

# Contents

Preface **xiii**

A Look Inside **xv**

About the Author **xvii**

## 1 The Story of Chemistry

*The Scientific Method: Think, Measure, Rethink* **xviii**

### 1.1 The Scientific Method **3**

- This book will help you understand current science-related issues. **3**
- Scientists follow a system of peer review and reproducibility. **4**
- The scientific method tests scientific hypotheses. **5**
- A theory is a well-substantiated and tested hypothesis. **7**
- Scientists create models that make experimental data easier to understand. **8**

**Key Words** matter, atom, scientific method, hypothesis, theory, model

 natureBOX Alien Bacteria and the Scientific Method **10**

### 1.2 Coming to Terms with the Very Large and the Very Small **8**

- Scientific notation allows us to work with really large and really small numbers. **8**
- There are two rules to remember when using scientific notation. **11**

**Key Word** scientific notation

### 1.3 Metric Units, Conversion Factors, and Dimensional Analysis **13**

- Chemists work with very large numbers of atoms because atoms are very small. **13**
- The metric system is an agreed-upon method of measurement used around the globe. **14**
- Conversion factors are fractions that express the same value—in different units—on the top and bottom. **15**

**Key Words** metric system, base unit, meter, conversion factor, dimensional analysis

### 1.4 The Metric Epicurean **17**


- There are several legitimate ways to express volume and temperature. **17**
- We use the gram when we measure mass and the second when we measure time. **19**

**Key Words** liter, Celsius temperature scale, mass

### 1.5 Juggling Measured Numbers **21**

- We can evaluate precision and accuracy for any repeated measurement that has a known standard. **21**
- Accuracy describes the closeness of a measurement to a known value. **22**
- Human beings use common sense to interpret results from calculators and scientific instruments. **24**

**Key Words** precision, accuracy, standard, global warming, climate change

 THEgreenBEAT News about the Environment: How Do We Measure Sea Level? **24**

## Chapter 1 Themes and Questions **25**

## 2 Atoms

*All about Atoms and What's Inside Them* **32**

### 2.1 Atoms: The Basis for Everything **34**

- All matter is composed of atoms. **34**
- Atoms are composed of three types of particles: protons, neutrons, and electrons. **35**
- Scientists define each element by its atomic number—the number of protons its atoms contain. **36**

**Key Words** radiation, charge, element, atomic symbol, nucleus, proton, electron, neutron, atomic number

### 2.2 A Brief Introduction to the Periodic Table **37**

- The periodic table is the central organizing principle in chemistry. **37**
- Scientists make and study transuranium elements in specialized laboratories. **39**

**Key Words** periodic table, period, group

### 2.3 Why Neutrons Matter 40

- Atoms of a given element can contain different numbers of neutrons. 40
- Samples of matter from different locations have distinctive distributions of isotopes. 42
- Isotopic measurements can reveal answers to questions, such as the origin of marble in ancient monuments. 44

**Key Words** mass number, isotope

### 2.4 Electrons: The Most Important Particle for Chemists 45

- Electrons are elusive. 45
- Energy levels are a way to imagine the distribution of electrons around the nucleus. 46
- The location of an electron with respect to the nucleus determines its role in the atom. 47


**Key Words** electron density, chemical reaction, energy level

### 2.5 Light and Its Interaction with Atoms 47

- Electrons can be excited to higher energy levels. 47
- Light is electromagnetic radiation. 48
- The greater the energy of light, the shorter its wavelength. 49
- A line spectrum is a pattern of lines of light that is characteristic of a given element. 52

**Key Words** ground state, excited state, light, electromagnetic radiation, electromagnetic spectrum, visible light, wavelength, line spectrum

 natureBOX Are Cell Phones Safe to Use? 50

 THEgreenBEAT News about the Environment: Have We Improved Our Light Bulbs? 55

## Chapter 2 Themes and Questions 56

## 3 Everything

*The Ways We Organize and Classify Matter* 62

### 3.1 How Elements Are Distributed in Nature 64

- We can divide the periodic table into metals, nonmetals, and metalloids. 64
- The appearance of soil is partly a function of the elements it contains. 66
- Like soil, the human body is a mixture of metals and nonmetals. 67

**Key Words** metal, nonmetal, metalloid, organic, inorganic

### 3.2 A Tour of the Periodic Table 68

- Scientists organize the elements vertically and horizontally on the periodic table. 68
- Each family of elements on the periodic table has its own family traits. 70

