



SIZER • WHITNEY

NUTRITION

Concepts and Controversies



FOURTEENTH EDITION

Dietary Reference Intakes (DRI)

The Dietary Reference Intakes (DRI) include two sets of values that serve as goals for nutrient intake—Recommended Dietary Allowances (RDA) and Adequate Intakes (AI). The RDA reflect 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. AI values are more tentative than RDA, but both may be used as goals for nutrient intakes. (Chapter 2 provides more details.)

In addition to the values that serve as goals for nutrient intakes (presented in the tables on these two pages), the DRI include a set of values called Tolerable Upper Intake Levels (UL). The UL represent the maximum 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.

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

AGE (YR)	REFERENCE BMI (kg/m ²)	REFERENCE HEIGHT cm (in)	REFERENCE WEIGHT kg (lb)	WATER ^a AI (L/day)	ENERGY EER ^b (cal/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 RDA (g/kg/day)
MALES												
0–0.5	—	62 (24)	6 (13)	0.7 ^a	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 ^a	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: 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 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 9 and Appendix H 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 calories 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 calories per day for each year of age above 19.

SOURCE: Adapted from the Dietary Reference Intakes series, National Academies Press. Copyright 1997, 1998, 2000, 2001, 2002, 2004, 2005, 2011 by the National Academy 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 (IU/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	400 (10 µg)	4	2.0
0.5-1	0.3	0.4	4	6	1.8	0.3	80	0.5	150	50	500	400 (10 µg)	5	2.5
CHILDREN														
1-3	0.5	0.5	6	8	2	0.5	150	0.9	200	15	300	600 (15 µg)	6	30
4-8	0.6	0.6	8	12	3	0.6	200	1.2	250	25	400	600 (15 µg)	7	55
MALES														
9-13	0.9	0.9	12	20	4	1.0	300	1.8	375	45	600	600 (15 µg)	11	60
14-18	1.2	1.3	16	25	5	1.3	400	2.4	550	75	900	600 (15 µg)	15	75
19-30	1.2	1.3	16	30	5	1.3	400	2.4	550	90	900	600 (15 µg)	15	120
31-50	1.2	1.3	16	30	5	1.3	400	2.4	550	90	900	600 (15 µg)	15	120
51-70	1.2	1.3	16	30	5	1.7	400	2.4	550	90	900	600 (15 µg)	15	120
>70	1.2	1.3	16	30	5	1.7	400	2.4	550	90	900	800 (20 µg)	15	120
FEMALES														
9-13	0.9	0.9	12	20	4	1.0	300	1.8	375	45	600	600 (15 µg)	11	60
14-18	1.0	1.0	14	25	5	1.2	400	2.4	400	65	700	600 (15 µg)	15	75
19-30	1.1	1.1	14	30	5	1.3	400	2.4	425	75	700	600 (15 µg)	15	90
31-50	1.1	1.1	14	30	5	1.3	400	2.4	425	75	700	600 (15 µg)	15	90
51-70	1.1	1.1	14	30	5	1.5	400	2.4	425	75	700	600 (15 µg)	15	90
>70	1.1	1.1	14	30	5	1.5	400	2.4	425	75	700	800 (20 µg)	15	90
PREGNANCY														
≤18	1.4	1.4	18	30	6	1.9	600	2.6	450	80	750	600 (15 µg)	15	75
19-30	1.4	1.4	18	30	6	1.9	600	2.6	450	85	770	600 (15 µg)	15	90
31-50	1.4	1.4	18	30	6	1.9	600	2.6	450	85	770	600 (15 µg)	15	90
LACTATION														
≤18	1.4	1.6	17	35	7	2.0	500	2.8	550	115	1200	600 (15 µg)	19	75
19-30	1.4	1.6	17	35	7	2.0	500	2.8	550	120	1300	600 (15 µg)	19	90
31-50	1.4	1.6	17	35	7	2.0	500	2.8	550	120	1300	600 (15 µg)	19	90

NOTE: For all nutrients, values for infants are AI. The table on page Y 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. Pregnant or lactating girls ages 14-18 also need 15 micrograms vitamin D per day.

^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.

Tolerable Upper Intake Levels (UL) for Vitamins

AGE (YR)	NIACIN (mg/day) ^a	VITAMIN B ₆ (mg/day) ^a	FOLATE (µg/day) ^a	CHOLINE (mg/day)	VITAMIN C (mg/day)	VITAMIN A (µg/day) ^b	VITAMIN D (IU/day)	VITAMIN E (mg/day) ^c
INFANTS								
0–0.5	—	—	—	—	—	600	1000 (25 µg)	—
0.5–1	—	—	—	—	—	600	1500 (38 µg)	—
CHILDREN								
1–3	10	30	300	1000	400	600	2500 (63 µg)	200
4–8	15	40	400	1000	650	900	3000 (75 µg)	300
9–13	20	60	600	2000	1200	1700	4000 (100 µg)	600
ADOLESCENTS								
14–18	30	80	800	3000	1800	2800	4000 (100 µg)	800
ADULTS								
19–70	35	100	1000	3500	2000	3000	4000 (100 µg)	1000
>70	35	100	1000	3500	2000	3000	4000 (100 µg)	1000
PREGNANCY								
≤18	30	80	800	3000	1800	2800	4000 (100 µg)	800
19–50	35	100	1000	3500	2000	3000	4000 (100 µg)	1000
LACTATION								
≤18	30	80	800	3000	1800	2800	4000 (100 µg)	800
19–50	35	100	1000	3500	2000	3000	4000 (100 µg)	1000

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

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

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

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: A UL 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. Copyright 1997, 1998, 2000, 2001, 2002, 2005, 2011 by the National Academy of Sciences.



SIZER • WHITNEY

NUTRITION

Concepts and Controversies

FOURTEENTH EDITION



Australia • Brazil • Mexico • Singapore • United Kingdom • United States

This is an electronic version of the print textbook. Due to electronic rights restrictions, some third party content may be suppressed. Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. The publisher reserves the right to remove content from this title at any time if subsequent rights restrictions require it. For valuable information on pricing, previous editions, changes to current editions, and alternate formats, please visit www.cengage.com/highered to search by ISBN#, author, title, or keyword for materials in your areas of interest.

Important Notice: Media content referenced within the product description or the product text may not be available in the eBook version.

**Nutrition: Concepts & Controversies,
Fourteenth Edition**
Frances Sienkiewicz Sizer and Ellie Whitney

Product Manager: Krista Mastroianni
Content Developer: Miriam Myers
Product Assistant: Victor Luu
Marketing Manager: Tom Ziolkowski
Content Project Manager: Carol Samet
Art Director: Michael Cook
Manufacturing Planner: Karen Hunt
Production Service: Heidi Allgair,
Cenveo® Publisher Services
Photo Researcher: Lumina Datamatics
Text Researcher: Lumina Datamatics
Text Designer: Tani Hasegawa, Michael Cook
Cover Designer: Michael Cook
Cover Image: Dave Le/Moment/Getty Images
Compositor: Cenveo® Publisher Services

© 2017, 2014, Cengage Learning

WCN: 02-200-203

ALL RIGHTS RESERVED. No part of this work covered by the copyright herein may be reproduced or distributed in any form or by any means, except as permitted by U.S. copyright law, without the prior written permission of the copyright owner.

For product information and technology assistance, contact us at
Cengage Learning Customer & Sales Support, 1-800-354-9706.

For permission to use material from this text or product,
submit all requests online at **www.cengage.com/permissions.**

Further permissions questions can be e-mailed to
permissionrequest@cengage.com.

Library of Congress Control Number: 2015936118

ISBN: 978-1-305-62799-4

Loose-leaf Edition:

ISBN: 978-1-305-63938-6

Cengage Learning

20 Channel Center Street
Boston MA 02210
USA

Cengage Learning is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at **www.cengage.com.**

Cengage Learning products are represented in Canada by Nelson Education, Ltd.

To learn more about Cengage Learning Solutions, visit **www.cengage.com.**

Purchase any of our products at your local college store or at our preferred online store **www.cengagebrain.com.**

About the Authors

Frances Sienkiewicz Sizer

M.S., R.D.N., F.A.N.D., attended Florida State University where, in 1980, she received her B.S., and in 1982 her M.S., in nutrition. She is certified as a charter Fellow of the Academy of Nutrition and Dietetics. She is a founding member and vice president of Nutrition and Health Associates, an information and resource center in Tallahassee, Florida, that maintains an ongoing bibliographic database tracking research in more than 1,000 topic areas of nutrition. Her textbooks include *Life Choices: Health Concepts and Strategies*; *Making Life Choices*; *The Fitness Triad: Motivation, Training, and Nutrition*; and others. She also authored *Nutrition Interactive*, an instructional college-level nutrition CD-ROM that pioneered the animation of nutrition concepts in college classrooms. She consults with an advisory board of professors from around the nation, and attends workshops on innovations in nutrition education. She has lectured at universities and at national and regional conferences and supports local hunger and homelessness relief organizations in her community.

To my family, near
and far, and especially to
Joan Spencer Webb.

—Fran

Eleanor Noss Whitney

Ph.D., received her B.A. in biology from Radcliffe College in 1960 and her Ph.D. in biology from Washington University, St. Louis, in 1970. Formerly on the faculty at Florida State University and a dietitian registered with the Academy of Nutrition and Dietetics, she now devotes full time to research, writing, and consulting in nutrition, health, and environmental issues. Her earlier publications include articles in *Science*, *Genetics*, and other journals. Her textbooks include *Understanding Nutrition*, *Understanding Normal and Clinical Nutrition*, *Nutrition and Diet Therapy*, and *Essential Life Choices* for college students and *Making Life Choices* for high school students. Her most intense interests presently include energy conservation, solar energy uses, alternatively fueled vehicles, and ecosystem restoration. She is an activist who volunteers full-time for the Citizens Climate Lobby.

