

# NUTRITION

## *From Science To You*

FOURTH EDITION

**Joan Salge Blake**  
BOSTON UNIVERSITY

**Kathy D. Munoz**  
HUMBOLDT STATE UNIVERSITY

**Stella L. Volpe**  
DREXEL UNIVERSITY

 **Pearson**

330 Hudson Street, NY NY 10013



Courseware Portfolio Manager: Michelle Yglecias  
Content Producer: Lizette Faraji  
Managing Producer: Nancy Tabor  
Courseware Director, Content Development: Barbara Yien  
Development Editor: Laura Bonazzoli  
Courseware Editorial Assistant: Nicole Constantine, Crystal Trigueros  
Rich Media Content Producer: Lucinda Bingham  
Full-Service Vendor: SPi Global  
Copyeditor: Laura Patchkovsky  
Compositor: SPi Global  
Art Coordinator: Morgan Ewald, Lachina Publishing Services  
Design Manager: Mark Ong

Interior Designer: Gary Hespenheide  
Cover Designer: Gary Hespenheide  
Rights & Permissions Project Manager: Linda DeMasi, Cenveo  
Publishing Services  
Rights & Permissions Management: Ben Ferrini  
Photo Researcher: Clare Maxwell  
Manufacturing Buyer: Stacey Weinberger, LSC Communications  
Executive Product Marketing Manager: Neena Bali, Alysun Burns  
Field Marketing Manager: Mary Salzman  
Printer/Binder: LSC Communications, Inc.  
Cover Printer: Phoenix Color/Hagerstown  
Cover Photo Credit: Natalia Klenova/Shutterstock

**Copyright © 2019, 2016, 2012** Pearson Education, Inc. All Rights Reserved. Printed in the United States of America. This publication is protected by copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise. For information regarding permissions, request forms and the appropriate contacts within the Pearson Education Global Rights & Permissions department, please visit [www.pearsoned.com/permissions/](http://www.pearsoned.com/permissions/).

Acknowledgements of third party content appear on page CR-1, which constitutes an extension of this copyright page.

PEARSON, ALWAYS LEARNING, and Mastering™ Nutrition are exclusive trademarks in the U.S. and/or other countries owned by Pearson Education, Inc. or its affiliates.

Unless otherwise indicated herein, any third-party trademarks that may appear in this work are the property of their respective owners and any references to third-party trademarks, logos or other trade dress are for demonstrative or descriptive purposes only. Such references are not intended to imply any sponsorship, endorsement, authorization, or promotion of Pearson's products by the owners of such marks, or any relationship between the owner and Pearson Education, Inc. or its affiliates, authors, licensees or distributors.

**Cataloging-in-Publishing data is on file with the Library of Congress**

Names: Blake, Joan Salge, author. | Munoz, Kathy D., 1951- author. | Volpe, Stella, 1963- author.

Title: Nutrition : from science to you / Joan Salge Blake (Boston University), Kathy D. Munoz (Humboldt State University), Stella L. Volpe (Drexel University).

Description: Fourth edition. | New York : Pearson, [2019]

Identifiers: LCCN 2017056138

Subjects: LCSH: Nutrition--Textbooks.

Classification: LCC RA784 .B553 2019 | DDC 613.2--dc23

LC record available at <https://lcn.loc.gov/2017056138>

ISBN 10: **0-13-466826-X**; ISBN 13: **978-0-134-66826-0** (Student edition)  
ISBN 10: **0-134-79645-4**; ISBN 13: **978-0-134-79645-1** (Instructor's Review Copy)

# Brief Contents

- 1 What Is Nutrition? 3
- 2 Tools for Healthy Eating 39
- 3 Digestion, Absorption, and Transport 75
- 4 Carbohydrates 111
- 5 Lipids 157
- 6 Proteins 205
- 7 Alcohol 247
- 8 Energy Metabolism 281
- 9 Fat-Soluble Vitamins 317
- 10 Water-Soluble Vitamins 359
- 11 Water 405
- 12 Major Minerals 433
- 13 Trace Minerals 469
- 14 Energy Balance and Body Composition 507
- 15 Weight Management 537
- 16 Nutrition and Fitness 577
- 17 Life Cycle Nutrition: Pregnancy through Infancy 619
- 18 Life Cycle Nutrition: Toddlers through Adolescents 665
- 19 Life Cycle Nutrition: Older Adults 697
- 20 Food Safety, Technology, and Sustainability 731
- 21 Global Nutrition and Malnutrition 779
- A Metabolism Pathways and Biochemical Structures A-3
- B Calculations and Conversions B-1
- C U.S. Exchange Lists for Meal Planning C-1
- D Organizations and Resources D-1

# Contents

## 1

### What Is Nutrition? 3

#### What Drives Our Food Choices? 4

- Taste and Enjoyment 4
- Culture and Environment 5
- Social Life and Trends 5
- Nutrition Knowledge 6
- Advertising 6
- Time, Convenience, and Cost 6
- Habits and Emotions 7



#### What Is Nutrition? 7

- Nutrients Are Essential Compounds in Food 8
- Most Nutrients Are Organic 8

#### What Are the Primary Roles of the Six Classes of Nutrients? 12

- Carbohydrates Are the Primary Energy Source 12
- Lipids Also Provide Energy 13
- Proteins Provide the Building Blocks for Tissue Synthesis 13
- Vitamins and Minerals Play Vital Roles in Metabolism 13
- Water Is Critical for Numerous Functions 14

#### How Can You Be Sure to Meet Your Nutritional Needs? 15

- The Best Approach Is to Consume a Balanced Diet 15
- Some Nutrient Needs Can Be Met with Fortified Foods or a Supplement 16

#### How Does Diet Influence Your Health? 16

- A Healthy Diet Reduces the Risk of Chronic Disease 16
- A Healthy Diet Prevents Nutrient-Deficiency Diseases 17
- A Healthy Diet Can Positively Affect Gene Expression 17

#### How Do We Assess Nutritional Status? 18

- The ABCD Method Is Used to Assess the Nutritional Status of Individuals 19
- Surveys Are Used to Assess the Nutritional Status of a Population Group 21

#### How Healthy Is the Average American Diet? 22

- The Quality of the American Diet Needs Improvement 22
- Rates of Overweight and Obesity in Americans Are Too High 23
- Healthy People 2020* Provides Health Objectives for Americans 23

#### What Is Credible Nutrition Research? 24

- Sound Nutrition Research Begins with the Scientific Method 24
- Scientists Use a Variety of Experiments to Test Hypotheses 26

#### HEALTHCONNECTION: How Can You Find and Recognize Credible Nutrition Information? 28

- Seek Information from Nutrition Experts 28
- Beware of Quackery 28
- Evaluate Nutrition News with a Critical Eye 29
- Know How to Evaluate Nutrition Information on the Internet 29

#### Visual Chapter Summary 31

## 2

### Tools for Healthy Eating 39

#### What Are the Key Principles of Healthy Eating? 40

- Healthy Eating Means Balance between Food Groups 40
- Healthy Eating Means Consuming a Variety of Foods 41
- Healthy Eating Means Moderate Intake of All Foods 41
- Healthy Eating Includes Nutrient-Dense Foods 41
- Healthy Eating Includes Low-Energy-Dense Foods 42



Many Resources Are Available for Planning a Healthy Diet 43

### What Are the Dietary Reference Intakes? 44

The DRIs Encompass Several Reference Values 45

**FOCUS Figure 2.2** Dietary Reference Intakes 46

You Can Use the DRIs to Plan a Quality Diet 47

### What Are the Dietary Guidelines for Americans? 49

#### What Is MyPlate? 49

MyPlate Emphasizes Changes in Diet 51

Use MyPlate to Choose Foods that Fit Your Kilocalorie Needs 53

#### What Is the Exchange System? 55

#### What Information Is on the Food Label? 58

Food Labels Are Strictly Regulated by the FDA 58

The Nutrition Facts Panel Indicates Nutrient Values 59

**FOCUS Figure 2.9** The Nutrition Facts Panel 60

The Percent Daily Values Help You Compare Packaged Foods 61

Label Claims Can Reveal Potential Health Benefits 62

#### HEALTHCONNECTION: Portion Distortion 65

Portion versus Serving Size: What's the Difference? 65

How Have Portion Sizes Changed? 66

Health Effects of Increased Portion Size 66

Tips for Controlling Portion Size 66

Visual Chapter Summary 68

## 3 Digestion, Absorption, and Transport 75

### What Are the Processes and Organs Involved in Digestion? 76

Digestion Begins in the Mouth 76

#### FOCUS Figure 3.1

##### The Digestive System 77

The Stomach Stores, Mixes, and Prepares Food for Digestion 78

Most Digestion Occurs in the Small Intestine 79

#### FOCUS Figure 3.6

##### Structures of the Small Intestinal Wall 80

The Large Intestine Absorbs Water and Some Nutrients 81

The Accessory Organs Secrete Digestive Juices 84



### How Is Food Propelled through the GI Tract? 84

#### How Is Food Chemically Digested? 86

Enzymes Drive the Process of Digestion 86

Certain Secretions Are Essential for Digestion 89

#### How Are Digested Nutrients Absorbed? 90

There Are Four Mechanisms of Nutrient Absorption 90

Fluid Absorption Occurs in the Large Intestine 93

#### How Do Hormones and the Nervous System Regulate Digestion? 93

Hormones in the GI Tract Regulate Digestion 94

The Enteric Nervous System Communicates Within and Beyond the GI Tract 95

#### How Are Nutrients Transported throughout the Body? 96

The Cardiovascular System Distributes Nutrients through Blood 96

The Lymphatic System Distributes Some Nutrients through the Lymph 97

The Excretory System Eliminates Waste 97

#### HEALTHCONNECTION: What Are Some Common Digestive Disorders? 98

Esophageal Problems 98

Disorders of the Stomach 98

Gallbladder Disease 99

Celiac Disease 99

Other Intestinal Disorders 101

Visual Chapter Summary 105

## 4 Carbohydrates 111

### What Are Carbohydrates and How Are They Classified? 112

Monosaccharides Are Single Sugar Units 113

Disaccharides Consist of Two Sugar Units 113

Oligosaccharides Have Three to Ten Sugar Units 116

Polysaccharides Consist of Many Sugar Units 117

### How Do We Digest and Absorb Carbohydrates? 120

Digestion of Carbohydrates Begins in the Mouth 120

Carbohydrates Are Absorbed as Monosaccharides 120

**FOCUS Figure 4.8** Carbohydrate Digestion and Absorption 121





## What Functions Do Carbohydrates Perform in the Body? 122

- Carbohydrates Provide Energy 123
- Carbohydrates Spare Protein 123
- Carbohydrates Prevent Ketosis 123

## How Do We Maintain Blood Glucose Levels? 124

- Insulin Regulates Glucose in the Blood 124
- Glucagon Regulates Liver Glycogenolysis 124
- Four Other Hormones Help Regulate Glucose Metabolism 124

### **FOCUS Figure 4.10** Hormones Regulate Blood Glucose 125

- Hypoglycemia Results When Blood Glucose Drops below Normal 126

## Why Is Dietary Fiber So Important for Promoting Health? 127

- Dietary Fiber Helps Prevent Constipation and Diverticulosis 127
- Dietary Fiber Helps Prevent Cardiovascular Disease, Diabetes, and Cancer 127
- Dietary Fiber Helps Prevent Obesity 129

## What Are the Recommendations for Carbohydrate Intake and the Best Food Sources? 129

- Whole Plant Foods and Dairy Products Are Good Sources of Carbohydrates 130
- Packaged Foods Can Be Good Sources of Carbohydrates 132
- Glycemic Index and Glycemic Load Can Be Used for Meal Planning 133

## How Do Natural Sugars, Added Sugars, and Sugar Substitutes Differ? 134

- Foods with Natural Sugars Are Generally More Nutrient Dense 134
- Added Sugars Are Used during Food Processing 135
- Sugar Can Cause Dental Caries 136
- Sugar Substitutes Add Sweetness but Not Kilocalories 136

### **HEALTHCONNECTION:** What Is Diabetes? 141

- Diabetes Types and Risk Factors 141

### **FOCUS Figure 4.22** Diabetes 143

- Diabetes Can Result in Long-Term Damage 146
- Control Is Key 146
- Preventing Type 2 Diabetes 147

