

Detailed Contents

Brief Contents iii | Preface iv | About the Author iv | Visual Tour v | Acknowledgments xiv

UNIT 1 Science, Chemistry, and Cells

1 Scientific Study of Life 2

- 1.1 What Is Life? 3
- 1.2 The Tree of Life Includes Three Main Branches 9
- 1.3 Scientists Study the Natural World 10
- 1.4 Investigating Life: The Orchid and the Moth 16

2 The Chemistry of Life 20

- 2.1 Atoms Make Up All Matter 21
- 2.2 Chemical Bonds Link Atoms 24
- 2.3 Water Is Essential to Life 29
- 2.4 Organisms Balance Acids and Bases 32
- 2.5 Organic Molecules Generate Life's Form and Function 33
- 2.6 Investigating Life: E. T. and the Origin of Life 43

3 Cells 48

- 3.1 Cells Are the Units of Life 49
- 3.2 Different Cell Types Characterize Life's Three Domains 51
- 3.3 A Membrane Separates Each Cell from Its Surroundings 54
- 3.4 Eukaryotic Organelles Divide Labor 56
- 3.5 The Cytoskeleton Supports Eukaryotic Cells 62
- 3.6 Cells Stick Together and Communicate with One Another 63
- 3.7 Investigating Life: Did the Cytoskeleton Begin in Bacteria? 64

4 The Energy of Life 68

- 4.1 All Cells Capture and Use Energy 69
- 4.2 Networks of Chemical Reactions Sustain Life 71

4.3 ATP Is Cellular Energy Currency 72

4.4 Enzymes Speed Biochemical Reactions 74

4.5 Membrane Transport May Release Energy or Cost Energy 75

4.6 Investigating Life: Does Natural Selection Maintain Cystic Fibrosis? 80

5 Photosynthesis 84

5.1 Life Depends on Photosynthesis 85

5.2 Photosynthetic Pigments Capture Sunlight 86

5.3 Chloroplasts Are the Sites of Photosynthesis 87

5.4 Photosynthesis Occurs in Two Stages 88

5.5 The Light Reactions Begin Photosynthesis 89

5.6 The Carbon Reactions Produce Carbohydrates 91

5.7 C_3 , C_4 , and CAM Plants Use Different Carbon Fixation Pathways 92

5.8 Investigating Life: Solar-Powered Sea Slugs 94

6 How Cells Release Energy 98

6.1 Cells Use Energy in Food to Make ATP 99

6.2 Cellular Respiration Includes Three Main Processes 100

6.3 In Eukaryotic Cells, Mitochondria Produce Most ATP 101

6.4 Glycolysis Breaks Down Glucose to Pyruvate 102

6.5 Aerobic Respiration Yields Much More ATP than Glycolysis Alone 103

6.6 How Many ATPs Can One Glucose Molecule Yield? 106

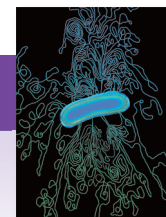
6.7 Other Food Molecules Enter the Energy-Extracting Pathways 107

6.8 Fermentation Generates ATP Only in Glycolysis 108

6.9 Investigating Life: Plants' "Alternative" Lifestyles Yield Hot Sex 109



UNIT 2 Biotechnology, Genetics, and Inheritance



7 DNA Structure and Gene Function 112

- 7.1 DNA Is a Double Helix 113
- 7.2 DNA Stores Genetic Information: An Overview 114
- 7.3 Transcription Uses a DNA Template to Create RNA 116
- 7.4 Translation Builds the Protein 118
- 7.5 Protein Synthesis Is Highly Regulated 121
- 7.6 Mutations Change DNA 123
- 7.7 Viruses Are Genes Wrapped in a Protein Coat 125
- 7.8 Viruses Infect All Cell Types 128
- 7.9 Drugs and Vaccines Help Fight Viral Infections 131
- 7.10 Viroids and Prions Are Other Noncellular Infectious Agents 132
- 7.11 Investigating Life: Clues to the Origin of Language 133