To Max, Zoey, Emily, Rebecca,
Kalijah, and Duchess with
love.

—Ellie



Brief Contents

Preface xvii

- 1 Food Choices and Human Health 1**
- 2 Nutrition Tools—Standards and Guidelines 31**
- 3 The Remarkable Body 70**
- 4 The Carbohydrates: Sugar, Starch, Glycogen, and Fiber 113**
- 5 The Lipids: Fats, Oils, Phospholipids, and Sterols 160**
- 6 The Proteins and Amino Acids 201**
- 7 The Vitamins 240**
- 8 Water and Minerals 292**
- 9 Energy Balance and Healthy Body Weight 343**
- 10 Performance Nutrition 389**
- 11 Diet and Health 428**
- 12 Food Safety and Food Technology 470**
- 13 Life Cycle Nutrition: Mother and Infant 516**
- 14 Child, Teen, and Older Adult 558**
- 15 Hunger and the Future of Food 599**

Appendixes A-1

Glossary GL-1

Index IN-1

Contents

Preface xvii

CHAPTER 1

Food Choices and Human Health 1

A Lifetime of Nourishment 2

The Diet and Health Connection 3

Genetics, Nutrition, and Individuality 4

Other Lifestyle Choices 4

THINK FITNESS: Why Be Physically Active? 5

Healthy People: Nutrition Objectives for the Nation 5

The Human Body and Its Food 6

Meet the Nutrients 7

Can I Live on Just Supplements? 8

The Challenge of Choosing Foods 9

The Abundance of Foods to Choose From 9

How, Exactly, Can I Recognize a Nutritious Diet? 11

Why People Choose Foods 12

The Science of Nutrition 14

The Scientific Approach 14

Scientific Challenge 14

Can I Trust the Media to Deliver Nutrition News? 17

National Nutrition Research 17

MY TURN: Lose Weight While You Sleep! 17

Changing Behaviors 18

The Process of Change 18

CONSUMER'S GUIDE TO: Reading Nutrition News 19

Taking Stock and Setting Goals 20

Start Now 20

FOOD FEATURE: How Can I Get Enough Nutrients Without Consuming Too Many Calories? 21

Concepts in Action: Track Your Diet 22

Self Check 23

CONTROVERSY 1: Sorting the Imposters from the Real Nutrition Experts 24

CHAPTER 2

Nutrition Tools—Standards and Guidelines 31

Nutrient Recommendations 32

Dietary Reference Intakes 32

The DRI Lists and Purposes 33

Understanding the DRI Recommended Intakes 34

How the Committee Establishes DRI Values—An RDA Example 35

Determining Individual Requirements 36

Setting Energy Requirements 36

Why Are Daily Values Used on Labels? 37

Dietary Guidelines for Americans 37

Diet Planning with the USDA Eating Patterns 39

THINK FITNESS: Recommendations for Daily Physical Activity 42

The Food Groups and Subgroups 42

Choosing Nutrient-Dense Foods 43



Norman Chan/Shutterstock.com

Diet Planning Application 44

MyPlate Educational Tool 46

MY TURN: Right Size—Supersize? 46

Flexibility of the USDA Eating Patterns 47

CONSUMER'S GUIDE TO: Controlling Portion Sizes at Home and Away 48

Food Lists for Diabetes and Weight Management 50

The Last Word on Diet Planning 51

Checking Out Food Labels 51

What Food Labels Must Include 51

What Food Labels *May* Include 54

FOOD FEATURE: Getting a Feel for the Nutrients in Foods 57

Concepts in Action: Compare Your Intakes with USDA Guidelines 60

Self Check 61

CONTROVERSY 2: Are Some Foods Superfoods for Health? 62

CHAPTER 3

The Remarkable Body 70

The Body's Cells 71

Genes Control Functions 72

Cells, Tissues, Organs, Systems 73

The Body Fluids and the Cardiovascular System 74

The Hormonal and Nervous Systems 76

What Do Hormones Have to Do with Nutrition? 76

How Does the Nervous System Interact with Nutrition? 77

The Immune System 79

Immune Defenses 79

Inflammation 80

The Digestive System 80

Why Do People Like Sugar, Salt, and Fat? 80

The Digestive Tract 81

The Mechanical Aspect of Digestion 83

The Chemical Aspect of Digestion 85

Microbes in the Digestive Tract 87

Are Some Food Combinations More Easily Digested Than Others? 87

If "I Am What I Eat," Then How Does a Peanut Butter Sandwich Become "Me"? 89

Absorption and Transport of Nutrients 90

A Letter from Your Digestive Tract 92

The Excretory System 96

Storage Systems 96

When I Eat More Than My Body Needs, What Happens to the Extra Nutrients? 97

Variations in Nutrient Stores 97

Conclusion 97

Self Check 98

MY TURN: I Am What I Drink 99

CONTROVERSY 3: Alcohol: Do the Benefits Outweigh the Risks? 100

CHAPTER 4

The Carbohydrates: Sugar, Starch, Glycogen, and Fiber 113

A Close Look at Carbohydrates 114

Sugars 115

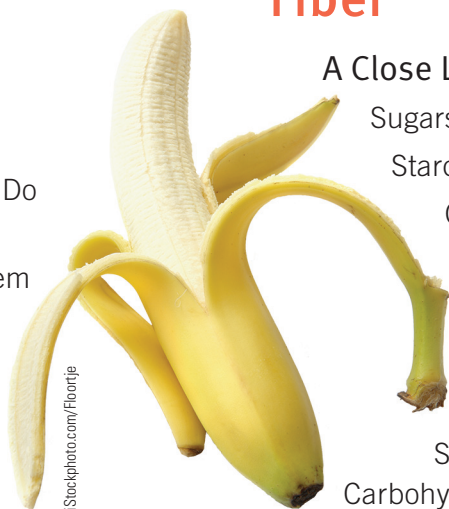
Starch 117

Glycogen 117

Fibers 117

The Need for Carbohydrates 119

If I Want to Lose Weight and Stay Healthy, Should I Avoid Carbohydrates? 119



Why Do Nutrition Experts Recommend Fiber-Rich Foods?	120
Fiber Intakes and Excesses	125
Whole Grains	127
From Carbohydrates to Glucose	128
Digestion and Absorption of Carbohydrate	129
CONSUMER'S GUIDE TO: Finding Whole-Grain Foods	130
Why Do Some People Have Trouble Digesting Milk?	134
The Body's Use of Glucose	135
Splitting Glucose for Energy	135
How Is Glucose Regulated in the Body?	136
Excess Glucose and Body Fatness	137
THINK FITNESS: What Can I Eat to Make Workouts Easier?	139
The Glycemic Index of Food	140
Diabetes	141
The Dangers of Diabetes	141
Prediabetes and the Importance of Testing	142
Type 1 Diabetes	142
Type 2 Diabetes	143
Medical Nutrition Therapy	144
MY TURN: 21st-Century Epidemic?	144
Physical Activity	146
If I Feel Dizzy between Meals, Do I Have Hypoglycemia?	146
Conclusion	147
FOOD FEATURE: Finding the Carbohydrates in Foods	147
Concepts in Action: Analyze Your Carbohydrate Intake	152
Self Check	153
CONTROVERSY 4: Are Added Sugars "Bad" for You?	154

CHAPTER 5

The Lipids: Fats, Oils, Phospholipids, and Sterols 160

Introducing the Lipids	161
How Are Fats Useful to the Body?	161
How Are Fats Useful in Food?	163
A Close Look at Lipids	164
Triglycerides: Fatty Acids and Glycerol	164
Saturated vs. Unsaturated Fatty Acids	165
Phospholipids and Sterols	167
Lipids in the Body	168
How Are Fats Digested and Absorbed?	168
Transport of Fats	169
Storing and Using the Body's Fat	171
Dietary Fat, Cholesterol, and Health	172
Recommendations for Lipid Intakes	172
Lipoproteins and Heart Disease Risk	174
What Does <i>Food</i> Cholesterol Have to Do with <i>Blood</i> Cholesterol?	176
Recommendations Applied	176
THINK FITNESS: Why Exercise the Body for the Health of the Heart?	177
Essential Polyunsaturated Fatty Acids	178
Why Do I Need Essential Fatty Acids?	178
Omega-6 and Omega-3 Fatty Acid Families	178
Health Effects of Omega-3 Fatty Acids	179
Where Are the Omega-3 Fatty Acids in Foods?	180
The Effects of Processing on Unsaturated Fats	181
CONSUMER'S GUIDE TO: Weighing Seafood's Risks and Benefits	182

What Is “Hydrogenated Vegetable Oil,”
and What’s It Doing in My Chocolate Chip
Cookies? 183