Visual Chapter Summary 148

# 5 Lipids 157

## What Are Lipids and How Do They Differ in Structure? 158

- Most Lipids Are Composed of Fatty Acids 158

Triglycerides Are the Most Common Lipid 162

Phospholipids Differ from Triglycerides 164

Sterols Are More Complex than Triglycerides 165

## How Are Lipids Digested, Absorbed, and Transported in the Body? 165

### **FOCUS Figure 5.10** Lipid Digestion and Absorption 166

Triglyceride Digestion Begins in the Mouth and Stomach 167

Most Triglycerides Are Digested and Prepared for Absorption in the Small Intestine 167

Chylomicrons Facilitate Lipid Absorption into the Lymph 167

Lipoproteins Transport Lipids 169

### **FOCUS Figure 5.15** Lipoprotein Transport and Distribution 171

## What Are the Functions of Lipids in the Body? 172

Fatty Acids Are Used for Energy 172

Dietary Fat Aids the Absorption of Lipid Compounds 173

Triglycerides Stored in Adipose Tissue Insulate the Body and Protect Vital Organs 173

Essential Fatty Acids Manufacture Eicosanoids and Maintain Cell Membranes 173

Cholesterol Is Used to Make Hormones, Bile, and Vitamin D 174

Phospholipids and Cholesterol Make Up Cell Membranes 174

## What Are the Recommendations for Daily Intake of Triglycerides and Cholesterol? 175

Dietary Fat Intake Is Based on a Percentage of Total Kilocalories 175

Essential Fatty Acids Have Specific Recommendations 177

Dietary Cholesterol and Phospholipids Are Not Essential 177

## What Are the Best, Worst, and Alternative Food Sources for Fat? 181

The Best Food Sources Are Low in Saturated Fat 181

Reduce Foods That Contain *Trans* Fat 185

Increase Plant Sterols and Stanols 187

Fat Substitutes Lower Fat in Foods 188

### **HEALTHCONNECTION:** What Is Heart Disease and What Factors Increase Risk? 190

Heart Disease Begins with Atherosclerosis 190

Some Risk Factors Are Not Controllable 190

### **FOCUS Figure 5.22** Atherosclerosis 191



Some Risk Factors Are Controllable	192
Modify Your Diet to Lower Your Risk of Heart Disease	192
Exercise, Manage Your Weight, and Quit Smoking	195
Visual Chapter Summary	198

## 6

### Proteins 205

#### What Are Proteins? 206

- The Building Blocks of Proteins Are Amino Acids 206
- The Organization and Shape of Proteins Affect Their Function 208
- Denaturation of Proteins Changes Their Shape 210



#### What Are the Key Steps in Digesting and Absorbing Protein? 211

- Protein Digestion Begins in the Stomach 211
- Protein Digestion Continues in the Small Intestine 211
- Amino Acids Are Absorbed in the Small Intestine 211
- FOCUS Figure 6.6 Protein Digestion and Absorption** 212

#### How Are Amino Acids Metabolized? 213

- Amino Acid Pools Allow Protein Synthesis on Demand 213
- Protein Synthesis Is Regulated by Genes 214
- FOCUS Figure 6.8 Protein Synthesis** 215
- Deamination Removes the Amine Group from Amino Acids 216
- Nonessential Amino Acids Are Synthesized through Transamination 216
- Excess Protein Is Converted to Body Fat 217

#### What Are the Functions of Protein in the Body? 217

- Proteins Provide Structural Support and Enable Movement 218
- Proteins Act as Catalysts 218
- Proteins Act as Chemical Messengers 218
- Proteins Help Regulate Fluid Balance 218
- Proteins Help Regulate Acid–Base Balance 219
- Proteins Transport Substances throughout the Body 219
- Proteins Contribute to a Healthy Immune System 220
- Proteins Can Provide Energy 220
- Protein Improves Satiety and Appetite Control 221

#### How Much Protein Do You Need Daily? 221

- Healthy Adults Should Be in Nitrogen Balance 221
- You Can Determine Your Own Protein Needs 223

#### What Are the Best Food Sources of Protein? 225

- Not All Protein Is Created Equal 225
- Many Healthy Foods Provide Significant Protein 229
- Most People Don't Need Protein Supplements 230

#### What Happens If You Eat Too Much or Too Little Protein? 232

- Eating Too Much Protein May Contribute to Chronic Disease 232
- Eating Too Little Protein Can Lead to Protein-Energy Malnutrition 234

#### HEALTHCONNECTION: What Is a Vegetarian Diet? 236

- Balanced Vegetarian Diets Confer Health Benefits 236
- A Healthy Vegetarian Diet Requires Planning 237

#### Visual Chapter Summary 240

## 7

### Alcohol 247

#### What Is Alcohol and How Is It Made? 248

- Alcohol Has Many Forms 248
- Alcohol Begins with Sugar 249

#### Why Do People Drink Alcohol and What Is Considered a Standard Drink? 250

- People Drink to Relax, Celebrate, and Socialize 250
- Advertisements Encourage Alcohol Consumption 251
- Moderate Drinking Is Measured in Terms of a Standard Drink 251

#### How Is Alcohol Absorbed, Circulated, and Metabolized in the Body? 252

- Alcohol Is Absorbed in the Stomach and Small Intestine 252
- Alcohol Is Metabolized in the Stomach and the Liver 252
- Alcohol Circulates in the Blood 254
- Gender, Genetics, and Ethnicity Affect Alcohol Metabolism 255

#### What Are the Short-Term Effects of Alcohol Consumption on the Body? 256

- Alcohol Affects the Brain 256
- Alcohol Causes Hangovers 258



## What Are the Effects of Chronic Excessive Alcohol Consumption on the Body? 259

Alcohol Can Interfere with Digestion, Absorption, and Nutrition 260

Alcohol Can Cause Liver Disease 263

Alcohol and Depression 264

Alcohol and Cardiovascular Disease 265

Alcohol Contributes to Cancer Risk 268

Alcohol Can Put a Pregnancy at Risk 268

### HEALTHCONNECTION: What Is Alcohol Use Disorder (AUD)? 269

Alcohol Use Disorder Can Be Treated But Not Cured 271

Visual Chapter Summary 273

## 8 Energy Metabolism 281

### What Is Metabolism? 282

Metabolism Is a Series of Chemical Reactions 282

Metabolism Takes Place within Cells 283

The Liver Plays a Central Role in Metabolism 284

Enzymes and Hormones Regulate Metabolism 284

### How Does ATP Fuel Metabolism? 285

Adenosine Triphosphate Is the Cell's Energy Source 285

ATP Can Be Regenerated from ADP and Creatine Phosphate 286

### How Do the Macronutrients Provide ATP? 287

Glycolysis Transforms Glucose to Pyruvate 287

Amino Acids and Glycerol Can Yield Pyruvate 290

Pyruvate Is Transformed into Acetyl CoA 293

Fatty Acids Can Be Converted to Acetyl CoA 294

Amino Acids Can Be Converted to Acetyl CoA 295

The Tricarboxylic Acid (TCA) Cycle Releases High-Energy Electrons 295

The Electron Transport Chain and Oxidative Phosphorylation Produce the Majority of ATP 296

### How Does Metabolism Change during the Absorptive and Postabsorptive States? 300

During the Absorptive State, Metabolism Favors Energy Storage 300

### FOCUS Figure 8.15 Metabolism during the Absorptive State 301



During the Postabsorptive State, Metabolism Favors Energy Production 302

### FOCUS Figure 8.16 Metabolism during the Postabsorptive State 303

### How Does the Body Metabolize Alcohol? 306

Alcohol Is Metabolized via Three Pathways 306

Excess Alcohol Is Stored as Fat 307

### HEALTHCONNECTION: What Are Genetic Disorders of Metabolism? 308

Phenylketonuria 308

Maple Syrup Urine Disease 309

Homocystinuria 309

Galactosemia 309

Glycogen Storage Disease 310

Visual Chapter Summary 311

## 9 Fat-Soluble Vitamins 317

### What Are Vitamins? 318

Vitamins Were Discovered about 100 Years Ago 318

There Are Criteria for Classifying Vitamins 319

All Vitamins Are Organic, but Differ in Structure and Function 319

Overconsumption of Some Vitamins Can Be Toxic 320

### How Do Vitamins Differ in Their Absorption and Storage? 320

Vitamins Differ in Bioavailability 320

Fat-Soluble Vitamins Are Stored after They Are Absorbed 321

Water-Soluble Vitamins Are Not Stored after Absorption 321

### What Are Antioxidants? 322

### What's the Best Source of Vitamins? 324

Vitamins Can Be Destroyed during Cooking or Storage 325

Some Foods Are Fortified with Vitamins 326

### EXPLORING Vitamin A 328

What Is Vitamin A? 328

Vitamin A Absorption and Transport 330

Metabolic Functions of Vitamin A 330

### FOCUS Figure 9.7 Retinal and Its Role in Vision 331

Daily Needs for Vitamin A 332

Food Sources of Vitamin A 333

Vitamin A Toxicity 334

Vitamin A Deficiency 334





## EXPLORING Vitamin D 335

- What Is Vitamin D? 335
- Vitamin D Metabolism 336
- Metabolic Functions of Vitamin D 336
- Daily Needs for Vitamin D 338
- Food Sources of Vitamin D 338
- Vitamin D Toxicity 339
- Vitamin D Deficiency 339

## EXPLORING Vitamin E 342

- What Is Vitamin E? 342
- Vitamin E Absorption and Transport 342
- Metabolic Functions of Vitamin E 342
- Vitamin E Toxicity 343
- Vitamin E Deficiency 344

## EXPLORING Vitamin K 345

- What Is Vitamin K? 345
- Vitamin K Absorption and Transport 345
- Daily Needs for Vitamin K 346
- Food Sources of Vitamin K 346
- Vitamin K Toxicity and Deficiency 346

## HEALTHCONNECTION: Are Vitamin Supplements Necessary for Good Health? 348

- Supplements Do Not Reduce Risks for CVD, Cancer, or Cognitive Decline 348
- Vitamin Supplements Are Not a Substitute for Healthy Eating 348
- Supplements May Be Helpful for Some Individuals 349
- Supplements Are Not Regulated Like Drugs 349

## Visual Chapter Summary 351

# 10

## Water-Soluble Vitamins 359

### What Are Water-Soluble Vitamins? 360

- Properties of Water-Soluble Vitamins 360
- The Primary Functions of Water-Soluble Vitamins 361

### EXPLORING Thiamin (Vitamin B<sub>1</sub>) 364

- What Is Thiamin (B<sub>1</sub>) 364
- Metabolic Functions of Thiamin 365
- Daily Needs for Thiamin 365
- Food Sources of Thiamin 365
- Thiamin Toxicity and Deficiency 365

### EXPLORING Riboflavin (Vitamin B<sub>2</sub>) 366

- What Is Riboflavin (B<sub>2</sub>) 366
- Metabolic Functions of Riboflavin 367
- Daily Needs for Riboflavin 368
- Food Sources of Riboflavin 368
- Riboflavin Toxicity and Deficiency 368

### EXPLORING Niacin (Vitamin B<sub>3</sub>) 369

- What Is Niacin (B<sub>3</sub>) 369
- Metabolic Functions of Niacin 370
- Daily Needs for Niacin 370
- Food Sources of Niacin 371

### Niacin Toxicity and Deficiency 371

### EXPLORING Pantothenic Acid 373

- What Is Pantothenic Acid? 373
- Metabolic Functions of Pantothenic Acid 373
- Daily Needs for Pantothenic Acid 373
- Food Sources of Pantothenic Acid 373
- Pantothenic Acid Toxicity and Deficiency 374

### EXPLORING Biotin 374

- What Is Biotin? 374
- Metabolic Functions of Biotin 374
- Daily Needs for Biotin 375
- Food Sources of Biotin 375
- Biotin Toxicity and Deficiency 375

