chapter 1 describes these DRI values in detail.

Estimated Energy Requirements (EER), Recommended Dietary Allowances (RDA), and Adequate Intakes (AI) for Water, Energy, and the Energy Nutrients

Age (yr)	Reference BMI	Reference Height cm (in.)	Reference Weight kg (lb)	Water ^a AI (L/day)	Energy EER ^b (kcal/day)	Carbohydrate RDA (g/day)	Total Fiber AI (g/day)	Total Fat AI (g/day)	Linoleic Acid AI (g/day)	Linolenic Acid ^c AI (g/day)	Protein RDA (g/day) ^d	Protein AI (g/kg/day)
Males												
0–0.5	—	62 (24)	6 (13)	0.7 ^e	570	60	—	31	4.4	0.5	9.1	1.52
0.5–1	—	71 (28)	9 (20)	0.8 ^f	743	95	—	30	4.6	0.5	11	1.20
1–3 ^g	—	86 (34)	12 (27)	1.3	1046	130	19	—	7	0.7	13	1.05
4–8 ^g	15.3	115 (45)	20 (44)	1.7	1742	130	25	—	10	0.9	19	0.95
9–13	17.2	144 (57)	36 (79)	2.4	2279	130	31	—	12	1.2	34	0.95
14–18	20.5	174 (68)	61 (134)	3.3	3152	130	38	—	16	1.6	52	0.85
19–30	22.5	177 (70)	70 (154)	3.7	3067 ^h	130	38	—	17	1.6	56	0.80
31–50	22.5 ⁱ	177 (70) ⁱ	70 (154) ⁱ	3.7	3067 ^h	130	38	—	17	1.6	56	0.80
>50	22.5 ⁱ	177 (70) ⁱ	70 (154) ⁱ	3.7	3067 ^h	130	30	—	14	1.6	56	0.80
Females												
0–0.5	—	62 (24)	6 (13)	0.7 ^e	520	60	—	31	4.4	0.5	9.1	1.52
0.5–1	—	71 (28)	9 (20)	0.8 ^f	676	95	—	30	4.6	0.5	11	1.20
1–3 ^g	—	86 (34)	12 (27)	1.3	992	130	19	—	7	0.7	13	1.05
4–8 ^g	15.3	115 (45)	20 (44)	1.7	1642	130	25	—	10	0.9	19	0.95
9–13	17.4	144 (57)	37 (81)	2.1	2071	130	26	—	10	1.0	34	0.95
14–18	20.4	163 (64)	54 (119)	2.3	2368	130	26	—	11	1.1	46	0.85
19–30	21.5	163 (64)	57 (126)	2.7	2403 ^j	130	25	—	12	1.1	46	0.80
31–50	21.5 ⁱ	163 (64) ⁱ	57 (126) ⁱ	2.7	2403 ^j	130	25	—	12	1.1	46	0.80
>50	21.5 ⁱ	163 (64) ⁱ	57 (126) ⁱ	2.7	2403 ^j	130	21	—	11	1.1	46	0.80
Pregnancy												
1st trimester				3.0	+0	175	28	—	13	1.4	46	0.80
2nd trimester				3.0	+340	175	28	—	13	1.4	71	1.10
3rd trimester				3.0	+452	175	28	—	13	1.4	71	1.10
Lactation												
1st 6 months				3.8	+330	210	29	—	13	1.3	71	1.30
2nd 6 months				3.8	+400	210	29	—	13	1.3	71	1.30

NOTE: BMI is calculated as the weight in kilograms divided by the square of the height in meters. For all nutrients, values for infants are AI. Dashes indicate that values have not been determined.

^aThe water AI includes drinking water, water in beverages, and water in foods; in general, drinking water and other beverages contribute about 70 to 80 percent, and foods, the remainder. Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz.

^bThe Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level. The values listed are based

on an “active” person at the reference height and weight and at the midpoint ages for each group until age 19. Chapter 8 and Appendix F provide equations and tables to determine estimated energy requirements.

^cThe linolenic acid referred to in this table and text is the omega-3 fatty acid known as alpha-linolenic acid.

^dThe values listed are based on reference body weights.

^eAssumed to be from human milk.

^fAssumed to be from human milk and complementary foods and beverages. This includes approximately 0.6 L (~2½ cups) as total fluid including formula, juices, and drinking water.

^gFor energy, the age groups for young children are 1–2 years and 3–8 years.

^hFor males, subtract 10 kcalories per day for each year of age above 19.

ⁱBecause weight need not change as adults age if activity is maintained, reference weights for adults 19 through 30 years are applied to all adult age groups.

^jFor females, subtract 7 kcalories per day for each year of age above 19.

SOURCE: Adapted from the *Dietary Reference Intakes series*, National Academies Press. National Academies of Sciences.

Recommended Dietary Allowances (RDA) and Adequate Intakes (AI) for Vitamins

Age (yr)	Thiamin RDA (mg/day)	Riboflavin RDA (mg/day)	Niacin RDA (mg/day) ^a	Biotin AI (µg/day)	Pantothenic acid AI (mg/day)	Vitamin B ₆ RDA (mg/day)	Folate RDA (µg/day) ^b	Vitamin B ₁₂ RDA (µg/day)	Choline AI (mg/day)	Vitamin C RDA (mg/day)	Vitamin A RDA (µg/day) ^c	Vitamin D RDA (µg/day) ^d	Vitamin E RDA (mg/day) ^e	Vitamin K AI (µg/day)
Infants														
0–0.5	0.2	0.3	2	5	1.7	0.1	65	0.4	125	40	400	10	4	2.0
0.5–1	0.3	0.4	4	6	1.8	0.3	80	0.5	150	50	500	10	5	2.5
Children														
1–3	0.5	0.5	6	8	2	0.5	150	0.9	200	15	300	15	6	30
4–8	0.6	0.6	8	12	3	0.6	200	1.2	250	25	400	15	7	55
Males														
9–13	0.9	0.9	12	20	4	1.0	300	1.8	375	45	600	15	11	60
14–18	1.2	1.3	16	25	5	1.3	400	2.4	550	75	900	15	15	75
19–30	1.2	1.3	16	30	5	1.3	400	2.4	550	90	900	15	15	120
31–50	1.2	1.3	16	30	5	1.3	400	2.4	550	90	900	15	15	120
51–70	1.2	1.3	16	30	5	1.7	400	2.4	550	90	900	15	15	120
>70	1.2	1.3	16	30	5	1.7	400	2.4	550	90	900	20	15	120
Females														
9–13	0.9	0.9	12	20	4	1.0	300	1.8	375	45	600	15	11	60
14–18	1.0	1.0	14	25	5	1.2	400	2.4	400	65	700	15	15	75
19–30	1.1	1.1	14	30	5	1.3	400	2.4	425	75	700	15	15	90
31–50	1.1	1.1	14	30	5	1.3	400	2.4	425	75	700	15	15	90
51–70	1.1	1.1	14	30	5	1.5	400	2.4	425	75	700	15	15	90
>70	1.1	1.1	14	30	5	1.5	400	2.4	425	75	700	20	15	90
Pregnancy														
≤18	1.4	1.4	18	30	6	1.9	600	2.6	450	80	750	15	15	75
19–30	1.4	1.4	18	30	6	1.9	600	2.6	450	85	770	15	15	90
31–50	1.4	1.4	18	30	6	1.9	600	2.6	450	85	770	15	15	90
Lactation														
≤18	1.4	1.6	17	35	7	2.0	500	2.8	550	115	1200	15	19	75
19–30	1.4	1.6	17	35	7	2.0	500	2.8	550	120	1300	15	19	90
31–50	1.4	1.6	17	35	7	2.0	500	2.8	550	120	1300	15	19	90