What Are *Trans*-Fatty Acids, and Are They
Harmful? 184

MY TURN: Heart to Heart 184

Fat in the Diet 185

Get to Know the Fats in Foods 185

Fats in Protein Foods 186

Milk and Milk Products 187

Grains 188

FOOD FEATURE: Defensive Dining 189

Concepts in Action: Analyze Your Lipid
Intake 194

Self Check 195

**CONTROVERSY 5: Is Butter Really Back? The
Lipid Guidelines Debate** 196

CHAPTER 6

The Proteins and Amino Acids 201

The Structure of Proteins 202

Amino Acids 202

How Do Amino Acids Build Proteins? 204

The Variety of Proteins 204

Denaturation of Proteins 207

**THINK FITNESS: Can Eating Extra Protein Make
Muscles Grow Stronger?** 209

Digestion and Absorption of Dietary Protein 209

Protein Digestion 209

What Happens to Amino
Acids after Protein Is
Digested? 210

The Importance of Protein 212

The Roles of Body
Proteins 212

iStockphoto.com/only_fabrizio



Providing Energy and Glucose 215

The Fate of an Amino Acid 217

**CONSUMER’S GUIDE TO: Evaluating Protein
and Amino Acid Supplements** 218

Food Protein: Need and Quality 219

How Much Protein Do People Need? 219

Nitrogen Balance 220

MY TURN: Veggin’ Out 221

Protein Quality 222

Protein Deficiency and Excess 224

What Happens When People Consume Too
Little Protein? 224

Is It Possible to Consume Too Much
Protein? 224

Is a Gluten-Free Diet Best for
Health? 225

**FOOD FEATURE: Getting Enough but Not
Too Much Protein** 226

Concepts in Action: Analyze Your Protein
Intake 230

Self Check 231

**CONTROVERSY 6: Vegetarian and Meat-
Containing Diets: What Are the Benefits and
Pitfalls?** 232

CHAPTER 7

The Vitamins 240

Definition and Classification of Vitamins 242

The Concept of Vitamin Precursors 242

Two Classes of Vitamins: Fat-Soluble
and Water-Soluble 242

The Fat-Soluble Vitamins 243

Vitamin A 244

Roles of Vitamin A
and Consequences of
Deficiency 244

Vitamin A Toxicity 246
Vitamin A Recommendations
and Sources 247
Beta-Carotene 248

**MY TURN: Take Your
Vitamins? 249**



Vitamin D 249

Roles of Vitamin D 250
Too Little Vitamin D—A Danger to
Bones 250
Too Much Vitamin D—A Danger to Soft
Tissues 252
Vitamin D from Sunlight 253
Vitamin D Intake Recommendations 254
Vitamin D Food Sources 254

Vitamin E 255

Roles of Vitamin E 255
Vitamin E Deficiency 255
**CONSUMER'S GUIDE TO: Sources of
Vitamin D 256**
Toxicity of Vitamin E 257
Vitamin E Recommendations and U.S.
Intakes 257
Vitamin E Food Sources 257

Vitamin K 258

Roles of Vitamin K 258
Vitamin K Deficiency 259
Vitamin K Toxicity 259
Vitamin K Requirements and Sources 259

The Water-Soluble Vitamins 260

Vitamin C 260

THINK FITNESS: Vitamins for Athletes 261
The Roles of Vitamin C 261
Deficiency Symptoms and Intakes 262
Vitamin C Toxicity 262
Vitamin C Recommendations 263
Vitamin C Food Sources 263

The B Vitamins in Unison 264

B Vitamin Roles in Metabolism 265
B Vitamin Deficiencies 265

The B Vitamins as Individuals 266

Thiamin 266

Riboflavin Roles 268

Niacin 269

Folate 269

Vitamin B₁₂ 272

Vitamin B₆ 273

Biotin and Pantothenic Acid 275

Non-B Vitamins 275

**FOOD FEATURE: Choosing Foods Rich
in Vitamins 280**

Concepts in Action: Analyze Your Vitamin
Intake 283

Self Check 284

**CONTROVERSY 7: Vitamin Supplements:
What Are the Benefits and Risks? 285**

CHAPTER 8

Water and Minerals 292

Water 294

Why Is Water the Most Indispensable
Nutrient? 295

The Body's Water Balance 296

Quenching Thirst and Balancing Losses 296

How Much Water Do I Need to Drink
in a Day? 298

CONSUMER'S GUIDE TO: Liquid Calories 299

Drinking Water: Types, Safety, and Sources 301

Hard Water or Soft Water—Which Is
Best? 301

Safety of Public Water 301

Water Sources 302

Body Fluids and Minerals 304

Water Follows Salt 304
Fluid and Electrolyte Balance 305
Acid-Base Balance 305

The Major Minerals 305

Calcium 305
Phosphorus 308

MY TURN: Drink Your Milk! 309

Magnesium 310
Sodium 312
Potassium 316
Chloride 317
Sulfate 317

The Trace Minerals 318

Iodine 318
Iron 319

THINK FITNESS: Exercise-Deficiency Fatigue 321

Zinc 324
Selenium 326
Fluoride 326
Chromium 327
Copper 328
Other Trace Minerals and Some Candidates 328