### EXPLORING Vitamin B<sub>6</sub> 376

- What Is Vitamin B<sub>6</sub>? 376
- Metabolic Functions of Vitamin B<sub>6</sub> 376
- Vitamin B<sub>6</sub> and Amino Acid Metabolism 376
- Daily Needs for Vitamin B<sub>6</sub> 377
- Food Sources of Vitamin B<sub>6</sub> 377
- Vitamin B<sub>6</sub> Toxicity and Deficiency 378

### EXPLORING Folate 378

- What Is Folate? 378
- Metabolic Functions of Folate 379
- Daily Needs for Folate 380
- Food Sources of Folate 380
- Folate Toxicity and Deficiency 381

### EXPLORING Vitamin B<sub>12</sub> 382

- What Is Vitamin B<sub>12</sub>? 382
- Metabolic Functions of Vitamin B<sub>12</sub> 382
- Daily Needs for Vitamin B<sub>12</sub> 383
- Food Sources of Vitamin B<sub>12</sub> 384
- Vitamin B<sub>12</sub> Toxicity and Deficiency 385

### EXPLORING Vitamin C 387

- What Is Vitamin C? 387
- Metabolic Functions of Vitamin C 387
- Daily Needs for Vitamin C 388
- Food Sources of Vitamin C 388
- Vitamin C Toxicity and Deficiency 389

### What Are Other Vitamin-Like Compounds? 391

- Choline Helps Protect the Liver 391
- Carnitine, Lipoic Acid, and Inositol Are Needed for Overall Health 392

### HEALTHCONNECTION: Do Antioxidant Nutrients and Phytochemicals Reduce the Risk of Cancer? 392

- Carcinogenesis: The Cancer Process 393
  - Physical Activity, Obesity, and Cancer Risk 393
  - The Role of Diet in Cancer Risk and Progression 394
- ## Visual Chapter Summary 397



# 11

## Water 405

### Why Is Water Essential to Life? 406

- Water Is a Universal Solvent and Transport Medium 407
- Water Helps Maintain Body Temperature 407
- Water Is a Lubricant and a Protective Cushion and Provides Structure to Muscle Cells 408
- Water Participates in Hydrolysis and Condensation Reactions 408
- Water Plays a Role in Acid–Base Balance 409

### How Is Water Balance Maintained? 409

- Sources of Body Water Include Beverages and Food 410
- Water Is Excreted through the Kidneys, Large Intestine, Lungs, and Skin 410
- Body Water Is Balanced between Fluid Compartments 411
- Electrolytes Participate in Fluid Balance 411
- Proteins Help Regulate Fluid Balance 413

### How Do Water and Sodium Affect Blood Pressure? 414

- ADH Helps Stimulate Fluid Intake and Reduce Urine Output 414
- Renin Helps the Body Reabsorb Water and Salts 414
- Aldosterone Stimulates Sodium Reabsorption 414

### How Much Water Do You Need and What Are the Best Sources? 416

### Do Diuretics Like Caffeine and Alcohol Affect Fluid Balance? 420

- Caffeine Does Not Cause Significant Loss of Body Water 420
- Alcohol Can Be Dehydrating 420
- Diuretic Medications Can Help Treat Hypertension 420

### HEALTHCONNECTION: What Are the Effects of Too Much or Too Little Water? 421

- Consuming Too Much Water Can Cause Hyponatremia 421
- Consuming Too Little Water Can Cause Dehydration 421

### FOCUS Figure 11.11 Fluid Balance during Exercise 422

- Monitor Water Intake to Avoid Overhydration and Dehydration 424

### Visual Chapter Summary 426



# 12

## Major Minerals 433

### What Are Minerals? 434

- Minerals Are Inorganic Elements 434
- Minerals Vary in Their Bioavailability 434
- Minerals Serve Numerous Functions 436
- Minerals Can Be Toxic 436

### EXPLORING Sodium 438

- What Is Sodium? 438
- Absorption, Transport, and Excretion of Sodium 438
- Metabolic Functions of Sodium 438
- Daily Needs for Sodium 439
- Food Sources of Sodium 440
- Sodium Excess 440
- Sodium Deficiency 442

### EXPLORING Chloride 442

- What Is Chloride? 442
- Metabolic Functions of Chloride 442
- Daily Needs for Chloride 443
- Food Sources of Chloride 443
- Chloride Toxicity and Deficiency 443

### EXPLORING Potassium 443

- What Is Potassium? 443
- Potassium Balance in the Body 443
- Metabolic Functions of Potassium 443
- Daily Needs for Potassium 444
- Food Sources of Potassium 444
- Potassium Toxicity and Deficiency 444

### EXPLORING Calcium 446

- What Is Calcium? 446
- Bioavailability and Absorption of Calcium 446
- Hormones Regulate Calcium Balance 446
- Metabolic Functions of Calcium 446

### FOCUS Figure 12.11 Hormones Maintain Calcium Homeostasis 447

- Daily Needs for Calcium 448
- Food Sources of Calcium 448
- Calcium Toxicity and Deficiency 449
- Calcium Supplements 449

### EXPLORING Phosphorus 450

- What Is Phosphorus? 450
- Metabolic Functions of Phosphorus 451
- Daily Needs for Phosphorus 451
- Food Sources of Phosphorus 451
- Phosphorus Toxicity and Deficiency 452

### EXPLORING Magnesium 452



What Is Magnesium? 452  
 Metabolic Functions of Magnesium 452  
 Daily Needs for Magnesium 453  
 Food Sources of Magnesium 453  
 Magnesium Toxicity and Deficiency 454

**EXPLORING Sulfate** 454

What Is Sulfate? 454  
 Metabolic Functions of Sulfate 454  
 Daily Needs for Sulfate 455  
 Food Sources of Sulfate 455  
 Sulfate Toxicity and Deficiency 455

**HEALTHCONNECTION: What Is Osteoporosis?** 455

Most Bone Growth Occurs Early in Life 456  
 Osteoporosis Is a Disease of Progressive Bone Loss 456  
 Bone Density Can Be Measured by DEXA 456  
 Several Lifestyle Factors Influence Bone Mass 457  
 Strategies to Prevent Osteoporosis 458

Visual Chapter Summary 461

# 13

## Trace Minerals 469

### What Are Trace Minerals and Why Do You Need Them? 470

Bioavailability of Trace Minerals  
 Can Vary 470  
 Most Trace Minerals Function as Cofactors 470  
 Trace Mineral Deficiencies and Toxicities  
 Are Hard to Identify 472

**EXPLORING Iron** 472

What Is Iron? 472  
 Iron Bioavailability 473  
 Iron Absorption and Transport 473  
 Metabolic Functions of Iron 474  
 Daily Needs for Iron 475  
 Food Sources of Iron 476  
 Iron Toxicity 476  
 Iron Deficiency 477

**EXPLORING Copper** 479

What Is Copper? 479  
 Copper Absorption and Transport 479  
 Metabolic Functions of Copper 479  
 Daily Needs for Copper 480  
 Food Sources of Copper 480  
 Copper Toxicity and Deficiency 480



**EXPLORING Zinc** 481

What Is Zinc? 481  
 Zinc Absorption, Transport, and Recycling 481  
 Metabolic Functions of Zinc 481  
 Daily Needs for Zinc 482  
 Food Sources of Zinc 482  
 Zinc Toxicity and Deficiency 483

**EXPLORING Selenium** 484

What Is Selenium? 484  
 Metabolic Functions of Selenium 484  
 Daily Needs for Selenium 484  
 Food Sources of Selenium 484  
 Selenium Toxicity and Deficiency 485

**EXPLORING Fluoride** 486

What Is Fluoride? 486  
 Metabolic Functions of Fluoride 486  
 Daily Needs for Fluoride 486  
 Food Sources of Fluoride 486  
 Fluoride Toxicity and Deficiency 487

**EXPLORING Chromium** 488

What Is Chromium? 488  
 Metabolic Functions of Chromium 488  
 Daily Needs for Chromium 488  
 Food Sources of Chromium 488  
 Chromium Toxicity and Deficiency 488

**EXPLORING Iodine** 489

What Is Iodine? 489  
 Metabolic Functions of Iodine 490  
 Daily Needs for Iodine 490  
 Food Sources of Iodine 490  
 Iodine Toxicity and Deficiency 491

**EXPLORING Molybdenum** 492

What Is Molybdenum? 492  
 Daily Needs for Molybdenum 492  
 Food Sources of Molybdenum 492  
 Molybdenum Toxicity and Deficiency 492

**EXPLORING Manganese** 492

What Is Manganese? 492  
 Metabolic Functions of Manganese 492  
 Daily Needs for Manganese 492  
 Food Sources of Manganese 493  
 Manganese Toxicity and Deficiency 493

### Are Any Other Minerals Important to Health? 494

**HEALTHCONNECTION: What Are Nutrient-Deficiency Anemias?** 495

In Microcytic Anemia, Red Blood Cells Are Smaller than Normal 495  
 In Macrocytic Anemia, Red Blood Cells Are Larger than Normal 496

Visual Chapter Summary 498



# 14

## Energy Balance and Body Composition 507

### What Is Energy Balance and Why Is It Important? 508

An Energy Imbalance Results in Weight Gain or Loss 508

Food and Beverages Provide Energy In 508

**FOCUS Figure 14.1** The Concept of Energy Balance 509

Body Processes and Physical Activity Result in Energy Out 511

### How Is Total Daily Energy Expenditure Calculated? 511

Basal Metabolism Contributes to TDEE 511

The Thermic Effect of Food Contributes to TDEE 512

The Thermic Effect of Exercise Contributes to TDEE 513



### How Do We Measure Energy Expenditure? 517

Direct and Indirect Calorimetry Measure Energy Expenditure 517

Simple Calculations Are Used to Estimate Energy Expenditure 518

### What Is Body Composition and How Is It Assessed? 519

Most Body Fat Is Stored in Adipose Tissue 519

Body Fat Level and Distribution Affect Health 520

Body Composition Is Assessed Indirectly 521

### How Do We Estimate a Healthy Body Weight? 523

Height and Weight Tables Are Problematic 524

Body Mass Index Is a Useful Indicator of Healthy Weight for Most People 524

### HEALTHCONNECTION: What Is Disordered Eating? 527

Eating Disorders Occur in Both Women and Men 527

Anorexia Nervosa Involves Severe Kilocalorie Restriction 528

Bulimia Nervosa Involves Cycles of Binge Eating and Purging 529

Binge Eating Disorder Involves Compulsive Overeating 529

Other Disordered Eating Behaviors Can Be Harmful 529

Different Eating Disorders Share Some Common Traits 530

Eating Disorders Can Be Treated 531

Visual Chapter Summary 532

# 15

## Weight Management 537

### Why Is Weight Management Important? 538

Being Overweight or Obese Increases Health Risks 538

Being Underweight Also Increases Health Risks 539

Overweight and Underweight Have Social and Psychological Risks 539

### How Is Food Intake Regulated? 540

Appetite Often Triggers Eating for Unnecessary Reasons 540

Hunger and Satiation Affect the Desire to Eat and Stop Eating 541

**FOCUS Figure 15.1** The Brain Controls Hunger and Satiation 542

### How Do Fat Cells Form and Expand? 543

The Number of Fat Cells in the Body Never Decreases 543

Fat Cells Can Grow and Shrink 544

### How Do Genetics and Environment Influence Obesity and Weight Management? 544

Nutrigenomics and Epigenetics May Influence Weight Control 544

Genetic Variants Can Influence Body Weight 546

Gene Theories May Help Explain Weight Variations 546

Environmental Factors Can Increase Appetite and Decrease Physical Activity 547



### How Can You Lose Weight Healthfully? 551

Avoid Fad Diets 552

Strive for a Reasonable Rate of Weight Loss 552

Remember That Kilocalories Count 553

Eat More Vegetables, Fruits, and Fiber 553

Add Some Protein and Fat to Meals 555

Increase Physical Activity 555

Modify Your Eating Behaviors 560

### How Can Weight Loss Be Maintained? 563

Diet and Exercise Can Aid in Maintaining Weight Loss 563

Self-Weighing Is a Positive Strategy to Maintain Weight Loss 564

### What Is the Healthiest Way to Gain Weight? 564

**HEALTHCONNECTION:** What Are the Medical Interventions for Severe Obesity? 565

Weight-Loss Medications May Improve Weight Loss but Have Side Effects 565

Bariatric Surgery Restricts Food Intake 566

Visual Chapter Summary 568

## 16

### Nutrition and Fitness 577

**What Is Physical Fitness and Why Is It Important?** 578

Physical Fitness Has Five Components 578

Physical Fitness Provides Numerous Health Benefits 579

**What Does a Successful Physical Fitness Program Look Like?** 580

Cardiorespiratory Exercise Improves Cardiorespiratory Endurance and Body Composition 580