NOTE: For all nutrients, values for infants are AI. The glossary on the inside back cover defines units of nutrient measure.

^aNiacin recommendations are expressed as niacin equivalents (NE), except for recommendations for infants younger than 6 months, which are expressed as preformed niacin.

^bFolate recommendations are expressed as dietary folate equivalents (DFE).

^cVitamin A recommendations are expressed as retinol activity equivalents (RAE).

^dVitamin D recommendations are expressed as cholecalciferol and assume an absence of adequate exposure to sunlight.

^eVitamin E recommendations are expressed as α -tocopherol.

Recommended Dietary Allowances (RDA) and Adequate Intakes (AI) for Minerals

Age (yr)	Sodium AI (mg/day)	Chloride AI (mg/day)	Potassium AI (mg/day)	Calcium RDA (mg/day)	Phosphorus RDA (mg/day)	Magnesium RDA (mg/day)	Iron RDA (mg/day)	Zinc RDA (mg/day)	Iodine RDA (µg/day)	Selenium RDA (µg/day)	Copper RDA (µg/day)	Manganese AI (mg/day)	Fluoride AI (mg/day)	Chromium AI (µg/day)	Molybdenum RDA (µg/day)
Infants															
0–0.5	120	180	400	200	100	30	0.27	2	110	15	200	0.003	0.01	0.2	2
0.5–1	370	570	700	260	275	75	11	3	130	20	220	0.6	0.5	5.5	3
Children															
1–3	1000	1500	3000	700	460	80	7	3	90	20	340	1.2	0.7	11	17
4–8	1200	1900	3800	1000	500	130	10	5	90	30	440	1.5	1.0	15	22
Males															
9–13	1500	2300	4500	1300	1250	240	8	8	120	40	700	1.9	2	25	34
14–18	1500	2300	4700	1300	1250	410	11	11	150	55	890	2.2	3	35	43
19–30	1500	2300	4700	1000	700	400	8	11	150	55	900	2.3	4	35	45
31–50	1500	2300	4700	1000	700	420	8	11	150	55	900	2.3	4	35	45
51–70	1300	2000	4700	1000	700	420	8	11	150	55	900	2.3	4	30	45
>70	1200	1800	4700	1200	700	420	8	11	150	55	900	2.3	4	30	45
Females															
9–13	1500	2300	4500	1300	1250	240	8	8	120	40	700	1.6	2	21	34
14–18	1500	2300	4700	1300	1250	360	15	9	150	55	890	1.6	3	24	43
19–30	1500	2300	4700	1000	700	310	18	8	150	55	900	1.8	3	25	45
31–50	1500	2300	4700	1000	700	320	18	8	150	55	900	1.8	3	25	45
51–70	1300	2000	4700	1200	700	320	8	8	150	55	900	1.8	3	20	45
>70	1200	1800	4700	1200	700	320	8	8	150	55	900	1.8	3	20	45
Pregnancy															
≤18	1500	2300	4700	1300	1250	400	27	12	220	60	1000	2.0	3	29	50
19–30	1500	2300	4700	1000	700	350	27	11	220	60	1000	2.0	3	30	50
31–50	1500	2300	4700	1000	700	360	27	11	220	60	1000	2.0	3	30	50
Lactation															
≤18	1500	2300	5100	1300	1250	360	10	13	290	70	1300	2.6	3	44	50
19–30	1500	2300	5100	1000	700	310	9	12	290	70	1300	2.6	3	45	50
31–50	1500	2300	5100	1000	700	320	9	12	290	70	1300	2.6	3	45	50

NOTE: For all nutrients, values for infants are AI. The glossary on the inside back cover defines units of nutrient measure.

Tolerable Upper Intake Levels (UL) for Vitamins

Age (yr)	Niacin (mg/day) ^a	Vitamin B ₆ (mg/day)	Folate (µg/day) ^a	Choline (mg/day)	Vitamin C (mg/day)	Vitamin A (IU/day) ^b	Vitamin D (µg/day)	Vitamin E (mg/day) ^c
Infants								
0–0.5	—	—	—	—	—	600	25	—
0.5–1	—	—	—	—	—	600	38	—
Children								
1–3	10	30	300	1000	400	600	63	200
4–8	15	40	400	1000	650	900	75	300
9–13	20	60	600	2000	1200	1700	100	600
Adolescents								
14–18	30	80	800	3000	1800	2800	100	800
Adults								
19–70	35	100	1000	3500	2000	3000	100	1000
>70	35	100	1000	3500	2000	3000	100	1000
Pregnancy								
≤18	30	80	800	3000	1800	2800	100	800
19–50	35	100	1000	3500	2000	3000	100	1000
Lactation								
≤18	30	80	800	3000	1800	2800	100	800
19–50	35	100	1000	3500	2000	3000	100	1000

^aThe UL for niacin and folate apply to synthetic forms obtained from supplements, fortified foods, or a combination of the two.

^cThe UL for vitamin E applies to any form of supplemental α-tocopherol, fortified foods, or a combination of the two.

^bThe UL for vitamin A applies to the preformed vitamin only.