FOOD FEATURE: Meeting the Need for Calcium 331



Robyn Mackenzie/Shutterstock.com

Concepts in Action: Analyze Your Calcium Intakes 333

Self Check 334

CONTROVERSY 8: Osteoporosis: Can Lifestyle Choices Reduce the Risk? 335

CHAPTER 9

Energy Balance and Healthy Body Weight 343

The Problems of Too Little or Too Much Body Fat 344

What Are the Risks from Underweight? 345

What Are the Risks from Too Much Body Fat? 345

What Are the Risks from Central Obesity? 346

How Fat Is Too Fat? 347

The Body's Energy Balance 349

Energy In and Energy Out 349

How Many Calories Do I Need Each Day? 349

Estimated Energy Requirements (EER) 351

The DRI Method of Estimating Energy Requirements 351

Body Weight vs. Body Fatness 352

Using the Body Mass Index (BMI) 352

Measuring Body Composition and Fat Distribution 352

How Much Body Fat Is Ideal? 353

The Appetite and Its Control 354

Hunger and Appetite—"Go" Signals 354

Satiation and Satiety—"Stop" Signals 356

Inside-the-Body Theories of Obesity 358

MY TURN: How Many Calories? 359

Outside-the-Body Theories of Obesity 359

THINK FITNESS: Activity for a Healthy Body Weight 361

How the Body Loses and Gains Weight 362

The Body's Response to Energy Deficit 362

The Body's Response to Energy Surplus 364

Achieving and Maintaining a Healthy Body Weight 365

CONSUMER'S GUIDE TO: Fad Diets 367

What Food Strategies Are Best for Weight Loss? 369

Physical Activity in Weight Loss and Maintenance 372

What Strategies Are Best for Weight Gain? 373

Medical Treatment of Obesity 374

Obesity Medications 374

Obesity Surgery 374

Herbal Products and Gimmicks 376

Once I've Changed My Weight, How Can I Stay Changed? 377

Conclusion 378

FOOD FEATURE: Behavior Modification for Weight Control 379

Concepts in Action: Analyze Your Energy Balance 381

Self Check 382

CONTROVERSY 9: The Perils of Eating Disorders 383

CHAPTER 10 Performance Nutrition 389

The Benefits of Fitness 390

The Nature of Fitness 390

Physical Activity Guidelines 392

The Essentials of Fitness 393



How Do Muscles Adapt to Physical Activity? 394

How Does Aerobic Training Benefit the Heart? 395

THINK FITNESS: Exercise Safety 396

Three Energy Systems 396

The Muscles' Energy Reservoir 397

The Anaerobic Energy System 398

The Aerobic Energy System 398

The Active Body's Use of Fuels 399

The Need for Food Energy 399

Glucose: A Major Fuel for Physical Activity 400

Other Factors Affecting Glycogen 402

MY TURN: How Much Is Enough? 403

Carbohydrate Recommendations for Athletes 403

Lipid Fuel for Physical Activity 404

Protein for Building Muscles and for Fuel 406

How Much Protein Should an Athlete Consume? 407

Vitamins and Minerals—Keys to Performance 408

Do Nutrient Supplements Benefit Athletic Performance? 408

Iron—A Mineral of Concern 409

Fluids and Temperature Regulation in Physical Activity 410

Water Losses during Physical Activity 410

Fluid and Electrolyte Needs during Physical Activity 411

Sodium Depletion and Water Intoxication 412

CONSUMER'S GUIDE TO: Selecting Sports Drinks 413

Other Beverages 414

Putting It All Together 415

FOOD FEATURE: Choosing a Performance Diet 416

Concepts in Action: Analyze Your Diet and Activities 420

Self Check 421

CONTROVERSY 10: Ergogenic Aids: Breakthroughs, Gimmicks, or Dangers? 422

CONSUMER'S GUIDE TO: Deciding about CAM 450

How Does Cancer Develop? 453

Which Diet Factors Affect Cancer Risk? 455

Conclusion 458

FOOD FEATURE: The DASH Diet: Preventive Medicine 459

Concepts in Action: Analyze Your Diet for Health Promotion 462

Self Check 463

CONTROVERSY 11: Nutritional Genomics: Can It Deliver on Its Promises? 464

**CHAPTER 11
Diet and Health 428**

The Immune System, Nutrition, and Diseases 430

The Effects of Malnutrition 430

The Immune System and Chronic Diseases 432

The Concept of Risk Factors 433

Cardiovascular Diseases 435

Atherosclerosis 436

Risk Factors for CVD 437

THINK FITNESS: Ways to Include Physical Activity in a Day 441

Recommendations for Reducing CVD Risk 442

Nutrition and Hypertension 444

How Does Blood Pressure Work in the Body? 445

Risk Factors for Hypertension 446

How Does Nutrition Affect Hypertension? 446

MY TURN: Fast-Food Generation? 448

Nutrition and Cancer 449

**CHAPTER 12
Food Safety and Food Technology 470**

Microbes and Food Safety 472

How Do Microbes in Food Cause Illness in the Body? 472

Food Safety from Farm to Plate 473

Safe Food Practices for Individuals 477

Which Foods Are Most Likely to Cause Illness? 481

Protein Foods 482

Raw Produce 484

Other Foods 485

Advances in Microbial Food Safety 487

Is Irradiation Safe? 488

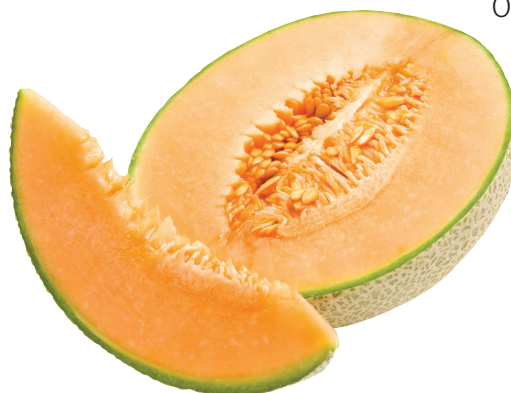
Other Technologies 489

Toxins, Residues, and Contaminants in Foods 490

Natural Toxins in Foods 490

Pesticides 491

CONSUMER'S GUIDE TO: Understanding Organic Foods 493



Viktor Malyshev/Shutterstock.com

MY TURN: Organic: Does It Matter? 495	Some Cautions for the Pregnant Woman 530
Animal Drugs—What Are the Risks? 495	
Environmental Contaminants 497	Drinking during Pregnancy 532
Are Food Additives Safe? 499	Alcohol's Effects 532
Regulations Governing Additives 500	Fetal Alcohol Syndrome 533
Additives to Improve Safety and Quality 500	Experts' Advice 534
Flavoring Agents 501	Troubleshooting 534
Fat Replacers and Artificial Fats 504	Diabetes 534
Incidental Food Additives 504	Hypertension 535
	Preeclampsia 535
Conclusion 505	Lactation 535
FOOD FEATURE: Processing and the Nutrients in Foods 505	MY TURN: Bringing Up Baby 536
Self Check 508	Nutrition during Lactation 536
CONTROVERSY 12: Genetically Engineered Foods: What Are the Pros and Cons? 509	When Should a Woman Not Breastfeed? 537
	Feeding the Infant 538
CHAPTER 13	Nutrient Needs 538
Life Cycle Nutrition: Mother and Infant 516	Why Is Breast Milk So Good for Babies? 540
Pregnancy: The Impact of Nutrition on the Future 517	Formula Feeding 542
Preparing for Pregnancy 517	CONSUMER'S GUIDE TO: Formula Advertising versus Breastfeeding Advocacy 543
The Events of Pregnancy 519	An Infant's First Solid Foods 544
Increased Need for Nutrients 521	Looking Ahead 547
Food Assistance Programs 526	FOOD FEATURE: Mealtimes with Infants 548
How Much Weight Should a Woman Gain during Pregnancy? 526	Concepts in Action: Analyze the Adequacy of a Diet for Pregnancy 549
Weight Loss after Pregnancy 527	Self Check 550
Should Pregnant Women Be Physically Active? 528	CONTROVERSY 13: Childhood Obesity and Early Chronic Diseases 551
Teen Pregnancy 528	
THINK FITNESS: Physical Activities for the Pregnant Woman 529	CHAPTER 14
Why Do Some Women Crave Pickles and Ice Cream While Others Can't Keep Anything Down? 529	Child, Teen, and Older Adult 558
	Early and Middle Childhood 559
	Feeding a Healthy Young Child 559
	Mealtimes and Snacking 563

How Do Nutrient Deficiencies Affect a Child's Brain? 566

The Problem of Lead 567

Food Allergy, Intolerance, and Aversion 568

Can Diet Make a Child Hyperactive? 571

Dental Caries 572

Is Breakfast Really the Most Important Meal of the Day for Children? 573

How Nourishing Are the Meals Served at School? 573

Nutrition in Adolescence 574

Nutrient Needs 576

Common Concerns 577

Eating Patterns and Nutrient Intakes 578

The Later Years 578

CONSUMER'S GUIDE TO: Nutrition for PMS Relief 579

Nutrition in the Later Years 581

Energy, Activity, and the Muscles 581

Protein Needs 582

THINK FITNESS: Benefits of Physical Activity for the Older Adult 583

Carbohydrates and Fiber 583

Fats and Arthritis 583

Vitamin Needs 584

Water and the Minerals 585

Can Nutrition Help People to Live Longer? 587

Immunity and Inflammation 588

Can Foods or Supplements Affect the Course of Alzheimer's Disease? 588

Food Choices of Older Adults 589

FOOD FEATURE: Single Survival and Nutrition on the Run 590

MY TURN: Eating Solo 591



iStockphoto.com/marm081

Concepts in Action: Analyze Three Diets 592

Self Check 593

CONTROVERSY 14: Nutrient–Drug Interactions: Who Should Be Concerned? 594

CHAPTER 15

Hunger and the Future of Food 599

U.S. Food Insecurity 600

Food Poverty in the United States 600

What U.S. Food Programs Address Low Food Security? 602

World Poverty and Hunger 604

The Malnutrition of Extreme Poverty 606

Hidden Hunger—Vitamin and Mineral Deficiencies 606

Two Faces of Childhood Malnutrition 607

Rehabilitation 608

The Future Food Supply and the Environment 608

Threats to the Food Supply 609

Fisheries and Food Waste 610

MY TURN: How Responsible Am I? 611

How Can People Help? 612

Government Action 612

Private and Community Enterprises 613

Educators and Students 613

Food and Nutrition Professionals 613

Individuals 613

Conclusion 613

CONSUMER'S GUIDE TO: Making "Green" Choices (Without Getting "Greenwashed") 614

Self Check 616

CONTROVERSY 15: How Can We Feed Ourselves Sustainably? 617

Appendixes

- A Table of Food Composition A-3
- B Dietary Guidelines B-1
- C Aids to Calculations C-1
- D Food Lists for Diabetes and Weight Management D-1
- E Eating Patterns to Meet the Dietary Guidelines for Americans E-1
- F Notes F-1

- G Answers to Chapter Questions G-1
- H Physical Activity Levels and Energy Requirements H-1
- I Chemical Structures: Carbohydrates, Lipids, and Amino Acids I-1

Glossary GL-1

Index IN-1

Preface

A billboard in Louisiana reads, “Come as you are. Leave different,” meaning that once you’ve seen, smelled, tasted, and listened to Louisiana, you’ll never be the same. This book extends the same invitation to its readers: come to nutrition science as you are, with all of the knowledge and enthusiasm you possess, with all of your unanswered questions and misconceptions, and with the habits and preferences that now dictate what you eat.

But leave different. Take with you from this study a more complete understanding of nutrition science. Take a greater ability to discern between nutrition truth and fiction, to ask sophisticated questions, and to find the answers. Finally, take with you a better sense of how to feed yourself in ways that not only please you and soothe your spirit but nourish your body as well.

For over 35 years, *Nutrition: Concepts and Controversies* has been a cornerstone of nutrition classes across North America, serving the needs of students and professors. In keeping with our tradition, in this, our 14th edition, we continue exploring the ever-changing frontier of nutrition science, confronting its mysteries through its scientific roots. We maintain our sense of personal connection with instructors and learners alike, writing for them in the clear, informal style that has become our trademark.

Pedagogical Features

Throughout these chapters, features tickle the reader’s interest and inform. For both verbal and visual learners, our logical presentation and our lively figures keep interest high and understanding at a peak. The photos that adorn many of our pages add pleasure to reading.

Many tried-and-true features return in this edition: Each chapter begins with What Do You Think? questions to pique interest. What Did You Decide? at the chapter’s end asks readers to draw conclusions. A list of Learning Objectives (LO) offers a preview of the chapter’s major goals, and the LO reappear under section headings to make clear the main take-away messages. Do the Math margin features challenge readers to solve nutrition problems, with examples provided. My Turn features invite the reader to hear stories from students in nutrition classes around the nation offer solutions to real-life situations. Think Fitness reminders alert readers to links among nutrition, fitness, and health. Food Feature sections act as bridges between theory and practice; they are practical applications of the chapter concepts. The consumer sections,

entitled A Consumer’s Guide To . . . , lead readers through an often bewildering marketplace with scientific clarity, preparing them to move ahead with sound marketplace decisions. Each Consumer’s Guide ends with review questions to improve recall of the main points.

By popular demand, we have retained our Snapshots of vitamins and minerals, which now reflect the 2015 Daily Values. These concentrated capsules of information depict food sources of vitamins and minerals, present DRI values, and offer the chief functions of each nutrient along with deficiency and toxicity symptoms.

New or major terms are defined in the margins of chapter pages or in nearby tables, and they also appear in the Glossary at the end of the book. The reader who wishes to locate any term can quickly do so by consulting the Index, which lists the page numbers of definitions in boldface type.

Two useful features close each chapter. First, our popular Concepts in Action diet and exercise tracking activities integrate chapter concepts with the Diet & Wellness Plus program. The second is the indispensable Self Check that provides study questions, with answers in Appendix G to provide immediate feedback to the learner.

Controversies

The Controversies of this book’s title invite you to explore beyond the safe boundaries of established nutrition knowledge. These optional readings, which appear at the end of each chapter, delve into current scientific topics and emerging controversies. These fast-changing topics are relevant to nutrition science today.

Chapter Contents

Chapter 1 begins the text with a personal challenge to students. It asks the question so many people ask of nutrition educators—“Why should people care about nutrition?” We answer with a lesson in the ways in which nutritious foods affect diseases and present a continuum of diseases from purely genetic in origin to those almost totally preventable by nutrition. After presenting some beginning facts about the genes, nutrients, bioactive food components, and nature of foods, the chapter goes on to present the *Healthy People* goals for the nation. It concludes with a discussion of scientific research and quackery.

Chapter 2 brings together the concepts of nutrient standards, such as the Dietary Reference Intakes, and diet planning using the Dietary Guidelines for



Workmans Photos/
Shutterstock.com

Americans 2015–2020. Chapter 3 presents a thorough, but brief, introduction to the workings of the human body from the genes to the organs, with major emphasis on the digestive system and its microbiota. Chapters 4–6 are devoted to the energy-yielding nutrients—carbohydrates, lipids, and protein. Controversy 4 has renewed its focus on theories and fables surrounding the health effects of added sugars in the diet. Controversy 5, new to this edition, considers the scientific debate surrounding lipid guidelines.