Strength Training Improves Muscle Strength, Muscle Endurance, and Body Composition 582

Stretching Improves Flexibility 582

The FITT Principle Can Be Used to Design a Fitness Program 582

High-Intensity Interval Training Is More Time-Efficient 584

Progressive Overload Can Help Improve Fitness over Time 585

**How Are Carbohydrate, Fat, and Protein Used During Exercise?** 586

Anaerobic Energy Production Fuels Quick, Intense Exercise 586

Aerobic Energy Production Fuels Sustained Exercise 587

Carbohydrate Is the Primary Energy Source During High-Intensity Exercise 588

Fat Is the Primary Energy Source during Low- to Moderate-Intensity Exercise 592

**FOCUS Figure 16.15 The Energy Sources That Fuel Our Activities** 594

Protein Is Primarily Used to Build and Repair Muscle 595

**How Do the Timing and Composition of Meals Affect Physical Activity?** 596

Food Intake Should Be Timed Appropriately 596

Carbohydrate and Protein Are Optimal Before Exercise 597

Simple Carbohydrates Are Beneficial During Exercise 598

Consume Carbohydrate and Protein Shortly After Exercise 598



**What Vitamins and Minerals Are Important for Fitness?** 599

Some Vitamins and Minerals Contribute to the Processes of Energy Metabolism 599

Antioxidants Can Help Protect Cells from Damage Caused by Exercise 599

Highly Active People Are at Increased Risk for Iron and Calcium Deficiencies 601

Vitamin and Mineral Supplements Are Generally Not Necessary 602

**How Does Exercise Influence Fluid Needs?** 604

Exercise Affects Fluid and Electrolyte Balance and Regulation of Body Temperature 604

Fluids Are Needed Before, During, and After Exercise 605

Some Beverages Are Better than Others 605

Consuming Too Little or Too Much Fluid Can Be Harmful 607

**HEALTHCONNECTION:** Can Ergogenic Aids Contribute to Exercise Performance and Fitness? 609

Creatine Monohydrate Improves Muscle Strength, Muscle Mass, and Anaerobic Metabolism during Some Activities 609

Caffeine Improves Perception and Aerobic Metabolism 609

Bicarbonate Loading May Improve Anaerobic Metabolism during Exercise 610

Amino Acid Supplementation Shows Some Benefit 610

Sports Bars and Shakes May Provide Some Nutritional Benefits 610

Visual Chapter Summary 612

## 17

### Life Cycle Nutrition: Pregnancy through Infancy 619

**What Are the Key Events of Prenatal Development?** 620

**What Health Behaviors Are Most Important for a Successful Pregnancy?** 623

Prospective Fathers Should Practice Healthy Habits 624

Women Should Practice Healthy Habits Before and During Pregnancy 624

Effective Management of Chronic Disease Is Essential Before a Woman Conceives 627



## What Nutrients and Health Behaviors Are Important in the First Trimester? 628

- Adequate Weight Gain Reduces the Risk of Complications 628
- Adequate Micronutrient Intake Is a Concern throughout Pregnancy 629
- Morning Sickness and Cravings Are Common 632
- Food Safety Is a Concern 633

## What Nutrients and Health Behaviors Are Important in the Second and Third Trimesters? 635

- Adequate Kilocalories, Carbohydrate, and Protein Are Critical 635
- Experts Recommend Exercise 636
- Heartburn and Constipation Are Common Discomforts 636
- Gestational Diabetes and Hypertension Are Potential Complications 637

## What Special Situations Do Younger, Older, or Low-Income Mothers-to-Be Face? 638

- Adolescent Mothers Face Nutritional Challenges 639
- Older Mothers May Have Special Concerns 639
- Low-Income Mothers May Need Food Assistance 639

## What Are the Benefits and Dietary Requirements of Breastfeeding? 640

- Breastfeeding Provides Nutritional and Health Benefits for Infants 641
- Breastfeeding Provides Physical, Emotional, and Financial Benefits for Mothers 643
- Breastfeeding Is Recommended by Experts 644
- Breastfeeding Mothers Have Special Dietary Needs 644
- Breastfeeding Mothers Should Limit or Entirely Avoid Certain Substances 644

## Why Is Formula a Healthy Alternative to Breast Milk? 646

- Some Women Are Not Able to Breastfeed 646
- Infant Formula Is Patterned After Breast Milk 647

## What Are an Infant's Nutrient Needs and Why Are They So High? 648

- Infants Grow at an Accelerated Rate 648
- Infants Have Specific Energy, Iron, and Other Nutrient Needs 649

## When Are Solid Foods Safe to Introduce to Infants? 650

- Solid Foods May Be Introduced Once Certain Milestones Are Met 650
- Solid Foods Should Be Introduced Gradually 651
- Some Foods Are Not Appropriate for Infants 651

## HEALTHCONNECTION: What Causes Food Allergies? 652

- Food Allergies Are Immune System Reactions 652
- Eight Foods Are Highly Allergenic 653

Visual Chapter Summary 655

# 18

## Life Cycle Nutrition: Toddlers through Adolescents 665

### What Are the Nutritional Needs of Toddlers and Preschoolers? 666

- Young Children Need Frequent, Small, Nutrient-Dense Meals and Snacks 666
- Young Children Need Adequate Carbohydrate, Fat, and Protein 668
- Young Children Need Adequate Iron, Calcium, and Vitamin D 668
- Young Children Need Adequate Fluid 670
- Young Children Can Grow Healthfully on Vegetarian Diets 670
- Added Sugars Should Be Limited in Young Children's Diets 671

### How Can Adults Influence Young Children's Food Preferences? 671

### What Factors Affect School-Age Children's Nutrition? 673

- MyPlate Can Help Guide Food Choices 673
- School Lunches Contribute to Children's Nutritional Status 675
- Breakfast Is Important 676
- Most Children Need to Eat More Fruits and Vegetables 677
- Food Allergies Remain a Concern 677
- Poverty Influences Children's Nutritional Status 678

### Why Are School-Age Children Experiencing High Rates of Obesity? 678

- About 17 Percent of U.S. School-Age Children Are Obese 678
- Multiple Factors Contribute to Childhood Obesity 679

### What Are the Nutritional Needs of Adolescents? 682

- Adolescents Need Calcium and Vitamin D for Bone Development 682
- Adolescents Need Iron for Muscle Growth and Blood Volume 683

### What Nutritional Issues Affect Adolescents? 684

- Social Factors Can Influence Teens' Health Habits 684
- Diet May Play a Modest Role in Adolescent Acne 684
- Adolescents Are at Risk for Disordered Eating 685

### HEALTHCONNECTION: What Are the Health Effects of Childhood Obesity? 687





- Obese Children Are at Increased Risk for Type 2 Diabetes 687
- Other Risks Are Associated with Childhood Obesity 687
- Early Assessment and Treatment Can Help Address Childhood Obesity 687

Visual Chapter Summary 689

## 19 Life Cycle Nutrition: Older Adults 697

### What Are the Demographics of Aging in America? 698

- America's Population Is Getting Older and More Diverse 698
- Improved Health Care Is Increasing Lifespan 699
- Poor Lifestyle Choices Contribute to the Leading Causes of Death in Older Adults 699

### What Changes Occur as Part of the Aging Process? 700

- Muscle and Bone Mass Decline 701
- Immune Function Decreases 701
- Sensory Abilities Decline 701
- Gastrointestinal Functions Change 702
- Brain Function Changes 702

### What Are the Nutrient Needs of Older Adults? 703

- Older Adults Have Lower Energy Needs 704
- Older Adults Need Ample Protein 705
- Carbohydrates Should Be Nutrient Dense and High in Fiber 707
- The AMDR for Fat Does Not Change with Age 707
- Older Adults Need to Stay Hydrated 707
- Older Adults Need the Right Amounts of Vitamins A, D, and B<sub>12</sub> 707
- Older Adults Need the Right Amounts of Iron, Zinc, Calcium, and Sodium 708
- Older Adults May Benefit from Vitamin and Mineral Supplements 709
- Older Adults Should Eat Right for Good Health and Disease Prevention 710

### What Nutrition-Related Health Concerns Affect Older Adults? 711

- Medications, Foods, and Supplements Can Interact in Harmful Ways 711
- Decreased Mobility Affects Many Older Adults 712
- Eye Disease Is a Concern for Many Older Adults 714
- Alzheimer's Disease Is a Progressive, Irreversible Form of Dementia 714

### What Socioeconomic and Psychological Issues Affect the Nutrition of Older Adults? 715

- Food Insecurity Has Nutritional Impacts 715
- Community Resources Exist for Older Adults 717
- Depression and Alcohol Abuse Can Affect Nutritional Health 717



### HEALTHCONNECTION: Why Are Older Adults at Increased Risk for Hypertension? 718

- Hypertension Develops Over Time 718
- Some Risk Factors for Hypertension Are Not Controllable 719
- Many Risk Factors for Hypertension Are Within Your Control 719
- Alcohol Consumption and Smoking 720
- Body Weight 720
- Physical Activity 720

Visual Chapter Summary 723

## 20 Food Safety, Technology, and Sustainability 731

### What Causes Foodborne Illness? 732

- Pathogens and Their Toxins Cause Most Foodborne Illness 732
- Some Illnesses Are Caused by Natural Toxins 737
- Chemical Agents Sometimes Cause Foodborne Illness 738
- Some People Are at Higher Risk for Foodborne Illness 739

### What Strategies Can Prevent Foodborne Illness? 739

- Practice Food Safety at Home 741
- Practice Food Safety While Traveling 746

### How Is the Food Supply Protected? 747

- Several Government Agencies and Programs Protect the Food Supply 748



Food Manufacturers Use Preservation Techniques to Destroy Contaminants 749  
Product Dating Identifies Peak Quality 751  
The Safety of the Water Supply Is Regulated 751

### What Role Do Food Additives and Other Chemicals Play in Food Production and Safety? 752

Some Additives Are Used to Preserve Foods 752  
Some Additives Enhance Food Quality and Appeal 753  
Food Additives Are Regulated by the FDA 754  
Hormones and Antibiotics Are Provided to Food-Producing Animals 755  
Pesticides Are Widely Used in Agriculture 757  
Organic Foods Meet USDA National Organic Standards 759

### What Is a Sustainable Food System? 761

Preserving Internal Natural Resources Is the First Step toward Sustainability 762  
Locally Grown Food Requires Fewer External Natural Resources 764

### HEALTHCONNECTION: Is Genetically Engineered Food Safe? 766

Genetic Engineering Is the Latest Form of Biotechnology 766  
Proponents Believe GMOs Can Increase the World's Food Supply 766  
Some Consumers and Environmentalists Have Concerns about GMOs 768  
GE Foods Are Highly Regulated in the United States 768

Visual Chapter Summary 770

## 21

# Global Nutrition and Malnutrition 779

### What Factors Contribute to Malnutrition in the United States? 780

Food Insecurity in the United States Is Significant 780  
Food Insecurity Is More Likely Among Certain Population Groups 781  
Poverty Contributes to Food Insecurity 782  
Illness and Disability Can Lead to Food Insecurity 783

### What Factors Contribute to Malnutrition around the World? 784

Discrimination Contributes to Malnutrition 784  
Political Sanctions and Armed Conflicts Disrupt the Food Supply 785  
Agricultural Challenges and Food Waste Limit the Food Supply 785  
Climate Change, Natural Disasters, and Depleted Resources Limit Food Production 786

Overpopulation Leads to Food Scarcity 786

The Nutrition Transition Can Contribute to Malnutrition 787

### Which Populations Are at Greatest Risk for Malnutrition Worldwide? 788

Pregnant and Lactating Women Are at Increased Risk for Malnutrition 788

Infants and Children Are Highly Susceptible to Malnutrition 788

The Ill and the Elderly Are Also at High Risk for Malnutrition 789

People Living in Poverty Have Unique Risk Factors for Overnutrition 789

### How Can We Reduce Hunger? 790

Improve Agriculture 791  
Improve Water and Sanitation 792  
Fortify Foods to Raise Nutrient Levels 793  
Promote Education 793  
Assistance Programs Are Working to End Hunger Around the World 793

### HEALTHCONNECTION: What Are the Effects of Chronic Undernutrition? 794

Children Suffer Impaired Growth and Development 794  
Weakened Immunity Results in Disease 795

Visual Chapter Summary 796

## Appendices

### Appendix A

Metabolism Pathways and Biochemical Structures A-3

### Appendix B

Calculations and Conversions B-1

### Appendix C

U.S. Exchange Lists for Meal Planning C-1

### Appendix D

Organizations and Resources D-1

Glossary G-1

Index I-1

Credits CR-1



# Special Features



Scan this QR code to access all Focus Figure Narrated Walkthroughs videos, Calculation Corner videos, and MP3 Tutor Sessions for this edition.