Tolerable Upper Intake Levels (UL) for Minerals

Age (yr)	Sodium (mg/day)	Chloride (mg/day)	Calcium (mg/day)	Phosphorus (mg/day)	Magnesium (mg/day) ^d	Iron (mg/day)	Zinc (mg/day)	Iodine (µg/day)	Selenium (µg/day)	Copper (µg/day)	Manganese (mg/day)	Fluoride (mg/day)	Molybdenum (µg/day)	Boron (mg/day)	Nickel (mg/day)	Vanadium (mg/day)
Infants																
0–0.5	—	—	1000	—	—	40	4	—	45	—	—	0.7	—	—	—	—
0.5–1	—	—	1500	—	—	40	5	—	60	—	—	0.9	—	—	—	—
Children																
1–3	1500	2300	2500	3000	65	40	7	200	90	1000	2	1.3	300	3	0.2	—
4–8	1900	2900	2500	3000	110	40	12	300	150	3000	3	2.2	600	6	0.3	—
9–13	2200	3400	3000	4000	350	40	23	600	280	5000	6	10	1100	11	0.6	—
Adolescents																
14–18	2300	3600	3000	4000	350	45	34	900	400	8000	9	10	1700	17	1.0	—
Adults																
19–50	2300	3600	2500	4000	350	45	40	1100	400	10,000	11	10	2000	20	1.0	1.8
51–70	2300	3600	2000	4000	350	45	40	1100	400	10,000	11	10	2000	20	1.0	1.8
>70	2300	3600	2000	3000	350	45	40	1100	400	10,000	11	10	2000	20	1.0	1.8
Pregnancy																
≤18	2300	3600	3000	3500	350	45	34	900	400	8000	9	10	1700	17	1.0	—
19–50	2300	3600	2500	3500	350	45	40	1100	400	10,000	11	10	2000	20	1.0	—
Lactation																
≤18	2300	3600	3000	4000	350	45	34	900	400	8000	9	10	1700	17	1.0	—
19–50	2300	3600	2500	4000	350	45	40	1100	400	10,000	11	10	2000	20	1.0	—

^dThe UL for magnesium applies to synthetic forms obtained from supplements or drugs only. NOTE: An Upper Limit was not established for vitamins and minerals not listed and for those age groups listed with a dash (—) because of a lack of data, not because these nutrients are safe to consume at any level of intake. All nutrients can have adverse effects when intakes are excessive.

SOURCE: Adapted from the *Dietary Reference Intakes series*, National Academies Press. National Academies of Sciences.

Understanding Nutrition

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Ellie Whitney
Sharon Rady Rolfes



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To the memory of Eva May Nunnely Hamilton, who first undertook to write this book with me in 1975. Her scholarship, enthusiasm, and warmth pervade its pages still. And to my partner, Sharon Rady Rolfes, whose dedication to accuracy and clarity has continuously improved this book from edition to edition.

Ellie Whitney

To the memory of my sweet mama, Gladys Abdelnour Rady, who nourished me with unconditional love and delicious Mediterranean food (long before others realized how healthy it was). All that I am began with her, and for that I am most thankful.

Sharon Rady Rolfes

About the Authors

Ellie Whitney grew up in New York City and received her BA and PhD degrees in English and Biology at Harvard and Washington Universities. She taught at both Florida State University and Florida A&M University, wrote newspaper columns on environmental matters for the *Tallahassee Democrat*, and coauthored almost a dozen college textbooks on nutrition, health, and related topics, many of which repeatedly reappear as new editions. She spent three decades exploring outdoor Florida and studying its ecology, and then cowrote *Priceless Florida: Natural Ecosystems and Native Species* (Pineapple Press, 2004). Now retired, and more concerned about climate change than any other issue, she volunteers full-time for the nonpartisan national nonprofit Citizens Climate Lobby.

Sharon Rady Rolfes received her MS in nutrition and food science from Florida State University. She is a founding member of Nutrition and Health Associates, an information resource center that maintains a research database on more than 1000 nutrition-related topics. She has taught at Florida State University and coauthored several other college textbooks, including *Understanding Normal and Clinical Nutrition*. In addition to writing, she serves as a consultant for various educational projects. Her volunteer work includes serving on the board of Working Well, a community initiative dedicated to creating a healthy workforce. She maintains her registration as a dietitian nutritionist and membership in the Academy of Nutrition and Dietetics.

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Preface

Nutrition is a science. The details of a nutrient's chemistry or a cell's biology can be overwhelming and confusing to some, but it needn't be. When the science is explained step by step and the facts are connected one by one, the details become clear and understandable. By telling stories about fat mice, using analogies of lamps, and applying guidelines to groceries, we make the science of nutrition meaningful and memorable. That has been our mission since the first edition—to reveal the fascination of science and share the excitement of nutrition with readers. We have learned from the thousands of professors and more than a million students who have used this book through the years that readers want an *understanding* of nutrition so they can make healthy choices in their daily lives. We hope that this book serves you well.

A Book Tour of This Edition

Understanding Nutrition presents the core information of an introductory nutrition course. The early chapters introduce the nutrients and their work in the body, and the later chapters apply that information to people's lives—describing the role of foods and nutrients in energy balance and weight control, in physical activity, in the life cycle, in disease prevention, in food safety, and in hunger.

The Chapters Chapter 1 begins by exploring why we eat the foods we do and continues with a brief overview of the nutrients, the science of nutrition, recommended nutrient intakes, assessment, and important relationships between diet and health. Chapter 2 describes the diet-planning principles and food guides used to create diets that support good health and includes instructions on how to read a food label. In Chapter 3 readers follow the journey of digestion and absorption as the body breaks down foods into nutrients. Chapters 4, 5, and 6 describe carbohydrates, fats, and proteins—their chemistry, roles in the body, and places in the diet. Then Chapter 7 shows how the body derives energy from these three nutrients. Chapters 8 and 9 continue the story with a look at energy balance, the factors associated with overweight and underweight, and the benefits and dangers of weight loss and weight gain. Chapters 10, 11, 12, and 13 complete the introductory lessons by describing the vitamins, the minerals, and water—their roles in the body, deficiency and toxicity symptoms, and sources.

The next seven chapters weave that basic information into practical applications, showing how nutrition influences

people's lives. Chapter 14 describes how physical activity and nutrition work together to support fitness. Chapters 15, 16, and 17 present the special nutrient needs of people through the life cycle—pregnancy and lactation; infancy, childhood, and adolescence; and adulthood and the later years. Chapter 18 focuses on the dietary risk factors and recommendations associated with chronic diseases, and Chapter 19 addresses consumer concerns about the safety of the food and water supply. Chapter 20 closes the book by examining hunger and the global environment.

The Highlights Every chapter is followed by a highlight that provides readers with an in-depth look at a current, and often controversial, topic that relates to its companion chapter. For example, Highlight 4 examines the scientific evidence behind some of the current controversies surrounding carbohydrates and their role in weight gain and weight loss. New to this edition are Critical Thinking Questions designed to encourage readers to develop clear, rational, open-minded, and informed thoughts based on the evidence presented in the highlight.

Special Features The art and layout in this edition have been carefully designed to be inviting while enhancing student learning. For example, numbered steps have been added to several figures to clarify sequences and processes. In addition, special features help readers identify key concepts and apply nutrition knowledge. For example, when a new term is introduced, it is printed in bold type, and a **definition** is provided. These definitions often include pronunciations and derivations to facilitate understanding. The glossary at the end of the book includes all defined terms.

definition (DEF-eh-NISH-en): the meaning of a word.