Chapters 7 and 8 present the vitamins, minerals, and water. Chapter 9 relates energy balance to body composition, obesity, and underweight and provides guidance on lifelong weight maintenance. Chapter 10 presents the relationships among physical activity, athletic performance, and nutrition, with some guidance about products marketed to athletes. Chapter 11 applies the essence of the first 10 chapters to disease prevention.

Chapter 12 delivers urgently important concepts of food safety. It also addresses the usefulness and safety of food additives, including artificial sweeteners and artificial fats, and explains the widely varying effects of processing on nutrients in foods. Chapters 13 and 14 emphasize the importance of nutrition through the life span, with issues surrounding childhood obesity in Controversy 13. Chapter 14 includes nutrition advice for feeding preschoolers, schoolchildren, teens, and the elderly.

Chapter 15 devotes attention to hunger and malnutrition, both in the United States and throughout the world. It also touches on the vast network of problems that threaten the future food supply, and explores sustainable diets as part of the solution.

Our Message to You

Our purpose in writing this text, as always, is to enhance our readers' understanding of nutrition science. We also hope the information on this book's pages will reach beyond the classroom into our readers' lives. Take the information you find inside this book home with you. Use it in your life: nourish yourself, educate your loved ones, and nurture others to be healthy. Stay up with the news, too—for despite all the conflicting messages, inflated claims, and even quackery that abound in the marketplace, true nutrition knowledge progresses with a genuine scientific spirit, and important new truths are constantly unfolding.

New to This Edition

Every section of each chapter of this text reflects the changes in nutrition science occurring since the last edition. The changes range from subtle shifts of emphasis to entirely new sections that demand our attention. Appendix F supplies current references; older references may be viewed in previous editions, available from the publisher.

Chapter 1

- New introductory section on water.
- Defines *NHANES*.
- Defines *registered dietitian nutritionist (RDN)*.

- Condensed and enhanced Tables C1–2 and C1–3.
- Condensed Tables C1–5 and C1–6.

Chapter 2

- Integration of the Dietary Guidelines for Americans 2015–2020.
- New table of shortfall and overconsumed nutrients.
- Defines *empty calories*.
- Introduces the American Diabetes Association's *Choose Your Foods* lists.
- New figure of dining-out trends.
- Updated labeling discussion and new figure to illustrate proposed changes to the Nutrition Facts Panel.
- Newly approved Daily Values used in inside back cover, figures, and discussions.
- New front of package labeling information and figure.
- New phytochemical Point/Counterpoint table.

Chapter 3

- Clarified Figure 3–4.
- New section to introduce microbiota of the intestinal tract.
- New table of definitions of common digestive disorders.
- New Point/Counterpoint table summarizing issues of alcohol and health.

Chapter 4

- Expanded coverage of the health effects of fermentable fibers and their products.
- New coverage and table of the glycemic index.
- New nutrition guidelines for diabetes.
- New section on relationship between obesity and diabetes.
- Updated table of diabetes diagnostic criteria.
- New figure illustrating sugar alcohols on a label.
- New table of added sugar intake through the life span.
- New coverage of added sugars and blood pressure.
- New Point/Counterpoint table on the health effects of added sugars.

Chapter 5

- Expanded coverage of dietary fat and satiety.
- Updated lipid intake recommendations.
- New emphasis on fat sources in Mediterranean eating patterns.
- Updated presentation of fast food choices.
- New figure explaining the Supplement Facts panel of a fish oil supplement.
- New Do the Math feature on percentages of fat in ground meats.
- New practical tips for consuming fish and seafood in Food Feature.
- New Controversy on scientific debate surrounding lipid guidelines, concluding with new eating patterns approach.
- New Point, Counterpoint table on lipid guidelines debate.

Chapter 6

- Expanded section on gluten-free diets, celiac disease, and gluten sensitivity.

- New discussion of protein labeling.
- New figure highlighting protein labeling.
- New Point/Counterpoint table on vegetarian and meat-containing diets.

Chapter 7

- Introduces the role of obesity in vitamin D deficiency.
- New table highlighting current research on the role of vitamin D in disease.
- New Daily Values for vitamins reflected in the Snapshots.
- New explanation of food fortification with B vitamins.
- New Point/Counterpoint table on arguments for and against dietary supplements.

Chapter 8

- New sports-drink labeling figure in Consumer's Guide.
- New Daily Values for minerals throughout the Snapshots.
- Revised and updated graph on sodium intakes of U.S. adults.
- Revised and updated graph on calcium sources in the U.S. diet.
- New presentation of lifetime plan for healthy bones.
- New Point/Counterpoint table on arguments for and against calcium supplements.

Chapter 9

- New table on underweight, overweight, and obesity in U.S. adults.
- New table presents American College of Cardiology/American Heart Association Task Force Guidelines.
- New coverage of intermittent fasting for weight control.
- Updated table of eating patterns for weight loss to reflect recent research and reviews.
- New figure and text coverage of calorie labels on restaurant menus.
- New section on potential benefits and risks, including nutrient deficiency risks, of obesity surgery.
- Added Contrave and Saxenda information.
- New discussion of the idea of binge eating as addiction.

Chapter 10

- New table on benefits of fitness.
- New discussion of exercise factors as molecular links between physical activity and health.
- Condensed and reorganized fitness sections.
- New major section on the body's three energy systems that support physical activity.
- Explains the "train low, compete high" theory.
- Expanded coverage of protein intakes for athletes.
- New table of protein-rich snacks for athletes.
- New coverage of vitamin D for athletes.
- Added DMAA and DMBA as unsafe supplements for athletes.

Chapter 11

- Enhanced the table of selected nutrients' roles in immune function.

- Newly revised tables of recommendations and strategies to reduce the risk of CVD and recommendations and strategies to reduce the risk of cancer.
- Emphasizes the role of obesity as a major risk factor for other chronic diseases throughout the chapter.
- New information related to the 2013 American College of Cardiology/American Heart Association guidelines for assessment of CVD risk and lifestyle modifications for reducing the risk of heart disease.
- New emphasis on risks and benefits of alternative therapies.
- New figure summarizing the relationship between risks and benefits.

Chapter 12

- Updated hand washing figure to reflect new guidelines.
- New table on how to wash produce.
- New figure depicting imported food in the U.S. diet.
- Updated figure on organic food labels.
- New table on natural toxins.
- New discussion of arsenic in apple juice and rice.
- New discussion of artificial sweeteners and GI flora.

Chapter 13

- New discussion of choline during pregnancy.
- New table of complications associated with smoking during pregnancy.
- New discussion of the importance of zinc in complementary foods for breastfed infants.
- Restructured and simplified table of nutrient supplements for infants.
- Reorganized Controversy 13.
- New table of physical complications of obesity during childhood.
- New figure demonstrating how to read a growth chart.
- New figure of sleep, screen time, and obesity in children.

Chapter 14

- Updated energy intake needs for children.
- New table of healthy snack ideas from each food group.
- Updated USDA Eating Pattern calorie intakes for children.
- New figure of physical symptoms of lead toxicity in children.
- New discussion on vitamin D and PMS.
- Increased coverage of dietary protein and muscle protein synthesis in the elderly.
- Caffeine information from the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee*.

Chapter 15

- Title change reflects current trends in sustainability research.
- New table of U.S. food security terms.
- New figure of expenditures for U.S. food programs.
- Reorganized world hunger and malnutrition section.
- New figure on mid-upper arm circumference.
- Defines *wasting*, *stunting*, and *marasmic kwashiorkor*.

Appendixes:

Appendix D: Presents the 2014 Food Lists for Diabetes and Weight Management.

Appendix E: Presents Eating Patterns recommended by the 2015–2020 Dietary Guidelines for Americans: Healthy U.S.-Style, Healthy Vegetarian, and Healthy Mediterranean-Style, and support materials for the Mediterranean diet.

Appendix H: Offers tables and figures to support physical activity.

Appendix I: New appendix of selected nutrient chemical structures.

Ancillary Materials

Students and instructors alike will appreciate the innovative teaching and learning materials that accompany this text.

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 75,000 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.

Acknowledgments

Our thanks to our partners Linda Kelly DeBruyne and Sharon Rolfes for decades of support. Thank you, Spencer Webb, RD, CSCS, for your guidance in Chapter 10 (and for getting us into shape, too). Thank you, K. Autumn Ehsaei, R.D.N., for generating our orderly endnote lists. And to Kathy Guilday, the Queen of Minutiae, many heartfelt thanks for your meticulous work and cheerful nature.

We are also grateful to the nutrition professionals who updated sections of this edition.

- Linda DeBruyne, M.S., R.D.N. (Chapter 11 and Chapter 13). Linda received her master's degree in nutrition from Florida State University and is a founding member of Nutrition and Health Associates. She also coauthors the college nutrition texts *Nutrition and Diet Therapy* and *Nutrition for Health and Health Care*.
- Crystal Clark Douglas, Ph.D., R.D.N./L.D.N. (Controversy 13 and Chapter 14). Crystal holds a doctoral degree in nutrition sciences from the University of Alabama at Birmingham and is the coauthor of multiple peer-reviewed publications. After teaching nutrition at Florida State University, she has maintained her professional skills working as a clinical dietitian and continuing to write on topics in nutrition.
- Shannon Dooies Gower-Winter, M.S., R.D.N./L.D.N. (Controversy 2, Chapter 7, and Chapter 8). Shannon graduated from Florida State University with her master's degree in nutrition. She has taught nutrition at Florida State University and lectured on topics related to childhood nutrition throughout the state. She currently conducts research in the area of nutritional neuroscience, where her work focuses on various roles of zinc in the brain. Her research has been presented at regional and national scientific conferences, and she has coauthored multiple articles in peer-reviewed journals.

Our special thanks to our publishing team—Miriam Myers, Heidi Allgair, and Carol Samet—for their hard work and dedication to excellence. Thank you to our marketing manager, Tom Ziolkowski, for ensuring that our text finds the hands of its readers.