## FOCUS FIGURE

- Focus Figure 2.2 Dietary Reference Intakes 46
- Focus Figure 2.9 The Nutrition Facts Panel 60
- Focus Figure 3.1 The Digestive System 77
- Focus Figure 3.6 Structures of the Small Intestinal Wall 80
- Focus Figure 4.8 Carbohydrate Digestion and Absorption 121
- Focus Figure 4.10 Hormones Regulate Blood Glucose 125
- Focus Figure 4.22 Diabetes 143
- Focus Figure 5.10 Lipid Digestion and Absorption 166
- Focus Figure 5.15 Lipoprotein Transport and Distribution 171
- Focus Figure 5.22 Atherosclerosis 191
- Focus Figure 6.6 Protein Digestion and Absorption 212
- Focus Figure 6.8 Protein Synthesis 215
- Focus Figure 8.15 Metabolism during the Absorptive State 301
- Focus Figure 8.16 Metabolism during the Postabsorptive State 303
- Focus Figure 9.7 Retinal and Its Role in Vision 331
- Focus Figure 11.11 Fluid Balance during Exercise 422
- Focus Figure 12.11 Hormones Maintain Calcium Homeostasis 447
- Focus Figure 14.1 The Concept of Energy Balance 509
- Focus Figure 15.1 The Brain Controls Hunger and Satiation 542
- Focus Figure 16.5 The Energy Sources That Fuel Our Activities 594

## HEALTHCONNECTION

- How Can You Find and Recognize Credible Nutrition Information? 28
- Portion Distortion 65
- What Are Some Common Digestive Disorders? 98
- What Is Diabetes? 141
- What Is Heart Disease and What Factors Increase Risk? 190
- What Is a Vegetarian Diet? 236
- What Is Alcohol Use Disorder (AUD)? 269

- What Are Genetic Disorders of Metabolism? 308
- Are Vitamin Supplements Necessary for Good Health? 348
- Do Antioxidant Nutrients and Phytochemicals Reduce the Risk of Cancer? 392
- What Are the Effects of Too Much or Too Little Water? 421
- What Is Osteoporosis? 455
- What Are Nutrient-Deficiency Anemias? 495
- What Is Disordered Eating? 527
- What Are the Medical Interventions for Severe Obesity? 565
- Can Ergogenic Aids Contribute to Exercise Performance and Fitness? 609
- What Causes Food Allergies? 652
- What Are the Health Effects of Childhood Obesity? 687
- Why Are Older Adults at Increased Risk for Hypertension? 718
- Is Genetically Engineered Food Safe? 766
- What Are the Effects of Chronic Undernutrition? 794



## Calculation Corner

- Calculating Kilocalories in a Snack of Chips and Soda 11
- Calculating AMDR 48
- Daily Carbohydrate Intake 129
- Calculating the AMDR for Fat 175
- Nitrogen Balance 221
- Protein Requirements 224
- Amino Acid Score 226
- PDCAAS 226
- Estimate Blood Alcohol Concentration 255
- Converting International Units for Vitamin A 333







Converting International Units for Vitamin D 338  
 Converting International Units for Vitamin E 343  
 Niacin Equivalents 371  
 Dietary Folate Equivalents 380  
 Calculating the Energy Content of a Meal 510  
 What's Your Estimated Energy Requirement (EER)? 518  
 Body Volume and Density 521  
 Converting BMI to Percent Body Fat 526  
 Calculating Percentage of Weight Loss 552  
 Calculating Energy Density 553  
 Target Heart Rate 583  
 Fluid Needs for Distance Runners 608  
 Determining Kilocalorie and Fat Content of Breast Milk 642  
 Interpreting a Growth Chart 667  
 Adolescent Calcium Needs 683  
 Estimating Energy Expenditure Using the Harris-Benedict Equation 705

## Chemistry Boost

Chemical Bonds 9  
 Covalent Bonds 11  
 Hydrolysis 86  
 pH Scale 88  
 Condensation Reaction 114  
 Fatty Acid Notations 162  
 Fermentation 249  
 Oxidation-Reduction Reactions 284  
 Reactions 346  
 The Role of Riboflavin in Redox Reactions 368  
 Water and Acid-Base Balance 409  
 The Oxidation and Reduction of Iron 475  
 ATP 586

## EXAMINING THE EVIDENCE

Does the Time of Day You Eat Impact Your Health? 56  
 Do Probiotics, Prebiotics, and Synbiotics Improve Your Health? 82

Is Increased Intestinal Permeability (aka Leaky Gut Syndrome) a Real Disorder? 91  
 Do Sugar-Sweetened Beverages Cause Obesity? 137  
 Is Coconut Oil the Next Superfood? 183  
 Does Soy Reduce the Risk of Heart Disease and Cancer? 228  
 Does Moderate Alcohol Consumption Provide Health Benefits? 266  
 Does Vitamin C Prevent the Common Cold? 390  
 Is Bottled Water—Plain or Enhanced—Healthier than Tap? 417  
 What Is NEAT About Fidgeting? 515  
 Do Diets Rich in Carbohydrates Make Us Fat? 549  
 The Microbiomes: Is There a Link to Obesity? 556  
 Which Exercise Is the Most Effective for Weight Loss? 558  
 Can a Change in Diet Prevent or Treat ADHD in Children? 669  
 Does Kilocalorie Restriction Extend Life? 706

## NUTRITION *in* PRACTICE

Nurse Practitioner 103	Kathy 460
Certified Diabetes Educator 145	Evelyn 478
Brendan 197	Sports Medicine Specialist and PT 562
Registered Nurse and MD 239	Athletic Trainer 600
Abby 341	WIC Nutritionist 634
Leland 386	Psychologist 686
Athletic Trainer 423	Occupational Therapist 721

## Self-Assessment

How Healthy Is Your Family Tree? 19  
 Does Your Diet Have Proportionality? 51  
 Are You at Risk for Type 2 Diabetes? 144  
 How Much Fat Is in Your Diet? 176  
 Red Flags for AUD 269  
 Are You Getting Enough Fat-Soluble Vitamins in Your Diet? 327  
 Are You Getting Enough Water-Soluble Vitamins in Your Diet? 364  
 Estimating Your Calcium Intake 458  
 Are You at Risk for an Eating Disorder? 531  
 How Much Does Your Environment Affect Your Energy Balance? 547  
 Are You Meeting Your Fitness Recommendations and Eating for Exercise? 608  
 Are You Ready for a Healthy Pregnancy? 623  
 DETERMINE Your Nutritional Health 716  
 How Do Your Food Safety Habits Stack Up? 746  
 Are You Food Secure? 783

## SPOTLIGHT

Dietary Guidelines for Americans, 2015-2020 50  
What Is Lactose Intolerance? 115  
The Mediterranean Diet: What Do People Living in the  
Mediterranean Do Differently? 179  
Protein Supplements 231  
Carbohydrate Loading 591  
Relative Energy Deficiency in Sport (RED-S) 603  
Breastfeeding at Work Can Work 645  
The Lowdown on Listeria 740  
Farmers Markets 765  
Hunger among Us (and How You Can Help!) 791

## TABLE TIPS

Tips for an Adequate, Balanced, Varied,  
and Moderate Diet 41  
Improve Your Digestion 97  
Improving Lactose Tolerance 116  
Increasing Daily Fiber Intake 129  
Ways to Enjoy Whole Grains 132  
Subtracting Added Sugars 136  
Easy Ways to Add Fish to the Diet 194  
Nuts about Nuts? 195  
Eating for a Healthy Heart 195  
Moderate Your Drinking 271  
Important Advice for Maintaining Energy Levels 300  
Preserve Your Vitamins! 326  
Score an A 335  
Ways to Get Vitamin D 339  
Enjoying Your Es 343  
Getting Your Ks 347  
Thrive with Thiamin 365  
Raise Your Riboflavin 368  
Need More Niacin? 371  
A Plethora of Pantothenic Acid 374

Boundless Biotin 375  
Boost Vitamin B<sub>6</sub> 377  
Fulfill Folate Needs 381  
Bolster Vitamin B<sub>12</sub> 384  
Juicy Ways to Get Vitamin C 388  
Bottoms Up 419  
Shake the Salt Habit 442  
Potassium Pointers 445  
Calcium Counts 449  
Balance Phosphorus with Calcium 452  
More Magnesium 453  
Increase Your Iron Intake 476  
Counting Copper 480  
Rethink Your Zinc 483  
Seek Selenium 485  
Find More Fluoride 487  
Cram in the Chromium 489  
Increase Your Iodine 490  
Managing Manganese 493  
Eat More to Weigh Less 555  
Adopt Some Healthy Habits 561  
340 Snacks 635  
Going from 340 to 450 636  
Prepare Tasty Treats for Toddlers 668  
Create Kid-Friendly, Iron-Rich Foods 670  
Tips for Packing School Lunches 676  
Breakfast on the Go 677  
Healthy Eating for Older Adults 710  
Avoid Toxins and Chemical Agents  
in Seafood 738  
Wash Your Hands! 741  
Avoiding Foodborne Illness While Traveling 746

## FITNESS TIPS

Increase Your NEAT 516  
Achieve Energy Balance 519  
Get UP and MOVE 557  
Get Moving! 584  
Exercising while Pregnant 637

# About the Authors



## **Joan Salge Blake, MS, RD, LDN**

*Boston University*

Dr. Joan Salge Blake is a Clinical Associate Professor and Dietetics Internship Director at Boston University's Sargent College of Health and Rehabilitation Sciences. She teaches both graduate and undergraduate nutrition courses. She received her MS and EdD from Boston University.

Joan is a member of the Academy of Nutrition and Dietetics (formerly the American Dietetic Association) and the Massachusetts Dietetic Association (MAND). She has been a presenter and Presiding Officer at both the AND Annual Meeting and the MAND Annual Convention and is a guest lecturer at both the Boston University Goldman School of Dental Medicine and the Boston University School of Medicine. She was previously named MDA's "Young Dietitian of the Year" and is the past Director of Education and Nominating Committee Chairperson for the MDA. She currently serves on the MDA board. Joan has received the Whitney Powers Excellence in Teaching award from Boston University and the Annie Galbraith Outstanding Dietitian award from the Massachusetts Dietetic Association.

In addition to teaching and writing, Joan has a private practice specializing in weight management and lifestyle changes. Joan is often asked to translate complex nutritional issues in popular terms in the media. She has conducted over 1,000 media interviews and is a contributor of nutrition articles in a variety of news outlets. Joan was an AND National Media Spokesperson for nine years.



## **Kathy D. Munoz, EdD, RDN**

*Humboldt State University*

Kathy D. Munoz is a professor emerita and professor of nutrition in the Department of Kinesiology and Recreation Administration at Humboldt State University. She teaches undergraduate introductory nutrition, exercise nutrition, and weight management courses, and teaching preparation in higher education courses in the Extended Education, College of eLearning. She received her EdD from the University of Southern California in curriculum design and an MS in Foods and Nutrition with a minor in exercise physiology from Oregon State University.

Kathy is a member of the Academy of Nutrition and Dietetics and the California Dietetic Association. Her professional memberships include Dietitians in Integrative and Functional Medicine (DIFM), Sports, Cardiovascular, and Wellness Nutrition (SCAN), and Weight Management (WM).