- **de** = from
- **finis** = boundary

LEARNING GPS

The opening page of each chapter provides a Learning GPS that serves as an outline and directs readers to the main heads (and subheads) within the chapter. Each main head is followed by a Learn It—a learning objective for the content covered in that section. The Learn It also appears within the text at the start of each main section as well as at the start of each Review It. After reading the chapter, students will be able to demonstrate competency in the Learn It objectives.

Nutrition in Your Life

The opening paragraph of each chapter—called Nutrition in Your Life—introduces the chapter’s content in a friendly and familiar way. This short paragraph closes with a preview of how readers might apply that content to their daily lives by inviting them to use the Nutrition Portfolio section at the end of the chapter.

Nutrition Portfolio

The Nutrition Portfolio section at the end of each chapter prompts readers to consider whether their personal choices are meeting the goals presented in the chapter. Most of these assignments include instructions that use the Diet & Wellness Plus program. Such tools help students assess their current choices and make informed decisions about healthy options.

> REVIEW IT Each major section within a chapter concludes with a Review It paragraph that summarizes key concepts. Similarly, Review It tables cue readers to important summaries.

Also featured in this edition are the 2010 *Dietary Guidelines for Americans*, which are introduced in Chapter 2 and presented throughout the text whenever their subjects are discussed. Look for the following design.



> DIETARY GUIDELINES FOR AMERICANS

These guidelines provide science-based advice to promote health and to reduce the risk of chronic disease through diet and physical activity.

>How To

Many of the chapters include “How To” features that guide readers through problem-solving tasks. For example, a “How

To” in Chapter 1 presents the steps in calculating energy intake from the grams of carbohydrate, fat, and protein in a food.

> TRY IT Each “How To” feature ends with a “Try It” activity that gives readers an opportunity to practice these new lessons.

STUDY CARD > 1

> STUDY IT To review the key points of this chapter and take a practice quiz, go to the Study Cards at the end of the book.

Study cards appear at the back of the text—one for each chapter. The Study It side of each card presents a review of the chapter’s core concepts, and perhaps a table or figure to

remind readers of key points. The Test It side of the study card provides essay and multiple-choice questions to help prepare students for exams.

The Appendixes

The appendixes are valuable references for a number of purposes. Appendix A summarizes background information on the hormonal and nervous systems, complementing Appendixes B and C on basic chemistry, the chemical structures of nutrients, and major metabolic pathways. Appendix D describes measures of protein quality. Appendix E provides detailed coverage of nutrition assessment, and Appendix F presents the estimated energy requirements for men and women at various levels of physical activity. Appendix G presents the 2008 *Choose Your Foods: Exchange List for Diabetes*. Appendix H is a 4000-item food composition table. Appendix I lists nutrition recommendations from the World Health Organization (WHO), and Appendix J presents the 2020 Healthy People nutrition-related objectives. Appendix K features aids to calculations, a short tutorial on converting metric measures and handling basic math problems commonly found in the world of nutrition.

The Inside Covers

The inside covers put commonly used information at your fingertips. The inside front covers (pp. A–C) present the current nutrient recommendations; the inside back covers feature the Daily Values used on food labels and a glossary of nutrient measures (p. Y on the left) as well as suggested weight ranges for various heights (p. Z on the right).

Notable Changes in This Edition

Because nutrition is an active science, staying current is paramount. Just as nutrition research continuously adds to and revises the accepted body of knowledge, this edition builds on the science of previous editions with the latest in nutrition research. Much has changed in the world of nutrition and in our daily lives since the first edition. The number of foods has increased dramatically—even as we spend less

time than ever in the kitchen preparing meals. The connections between diet and disease have become more apparent—and consumer interest in making smart health choices has followed. More people are living longer and healthier lives. The science of nutrition has grown rapidly, with new “facts” emerging daily. In this edition, as with all previous editions, every chapter has been revised to enhance learning by presenting current information accurately and attractively. For all chapters and highlights we have:

- Reviewed and updated content
- Created several new figures and tables and revised others to enhance learning
- Added Critical Thinking Questions to the highlights
- Revised figures to reflect new food and supplement labels and tables to include nutrients of concern (vitamin D, calcium, potassium, and iron)

Chapter 1

- Created table to summarize ways to describe six classes of nutrients
- Introduced *registered dietitian nutritionist (RDN)*, another term to describe an RD

Chapter 2

- Revised figure comparing nutrient density of two breakfasts to include potassium and vitamin D
- Introduced new food labels and revised figure to illustrate differences
- Introduced front-of-package labeling and added figure to illustrate

Chapter 3

- Introduced *microbiome* and revised section on gastrointestinal bacteria

Chapter 4

- Revised table showing nutrients in sugars and other foods to include potassium and vitamin D
- Created tables to define glucose for normal and diabetes; to show the glycemic index of a few common foods; to list the functions of sugars in foods; to present ways to prevent dental caries
- Included fructose metabolism in the highlight

Chapter 5

- Created tables to define blood lipids for heart health; to list fat choices among protein foods and among milk products; to show omega-3 fatty acid quantities in a variety of fish and seafood
- Created new figure on how to read fish oil supplement labels
- Added definitions for resistin and adiponectin

Chapter 6

- Expanded discussion on the association between dietary protein and body weight

Chapter 7

- Created new figure illustrating labels on beer, wine, and liquor

Chapter 8

- Discussed “3500 calorie rule” and its limitations
- Created new tables for estimating energy expended on basal metabolism and on thermic effect of foods and for percent body fat at various BMI
- Revised section on female athlete triad to include new expanded term—Relative Energy Deficiency in Sports (RED-S)—and created new table of its adverse consequences
- Added discussion of food addiction to section on binge eating disorder

Chapter 9

- Added discussion of brite adipocytes to section on brown adipocyte tissue and uncoupling proteins
- Updated table on FDA-approved weight loss drugs
- Revised figure on gastric surgery used to treat obesity
- Deleted discussion and figure on unrealistic expectations
- Created new table of national strategies to prevent obesity
- Updated table on popular weight loss diets

Chapter 11

- Added a paragraph on “golden rice,” a genetically modified rice used in the worldwide fight against vitamin A deficiency
- Added details on vitamin D’s non-bone-related roles
- Rewrote the introduction to vitamin E
- Rewrote the food sources of vitamin K paragraph to include the terms phyloquinone (vitamin K₁) and menaquinone (vitamin K₂)

Chapter 12

- Revised calcium balance figure

Chapter 13

- Created table of factors influencing iron absorption

Chapter 14

- Reorganized, shortened, and rewrote section on Developing Fitness

- Reorganized, clarified, and rewrote section entitled Energy Systems and Fuels to Support Activity
- Enhanced and reorganized table of primary fuels used for activities of different intensities and durations
- Created new table comparing symptoms of heat stroke and hypothermia
- Added discussion and definition of beta-alanine to highlight on ergogenic aids