**Key Word** period

### 3.3 Categorizing Matter 72

- It is not easy to put all matter into neat categories. 72
- In everyday life, pure substances are not truly pure. 73
- Mixtures contain more than one pure substance. 73

**Key Words** pure substance, mixture, alloy

### 3.4 Compounds and Chemical Formulas 74

- We can classify matter according to the number of different elements it contains. 74
- The chemical formula for Adderall can be determined by looking at its structure. 79

**Key Words** compound, law of constant composition, chemical formula

 natureBOX The Problem with Gold Mining 76

### 3.5 When Substances Change 79

- The three states of matter are gas, liquid, and solid. 79
- Many mixtures can be easily separated by physical means. 81
- When a chemical change happens, substances become other substances. 82

**Key Words** phase, solid, liquid, gas, physical change, chemical change

 THEgreenBEAT News about the Environment: E-Waste 83

## Chapter 3 Themes and Questions 85

## 4 Bonds

*An Introduction to the Forces within Substances* 92

### 4.1 The Octet Rule 95

- The noble gases are especially stable. 95
- Electrons in an atom are either core electrons or valence electrons. 96
- Atoms with eight valence electrons have special stability and obey the octet rule. 99

**Key Words** noble gas, valence electron, core electron, octet rule, noble gas configuration, duet rule

### 4.2 An Introduction to Bonding 100

- Atoms achieve stability by gaining or losing electrons. 100
- Lewis dot diagrams are a way to keep track of electrons. 101


**Key Words** Lewis dot diagram, lone pair

### 4.3 Ionic Bonds 102

- Atoms gain stability by taking or giving away electrons. 102
- The periodic table organizes ions according to charge. 104

- Cations and anions combine in a way that balances their charges. **105**
- Most salts exist as crystals that have a repeating pattern of cations and anions. **106**

**Key Words** chemical bond, ion, cation, anion, ionic bond, ionic compound (salt), crystal, formula unit, control experiment

 **natureBOX** Should We Use Silver Nanoparticles to Reduce Body Odor? **108**

#### 4.4 Covalent Bonds and Bond Polarity **108**

- Atoms gain stability when they make molecules by sharing electrons in covalent bonds. **108**
- Covalent bonds can form between atoms of different elements. **110**
- Scientists depict salts and molecules differently because they have different types of bonds. **111**

**Key Words** covalent bond, molecule, diatomic molecule, nonpolar, polar

#### 4.5 Bonding in Metals **113**


- For substances that are composed only of metals, metallic bonds hold atoms together. **113**
- Metals are malleable and conduct electricity. **113**

**Key Word** metallic bond

#### 4.6 Determining the Type of Bond between Two Atoms **114**

- Electronegativity is the tendency of an atom to draw electrons toward itself. **114**
- The proximity of elements on the periodic table is a clue to the type of bond that will form between them. **115**

**Key Word** electronegativity

 **THEgreenBEAT** News about the Environment: Collaborative Consumption **116**

### Chapter 4 Themes and Questions **117**

## 5 Carbon

*Elemental Carbon, Organic Molecules, and Carbon Footprints* **124**

### 5.1 Why Is Carbon Special? **127**


- Carbon has special properties because of its small size. **127**
- A carbon atom can form four bonds. **128**
- We draw molecules in a way that shows they are three-dimensional. **129**
- Diamonds are strong thanks to a three-dimensional network of covalent bonds. **130**

**Key Words** uniqueness principle, methane, molecular structure, tetrahedron, network solid

### 5.2 Graphite, Graphene, Buckyballs, and the Multiple Bond **131**

- A carbon atom can form multiple bonds to other atoms. **131**
- Carbon atoms form four bonds in various ways. **134**
- Carbon's allotropes feature examples of single bonds and multiple bonds. **135**
- When atoms share more than two electrons, the bonds between them are shorter and stronger. **136**
- The buckyball is an allotrope of carbon. **137**

**Key Words** multiple bond, allotrope, bond energy, bond length, carbon footprint, buckyball, greenhouse gas

 **natureBOX** Assessing Carbon Footprints **138**

### 5.3 Making Sense of Organic Molecules **140**

- The most common elements in organic molecules each form a predictable number of bonds. **140**
- Chemists use line structures to draw organic molecules. **141**

**Key Words** hydrocarbon, heteroatom, line structure, full structure

### 5.4 Selected Organic Functional Groups **143**

- There is a remarkable diversity of organic molecules. **143**
- Sulfides contain a sulfur atom in a hydrocarbon framework. **145**
- Carboxylic acids are an important class of organic molecules with many varied uses. **146**
- Amines are found in molecules that affect the brain. **146**