8 DNA Replication and Cell Division 138

- 8.1 Cells Divide, and Cells Die 139
- 8.2 DNA Replication Precedes Cell Division 141
- 8.3 Bacteria and Archaea Divide by Binary Fission 142
- 8.4 Replicated Chromosomes Condense as a Cell Prepares to Divide 143
- 8.5 In Eukaryotes, Mitotic Cell Division Generates Exact Copies 145
- 8.6 Cancer Arises When Cells Divide Out of Control 148
- 8.7 Investigating Life: Cutting Off a Tumor's Supply Lines in the War on Cancer 150

9 Sexual Reproduction and Meiosis 154

- 9.1 Why Sex? 155
- 9.2 Diploid Cells Contain Two Homologous Sets of Chromosomes 156
- 9.3 Meiosis Is Essential in Sexual Reproduction 157
- 9.4 In Meiosis, DNA Replicates Once, but the Nucleus Divides Twice 158

9.5 Meiosis Generates Enormous Variability 160

9.6 Mitosis and Meiosis Have Different Functions: A Summary 164

9.7 Errors Sometimes Occur in Meiosis 165

9.8 Investigating Life: A New Species Is Born, but Who's the Daddy? 166

10 Patterns of Inheritance 170

10.1 Chromosomes Are Packets of Genetic Information: A Review 171

10.2 Mendel's Experiments Uncovered Basic Laws of Inheritance 172

10.3 The Two Alleles of Each Gene End Up in Different Gametes 175

10.4 Genes on Different Chromosomes Are Inherited Independently 178

10.5 Studies of Linked Genes Have Yielded Chromosome Maps 180

10.6 Gene Expression Can Appear to Alter Mendelian Ratios 182

10.7 Sex-Linked Genes Have Unique Inheritance Patterns 184

10.8 Pedigrees Show Modes of Inheritance 187

10.9 Most Traits Are Influenced by the Environment and Multiple Genes 189

10.10 Investigating Life: Heredity and the Hungry Hordes 190

11 DNA Technology 198

11.1 DNA Technology Is Changing the World 199

11.2 DNA Technology's Tools Apply to Individual Genes or Entire Genomes 200

11.3 Stem Cells and Cloning Add New Ways to Copy Cells and Organisms 206

11.4 Many Medical Tests and Procedures Use DNA Technology 210

11.5 Investigating Life: What Makes Us Human? 213

UNIT 3 Evolution and Diversity

12 Forces of Evolutionary Change 218

- 12.1 Evolution Acts on Populations 219
- 12.2 Evolutionary Thought Has Evolved for Centuries 220
- 12.3 Natural Selection Molds Evolution 225
- 12.4 Evolution Is Inevitable in Real Populations 228
- 12.5 Natural Selection Can Shape Populations in Many Ways 230
- 12.6 Sexual Selection Directly Influences Reproductive Success 232
- 12.7 Evolution Occurs in Several Additional Ways 234
- 12.8 Investigating Life: Size Matters in Fishing Frenzy 237

13 Evidence of Evolution 242

- 13.1 Clues to Evolution Lie in the Earth, Body Structures, and Molecules 243
- 13.2 Fossils Record Evolution 245
- 13.3 Biogeography Considers Species' Geographical Locations 247
- 13.4 Anatomical Comparisons May Reveal Common Descent 249
- 13.5 Embryonic Development Patterns Provide Evolutionary Clues 251
- 13.6 Molecules Reveal Relatedness 252
- 13.7 Investigating Life: Evolving Backwards 254

14 Speciation and Extinction 258

- 14.1 What Is a Species? 259
- 14.2 Reproductive Barriers Cause Species to Diverge 260
- 14.3 Spatial Patterns Define Two Types of Speciation 263
- 14.4 Speciation May Be Gradual or Occur in Bursts 266
- 14.5 Extinction Marks the End of the Line 267
- 14.6 Biological Classification Systems Are Based on Common Descent 268
- 14.7 Investigating Life: Birds Do It, Bees Do It 272