Kathy has published articles in *Research Quarterly for Exercise and Sport*, *Children's Health Care*, the *Journal of Nutrition Education*, and the *International Journal of Sport Nutrition and Exercise*, and has co-authored a series of nutrition and physical activity curriculum guides for elementary teachers. Kathy has also been recognized for her research in, and development of curriculum for, asynchronous learning.





## **Stella L. Volpe, PhD, RD, LDN, FACSM**

*Drexel University*

Dr. Stella Lucia Volpe is Professor and Chair of the Department of Nutrition Sciences at Drexel University. Stella is a nutritionist and exercise physiologist who has built a program of research focusing on three interrelated areas that traverse the lifespan: (1) obesity and diabetes prevention via mineral supplementation, (2) weight management through diet, exercise, and educational programs, and (3) environmental change leading to weight management. She is conducting a cross-sectional, long-term study assessing body composition, resting metabolic rate, maximal oxygen consumption and diet in athletes. In addition, she has recently completed a three-year, school-based obesity prevention trial.

Stella received her BS in Exercise Science from the University of Pittsburgh, her MS in Exercise Physiology from Virginia Tech, and her PhD in Nutrition, also from Virginia Tech.

Prior to beginning her faculty appointment at Drexel University, Stella was on the faculty of the University of Pennsylvania, and previous to that, she was on the faculty at the University of Massachusetts, Amherst. Stella is both a Certified Clinical Exercise Physiologist (American College of Sports Medicine [ACSM]), and a Registered Dietitian Nutritionist. She is a Fellow of the ACSM. Stella is a competitive athlete in field hockey, rowing, ice hockey. She enjoys being active with her husband and their German Shepherd dogs, Sasha and Bear.

# Preface

## Why We Wrote *Nutrition: From Science to You*

We wrote *Nutrition: From Science to You* to provide you with a solid foundation about nutrition and how it affects *you* and your nutritional needs, concerns, and questions.

Between the three of us, we have more than 60 years of experience teaching college-level nutrition. We've conducted and published research, studied the literature, and listened to and watched our students learn the science. We've taken copious notes regarding students' questions, interests, concerns, and misunderstandings, both in and outside the classroom. These years of experience have culminated in a textbook that we believe translates the latest nutrition science into a readable format to provide you with information that you can easily incorporate into your life and the lives of others.

As a college student, you are exposed to a steady stream of nutrition and health information from the media, your family and friends, and the Internet. Although you may think Google has the answer to your nutrition questions, we have seen students frequently fall victim to misinformation found on the Web. We designed *Nutrition: From Science to You* to be as user friendly as possible, and packed exclusively with sound nutrition information. The text goes beyond basic nutrition science and provides realistic advice and strategies to help you apply what you learn in your own life. The text is written to meet *your* nutritional concerns and answer *your* questions.

Remember, nutrition matters to *you!* What you eat today and tomorrow will affect you and your body for years to come. Just as important, what you learn about nutrition today will enable you to make a positive effect on the lives of others from now on.

## New to This Edition

- **The 2015 Dietary Guidelines of America and Nutrition Facts Panel** are fully integrated into the fourth edition.
- **Focus Figure Video Walkthroughs** narrated by author Joan Salge Blake provide a video tour of the full-page Focus Figure, where each part is broken down and further explained by Joan Salge Blake, just as she would do in the classroom. Students can access these videos in—and instructors can assign them from—Mastering Nutrition.
- **Inter-professional Nutrition in Practice case studies** encourage critical thinking and emphasize the applicability of the content to your own life and future career. Some case studies draw upon Joan Salge Blake's experience as a dietitian working with actual clients, while others have been created with a new focus for those students interested in pursuing other allied health professions such as nursing, physical therapy, etc.
- **New and expanded topics such as:** prediabetes, non-celiac gluten sensitivity, FODMAP diet, FITT and high intensity interval training, prebiotics and synbiotics, and more. In addition, Chapter 8, including metabolism and energy metabolism pathways, has been significantly restructured for clarity.

## Other Key Features

- **Learning Outcomes** are used to structure the chapter: each main heading is accompanied by its own learning outcome; **The Take-Home Message** at the end of each main section repeats the learning outcome number before a brief summation of the key points; and the **Visual Chapter Summary** is organized by learning outcome number and contains key images and concepts. This strong pedagogical structure throughout the chapter promotes comprehension and facilitates study and review.
- **Health Connections** appear in each chapter directly before the Visual Chapter Summary. These sections, which are tied to learning outcomes, highlight diseases and disorders in which nutrition plays a major role, as well as nutritional practices that offer unique health benefits.
- **Content has been updated throughout** to be consistent with new guidelines, data, research, and trends.
- **Mastering™ Nutrition**, the online homework, tutorial, and assessment system, delivers self-paced tutorials and activities that provide individualized coaching, focus on your course objectives, and are responsive to your personal progress. The Mastering system is the most effective and widely used online homework, tutorial, and assessment system for the sciences. It helps instructors maximize class time with customizable, easy-to-assign, and automatically graded assessments that motivate students to learn outside of class and arrive prepared for lectures. Mastering Nutrition for the fourth edition includes new Focus Figure Coaching Activities, updated NutriTools Coaching Activities, and much more. Learn more at [www.masteringhealthandnutrition.com](http://www.masteringhealthandnutrition.com).
- **MyDietAnalysis mobile website** is available, so you can track your diet and activity intake accurately, anytime, and anywhere from your mobile device. Learn more at [www.mydietanalysis.com](http://www.mydietanalysis.com). Access to MyDietAnalysis is included in Mastering Nutrition at no additional cost.
- **Examining the Evidence** features look at the latest research on hot topics in nutrition today. These features guide you to making better, informed choices in your personal nutrition, while also demonstrating the ways nutrition professionals are constantly expanding and refining our understanding of nutritional science.
- **Exploring Micronutrients** within Chapters 9, 10, 12, and 13 are self-contained sections that incorporate photos, illustrations, and text to present each vitamin and mineral. Each micronutrient is discussed using the same categories (forms, absorption and transport, functions, daily needs, food sources, and toxicity and deficiency symptoms) for a consistent and easy-to-study format.
- **Chemistry Boosts** review chemistry concepts within the context in which you need to know them.
- **Calculation Corners** walk through mathematical equations used in the chapter and give you practice working the equations themselves. These features also have corresponding math video activities in Mastering Nutrition.
- **True or False?** pretests open each chapter with 10 true/false statements that help you realize that the things you think you know about nutrition aren't always accurate. Answers are given at the end of the chapter.
- **Table Tips** give practical ideas for incorporating adequate amounts of each nutrient into your diet using widely available foods.
- **Self-Assessments** throughout the book ask you to think about your own diet and behaviors and how well you are meeting your various nutrient needs.

## Chapter-by-Chapter Updates

Nutrition research and applications continue to expand our understanding of this advancing and dynamic science. To keep pace, we've reorganized the content, and visually



improved the figures and tables to enrich student learning in each chapter in the 4th edition of *Nutrition: From Science to You*.

## Chapter 1: What Is Nutrition?

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Updated statistics on such key topics as the obesity epidemic, consumption trends, the quality of the American diet, leading causes of death in the United States.
- Moved content on meeting nutrition needs into its own section with Learning Outcome and The Take-Home Message.
- Created a new Health Connection on *Finding Credible Nutrition Information*.

## Chapter 2: Tools for Healthy Eating

- Learning outcomes are highlighted to match the major headings, the Take-Home Message, and visual chapter summaries.
- Added a new Focus Figure 2.3, *Dietary Reference Intakes*.
- Created a new Focus Figure 2.10, *The Nutrition Facts Panel*, to describe the newest proposed food label changes.
- Developed a new Health Connection, with accompanying Learning Outcome and The Take-Home Message, on *Portion Distortion* to provide guidance on how to recognize healthy portion sizes to reduce the risk of weight gain.

## Chapter 3: Digestion, Absorption, and Transport

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summary sections.
- Added a new Figure 3.12 summarizing the actions of digestive hormones.
- Added a new Figure 3.13 on how the cardiovascular and lymphatic systems transport nutrients.
- Added a new Figure 3.16 on the effects celiac disease has on the wall of the small intestine.
- Consolidated coverage of celiac disease and other digestive disorders into a new Health Connection with accompanying Learning Outcome and The Take-Home Message.

## Chapter 4: Carbohydrates

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Created a new Figure 4.9 on absorption and storage of monosaccharides.
- Added a discussion of hypoglycemia to the section on regulating blood glucose.
- Added a new Focus Figure 4.23, *Diabetes*, showing the mechanisms involved in both type 1 and type 2 diabetes.
- Revised all carbohydrate food source diagrams to feature new foods.
- Added a discussion of glycemic index and glycemic load to the section on best food sources of carbohydrates.
- Created a new Examining the Evidence feature, *Do Sugar-Sweetened Beverages Cause Obesity?*
- Updated coverage of sugar substitutes.
- Relocated Health Connection on diabetes and included Learning Outcome and The Take-Home Message.

## Chapter 5: Lipids

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised headings to clarify when the discussion covers lipids in general or triglycerides specifically.
- Revised the Focus Figure 5.16, *Lipid Digestion and Absorption*.
- Created a new Figure 5.15, *Lipoproteins*, to illustrate the both the size and compositions differences between the lipoproteins.
- Created a new Figure 5.18 on the metabolism of linoleic acid and alpha-linolenic acid.
- Moved both Figure 5.19 on the production of bile from cholesterol and Figure 5.20 on the phospholipid bilayer to the section discussing the roles of phospholipids and cholesterol in the body.
- Revised all lipid food source diagrams to feature new foods.
- Updated the research on the Mediterranean Diet in a new Spotlight box and added a new figure of the latest Healthy Mediterranean Diet Pyramid.
- Added a new Examining the Evidence feature, *Is Coconut Oil the Next Superfood?*
- Updated the Health Connection on heart disease and added a Learning Outcome and The Take-Home Message.
- Created a new Focus Figure 5.25, *Atherosclerosis*.

## Chapter 6: Proteins

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised Figure 6.1 on the structural differences between carbohydrates, proteins, and fats.
- Revised Figure 6.2 on the organization and shape of proteins.
- Modified Focus Figure 6.6 on the digestion and absorption of protein.
- Revised Focus Figure 6.7 on protein synthesis.
- Modified Figure 6.9 on deamination and transamination.
- Moved coverage of amino acid score, PDCAAS, biological value, protein quality to the section discussing food sources of protein.
- Updated the statistics and references in the Examining the Evidence feature, *Does Soy Reduce the Risk of Disease?*
- Revised all protein food source diagrams to feature new foods.
- Expanded the Health Connection on vegetarian diets, with accompanying Learning Outcome and The Take-Home Message, to include benefits and potential risks of vegetarian diets.
- Added Figure 6.20, *MyVeganPlate*.

## Chapter 7: Alcohol

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Reorganized the order of the topics presented and updated latest statistics and research.
- Moved content on reasons for drinking into its own section with Learning Outcome and The Take-Home Message.
- Moved content on short-term effects of alcohol into its own section with Learning Outcome and The Take-Home Message.
- Expanded the coverage of the negative impact of alcohol consumption, including the statistics on depression.

- Moved *Figure 1, How Red Wine May Affect the Risk of Cardiovascular Disease* to the Examining the Evidence, *Does Moderate Alcohol Consumption Provide Health Benefits?*
- Expanded the information on the moderate consumption of alcohol to emphasize the age-related benefits not seen in younger adults.
- Expanded the content on alcohol abuse and alcoholism in the Health Connection, with accompanying Learning Outcome and The Take-Home Message, and updated statistics on the prevalence of different types of alcohol abuse.

## Chapter 8: Energy Metabolism

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Modified references to high-energy electrons and hydrogen ions throughout the chapter.
- Created a new figure for the Chemistry Boost box that illustrates oxidation-reduction reactions.
- Revised Figure 8.5, *The Metabolic Fate of Food*.
- Created a new Table 8.2, *Glucogenic and Ketogenic Amino Acids*
- Revised Figure 8.11, *Fatty Acids Are Oxidized for Energy*.
- Revised Figure 8.13, *The Electron Transport Chain*.
- Revised explanation of electron transport chain and oxidative phosphorylation.
- Revised Figure 8.18, *The Metabolism of Alcohol*.
- Created a new Figure 8.19 to illustrate galactosemia.
- Expanded the Health Connection, with accompanying Learning Outcome and The Take-Home Message, on inborn errors of metabolism.