Chapter 15

- Created several new tables: benefits of WIC, risk factors for gestational diabetes, signs and symptoms of pre-eclampsia, complications from smoking during pregnancy, tips to prevent listeriosis
- Reorganized sections on fetal programming and fetal development of chronic diseases

Chapter 16

- Created several new tables: protective factors in breast milk, tips for picky eaters, examples of foods and non-food items children can choke on, iron recommendations for adolescents
- Added information about fluoride and formula preparation
- Added brief discussion about new AAP guidelines for reduced, low-fat, and fat-free milk for toddlers
- Added discussion of new school meal initiatives

Chapter 17

- Created new figure comparing healthy lens with cataract lens

Chapter 18

- Created new tables for selected nutrient roles in immune function and criteria for diagnosis of diabetes
- Revised, reworked, and updated tables for recommendations and strategies to reduce the risk of CVD and recommendations and strategies to reduce the risk of cancer
- Emphasized role of obesity throughout the chapter as major risk for other chronic diseases
- Included information related to 2013 American College of Cardiology/American Heart Association guidelines for assessment of CVD risk and lifestyle modifications for reducing risk of heart disease
- Added discussion and definitions of fasting plasma glucose test and A1C test for diabetes

Chapter 19

- Added brief discussion in Nutritional Adequacy of Foods section on ultraprocessed foods

- Added a paragraph in the Environmental Contaminants section on arsenic
- Added more information throughout Pesticide section on children's health and consumers' perceptions
- Added brief discussion in Food Additives section comparing natural and artificial additives
- Added a paragraph in Food Additives section on edible packaging

Chapter 20

- Added discussion on controversy surrounding whether SNAP participants should be allowed to purchase soft drinks and other non-nutritious foods and beverages
- Added tips to reduce food waste to the How To feature on p. 667
- Added discussion on eco-friendly products and packaging to the highlight

Student and Instructor Resources

MindTap: A new approach to highly personalized online learning. Beyond an eBook, homework solution, digital supplement, or premium website, MindTap is a digital learning platform that works alongside your campus LMS to deliver course curriculum across the range of electronic devices in your life. MindTap is built on an “app” model allowing enhanced digital collaboration and delivery of engaging content across a spectrum of Cengage and non-Cengage resources.

Instructor Companion Site: Everything you need for your course in one place! This collection of book-specific lecture and class tools is available online via www.cengage.com/login. Access and download PowerPoint presentations, images, instructor's manual, videos, and more.

Test Bank with Cognero: Cengage Learning Testing Powered by Cognero is a flexible, online system that allows you to:

- author, edit, and manage test bank content from multiple Cengage Learning solutions
- create multiple test versions in an instant
- deliver tests from your LMS, your classroom, or wherever you want

Diet & Wellness Plus: Diet & Wellness Plus helps you understand how nutrition relates to your personal health goals. Track your diet and activity, generate reports, and analyze the nutritional value of the food you eat. Diet & Wellness Plus includes over 55,000 foods as well as custom food and recipe features. The new Behavior Change Planner helps you identify risks in your life and guides you through the key steps to make positive changes.

Global Nutrition Watch: Bring currency to the classroom with Global Nutrition Watch from Cengage Learning. This user-friendly website provides convenient access to thousands of trusted sources, including academic journals, newspapers, videos, and podcasts, for you to use for research projects or classroom discussion. Global Nutrition Watch is updated daily to offer the most current news about topics related to nutrition.

Closing Comments

We have taken great care to provide accurate information and have included many references at the end of each

chapter and highlight. To keep the number of references manageable over the decades, however, many statements that appeared in previous editions with references now appear without them. All statements reflect current nutrition knowledge, and the authors will supply references upon request. In addition to supporting text statements, the end-of-chapter references provide readers with resources for finding a good overview or more details on the subject. Nutrition is a fascinating subject, and we hope our enthusiasm for it comes through on every page.

Ellie Whitney

Sharon Rady Rolfes

January 2015

Acknowledgments

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Understanding Nutrition



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1

An Overview of Nutrition

Nutrition in Your Life

Believe it or not, you have probably eaten at least 20,000 meals in your life. Without any conscious effort on your part, your body uses the nutrients from those foods to make all its components, fuel all its activities, and defend itself against diseases. How successfully your body handles these tasks depends, in part, on your food choices. Nutritious food choices support healthy bodies. In the Nutrition Portfolio at the end of this chapter, you can see how your current food choices are influencing your health and risk of chronic diseases.

Nutrition has always played a significant role in your life. Every day, several times a day, you select **foods** that influence your body's health. Each day's food choices may benefit or harm health only a little, but over time, the consequences of these choices become major. That being the case, paying close attention to good eating habits now supports health benefits later. Conversely, carelessness about food choices can contribute to **chronic diseases**. Of course, some people will become ill or die young no matter what choices they make, and others will live long lives despite making poor choices. For most of us, however, the food choices we make will benefit or impair our health in proportion to the wisdom of those choices.

Although most people realize food habits affect health, they often choose foods for other reasons. After all, foods bring pleasures, traditions, and associations as well as nourishment. The challenge, then, is to combine favorite foods and fun times with a nutritionally balanced **diet**. Take a moment to review the definition and note that *diet* does *not* mean a restrictive food plan designed for weight loss. It simply refers to the foods and beverages a person consumes. Whether it's a vegetarian diet, a weight-loss diet, or any other kind of diet depends on the types of foods and beverages a person chooses.

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nutrition: the science of the nutrients in foods and their actions within the body. A broader definition includes the study of human behaviors related to food and eating.

foods: products derived from plants or animals that can be taken into the body to yield energy and nutrients for the maintenance of life and the growth and repair of tissues.

chronic diseases: diseases characterized by slow progression and long duration. Examples include heart disease, diabetes, and some cancers.

• **chronos** = time

diet: the foods and beverages a person eats and drinks.



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An enjoyable way to learn about a culture is to taste the ethnic foods.

1.1 Food Choices

› **LEARN IT** Describe how various factors influence personal food choices.

People decide what to eat, when to eat, how much to eat, and even whether to eat in highly personal ways based on a complex interaction of genetic, behavioral, or social factors rather than on an awareness of nutrition's importance to health.¹ A variety of food choices can support good health, and an understanding of human nutrition helps you make sensible selections more often.

Preferences As you might expect, the number one reason most people choose certain foods is taste—they like the flavor. Two widely shared preferences are for the sweetness of sugar and the savoriness of salt.² High-fat foods also appear to be a universally common preference. Other preferences might be for the hot peppers common in Mexican cooking or the curry spices of Indian cuisine. Research suggests that genetics may influence taste perceptions and therefore food likes and dislikes.³ Similarly, the hormones of pregnancy seem to influence food cravings and aversions (see Chapter 15).