**Key Words** functional group, sulfide, carboxylic acid, amine

 **THEgreenBEAT** News about the Environment: Carbon Capture and Sequestration **148**

### Chapter 5 Themes and Questions **150**

## 6 Air

*A Study of the Gases in Our Atmosphere* **158**

### 6.1 The Nature of Gases **161**


- Of the three phases of matter, gases are the simplest. **161**
- Gas particles move fast and are far apart from one another. **162**
- Fast-moving gas particles mix together quickly and completely. **163**

**Key Word** diffusion

## 6.2 Pressure 164

- The pressure that a gas exerts is related to the collisions the gas particles make with their container. **164**
- Pressure is a force applied to a surface. **165**
- Atmospheric pressure changes with altitude. **165**
- A gas particle's mean free path is the distance it travels between collisions. **167**
- Atmospheric pressure is the pressure exerted on us by air in the environment. **169**

**Key Words** pressure, mean free path, atmospheric pressure, barometer, millimeters of mercury (mm Hg), atmosphere (atm) hydraulic fracturing/fracking, shale

 natureBOX Is Natural Gas the Ideal Energy Resource? **168**

## 6.3 Variables That Affect Gases: Moles, Temperature, Volume, and Pressure 170


- The mole allows us to count very small things, such as atoms and molecules. **170**
- Four variables dictate the behavior of a gas. **172**

**Key Words** STP, mole, molar volume, Avogadro's number, variable

## 6.4 The Gas Laws: An Introduction 173

- Pressure and volume are inversely proportional to one another. **173**
- If we change the number of moles of a gas, the volume of the gas changes. **174**
- If we change the temperature of a gas, the volume or pressure changes. **176**

**Key Words** gas law, Boyle's law, Avogadro's law, Amonton's law, Charles's law

 THEgreenBEAT News about the Environment: Bees as Gas Detectives **179**

## Chapter 6 Themes and Questions 180

# 7 Chemical Reactions

*How We Keep Track of Chemical Changes* **186**

## 7.1 Sparks! The Thermite Reaction 189

- Balanced chemical equations represent chemical reactions. **189**
- The total number of each type of atom must be the same on both sides of a chemical equation. **190**
- We add coefficients to reactants and/or products to balance chemical equations. **191**
- Balancing equations is a trial-and-error process. **193**

**Key Words** chemical equation, reactant, product, coefficient, law of conservation of mass

## 7.2 Atomic Accounting 195

- We can view a chemical equation from different perspectives. **195**


- The mole is a counting device that helps us to think on a macroscopic scale. **196**
- Molar mass is a way to convert mole units to mass units. **197**
- We can calculate molar mass for any element or compound. **197**

**Key Words** atomic scale, laboratory scale, molar mass

## 7.3 Stoichiometry 198

- Stoichiometry allows us to use chemical equations to perform chemical reactions. **198**
- We can use chemical equations to scale up or scale down a chemical reaction. **200**
- Balanced chemical equations obey the law of conservation of mass. **200**


**Key Words** stoichiometry, combustion

 natureBOX Two Ozone Holes? **202**

## 7.4 Chemical Reactions in the Real World 204

- Real chemical reactions are usually not as straightforward as their equations imply. **204**
- A reaction energy diagram illustrates the progress of a chemical reaction. **204**
- Reactants must scale an energy hill to become products. **206**
- Catalysts make chemical reactions go faster. **207**

**Key Words** side product, reaction energy diagram, endothermic, exothermic, activation energy, catalyst, methane

 THEgreenBEAT News about the Environment: Cow Flatulence and Global Warming **209**

## Chapter 7 Themes and Questions 210

# 8 Water

*Why Water Is Critical for Human Beings and the Planet* **218**

## 8.1 Water Footprints 220

- A water footprint tallies the total water use by a person, a business, a country, or the planet. **220**
- Fresh water is only a small percentage of all the water on Earth. **222**
- Much of Earth's freshwater supply is polluted. **225**
- In the United States, drinking water is protected by the Safe Drinking Water Act. **226**

**Key Words** water footprint, potable, fresh water, water cycle, evaporation, water vapor, condensation, precipitation, sublimation, Superfund site, Safe Drinking Water Act, flocculant