## Chapter 9: Fat-Soluble Vitamins

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- For each fat-soluble vitamin, included the Learning Outcome at the beginning of the section, and added a new The Take-Home Message at the end.
- Revised all fat-soluble vitamin food source diagrams to feature new foods.
- Created a new Focus Figure 9.8, *Retinal and Its Role in Vision*.
- Revised Table 9.4 on the function, daily needs, food sources, toxicity, and deficiency of each fat-soluble vitamin.
- Moved the Nutrition in Practice on vitamin D deficiency to fall within the vitamin D section.
- Created a new Health Connection, with accompanying Learning Outcome and The Take-Home Message, on the role of vitamin supplements in good health.
- Added a new Figure 9.27 on dietary supplement labels.

## Chapter 10: Water-Soluble Vitamins

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised Figure 10.1, *Digesting and Absorbing Water-Soluble Vitamins*.
- Moved Figure 10.3 on the functions of B vitamins in energy metabolism to the section discussing the primary functions of water-soluble vitamins.
- Revised Table 10.1 on the function, daily needs, food sources, toxicity, deficiency, and active form of each water-soluble vitamin.
- For each water-soluble vitamin, included the Learning Outcome at the beginning of the section, and added a new The Take-Home Message at the end.



- Revised all water-soluble vitamin food source diagrams to feature new foods.
- Revised Figure 10.16, *Pantothenic Acid and Energy Metabolism*.
- Revised Figure 10.20, *Vitamin B<sub>6</sub> Assists in Transamination*.
- Revised Figure 10.23, *The Digestion of Folate*
- Added new Figure 10.28 on the absorption of vitamin B<sub>12</sub>, including the reactions of vitamin B<sub>12</sub> with the R protein and intrinsic factor in the gastrointestinal tract.
- Revised discussion of how folate deficiency may mask vitamin B<sub>12</sub> deficiency.
- Updated the information in the Examining the Evidence feature on vitamin C and the common cold.
- Added a new Health Connection, with accompanying Learning Outcome and The Take-Home Message, on the role of a healthy diet and lifestyle in cancer risk.

## Chapter 11: Water

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised Figure 11.1, *The Composition of the Body*.
- Revised Figure 11.5, *Sources of Body Water and Routes of Excretion*.
- Updated the Examining the Evidence feature on bottled water to include the most recent research.
- Updated coverage of the health effects of too much or too little water with the latest research and moved into a new Health Connection, with accompanying Learning Outcome and The Take-Home Message,
- Added a new Focus Figure 11.12, *Fluid Balance during Exercise*.

## Chapter 12: Major Minerals

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised Table 12.2 on the function, daily needs, food sources, toxicity, and deficiency, of each major mineral.
- For each major mineral, included the Learning Outcome at the beginning of the section, and added a new The Take-Home Message at the end.
- Revised all major mineral food source diagrams to feature new foods.
- Revised Figure 12.4, *Sodium Helps Transport Some Nutrients*.
- Revised Figure 12.8 to illustrate the size of a kidney stone.
- Created a new Focus Figure 12.11 on the hormonal regulation of blood calcium levels.
- Revised and updated the content on bone mass and osteoporosis in the Health Connection, with accompanying Learning Outcome and The Take-Home Message.

## Chapter 13: Trace Minerals

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised Table 13.1 on the function, daily needs, food sources, toxicity, deficiency, and interaction of each trace mineral.
- For each trace mineral, included the Learning Outcome at the beginning of the section, and added a new The Take-Home Message at the end.
- Revised all trace mineral food source diagrams to feature new foods.
- Expanded the Health Connection, with accompanying Learning Outcome and The Take-Home Message, to include the causes, symptoms, testing, and treatment for both microcytic and macrocytic anemia.

- Revised Figure 13.18 compares healthy red blood cells to microcytic and macrocytic red blood cells affected by anemia.

## Chapter 14: Energy Balance and Body Composition

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Added a new Focus Figure 14.1 describing energy balance, negative energy balance, and positive energy balance.
- Expanded discussion of the health risks associated with underweight and overweight.
- Added Table 14.6 defining the terms underweight, overweight, and obesity classified by BMI.
- Added Table 14.7 listing different methods of classifying obesity in adults.
- Created a new Health Connection, with accompanying Learning Outcome and The Take-Home Message, on disordered eating using updated content previously located in Chapter 15.
- Added Table 14.8 presenting the diagnostic criteria for classifying eating disorders.
- Added Table 14.9 explaining the warning signs associated with eating disorders.
- Added a Self-Assessment feature, *Are You At Risk for an Eating Disorder?*

## Chapter 15: Weight Management

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Updated all statistics about the prevalence of overweight and obesity.
- Added new information on weight bias and discrimination and the classification of obesity as a disease by the AMA.
- Created a new Figure 15.1 describing the cost of treating obesity in America.
- Created a new Focus Figure 15.2 on hormonal regulation of hunger and satiety.
- Created a new Figure 14.4 illustrating lipoprotein lipase activity in lean, overweight, and obese adults.
- Included a new section on the role of nutrigenomics and epigenetics in obesity and weight management.
- Created a new Figure 15.5 on the structure of an epigenome.
- Added a discussion of decreased physical activity due to the prevalence of the automobile.
- Added a new Examining the Evidence feature on carbohydrates and their role in obesity.
- Expanded the discussion on low-energy-density foods as they relate to weight management.
- Added a new Examining the Evidence feature on microbiomes and their possible link to obesity.
- Added a new Examining the Evidence feature on whether anaerobic or aerobic exercise is the most effective for weight loss.
- Revised and updated the content on obesity medications and bariatric surgery in the Health Connection feature, with accompanying Learning Outcome and The Take-Home Message.

## Chapter 16: Nutrition and Fitness

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Added a new Focus Figure 16.5 on energy sources that fuel different levels of activity.

- Added a new Table 16.3 on the timing of foods and amount of macronutrients needed to improve exercise performance.
- Added a new Nutrition in Practice on an athlete, which introduces the student to the process of nutrition counseling and dietetics in a real-world setting.
- Revised the Spotlight feature on the female athlete triad with the latest diagnostic terminology.
- Created a new Health Connection, with accompanying Learning Outcome and The Take-Home Message, on the role of various dietary supplements in exercise performance and fitness.
- Added discussion of the potential risks and benefits of bicarbonate loading and amino acid supplementation.

## Chapter 17: Life Cycle Nutrition: Pregnancy through Infancy

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised coverage of fetal health risks associated with pregnancy in overweight or underweight women with latest research.
- Revised coverage of fetal health risks associated with drug use during pregnancy.
- Revised discussion of goals for weight gain during pregnancy.
- Revised discussions of iron and vitamin D needs during pregnancy to emphasize the value of supplementation for most women.
- Revised Figure 17.8, *The Letdown Response*.
- Revised coverage of the relationship between breast-feeding and risk of developing food allergies with latest research.
- Updated discussion of feeding infants juice with the latest recommendations from the AAP.
- Updated the Health Connection on food allergies and added a Learning Outcome and The Take-Home Message.

## Chapter 18: Life Cycle Nutrition: Toddlers through Adolescence

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Updated discussion of young children's iron needs.
- Revised Figure 18.3 on the USDA's SuperTracker website.
- Revised coverage of the National School Lunch Program.
- Added discussion of the School Breakfast Program.
- Added a section on determining childhood overweight and obesity.
- Updated Figure 18.4, *Increase in Overweight among U.S. Children and Adolescents*.
- Updated and expanded section on the factors contributing to overweight and obesity in children to include discussions of sugary beverages, genetics, family environment, targeting marketing, and peer influence.
- Updated the Examining the Evidence feature, *Does Sugar Cause Behavior Problems in Children?*
- Updated coverage of eating disorders in adolescents with latest research.
- Updated and expanded Health Connection, with accompanying Learning Outcome and The Take-Home Message, on health effects of childhood obesity to include risks of CVD and psychological problems, as well as approaches to obesity reduction and management.



## Chapter 19: Life Cycle Nutrition: Older Adults

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Updated discussion of lifestyle factors that contribute to the leading causes of death in older Americans.
- Revised discussion of changes in body composition during aging.
- Created a new Table 19.1 on the recommended dietary changes for older adults.
- Updated the Examining the Evidence feature, *Does Kilocalorie Restriction Extend Life?*.
- Updated discussion of older adults' potential benefit from supplements with latest research.
- Revised coverage of Alzheimer's disease.
- Added a new Health Connection, with accompanying Learning Outcome and The Take-Home Message, on hypertension.

## Chapter 20: Food Safety, Technology, and Availability

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised chapter opening section.
- Updated statistics throughout chapter.
- Revised Figure 20.1, *Bioaccumulation of Toxins*.
- Revised Figure 20.3 on cross-contamination.
- Updated Table 20.2, *Safe Food Temperatures*.
- Revised Table 20.3, *Agencies that Oversee the Food Supply*.
- Revised Figure 20.7, *The Farm-to-Table Continuum*.
- Moved coverage of label terms for animal foods to the section on the use of hormones and antibiotics.
- Updated and relocated discussion of organic food production.
- New Figure 20.13 of a sustainable systems framework.
- Updated coverage of genetically engineered food in a new Health Connection, with accompanying Learning Outcome and The Take-Home Message.

## Chapter 21: Global Nutrition and Malnutrition

- Learning Outcomes tie into major headings, The Take-Home Messages, and Visual Chapter Summaries.
- Revised focus of chapter to address hunger as well as other forms of malnutrition, including overnutrition.
- Added a new section defining hunger, malnutrition, undernutrition, and overnutrition.
- Updated statistics about the prevalence of hunger and food insecurity in the United States and worldwide.
- Updated Figure 21.1, *Hunger in the United States*.
- Created new Figure 21.2 on world population growth.
- Added a new section on food deserts in the United States.
- Created a new Figure 21.3 showing food insecurity worldwide.
- Added new sections on food waste and nutrition transition to the discussion of malnutrition worldwide.
- Added new section on malnutrition in overweight and obese individuals.
- Created new Table 21.2, *Food Assistance Programs in the United States*.

- Added a new section on global programs addressing issues related to food and water supply.
- Revised discussion of health effects of chronic hunger in a new Health Connection, with accompanying Learning Outcome and The Take-Home Message.

## Supplements

### Mastering Nutrition with MyDietAnalysis with Pearson eText

[www.masteringnutrition.pearson.com](http://www.masteringnutrition.pearson.com)

The Mastering Nutrition with MyDietAnalysis online homework, tutorial, and assessment system delivers self-paced tutorials that provide individualized coaching, focus on your course objectives, and are responsive to each student's progress. Set up your course in 15 minutes with proven, assignable, and automatically graded nutrition activities that reinforce your course's learning outcomes.

- **Visual Chapter Summary Coaching Activities** review the main ideas of the chapter while incorporating engaging assessments.
- **NEW Focus Figure Narrated Walkthrough Coaching Activities** guide students through key nutrition concepts with interactive mini-lessons.
- **NEW MyDietAnalysis Personalized Diet Analysis Activities** provide students with hands-on diet analysis practice that can also be automatically graded.
- **Reading Quizzes** (20 questions per chapter) ensure that students have completed the assigned reading before class.
- **Dynamic Study Modules** help students study effectively by continuously assessing student performance and providing practice in areas where students struggle the most.
- **25 ABC News Videos** with quizzing bring nutrition to life and spark discussion on current hot topics in the nutrition field. They include multiple-choice questions that provide wrong-answer feedback to redirect students to the correct answer.
- **40 Nutrition Animations Activities** explain big-picture concepts that help students learn the hardest topics in nutrition. These animations have questions that provide wrong-answer feedback that address students' common misconceptions.
- **Math Video Coaching Activities**, accessible through Mastering, provide hands-on practice of important nutrition-related calculations.
- **Mobile-ready NutriTools Coaching Activities** allow students to combine and experiment with different food options and learn firsthand how to build healthier meals.
- **MP3 Chapter Summary** relate to chapter content and come with multiple-choice questions that provide wrong-answer feedback.
- **Access to *Get Ready for Nutrition*** gives students extra math and chemistry study assistance.
- **The Study Area** is broken down into learning areas and includes videos, animations, MP3s, and much more.