Habit People sometimes select foods out of habit. They eat cereal every morning, for example, simply because they have always eaten cereal for breakfast. Eating a familiar food and not having to make any decisions can be comforting.

Ethnic Heritage and Regional Cuisines Among the strongest influences on food choices are ethnic heritage and regional cuisines. People tend to prefer the foods they grew up eating. Every country, and in fact every region of a country, has its own typical foods and ways of combining them into meals. These cuisines reflect a unique combination of local ingredients and cooking styles. Chowder in New England is made with clams, but in the Florida Keys conch is the featured ingredient. The Pacific Northwest is as famous for its marionberry pie as Georgia is for its peach cobbler. Philly has its cheesesteaks and New Orleans has its oyster po'boys. The "American diet" includes many ethnic foods and regional styles, all adding variety to the diet.

Enjoying traditional **ethnic foods** provides an opportunity to celebrate a person's heritage. People offering ethnic foods share a part of their culture with others, and those accepting the foods learn about another's way of life. Developing **cultural competence** honors individual preferences and is particularly important for professionals who help others plan healthy diets.

Social Interactions Most people enjoy companionship while eating. It's fun to go out with friends for a meal or share a snack when watching a movie together. Meals are often social events, and sharing food is part of hospitality. Social customs invite people to accept food or drink offered by a host or shared by a group—regardless of hunger signals. Chapter 9 describes how people tend to eat more food when socializing with others.

Availability, Convenience, and Economy People often eat foods that are accessible, quick and easy to prepare, and within their financial means. Consumers who value convenience frequently eat out, bring home ready-to-eat meals, or have food delivered. Even when they venture into the kitchen, they want to prepare a meal in 15 to 20 minutes, using less than a half dozen ingredients—and those "ingredients" are often semiprepared foods, such as canned soups and frozen foods.

Consumer emphasis on convenience limits food choices to the selections offered on menus and products designed for quick preparation. Whether decisions based on convenience meet a person's nutrition needs depends on the choices made. Eating a banana or a candy bar may be equally convenient, but the fruit provides more vitamins and minerals and less sugar and fat.

Rising food costs have shifted some consumers' priorities and changed their shopping habits.⁴ They are less likely to buy higher-priced convenience foods and

ethnic foods: foods associated with particular cultural groups.

cultural competence: having an awareness and acceptance of cultures and the ability to interact effectively with people of diverse cultures.

more likely to buy less-expensive store brand items and prepare home-cooked meals. In fact, more than 70 percent of meals are prepared in the home.⁵ Those who frequently prepare their own meals report more positive emotions and healthier food choices.⁶ They tend to eat fast food less often and are more likely to meet dietary guidelines for fat, calcium, fruits, vegetables, and whole grains. Not surprisingly, when eating out, consumers choose low-cost fast-food outlets over more expensive fine-dining restaurants. Foods eaten away from home, especially fast-food meals, tend to be high in calories, total fat, saturated fat, and *trans* fat—which can contribute to a variety of health problems.⁷

Unfortunately, healthful diets that include plenty of fruits and vegetables tend to be more costly than less healthful diets featuring foods containing solid fats and added sugars.⁸ These low-cost foods are often high in calories and low in nutrients.⁹ Consumers can improve the quality of their diets without increasing their spending by choosing more plant-based foods, such as nuts, legumes, and whole grains, and fewer refined grains, red and processed meats, and high-fat milk products.¹⁰

Positive and Negative Associations People tend to like particular foods associated with happy occasions—such as hot dogs at ball games or cake and ice cream at birthday parties. By the same token, people can develop aversions and dislike foods that they ate when they felt sick or that they were forced to eat in negative situations. Similarly, children learn to like and dislike certain foods when their parents use foods as rewards or punishments. Negative experiences can have long-lasting influences on food preferences. More than 50 years after World War II, veterans who had experienced intense combat in the Pacific dislike Chinese and Japanese food significantly more than their peers who were not engaged in battle or those who fought elsewhere.

Emotions Emotions guide food choices and eating behaviors.¹¹ Some people cannot eat when they are emotionally upset. Others may eat in response to a variety of emotional stimuli—for example, to relieve boredom or depression or to calm anxiety. A depressed person may choose to eat rather than to call a friend. A person who has returned home from an exciting evening out may unwind with a late-night snack. These people may find emotional comfort, in part, because foods can influence the brain's chemistry and the mind's response. Carbohydrates and alcohol, for example, tend to calm, whereas proteins and caffeine are more likely to stimulate. Eating in response to emotions and stress can easily lead to overeating and obesity, but it may be helpful at times. For example, sharing food at times of bereavement serves both the giver's need to provide comfort and the receiver's need to be cared for and to interact with others as well as to take nourishment.

Values Food choices may reflect people's religious beliefs, political views, or environmental concerns. For example, some Christians forgo meat on Fridays during Lent (the period prior to Easter), Jewish law includes an extensive set of dietary rules that govern the use of foods derived from animals, and Muslims fast between sunrise and sunset during Ramadan (the ninth month of the Islamic calendar). Some vegetarians select foods based on their concern for animal rights. A concerned consumer may boycott fruit picked by migrant workers who have been exploited. People may buy vegetables from local farmers to save the fuel and environmental costs of foods shipped from far away. They may also select foods packaged in containers that can be reused or recycled. Some consumers accept or reject foods that have been irradiated, grown organically, or genetically modified, depending on their approval of these processes (see Chapter and Highlight 19 for a complete discussion).



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To enhance your health, keep nutrition in mind when selecting foods. To protect the environment, shop at local markets and reuse cloth shopping bags.

Body Weight and Image Sometimes people select certain foods and supplements that they believe will improve their physical appearance and avoid those they believe might be detrimental. Such decisions can be beneficial when based on sound nutrition and fitness knowledge, but decisions based on fads or carried to extremes undermine good health, as pointed out in later discussions of eating disorders (Highlight 8) and dietary supplements commonly used by athletes (Highlight 14).

Nutrition and Health Benefits Finally, of course, many consumers make food choices they believe will improve their health.¹² Food manufacturers and restaurant chefs have responded to scientific findings linking health with nutrition by offering an abundant selection of health-promoting foods and beverages.¹³ Foods that provide health benefits beyond their nutrient contributions are called **functional foods**. Functional foods include whole foods as well as fortified, enriched, or enhanced foods.¹⁴ Whole foods—as natural and familiar as oatmeal or tomatoes—are the simplest functional foods. In some cases, foods have been modified to provide health benefits, perhaps by lowering the *trans* fat contents. In other cases, manufacturers have fortified foods by adding nutrients or **phytochemicals** that provide health benefits (see Highlight 13). Examples of these functional foods include orange juice fortified with calcium to help build strong bones and margarine made with a plant sterol that lowers blood cholesterol.