15 Evolution and Diversity of Microbial Life 276

- 15.1 Life's Origin Remains Mysterious 277

- 15.2 Prokaryotes Are a Biological Success Story 281

- 15.3 Eukaryotic Cells and Multicellularity Arose More Than a Billion Years Ago 288

- 15.4 Protists Are the Simplest Eukaryotes 290

- 15.5 Fungi Are Essential Decomposers 296

- 15.6 Investigating Life: The Battle for Position in Cacao Tree Leaves 301

16 Evolution and Diversity of Plants 304

- 16.1 Plants Have Changed the World 305

- 16.2 Bryophytes Are the Simplest Plants 310

- 16.3 Seedless Vascular Plants Have Xylem and Phloem but No Seeds 312

- 16.4 Gymnosperms Are "Naked Seed" Plants 314

- 16.5 Angiosperms Produce Seeds in Fruits 316

- 16.6 Investigating Life: Genetic Messages from Ancient Ecosystems 318

17 Evolution and Diversity of Animals 322

- 17.1 Animals Live Nearly Everywhere 323

- 17.2 Sponges Are Simple Animals That Lack Differentiated Tissues 327

- 17.3 Cnidarians Are Radially Symmetrical, Aquatic Animals 328

- 17.4 Flatworms Have Bilateral Symmetry and Incomplete Digestive Tracts 329

- 17.5 Mollusks Are Soft, Unsegmented Animals 330

- 17.6 Annelids Are Segmented Worms 331

- 17.7 Nematodes Are Unsegmented, Cylindrical Worms 332

- 17.8 Arthropods Have Exoskeletons and Jointed Appendages 333

- 17.9 Echinoderm Adults Have Five-Part, Radial Symmetry 338

- 17.10 Most Chordates Are Vertebrates 339

- 17.11 Chordate Diversity Extends from Water to Land to Sky 341

- 17.12 Fossils and DNA Tell the Human Evolution Story 347

- 17.13 Investigating Life: Discovering the "Fishapod" 352



UNIT 4 Ecology

18 Population Ecology 360

- 18.1 Ecology Is the Study of Interactions 361
- 18.2 A Population Consists of Individuals of One Species 362
- 18.3 Births and Deaths Help Determine Population Size 363
- 18.4 Population Growth May Be Exponential or Logistic 366
- 18.5 Natural Selection Influences Life Histories 368
- 18.6 The Human Population Continues to Grow 371
- 18.7 Investigating Life: Let Your Love Light Shine 374

19 Communities and Ecosystems 378

- 19.1 Organisms Interact Within Communities and Ecosystems 379
- 19.2 Earth Has Diverse Climates 380
- 19.3 Biomes Are Ecosystems with Distinctive Communities of Life 382
- 19.4 Community Interactions Occur Within Each Biome 387

- 19.5 A Community's Diversity and Species Composition May Change Over Time 391

- 19.6 Ecosystems Require Continuous Energy Input 393

- 19.7 Chemicals Cycle Within Ecosystems 398

- 19.8 Investigating Life: Two Kingdoms and a Virus Team Up to Beat the Heat 403

20 Preserving Biodiversity 408

- 20.1 Earth's Biodiversity Is Dwindling 409

- 20.2 Many Human Activities Destroy Habitats 410

- 20.3 Pollution Degrades Habitats 412

- 20.4 Global Climate Change Alters and Shifts Habitats 414

- 20.5 Exotic Invaders and Overexploitation Devastate Many Species 417

- 20.6 Some Biodiversity May Be Recoverable 419

- 20.7 Investigating Life: The Case of the Missing Frogs: Is Climate the Culprit? 422