### MyDietAnalysis Premium Website

[www.mydietanalysis.com](http://www.mydietanalysis.com)

MyDietAnalysis was developed by the nutrition database experts at ESHA Research, Inc. and is tailored for use in college nutrition courses. MyDietAnalysis is available as a single sign-on to Mastering Nutrition.

- View a classwide nutritional average. MyDietAnalysis will allow you to see a nutritional profile of your entire class, enabling you to base your lecture on your students' needs.
- Video help with associated quizzes covers the topics students struggle with most.
- A mobile website version of MyDietAnalysis is also available for mobile devices.

## Learning Catalytics

Learning Catalytics is a “bring your own device” student engagement, assessment, and classroom intelligence system that allows students to use their smartphones, tablets, or laptops to respond to questions in class. With Learning Catalytics, you can assess students in real-time using open ended question formats to uncover student misconceptions and adjust lecture accordingly and automatically create groups for peer instruction based on student response patterns, to improve discussion productivity.

## Digital Instructional Resources

These valuable teaching resources include everything you need to create lecture presentations and course materials, including JPEG and PowerPoint® files of all the art, tables, and selected photos from the text, and “stepped-out” art for selected figures from the text, as well as animations, all available for download from within Mastering Nutrition or [www.pearson.com](http://www.pearson.com).

The Digital Instructional Resources includes:

- PowerPoint lecture outlines with links to Nutrition Animations and *ABC News* Lecture Launcher Videos
- Media Link PowerPoint slides for easy importing of videos and animations
- PowerPoint slides with a Jeopardy-type quiz show
- Questions for Classroom Response Systems (CRS) in PowerPoint format, allowing you to import the questions into your own CRS
- Instructor’s Resource and Support Manual
- Test Bank (Microsoft® Word, RTF, and PDF files) and Computerized Test Bank
- Introduction to Mastering Nutrition
- Introductory video for Learning Catalytics
- *East Right! Healthy Eating in College and Beyond*
- *Food Composition Table*

## Acknowledgments

It takes a village, and then some, when it comes to writing a dynamic textbook. *Nutrition: From Science to You* is no exception. We personally want to extend our gratitude to all of those who passionately shared their expertise and support to make *Nutrition: From Science to You* better than we could have envisioned.

Beginning with the energetic staff at Pearson, we would like to thank Michelle Yglecias, who helped make our vision for this textbook into a reality. Laura Bonazzoli’s comprehensive developmental editing improved the clarity of *Nutrition: From Science to You* and made it more enjoyable to read. A special thank you to Barbara Yien, Director of Development, as well, for helping steer the ship while Michelle Yglecias was on maternity leave.

Crackerjack Rich Media Content Producer Lucinda Bingham and Mastering Nutrition Content Development Lead Lorna Perkins worked diligently to create the best media supplements for *Nutrition: From Science to You*. Thanks also to editorial assistant Nicole Constantine for all of her behind-the-scenes work.

A very special thanks to Lizette Faraji, Content Producer, and Nathaniel Jones, Project Manager at SPi Global, for all of their hard work shepherding this book through to publication. Our humble appreciation also goes to Gary Hespenheide, whose design made the text, art, and photos all come alive; and to design manager Mark Ong.

Marketing takes energy, and that’s exactly what Executive Product Marketing Managers Neena Bali, Alysun Burns, and Field Marketing Manager, Mary Salzman, generate nonstop. The many instructors who reviewed the first, second, and third editions, as well as those who reviewed and class-tested early versions of this book, are listed on the following pages. We are grateful to all of them for helping in the development of *Nutrition: From Science to You*.

The village also included loyal contributors who lent their expertise to specific chapters. They are: Whitney Evans, PhD of Brown University Alpert Medical School who revised the three “life cycle” chapters; Kellene Isom, MS, RD, LDN of Brigham and Women’s Hospital, who overhauled and expanded the food safety, technology, and sustainability chapter; and Claire Alexander, who updated the global nutrition and malnutrition chapter.

Lastly, an endless thanks to our colleagues, friends, and especially our families. Joan would like to “thank my family, Adam, Brendan, and Craig for their love and support when I was working more than I should have been.” Kathy sends a special thanks to “my husband Rich and our children Heather, Wes, and Ryan for keeping me sane and grounded, and my sister Vicki for her steadfast support.” Stella would like to acknowledge “my husband, Gary Snyder, for his constant support; and our wonderful dogs, Sasha and Bear, for always making me smile! And to my Mom and Dad, who both instilled in me a wonderful relationship with food, especially home grown and homemade food.”

## Reviewers

### First Edition

Janet Anderson  
*Utah State University*

Sandra Baker  
*University of Delaware*

Gita Bangera  
*Bellevue College*

Lisa Blackman  
*Tarrant County College, Northwest*

Jeanne Boone  
*Palm Beach State College*

John Capeheart  
*University of Houston-Downtown*

Susan Chou  
*American River College*

Nicole Clark  
*Indiana University of Pennsylvania*

Susan Cooper  
*Montana State University-Great Falls College of Technology*

Jessica Coppola  
*Sacramento City College*

Lynn Monahan Couch  
*West Chester University of Pennsylvania*

Wendy Cunningham  
*California State University, Sacramento*

Jeannette Davidson  
*Bradley University*

Holly Dieken  
*The University of Tennessee at Chattanooga*

Johanna Donnenfield  
*Scottsdale Community College*

Roberta Durschlag  
*Boston University*

Brenda Eissenstat  
*The Pennsylvania State University*

Sheryl L. Fuller-Espie  
*Cabrini College*

Eugene J. Fenster  
*Metropolitan Community College, Longview*

Alyce D. Fly  
*Indiana University*

Sara Folta  
*Tufts University*

Betty Forbes  
*West Virginia University*

Sue Fredstrom  
*Minnesota State University, Mankato*

Teresa Fung  
*Simmons College*

Susan Gaumont  
*Chandler-Gilbert Community College*

Jill Golden  
*Orange Coast College*

Gloria Gonzalez  
*Pensacola State College*

Donna Handley  
*The University of Rhode Island*

William Helferich  
*University of Illinois at Urbana-Champaign*

Catherine Howard  
*Texarkana College*

Karen Israel  
*Anne Arundel Community College*

Seema Jejurikar  
*Bellevue College*

Jayanthi Kandiah  
*Ball State University*

Vicki Kloosterhouse  
*Oakland Community College*

Allen Knehans  
*The University of Oklahoma*

Kathy Knight  
*The University of Mississippi*

Shui-Ming Kuo  
*University at Buffalo*

Robert D. Lee  
*Central Michigan University*

Sharon Lemons  
*Tarrant County College, Northwest*

Darlene Levinson  
*Oakland Community College*

Rose Martin  
*Iowa State University*

Mary Martinez  
*Central New Mexico Community College*

George F. McNeil  
*Fort Hays State University*

Monica Meadows  
*The University of Texas at Austin*

Kathleen Melanson  
*The University of Rhode Island*



Mithia Mukutmoni  
*Sierra College*

Pat Munn  
*Metropolitan Community College,  
Longview*

Megan Murphy  
*Southwest Tennessee Community College*

Dan Neisner  
*Walla Walla Community College*

Corin Nishimura  
*Leeward Community College*

Anna Page  
*Johnson County Community College*

Jill Patterson  
*The Pennsylvania State University*

Janet Peterson  
*Linfield College*

Gwendolyn Pla  
*Howard University*

Roseanne Poole  
*Tallahassee Community College*

Linda Pope  
*Southwest Tennessee Community College*

Elizabeth Quintana  
*West Virginia University*

Denise Russo  
*Cabrillo College*

Kevin Schalinske  
*Iowa State University*

Diana Spillman  
*Miami University*

Sherry Stewart  
*Navarro College*

Leeann Sticker  
*Northwestern State University*

Susan Swadener  
*California Polytechnic State University, San  
Luis Obispo*

Janelle Walter  
*Baylor University*

Sandy Walz  
*West Chester University of Pennsylvania*

Daryle Wane  
*Pasco-Hernando State College*

Garrison Wilkes  
*University of Massachusetts-Boston*

Jessie Yearwood  
*El Centro College*

Gloria Young  
*Virginia State University*

Maureen Zimmerman  
*Mesa Community College*

## Second Edition

Ellen Brennan  
*San Antonio College*

Wendy Buchan  
*California State University, Sacramento*

Nicole A. Clark  
*Indiana University of Pennsylvania*

Mary Dean Coleman-Kelly  
*The Pennsylvania State University*

Eugene J. Fenster  
*Metropolitan Community College,  
Longview*

Karen Friedman-Kester  
*Harrisburg Area Community College*

Amy Frith  
*Ithaca College*

Susan Edgar Helm  
*Pepperdine University*

Shanil Juma  
*Texas Woman's University*

Allen Knehans  
*The University of Oklahoma  
Health Sciences Center*

Julia L. Lapp  
*Ithaca College*

John Radcliffe  
*Texas Woman's University*

Nancy L. Shearer  
*Cape Cod Community College*

Eric Vlahov  
*The University of Tampa*

Heidi Wengreen  
*Utah State University*

## Third Edition

Julie Albrecht  
*University of Nebraska Lincoln*

Sandra Brown  
*University of Delaware*

Donna M. Cain  
*Collin County Community College*

Jana Gonsalves  
*American River College*

Cindy Hudson  
*Hinds Community College*

Ruth Anne McGinley  
*Harrisburg Area Community College*

Judith Myhand  
*Louisiana State University*

Rebecca Orr  
*Collin County Community College*

John Radcliffe  
*Texas Woman's University*

Jacqueline Vernarelli  
*Fairfield University*

Stanley Wilfong  
*Baylor University*

## Fourth Edition

Valerie Amend  
*Ball State University*

Carol Barnes  
*Mississippi College*

Christina Sullivan  
*City College of San Francisco*

Alison Borkowska  
*Pennsylvania State University*

Wendy Buchan  
*California State University, Sacramento*

Kevin Cooper  
*Sierra College*

Rebecca Creasy  
*Texas A&M University*

Yanyan Li  
*Husson University*

Rosanna Licht  
*Pasco-Hernando State College*

Marcia Magnus  
*Florida State University*

Adam Pennell  
*California State University, Bakersfield*

Shelia Taylor  
*Ozarks Technical Community College*

Yolanda Williams  
*Harrisburg Area Community College, Harrisburg*

## Class Testers

Janet Anderson  
*Utah State University*

Jeanne Boone  
*Palm Beach State College*

Jessica Coppola  
*Sacramento City College*

Robert Cullen  
*Illinois State University*

Gloria Gonzales  
*Pensacola State College*

Jill Goode-Englett  
*University of North Alabama*

Debra Head  
*University of Central Arkansas*

Lenka Humenikova-Shriver  
*Oklahoma State University*

Allen Knehans  
*The University of Oklahoma*

Janet Levin  
*Pensacola State College*

Darlene Levinson  
*Oakland Community College*

Anna Miller  
*De Anza College*

Vijaya Narayanan  
*Florida International University*

Anna Page  
*Johnson County Community College*

Nancy Parkinson  
*Miami University*

Renee Romig  
*Western Iowa Tech Community College*

Janet Sass  
*Northern Virginia Community College,  
Annandale*

Susan Swadener  
*California Polytechnic State University, San  
Luis Obispo*

Janelle Walter  
*Baylor University*

Suzy Weems  
*Baylor University*

Jennifer Zimmerman  
*Tallahassee Community College*

I am nothing without my ABCs. Thanks.

—*Joan Salge Blake*

I dedicate this to my family for their love and support that sustained me through the development of this book. And to my students, both present and past, for whom this book was written.

—*Kathy D. Munoz*

I would like to dedicate this book to my Mom, Felicetta Volpe, and my Dad, Antonio Volpe (in memory). I would also like to dedicate this book to my husband, Gary Snyder, and our dogs, Sasha and Bear.

—*Stella Lucia Volpe*

# NUTRITION

*From  
Science  
To You*