Consumers typically welcome new foods into their diets, provided that these foods are reasonably priced, clearly labeled, easy to find in the grocery store, and convenient to prepare. These foods must also taste good—as good as the traditional choices. Of course, a person need not eat any “special” foods to enjoy a healthy diet; many “regular” foods provide numerous health benefits as well. In fact, “regular” foods such as whole grains; vegetables and legumes; fruits; seafood, meats, poultry, eggs, nuts, and seeds; and milk products are among the healthiest choices a person can make.

› **REVIEW IT** Describe how various factors influence personal food choices.

A person selects foods for a variety of reasons. Whatever those reasons may be, food choices influence health. Individual food selections neither make nor break a diet’s healthfulness, but the balance of foods selected over time can make an important difference to health.¹⁵ For this reason, people are wise to think “nutrition” when making their food choices.



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Foods bring pleasure—and nutrients.

functional foods: foods that have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels.

phytochemicals (FIE-toe-KEM-ih-cals): nonnutrient compounds found in plants. Some phytochemicals have biological activity in the body.

• **phyto** = plant

energy: the capacity to do work. The energy in food is chemical energy. The body can convert this chemical energy to mechanical, electrical, or heat energy.

nutrients: chemical substances obtained from food and used in the body to provide energy, structural materials, and regulating agents to support growth, maintenance, and repair of the body’s tissues. Nutrients may also reduce the risks of some diseases.

1.2 The Nutrients

› **LEARN IT** Name the six major classes of nutrients and identify which are organic and which yield energy.

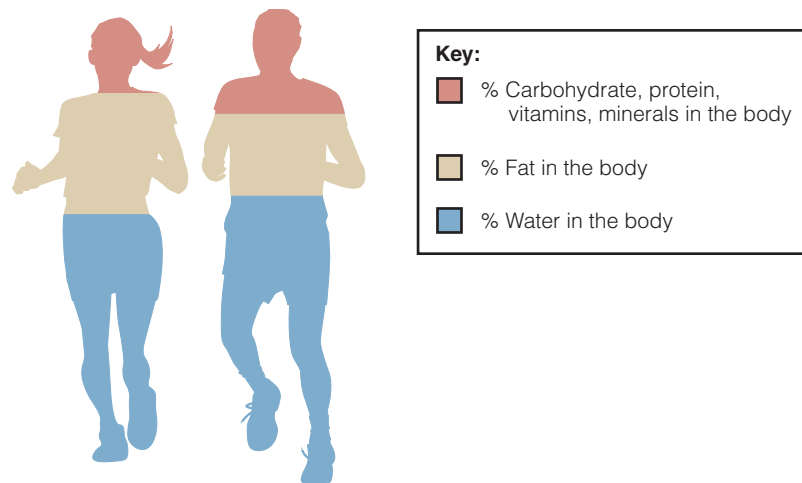
Biologically speaking, people eat to receive nourishment. Do you ever think of yourself as a biological being made of carefully arranged atoms, molecules, cells, tissues, and organs? Are you aware of the activity going on within your body even as you sit still? The atoms, molecules, and cells of your body continuously move and change, even though the structures of your tissues and organs and your external appearance remain relatively constant. The ongoing growth, maintenance, and repair of the body’s tissues depend on the **energy** and the **nutrients** received from foods.

Nutrients in Foods and in the Body Amazingly, our bodies can derive all the energy, structural materials, and regulating agents we need from the foods we eat. This section introduces the nutrients that foods deliver and shows how they participate in the dynamic processes that keep people alive and well.

Nutrient Composition of Foods Chemical analysis of a food such as a tomato shows that it is composed primarily of water (95 percent). Most of the solid materials are carbohydrates, lipids (fats), and proteins. If you could remove these materials, you would find a tiny residue of vitamins, minerals, and other

> FIGURE 1-1 Body Composition of Healthy-Weight Men and Women

The human body is made of compounds similar to those found in foods—mostly water (60 percent) and some fat (18 to 21 percent for young men, 23 to 26 percent for young women), with carbohydrate, protein, vitamins, minerals, and other minor constituents making up the remainder. (Chapter 8 describes the health hazards of too little or too much body fat.)



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compounds. Water, carbohydrates, lipids, proteins, vitamins, and some of the minerals found in foods represent the six classes of nutrients—substances the body uses for the growth, maintenance, and repair of its tissues.

This book focuses mostly on the nutrients, but foods contain other compounds as well—fibers, phytochemicals, pigments, additives, alcohols, and others. Some are beneficial, some are neutral, and a few are harmful. Later sections of the book touch on these compounds and their significance.

Nutrient Composition of the Body A chemical analysis of your body would show that it is made of materials similar to those found in foods (see Figure 1-1). A healthy 150-pound body contains about 90 pounds of water and about 20 to 45 pounds of fat. The remaining pounds are mostly protein, carbohydrate, and the major minerals of the bones. Vitamins, other minerals, and incidental extras constitute a fraction of a pound.

Chemical Composition of Nutrients The simplest of the nutrients are the minerals. Each mineral is a chemical element; its atoms are all alike. As a result, its identity never changes. For example, iron may have different electrical charges, but the individual iron atoms remain the same when they are in a food, when a person eats the food, when the iron becomes part of a red blood cell, when the cell is broken down, and when the iron is lost from the body by excretion. The next simplest nutrient is water, a compound made of two elements—hydrogen and oxygen. Minerals and water are **inorganic** nutrients—which means they do not contain carbon.

The other four classes of nutrients (carbohydrates, lipids, proteins, and vitamins) are more complex. In addition to hydrogen and oxygen, they all contain carbon, an element found in all living things; they are therefore called **organic** compounds (meaning, literally, “alive”).* This chemical definition of *organic* differs from the agricultural definition. As Chapter 19 explains, organic farming refers to growing crops and raising livestock according to standards set by the

inorganic: not containing carbon or pertaining to living organisms. The two classes of nutrients that are inorganic are minerals and water.

• **in** = not

organic: in chemistry, substances or molecules containing carbon-carbon bonds or carbon-hydrogen bonds that are characteristic of living organisms. The four classes of nutrients that are organic are carbohydrates, lipids (fats), proteins, and vitamins.

* Note that this definition of *organic* excludes coal, diamonds, and a few carbon-containing compounds that contain only a single carbon and no hydrogen, such as carbon dioxide (CO_2), calcium carbonate (CaCO_3), magnesium carbonate (MgCO_3), and sodium cyanide (NaCN).

TABLE 1-1 The Six Classes of Nutrients

Nutrient	Organic	Inorganic	Energy-yielding	Macronutrient	Micronutrient
Carbohydrates	✓		✓	✓	
Lipids (fats)	✓		✓	✓	
Proteins	✓		✓	✓	
Vitamins	✓				✓
Minerals		✓			✓
Water		✓			

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US Department of Agriculture (USDA). Protein and some vitamins also contain nitrogen and may contain other elements such as sulfur as well.