We would also like to thank Chimborazo Publishing, Inc. for their work on the student and instructor ancillaries for the 14th edition, which includes the test bank, instructor's manual, and PowerLecture.

Reviewers of Recent Editions

As always, we are grateful for the instructors who took the time to comment on this revision. Your suggestions were invaluable in strengthening the book and suggesting new lines of thought. We hope you will continue to provide your comments and suggestions.

Alex Kojo Anderson, *University of Georgia, Athens*
Sharon Antonelli, *San Jose City College*
L. Rao Ayyagari, *Lindenwood University*

James W. Bailey, *University of Tennessee*
Ana Barreras, *Central New Mexico Community College*
Karen Basinger, *Montgomery College*
Leah Carter, *Bakersfield College*
Melissa Chabot, *SUNY at Buffalo*
Janet Colson, *Middle Tennessee State University*
Priscilla Connors, *University of North Texas*
Karen Davidowitz Corbin, *The Translational Research Institute
for Metabolism and Diabetes*
Monica L. Easterling, *Wayne County Community College District*
Katie Faulk, *Pacific Oregon University*
Shannon Gower-Winter, *Florida State University*
Jena Nelson Hall, *Butte Community College*
Charlene G. Harkins, *University of Minnesota, Duluth*
Sharon Anne Himmelstein, *Central New Mexico Community College*
Rachel Johnson, *University of Vermont*
Judy Kaufman, *Monroe Community College*
David Lightsey, *Bakersfield College*
Craig Meservey, *New Hampshire Technical Institute*

Liza Marie Mohanty, *Olive-Harvey College*
Eimear M. Mullen, *Northern Kentucky University*
Suzanne Linn Nelson, *University of Colorado at Boulder*
Steven Nizielski, *Grand Valley State University*
Carmen Nochera, *Grand Valley State University*
David J. Pavlat, *Central College*
Begoña Cirera Perez, *Chabot College*
Cydne Perry, *Shepherd University*
Liz Quintana, *West Virginia University*
Janice M. Rueda, *Wayne State University*
Donal Scheidel, *University of South Dakota*
Carole A. Sloan, *Henry Ford Community College*
Leslie S. Spencer, *Rowan University*
Ilene Sutter, *California State University, Northridge*
Sue Ellen Warren, *El Camino College*
Barbara P. Zabitz, *Wayne County Community College
District*
Joseph Zielinski, *SUNY at Brockport*
Nancy Zwick, *Northern Kentucky University*

1

Food Choices and Human Health

what do you think?

Can your diet make a real difference between getting sick or staying healthy?

Are supplements more powerful than food for ensuring good nutrition?

What makes your favorite foods your favorites?

Are news and media nutrition reports informative or confusing?

Learning Objectives

After reading this chapter, you should be able to accomplish the following:

- LO 1.1** Discuss the impact of food choices on a person's health.
- LO 1.2** List seven major categories of nutrition and weight-related objectives included in the publication *Healthy People 2020*.
- LO 1.3** Specify the six classes of nutrients.
- LO 1.4** Recognize the challenges and solutions to choosing a health-promoting diet.
- LO 1.5** Describe the science of nutrition.
- LO 1.6** Explain the significance of behavior change in improving a person's diet.
- LO 1.7** Discuss the importance of nutrient density in creating an effective diet plan.
- LO 1.8** Evaluate the authenticity of nutrition information sources.



Jack Frog/Shutterstock.com

When you choose foods with nutrition in mind, you can enhance your own well-being.

food medically, any substance that the body can take in and assimilate that will enable it to stay alive and to grow; the carrier of nourishment; socially, a more limited number of such substances defined as acceptable by each culture.

nutrition the study of the nutrients in foods and in the body; sometimes also the study of human behaviors related to food.

diet the foods (including beverages) a person usually eats and drinks.

nutrients components of food that are indispensable to the body's functioning. They provide energy, serve as building material, help maintain or repair body parts, and support growth. The nutrients include water, carbohydrate, fat, protein, vitamins, and minerals.

If you care about your body, and if you have strong feelings about **food**, then you have much to gain from learning about **nutrition**—the science of how food nourishes the body. Nutrition is a fascinating, much talked-about subject. Each day, newspapers, Internet websites, radio, and television present stories of new findings on nutrition and heart health or nutrition and cancer prevention, and at the same time, advertisements and commercials bombard us with multicolored pictures of tempting foods—pizza, burgers, cakes, and chips. If you are like most people, when you eat you sometimes wonder, “Is this food good for me?” or you berate yourself, “I probably shouldn’t be eating this.”

When you study nutrition, you learn which foods serve you best, and you can work out ways of choosing foods, planning meals, and designing your **diet** wisely. Knowing the facts can enhance your health and your enjoyment of eating while relieving your feelings of guilt or worry that you aren’t eating well.

This chapter addresses these “why,” “what,” and “how” questions about nutrition:

- *Why* care about nutrition? Why be concerned about the **nutrients** in your foods? Why not just take supplements?
- *What* are the nutrients in foods, and what roles do they play in the body? What are the differences between vitamins and minerals?
- *What* constitutes a nutritious diet? How can you choose foods wisely, for nutrition's sake? What factors motivate your choices?
- *How* do we know what we know about nutrition? How does nutrition science work, and how can a person keep up with changing information?

Controversy 1 concludes the chapter by offering ways to distinguish between trustworthy sources of nutrition information and those that are less reliable.

A Lifetime of Nourishment

LO 1.1 Discuss the impact of food choices on a person's health.

If you live for 65 years or longer, you will have consumed more than 70,000 meals, and your remarkable body will have disposed of 50 tons of food. The foods you choose most often have cumulative effects on your body.^{1*} As you age, you will see and feel those effects—if you know what to look for.

Your body renews its structures continuously, and each day, it builds a little muscle, bone, skin, and blood, replacing old tissues with new. It may also add a little fat if

*Reference notes are found in Appendix F.

you consume excess food energy (calories) or subtract a little if you consume less than you require. Some of the food you eat today becomes part of “you” tomorrow.

The best food for you, then, is the kind that supports the growth and maintenance of strong muscles, sound bones, healthy skin, and sufficient blood to cleanse and nourish all parts of your body. This means you need food that provides not only the right amount of energy but also sufficient nutrients—that is, enough water, carbohydrates, fats, protein, vitamins, and minerals. If the foods you eat provide too little or too much of any nutrient today, your health may suffer just a little today. If the foods you eat provide too little or too much of one or more nutrients every day for years, then in later life you may suffer severe disease effects.

A well-chosen diet supplies enough energy and enough of each nutrient to prevent **malnutrition**. Malnutrition includes deficiencies, imbalances, and excesses of nutrients, alone or in combination, any of which can take a toll on health over time.

KEY POINTS

- The nutrients in food support growth, maintenance, and repair of the body.
- Deficiencies, excesses, and imbalances of energy and nutrients bring on the diseases of malnutrition.

The Diet and Health Connection

Your choice of diet profoundly affects your health, both today and in the future. Only two common lifestyle habits are more influential: smoking and using other forms of tobacco and drinking alcohol in excess. Of the leading causes of death listed in Table 1–1, four—heart disease, cancers, strokes, and diabetes—are directly related to nutrition, and another—accidents—is related to drinking alcohol.

Many older people suffer from debilitating conditions that could have been largely prevented had they known and applied the nutrition principles known today. The **chronic diseases**—heart disease, diabetes, some kinds of cancer, dental disease, and adult bone loss—all have a connection to poor diet. These diseases cannot be prevented by a good diet alone; they are to some extent determined by a person’s genetic constitution, activities, and lifestyle. Within the range set by your genetic

Table 1–1

Leading Causes of Death in the United States

	Percentage of Total Deaths
1. Heart disease	23.7
2. Cancers	22.9
3. Chronic lung diseases	5.7
4. Strokes	5.1
5. Accidents	4.9
6. Alzheimer’s disease	3.4
7. Diabetes mellitus	2.9
8. Pneumonia and influenza	2.1
9. Kidney disease	1.8
10. Suicide	1.5

Note: The diseases highlighted in bold have relationships with diet.

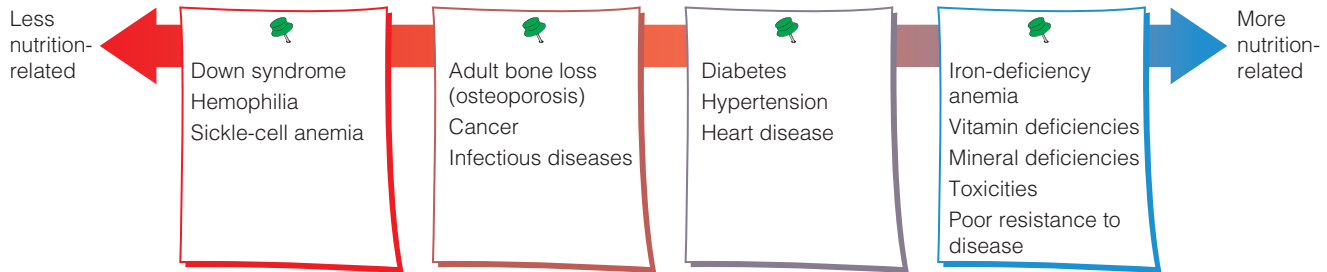
Source: J. Xu and coauthors, *Mortality in the United States, 2012*, NCHS Data Brief 168, October 2014.

malnutrition any condition caused by excess or deficient food energy or nutrient intake or by an imbalance of nutrients. Nutrient or energy deficiencies are forms of undernutrition; nutrient or energy excesses are forms of overnutrition.

chronic diseases degenerative conditions or illnesses that progress slowly, are long in duration, and lack an immediate cure; chronic diseases limit functioning, productivity, and the quality and length of life. Examples include heart disease, cancer, and diabetes.