## 8.2 The Nature of Liquid Water 227

- Intermolecular forces are forces between molecules. **227**

- Hydrogen bonds are the strongest type of intermolecular force. **228**
- Water molecules are polar and experience dipole–dipole interactions. **229**
- Ice is less dense than water. **230**

**Key Words** intermolecular force, hydrogen bond, dipole, dipole–dipole interaction, density



### 8.3 Changing Phases: Water and Ice **232**

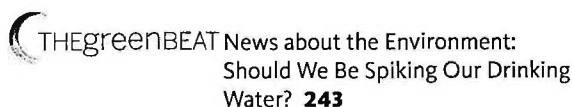
- Freezing and melting occur at the same temperature. **232**
- Freezing of water contributes to hurricane-force winds. **234**
- While a substance changes phase, its temperature remains constant. **235**
- Heating curves illustrate how phases change. **236**
- Water has a high specific heat. **237**

**Key Words** freezing point, melting point, heating curve, specific heat, passive solar

### 8.4 Changing Phases: Water and Water Vapor **240**

- The boiling point of water depends on altitude. **240**
- Summary: During phase changes, intermolecular interactions are made and broken. **242**

**Key Word** boiling point



## Chapter 8 Themes and Questions **244**

## 9 Salts and Aqueous Solutions

*The Nature of Salts and How They Interact with Water* **250**

### 9.1 Review: The Nature of Salts **252**

- Salts are ionic solids. **252**
- Salts pack tightly into a crystalline lattice. **254**

**Key Words** cation, anion

### 9.2 Polyatomic Ions **255**

- Egyptian mummies can help us understand the behavior of salts. **255**
- Polyatomic ions include multiple atoms and one or more charges. **256**
- Salts are electrically neutral. **256**

**Key Words** monatomic ion, simple salt, polyatomic ion

### 9.3 The Hydration of Ions **257**

- Water molecules are polar and contain a dipole. **257**
- Cations and anions are hydrated by water molecules. **258**

- Most salts easily dissolve in water because salts and water are both polar substances. **259**
- A dynamic equilibrium exists in a saturated salt solution. **261**

**Key Words** hydration, ion–dipole interaction, aqueous solution, dissolve, solvent, solute, dissociation, solubility, saturated solution, precipitation, equilibrium

### 9.4 Concentration and Electrolytes **264**

- Gatorade is an electrolyte solution. **264**
- Molarity indicates how much solute is dissolved in a given volume of solvent. **265**
- There are several ways to express concentration. **267**

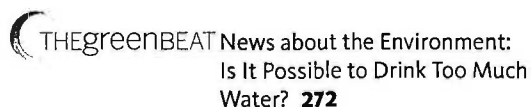
**Key Words** electrolyte, concentration, molarity, mass percent



### 9.5 Osmosis and Concentration Gradients **269**

- Living cells use semipermeable membranes to control the flow of substances through the organism. **269**
- Concentration gradients for various ions are maintained across cell membranes. **271**

**Key Words** semipermeable membrane, osmosis, Hyponatremia, water intoxication, edema



## Chapter 9 Themes and Questions **273**

## 10 pH and Acid Rain

*Acid Rain and Our Environment* **280**

### 10.1 The Autoionization of Water **283**

- There are two ways to depict protons in aqueous solutions. **283**
- Water molecules can break apart and form ions. **283**

**Key Words** hydronium ion, autoionization, hydroxide ion, acid, acidic solution

### 10.2 Acids, Bases, and the pH Scale **285**

- Acids ionize in water to produce protons. **285**
- The pH expresses proton concentration. **286**
- Acidic solutions have pH values less than 7.00. **288**
- Basic solutions have pH values greater than 7.00. **289**
- We use the pH scale to describe acid or base strength. **290**
- What can pink polka-dotted airplanes tell us about the measurement of pH? **290**

**Key Words** dissociation, strong acid, weak acid, pH, neutral, acidic, basic, base, indicator, corrosion

### 10.3 Acid Rain Part I: Sulfur-Based Pollution 292

- Compounds in air dissolve in water and change the water's pH. 292
- Sulfur compounds are one of two major sources of acid rain. 294
- Sulfur dioxide can be scrubbed from coal plant flue gases. 295
- Some types of coal produce more sulfur dioxide than others. 296
- Even clean coal is a dirty, nonrenewable source of energy. 297

**Key Words** acid rain, Clean Air Act, Environmental Protection Agency (EPA), parts per million (ppm), parts per billion (ppb), clean coal plant, flue gas desulfurization