Essential Nutrients The body can make some nutrients, but it cannot make all of them. Also, it makes some in insufficient quantities to meet its needs and, therefore, must obtain these nutrients from foods. The nutrients that foods must supply are **essential nutrients**. When used to refer to nutrients, the word *essential* means more than just “necessary”; it means “needed from outside the body”—normally, from foods.

The Energy-Yielding Nutrients: Carbohydrate, Fat, and Protein

In the body, three of the organic nutrients can be used to provide energy: carbohydrate, fat, and protein. In contrast to these **energy-yielding nutrients**, vitamins, minerals, and water do not yield energy in the human body.

Carbohydrate, fat, and protein are sometimes called *macronutrients* because the body requires them in relatively large amounts (many grams daily). In contrast, vitamins and minerals are *micronutrients*, required only in small amounts (milligrams or micrograms daily). Table 1-1 summarizes some of the ways the six classes of nutrients can be described.

Energy Measured in kCalories The energy released from carbohydrates, fats, and proteins can be measured in **calories**—tiny units of energy so small that a single apple provides tens of thousands of them. To ease calculations, energy is expressed in 1000-calorie metric units known as kilocalories (shortened to calories, but commonly called “calories”). When you read in popular books or magazines that an apple provides “100 calories,” it actually means 100 kcalories. This book uses the term *kcalorie* and its abbreviation *kcal* throughout, as do other scientific books and journals. The “How To” on p. 9 provides a few tips on “thinking metric.”

Energy from Foods The amount of energy a food provides depends on how much carbohydrate, fat, and protein it contains. When completely broken down in the body, a gram of carbohydrate yields about 4 kcalories of energy; a gram of protein also yields 4 kcalories; and a gram of fat yields 9 kcalories (see Table 1-2).* The “How To” on p. 10 explains how to calculate the energy available from foods.

Because fat provides more energy per gram, it has a greater **energy density** than either carbohydrate or protein. Figure 1-2 on p. 10 compares the energy density of two breakfast options, and later chapters describe how foods with a high energy density help with weight *gain*, whereas those with a low energy density help with weight *loss*.

One other substance contributes energy—alcohol. Alcohol, however, is not considered a nutrient. Unlike the nutrients, alcohol does not sustain life. In fact, it interferes with the growth, maintenance, and repair of the body. Its only common characteristic with nutrients is that it yields energy (7 kcalories per gram) when metabolized in the body.

*For those using kilojoules: 1 g carbohydrate = 17 kJ; 1 g protein = 17 kJ; 1 g fat = 37 kJ; and 1 g alcohol = 29 kJ.

TABLE 1-2 kCalorie Values of Energy Nutrients

Nutrients	Energy
Carbohydrate	4 kcal/g
Fat	9 kcal/g
Protein	4 kcal/g

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NOTE: Alcohol contributes 7 kcal/g that can be used for energy, but it is not considered a nutrient because it interferes with the body’s growth, maintenance, and repair.

essential nutrients: nutrients a person must obtain from food because the body cannot make them for itself in sufficient quantity to meet physiological needs; also called *indispensable nutrients*. About 40 nutrients are currently known to be essential for human beings.

energy-yielding nutrients: the nutrients that break down to yield energy the body can use:

- Carbohydrate
- Fat
- Protein

calories: a measure of *heat* energy. Energy provided by foods and beverages is measured in *kilocalories* (1000 calories equal 1 kilocalorie), abbreviated *kcalories* or *kcal*. One kcalorie is the amount of heat necessary to raise the temperature of 1 kilogram (kg) of water 1°C. The scientific use of the term *kcalorie* is the same as the popular use of the term *calorie*.

energy density: a measure of the energy a food provides relative to the weight of the food (kcalories per gram).

>How To

Think Metric

Like other scientists, nutrition scientists use metric units of measure. They measure food energy in kilocalories, people's height in centimeters, people's weight in kilograms, and the weights of foods and nutrients in grams, milligrams, or micrograms. For ease in using these measures, it helps to remember that the prefixes imply 1000. For example, a *kilogram* is 1000 grams, a *milligram* is 1/1000 of a gram, and a *microgram* is 1/1000 of a milligram.

Most food labels and many recipes provide "dual measures," listing both

household measures, such as cups, quarts, and teaspoons, and metric measures, such as milliliters, liters, and grams. This practice gives people an opportunity to gradually learn to "think metric."

A person might begin to "think metric" by simply observing the measure—by noticing the amount of soda in a 2-liter bottle, for example. Through such experiences, a person can become familiar with a measure without having to do any conversions.

The international unit for measuring food energy is the joule—the amount of energy expended when 1 kilogram is moved 1 meter by a force of 1 newton. The joule is thus a

measure of work energy, whereas the calorie is a measure of heat energy. While many scientists and journals report their findings in kilojoules (kJ), many others, particularly those in the United States, use calories (kcal). To convert energy measures from calories to kilojoules, multiply by 4.2; to convert kilojoules to calories, multiply by 0.24. For example, a 50-kcalorie cookie provides 210 kilojoules:

$$50 \text{ kcal} \times 4.2 = 210 \text{ kJ}$$

Appendix K provides assistance and conversion factors for these and other units of measure.

Volume: Liters (L)

1 L = 1000 milliliters (mL)
0.95 L = 1 quart
1 mL = 0.03 fluid ounces
240 mL = 1 cup



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A liter of liquid is approximately one US quart. (Four liters are only about 5 percent more than a gallon.)



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One cup of liquid is about 240 milliliters; a half-cup of liquid is about 120 milliliters.

Weight: Grams (g)

1 g = 1000 milligrams (mg)
1 g = 0.04 ounce (oz)
1 oz = 28.35 g (or 30 g)
100 g = 3½ oz
1 kilogram (kg) = 1000 g
1 kg = 2.2 pounds (lb)
454 g = 1 lb



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A half-cup of vegetables weighs about 100 grams; one pea weighs about ½ gram.

A kilogram is slightly more than 2 lb; conversely, a pound is about ½ kg.



Stephen Barnes/Farming/Alamy

A 5-pound bag of potatoes weighs about 2 kilograms, and a 176-pound person weighs 80 kilograms.

> **TRY IT** Convert your body weight from pounds to kilograms and your height from inches to centimeters.

Most foods contain the energy-yielding nutrients, as well as vitamins, minerals, water, and other substances. For example, meat contains water, fat, vitamins, and minerals as well as protein. Bread contains water, a trace of fat, a little protein, and some vitamins and minerals in addition to its carbohydrate. Only a few foods are exceptions to this rule, the common ones being sugar (pure carbohydrate) and oil (essentially pure fat).