Figure 1-1**Nutrition and Disease**

Not all diseases are equally influenced by diet. Some are almost purely genetic, like the anemia of sickle-cell disease. Some may be inherited (or the tendency to develop them may be inherited in the genes) but may be influenced by diet, like some forms of diabetes. Some are purely dietary, like the vitamin and mineral deficiency diseases.



inheritance, however, the likelihood of developing these diseases is strongly influenced by your daily choices.

KEY POINT

- Nutrition profoundly affects health.

Genetics, Nutrition, and Individuality

Consider the role of genetics. Genetics and nutrition affect different diseases to varying degrees (see Figure 1-1). The **anemia** caused by sickle-cell disease, for example, is purely hereditary and thus appears at the left of Figure 1-1 as a genetic condition largely unrelated to nutrition. Nothing a person eats affects the person's chances of contracting this anemia, although nutrition therapy may help ease its course. At the other end of the spectrum, iron-deficiency anemia most often results from undernutrition. Diseases and conditions of poor health appear all along this continuum, from almost entirely genetically based to purely nutritional in origin; the more nutrition-related a disease or health condition is, the more successfully sound nutrition can prevent it.

Furthermore, some diseases, such as heart disease and cancer, are not one disease but many. Two people may both have heart disease but not the same form; one person's cancer may be nutrition-related, but another's may not be. Individual people differ genetically from each other in thousands of subtle ways, so no simple statement can be made about the extent to which diet can help any one person avoid such diseases or slow their progress.

The identification of the human **genome** establishes the entire sequence of the **genes** in human **DNA**. This work has, in essence, revealed the body's instructions for making all of the working parts of a human being. The human genome is 99.9% the same in all people; all of the normal variations such as differences in hair color, as well as variations that result in diseases such as sickle-cell anemia, lie in the 0.1% of the genome that varies. Nutrition scientists are working quickly to apply this new wealth of knowledge to benefit human health. Later chapters expand on the emerging story of nutrition and the genes.

KEY POINTS

- Diet influences long-term health within the range set by genetic inheritance.
- Nutrition has little influence on some diseases but strongly affects others.

Other Lifestyle Choices

Besides food choices, other lifestyle choices affect people's health. Tobacco use and alcohol and other substance abuse can destroy health. Physical activity, sleep, emotional stress, and other environmental factors can also modify the severity of some diseases.

anemia a blood condition in which red blood cells, the body's oxygen carriers, are inadequate or impaired and so cannot meet the oxygen demands of the body.

genome (GEE-nome) the full complement of genetic information in the chromosomes of a cell. In human beings, the genome consists of about 35,000 genes and supporting materials. The study of genomes is *genomics*. Also defined in the Controversy section of Chapter 11.

genes units of a cell's inheritance; sections of the larger genetic molecule DNA (deoxyribonucleic acid). Each gene directs the making of one or more of the body's proteins.

DNA an abbreviation for deoxyribonucleic (dee-OX-ee-RYE-bow-nu-CLAY-ick) acid, the thread-like molecule that encodes genetic information in its structure; DNA strands coil up densely to form the chromosomes (Chapter 3 provides more details).

Why should people bother to be physically active? A person's daily food choices can powerfully affect health, but the combination of nutrition and physical activity is more powerful still. People who combine regular physical activity with a nutritious diet can expect to receive at least some of these benefits:

- Reduced risks of cardiovascular diseases, diabetes, certain cancers, hypertension, and other diseases.
- Increased endurance, strength, and flexibility.
- More cheerful outlook and less likelihood of depression.
- Improved mental functioning.
- Feeling of vigor.
- Feeling of belonging—the companionship of sports.
- Stronger self-image.
- Reduced body fat and increased lean tissue.
- A more youthful appearance, healthy skin, and improved muscle tone.
- Greater bone density and lessened risk of adult bone loss in later life.
- Increased independence in the elderly.
- Sound, beneficial sleep.
- Faster wound healing.
- Reduced menstrual symptoms.
- Improved resistance to infection.

If even half of these benefits were yours for the asking, wouldn't you step up to claim them? In truth, they are yours to claim, at the price of including physical activity in your day. Chapter 10 explores the topics of fitness and physical activity.

start now! → Ready to make a change? Go to Diet & Wellness Plus online and track your physical activities—all of them—for three days. (The Concepts in Action activity at the end of this chapter will use this information.) After you have recorded your activities, see how much time you spent exercising at a moderate to vigorous level. Could you increase your level and amount of activity?

Physical activity is so closely linked with nutrition in supporting health that most chapters of this book offer a feature called Think Fitness, such as the one above.

KEY POINT

- Life choices, such as being physically active or using tobacco or alcohol, can improve or damage health.

Healthy People: Nutrition Objectives for the Nation

LO 1.2 List seven major categories of nutrition and weight-related objectives included in the publication *Healthy People 2020*.

In its publication *Healthy People*, the U.S. Department of Health and Human Services sets specific 10-year objectives to guide national health promotion efforts.² The vision of *Healthy People 2020* is a society in which all people live long, healthy lives. Table 1–2 (p. 6) provides a quick scan of the nutrition and weight-related objectives set for this decade. The inclusion of nutrition and food-safety objectives shows that public health officials consider these areas to be top national priorities.

In 2015, the nation's health report was mixed: the number of adults meeting physical activity and muscle strengthening guidelines increased from 18 percent to over 20 percent of the population, but most people's diets still lacked enough vegetables, and obesity rates were creeping higher among people aged two years and older.³ To fully meet the current *Healthy People* goals, our nation must take steps to change its habits.

The next section shifts our focus to the nutrients at the core of nutrition science. As your course of study progresses, the individual nutrients will become like old friends, revealing more and more about themselves as you move through the chapters.

KEY POINT

- Each decade, the U.S. Department of Health and Human Services sets health and nutrition objectives for the nation.



The aim of Healthy People 2020 is to help people live long, healthy lives.

Table 1–2

Healthy People 2020, Selected Nutrition and Body Weight Objectives

Many other Objectives for the Nation are available at www.healthypeople.gov.

Chronic Diseases
<ul style="list-style-type: none"> Reduce the proportion of adults with osteoporosis.
<ul style="list-style-type: none"> Reduce the death rates from cancer, diabetes, heart disease, and stroke.
<ul style="list-style-type: none"> Reduce the annual number of new cases of diabetes.
Food Safety
<ul style="list-style-type: none"> Reduce outbreaks of certain infections transmitted through food.
<ul style="list-style-type: none"> Reduce severe allergic reactions to food among adults with diagnosed food allergy.
Maternal, Infant, and Child Health
<ul style="list-style-type: none"> Reduce the number of low birthweight infants and preterm births.
<ul style="list-style-type: none"> Increase the proportion of infants who are breastfed.
<ul style="list-style-type: none"> Reduce the occurrence of fetal alcohol syndrome (FAS).
<ul style="list-style-type: none"> Reduce iron deficiency among children, adolescents, women of childbearing age, and pregnant women.
<ul style="list-style-type: none"> Reduce blood lead levels in children.
<ul style="list-style-type: none"> Increase the number of schools offering breakfast.
Food and Nutrient Consumption
<ul style="list-style-type: none"> Increase vegetables, fruits, and whole grains in the diets of those aged 2 years and older, and reduce solid fats and added sugars.
Eating Disorders
<ul style="list-style-type: none"> Reduce the proportion of adolescents who engage in disordered eating behaviors in an attempt to control their weight.
Physical Activity and Weight Control
<ul style="list-style-type: none"> Increase the proportion of children, adolescents, and adults who are at a healthy weight.
<ul style="list-style-type: none"> Reduce the proportions of children, adolescents, and adults who are obese.
<ul style="list-style-type: none"> Reduce the proportion of people who engage in no leisure-time physical activity.
<ul style="list-style-type: none"> Increase the proportion of schools that require daily physical education for all students.
Food Security
<ul style="list-style-type: none"> Eliminate very low food security among children in U.S. households.

Source: www.healthypeople.gov.

The Human Body and Its Food

LO 1.3 Specify the six classes of nutrients.

As your body moves and works each day, it must use **energy**. The energy that fuels the body's work comes indirectly from the sun by way of plants. Plants capture and store the sun's energy in their tissues as they grow. When you eat plant-derived foods such as fruits, grains, or vegetables, you obtain and use the solar energy they

energy the capacity to do work. The energy in food is chemical energy; it can be converted to mechanical, electrical, thermal, or other forms of energy in the body. Food energy is measured in calories, defined on page 8.

Table 1–3

Elements in the Six Classes of Nutrients

The nutrients that contain carbon are organic.

	Carbon	Oxygen	Hydrogen	Nitrogen	Minerals
Carbohydrate	✓	✓	✓		
Fat	✓	✓	✓		
Protein	✓	✓	✓	✓	^b
Vitamins	✓	✓	✓	✓ ^a	^b
Minerals					✓
Water		✓	✓		

^aAll of the B vitamins contain nitrogen; amine means nitrogen.

^bProtein and some vitamins contain the mineral sulfur; vitamin B₁₂ contains the mineral cobalt.

have stored. Plant-eating animals obtain their energy in the same way, so when you eat animal tissues, you are eating compounds containing energy that came originally from the sun.

The body requires six kinds of nutrients—families of molecules indispensable to its functioning—and foods deliver these. Table 1–3 lists the six classes of nutrients. Four of these six are **organic**; that is, the nutrients contain the element carbon derived from living things.