### natureBOX Cathedral Vinaigrette 298

### 10.4 Acid Rain Part II: Nitrogen-Based Pollution 299

- Industrial and agricultural uses of nitrogen disrupt the nitrogen cycle. 299
- Nitrogen oxides are by-products of burning gasoline and contribute to acid rain. 300
- Catalytic converters reduce the emission of harmful gases from cars. 302
- NO<sub>x</sub> emissions have decreased more slowly than SO<sub>2</sub> emissions. 303

**Key Words** fixation, eutrophication, dead zone, catalytic converter

### 10.5 The Effects of Acid Rain 304

- Natural waters have a limited tolerance for added acid or base. 304
- Acid rain harms forests as well as bodies of water. 305
- Acid rain deprives soils of nutrients and releases toxins that damage trees. 306

**Key Words** buffer, neutralization, liming

### THEgreenBEAT News about the Environment: Caught Pink Handed? 308

### Chapter 10 Themes and Questions 309

## 11 Nukes

### *The Fundamentals of Nuclear Chemistry* 316

#### 11.1 The Nature of Nuclear Reactions 319

- We owe our current understanding of radioactivity and nuclear reactions, in large part, to the work of four women. 319
- Nuclear reactions differ from chemical reactions. 321
- In a nuclear equation, the neutrons and protons are usually balanced on each side. 323
- There are three important types of radioactive decay. 324

**Key Words** radioactive, nuclear fission, nuclear reaction, radioactive decay, alpha decay, beta decay, gamma radiation

#### 11.2 Energy from the Nucleus 326

- Most nuclear reactions produce much more energy than chemical reactions. 326
- Chain reactions take place in a nuclear reactor. 327
- Uncontrolled chain reactions occur when fission bombs are detonated. 328

**Key Words** control rods, chain reaction, critical mass

#### 11.3 It's a Wonderful Half-Life 329

- Radon gas is a natural form of radiation. 329
- Half-life is the time it takes for one-half of a radioactive sample to decay. 332

**Key Words** radon, radioactive decay series, half-life

### natureBOX Who's Going to Take Out the Trash? 330

#### 11.4 Living Organisms and Radiation 334

- Nuclear medicine uses radioactive isotopes to treat and diagnose diseases. 334
- There are different ways to express radiation dose and exposure. 336

**Key Words** radioactive tracer, sievert (Sv), rem, passive nuclear safety

### THEgreenBEAT News about the Environment: Are Our Nuclear Power Plants Safe Enough? 337

### Chapter 11 Themes and Questions 338

## 12 Energy, Power, and Climate Change

### *New Ways to Generate Power and Store Energy* 344

#### 12.1 Energy and Power 347

- Energy can be converted from one form to another. 347
- Power expresses energy use over time. 348
- Energy cannot be created or destroyed. 349

**Key Words** energy, force, power, watt, first law of thermodynamics

#### 12.2 Fossil Fuels: What They Are and Where We Get Them 351

- Fossil fuels are hydrocarbon mixtures. 351
- Refineries separate crude oil into usable fractions. 353

**Key Words** fossil fuel, fractionation

#### 12.3 Fossil Fuels and Climate Change 355

- Fuels combust in the presence of oxygen molecules. 355
- A car's fuel economy is related to its power. 355
- Climate change is the result of global warming. 357
- Atmospheric carbon dioxide levels reached 400 ppm in 2013. 359

**Key Words** gasoline, fuel economy, greenhouse effect, enhanced greenhouse effect

## 12.4 Meeting New Environmental Standards 360

- Paradigm shifts occur when old approaches are challenged. 360
- U.S. CAFE laws set minimum levels on fuel economy for cars and trucks. 362

**Key Words** Corporate Average Fuel Economy (CAFE) laws



## 12.5 Storing Energy in Hydrogen Molecules 363

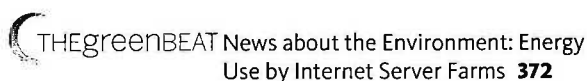
- Fuel cells use redox reactions to produce electricity and water. 363
- Redox reactions combine oxidation and reduction half-reactions. 364
- Fuel cells are limited by the availability of hydrogen gas. 366

**Key Words** electrolysis, fuel cell, electrochemical cell, oxidation, reduction, redox reaction, anode, electric current, cathode

## 12.6 Energy from the Sun 366

- The sun is a virtually limitless source of energy. 366
- Photovoltaic cells convert sunlight into electrical energy. 367
- Rechargeable batteries are electrochemical cells that can be used to store solar energy. 368
- Solar energy can be used anywhere the sun shines. 370