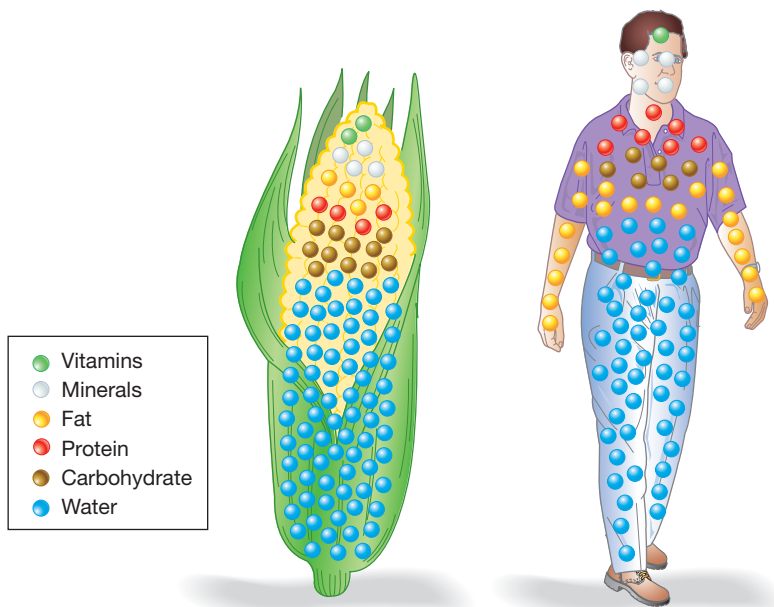
Meet the Nutrients

The human body and foods are made of the same materials, arranged in different ways (see Figure 1–2). When considering quantities of foods and nutrients, scientists often measure them in **grams**, units of weight.

Figure 1–2

Components of Food and the Human Body

Foods and the human body are made of the same materials.



organic carbon containing. Four of the six classes of nutrients are organic: carbohydrate, fat, protein, and vitamins. Organic compounds include only those made by living things and do not include compounds such as carbon dioxide, diamonds, and a few carbon salts.

grams units of weight. A gram (g) is the weight of a cubic centimeter (cc) or milliliter (ml) of water under defined conditions of temperature and pressure. About 28 grams equal an ounce.

Table 1–4

Calorie Values of Energy-Yielding Nutrients

The energy a person consumes in a day's meals comes from these three energy-yielding nutrients; alcohol, if consumed, also contributes energy.

Energy Nutrient	Energy
Carbohydrate	4 cal/g
Fat (lipid)	9 cal/g
Protein	4 cal/g

Note: Alcohol contributes 7 cal/g that the human body can use for energy. Alcohol is not classed as a nutrient, however, because it interferes with growth, maintenance, and repair of body tissues.

energy-yielding nutrients the nutrients the body can use for energy—carbohydrate, fat, and protein. These also may supply building blocks for body structures. Also called *macronutrients*.

essential nutrients the nutrients the body cannot make for itself (or cannot make fast enough) from other raw materials; nutrients that must be obtained from food to prevent deficiencies.

calories units of energy. In nutrition science, the unit used to measure the energy in foods is a kilocalorie (also called *kcalorie* or *Calorie*): it is the amount of heat energy necessary to raise the temperature of a kilogram (a liter) of water 1 degree Celsius. This book follows the common practice of using the lowercase term *calorie* (abbreviated *cal*) to mean the same thing.

The Energy-Yielding Nutrients Of the four organic nutrients, three are **energy-yielding nutrients**, meaning that the body can use the energy they contain. The carbohydrates and fats (fats are also called lipids) are especially important energy-yielding nutrients. As for protein, it does double duty: it can yield energy, but it also provides materials that form structures and working parts of body tissues. (Alcohol yields energy, too—see the note to Table 1–4).

Vitamins and Minerals The fourth and fifth classes of nutrients are the vitamins and the minerals, sometimes referred to as *miconutrients* because they are present in tiny amounts. These provide no energy to the body. A few minerals serve as parts of body structures (calcium and phosphorus, for example, are major constituents of bone), but all vitamins and minerals act as regulators. As regulators, the vitamins and minerals assist in all body processes: digesting food; moving muscles; disposing of wastes; growing new tissues; healing wounds; obtaining energy from carbohydrate, fat, and protein; and participating in every other process necessary to maintain life. Later chapters are devoted to these six classes of nutrients.

Water Although last on the list, water is foremost in quantity among the six classes of nutrients. The body constantly loses water, mainly through sweat, breath, and urine, and that water must constantly be replaced. Without sufficient water, the body's cells cannot function.

The Concept of Essential Nutrients When you eat food, then, you are providing your body with energy and nutrients. Furthermore, some of the nutrients are **essential nutrients**, meaning that if you do not ingest them, you will develop deficiencies; the body cannot make these nutrients for itself. Essential nutrients are found in all six classes of nutrients. Water is an essential nutrient; so is a form of carbohydrate; so are some lipids, some parts of protein, all of the vitamins, and the minerals important in human nutrition.

Calorie Values Food scientists measure food energy in kilocalories, units of heat. This book uses the common word **calories** to mean the same thing. It behooves the person who wishes to control food energy intake and body fatness to learn the calorie values of the energy nutrients, listed in Table 1–4. The most energy-rich of the nutrients is fat, which contains 9 calories in each gram. Carbohydrate and protein each contain only 4 calories in a gram. Weight, measure, and other conversion factors needed for the study of nutrition are found in Appendix C at the back of the book.

Scientists have worked out ways to measure the energy and nutrient contents of foods. They have also calculated the amounts of energy and nutrients various types of people need—by gender, age, life stage, and activity. Thus, after studying human nutrient requirements (in Chapter 2), you will be able to state with some accuracy just what your own body needs—this much water, that much carbohydrate, so much vitamin C, and so forth. So why not simply take pills or **dietary supplements** in place of food? Because, as it turns out, food offers more than just the six basic nutrients.

KEY POINTS

- The energy-yielding nutrients are carbohydrates, fats (lipids), and protein.
- The regulator nutrients are vitamins and minerals.
- Foremost among the nutrients in food is water.
- Essential nutrients in the diet prevent deficiencies.
- Food energy is measured in calories; nutrient quantities are often measured in grams.

Can I Live on Just Supplements?

Nutrition science can state what nutrients human beings need to survive—at least for a time. Scientists are becoming skilled at making **elemental diets**—life-saving liquid diets of precise chemical composition for hospital patients and others who cannot eat ordinary food. These formulas, administered for days or weeks, support not only continued life but also recovery from nutrient deficiencies, infections, and wounds. Formulas can also stave off weight loss in the elderly or anyone in whom eating is impaired.

Formula diets are essential to help sick people to survive, but they do not enable people to thrive over long periods. Even in hospitals, elemental diet formulas do not support optimal growth and health and may even lead to medical complications. Although serious problems are rare and can be detected and corrected, they show that the composition of these diets is not yet perfect for all people in all settings.

Lately, marketers have taken these liquid supplement formulas out of the medical setting and have advertised them heavily to healthy people of all ages as “meal replacers” or “insurance” against malnutrition. The truth is that real food is superior to such supplements. Most healthy people who eat a nutritious diet need no dietary supplements at all.

Food Is Best Even if a person’s basic nutrient needs are perfectly understood and met, concoctions of nutrients still lack something that foods provide. Hospitalized clients who are fed nutrient mixtures through a vein often improve dramatically when they can finally eat food. Something in real food is important to health—but what is it? What does food offer that cannot be provided through a needle or a tube? Science has some partial explanations, some physical and some psychological.

In the digestive tract, the stomach and intestine are dynamic, living organs, changing constantly in response to the foods they receive—even to just the sight, aroma, and taste of food. When a person is fed through a vein, the digestive organs, like unused muscles, weaken and grow smaller. Medical wisdom now dictates that a person should be fed through a vein for as short a time as possible and that real food taken by mouth should be reintroduced as early as possible. The digestive organs also release hormones in response to food, and these send messages to the brain that bring the eater a feeling of satisfaction: “There, that was good. Now I’m full.” Eating offers both physical and emotional comfort.

Complex Interactions Foods are chemically complex. In addition to their nutrients, foods contain **phytochemicals**, compounds that confer color, taste, and other characteristics to foods. Some may be **bioactive** food components that interact with metabolic processes in the body and may affect disease risks. Even an ordinary baked potato contains hundreds of different compounds. Nutrients and other food components interact with each other in the body and operate best in harmony with one another. In view of all this, it is not surprising that food gives us more than just nutrients. If it were otherwise, *that* would be surprising.

KEY POINTS

- Nutritious food is superior to supplements for maintaining optimal health.
- Most healthy people who eat a nutritious diet do not need supplements at all.

The Challenge of Choosing Foods

LO 1.4 Recognize the challenges and solutions to a health-promoting diet.

Well-planned meals convey pleasure and are nutritious, too, fitting your tastes, personality, family and cultural traditions, lifestyle, and budget. Given the astounding numbers and varieties available, a consumer can easily lose track of what individual foods contain and how to put them together into a health-promoting diet. A few definitions and basic guidelines can help.

The Abundance of Foods to Choose From

A list of the foods available 100 years ago would be relatively short. It would consist mostly of **whole foods**—foods that have been around for a long time, such as vegetables, fruits, meats, milk, and grains (see Table 1–5 for a glossary of food types, p. 10). These foods have been called basic, unprocessed, natural, or farm foods. By whatever name, choosing a sufficient variety of these foods each day is an easy way to obtain a nutritious diet. On a given day, however, well over 80 percent of our population



Brian Chase/Shutterstock.com

Some foods offer phytochemicals in addition to the six classes of nutrients.

dietary supplements pills, liquids, or powders that contain purified nutrients or other ingredients (see Controversy in Chapter 7).

elemental diets diets composed of purified ingredients of known chemical composition; intended to supply all essential nutrients to people who cannot eat foods.

phytochemicals compounds in plant-derived foods (*phyto*, pronounced FYE-toe, means “plant”).

bioactive having chemical or physical properties that affect the functions of the body tissues. See also the Controversy in Chapter 2.