**Key Words** photosynthesis, deforestation, solar energy, photovoltaic cell, semiconductor, battery, net metering



## Chapter 12 Themes and Questions 374

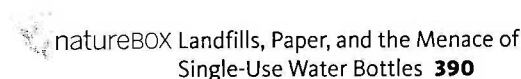
# 13 Sustainability and Recycling

*Finding Better Ways to Use (and Reuse) Our Resources 380*

## 13.1 What Is Sustainability? 383

- Sustainability is the capacity to endure. 383
- A life-cycle assessment accounts for the energy and materials that go into making a product. 385
- It is possible to estimate the environmental impact of a product or process. 387
- Cradle-to-cradle design includes a plan for product reuse. 389

**Key Words** biodegrade, sustainability, life-cycle assessment (LCA), cradle-to-cradle, bisphenol A (BPA)



## 13.2 What Is Plastic? 391

- Plastics are made from polymers, which are large organic molecules. 391

- Natural rubber is a polymer called polyisoprene. 392

**Key Words** monomer, polymer, plastic

## 13.3 The Physical Properties of Polymers 394

- The structure of a polymer often dictates its physical properties. 394
- Polymers can be designed for rigidity and toughness. 396
- Crystallites can make polymers more rigid. 397

**Key Words** hydrophobic, hydrophilic, amide, cross-links, crystallite

## 13.4 Recyclable and Sustainable Plastics 398

- We can categorize plastics as thermoplastic polymers or thermosetting polymers. 398
- Plastics are recycled according to their resin ID codes. 399
- Recycled plastics can be made into new products and structures. 401
- Waste plastics that are not recycled end up in the landfill or the incinerator. 402
- The structure of a polymer dictates its biodegradability. 404

**Key Words** thermoplastic polymers, thermosetting polymers, resin ID code, VOC, recyclable, bioplastic, lightweighting



## Chapter 13 Themes and Questions 407

# 14 Food

*The Biochemistry of the Foods We Eat 414*

## 14.1 Protein: The Most Critical Nutrient 417

- The human body needs a mixture of fuels for optimal health. 417
- Both micronutrients and macronutrients are part of a balanced diet. 418
- Amino acids are the monomers that make up proteins, which are polymers. 419
- Protein chains can fold into globular proteins. 422
- Structural proteins play mechanical and structural roles. 423

**Key Words** nutrient, macronutrient, biomolecule, micronutrient, malnutrition, protein, amino acid, peptide bond, disulfide bond, globular protein, enzyme

## 14.2 How Proteins Are Made 425

- DNA is a polymer of nucleotides. 425
- Genes within DNA are transcribed into RNA, which is translated into protein. 427

**Key Words** deoxyribonucleic acid (DNA), nucleic acid, nitrogenous base, nucleotide, complementary base pair, double helix, gene, ribonucleic acid (RNA), transcription, genetic code, triplet, translation

### 14.3 Genetic Engineering and GMOs 430

- Genetic engineering alters the DNA of food crops. **430**
- Genetic engineering is used to grow herbicide- or insect-resistant food crops. **430**
- The use of certain GMOs is controversial. **432**

**Key Words** genetic engineering, genetically modified organism (GMO), transgenic organism

- natureBOX The Demise of Natural Orange Juice **432**

### 14.4 Carbohydrates 434

- There is an obesity epidemic among children and adults in the United States. **434**
- Carbohydrates can be simple or complex, and grains can be refined or whole. **436**
- Digestion breaks down complex carbohydrates into monosaccharides and disaccharides. **437**

**Key Words** body mass index (BMI), carbohydrate, saccharide, sugar, complex carbohydrate, whole grain, dietary fiber

### 14.5 Fats 439

- Human beings store energy in the form of fat. **439**
- Lipids are hydrophobic molecules that are not polymeric. **439**

- Many properties of fatty acids depend on the number of double bonds the fatty acids contain. **442**
- Fatty acids are stored in the form of triglycerides. **443**

**Key Words** lipid, hydrophobic, fatty acid, triglyceride, trans fat, hydrogenation, biodiesel



News about the Environment:  
Indoor Plantations: The Answer to  
the World's Food Shortage? **444**

### Chapter 14 Themes and Questions 445

**Appendix A** Working with Measured Numbers:  
Significant Figures **452**

**Appendix B** Answers to Odd-Numbered End-of-  
Chapter Questions **456**

Glossary **492**

Index **498**