UNIT 5 Plant Physiology

21 Plant Form and Function 426

- 21.1 Vegetative Plant Parts Include Stems, Leaves, and Roots 427
- 21.2 Soil and Air Provide Water and Nutrients 428
- 21.3 Plant Cells Build Tissues 430
- 21.4 Tissues Build Stems, Leaves, and Roots 433
- 21.5 Plants Have Flexible Growth Patterns, Thanks to Meristems 436
- 21.6 Vascular Tissue Transports Water, Minerals, and Sugar 440
- 21.7 Investigating Life: The Hidden Cost of Traps 444

22 Reproduction and Development of Flowering Plants 448

- 22.1 Angiosperms Reproduce Sexually and Asexually 449

- 22.2 The Angiosperm Life Cycle Includes Flowers, Fruits, and Seeds 450

- 22.3 Plant Growth Begins with Seed Germination 456

- 22.4 Hormones Regulate Plant Growth and Development 457

- 22.5 Light Is a Powerful Influence on Plant Life 460

- 22.6 Plants Respond to Gravity and Touch 461

- 22.7 Investigating Life: A Red Hot Chili Pepper Paradox 462



UNIT 6 Animal Physiology



23 Animal Tissues and Organ Systems 466

- 23.1 Specialized Cells Build Animal Bodies 467
- 23.2 Animals Consist of Four Tissue Types 468
- 23.3 Organ Systems Are Interconnected 472
- 23.4 Organ System Interactions Promote Homeostasis 474
- 23.5 The Integumentary System Regulates Temperature and Conserves Moisture 476
- 23.6 Investigating Life: Vitamins and the Evolution of Human Skin Pigmentation 477

24 The Nervous System and the Senses 482

- 24.1 The Nervous System Forms a Rapid Communication Network 483
- 24.2 Neurons Are the Functional Units of a Nervous System 484
- 24.3 Action Potentials Convey Messages 485
- 24.4 Neurotransmitters Pass the Message from Cell to Cell 488
- 24.5 The Peripheral Nervous System Consists of Nerve Cells Outside the Central Nervous System 491
- 24.6 The Central Nervous System Consists of the Spinal Cord and Brain 492
- 24.7 The Senses Connect the Nervous System with the Outside World 496
- 24.8 The General Senses Detect Touch, Temperature, and Pain 497
- 24.9 The Senses of Smell and Taste Detect Chemicals 498
- 24.10 Vision Depends on Light-Sensitive Cells 500
- 24.11 The Sense of Hearing Begins in the Ears 502
- 24.12 Investigating Life: The Nerve of Those Clams! 503

25 The Endocrine System 508

- 25.1 The Endocrine System Uses Hormones to Communicate 509
- 25.2 Hormones Stimulate Responses in Target Cells 510

- 25.3 The Hypothalamus and Pituitary Gland Oversee Endocrine Control 511
- 25.4 Hormones from Many Glands Regulate Metabolism 514
- 25.5 Hormones from the Ovaries and Testes Control Reproduction 518
- 25.6 Investigating Life: Addicted to Affection 519

26 The Skeletal and Muscular Systems 524

- 26.1 Skeletons Take Many Forms 525
- 26.2 The Vertebrate Skeleton Features a Central Backbone 526
- 26.3 Bones Provide Support, Protect Internal Organs, and Supply Calcium 527
- 26.4 Muscle Movement Requires Contractile Proteins and ATP 530
- 26.5 Muscle Fibers Generate ATP in Multiple Ways 535
- 26.6 Muscle Fiber Types Influence Athletic Performance 536
- 26.7 Investigating Life: Did a Myosin Gene Mutation Make Humans Brainier? 537

27 The Circulatory and Respiratory Systems 542

- 27.1 Blood Has Diverse Functions 543
- 27.2 Animal Circulatory Systems Range from Simple to Complex 545
- 27.3 Blood Circulates Through the Heart and Blood Vessels 547
- 27.4 The Human Heart Is a Muscular Pump 548
- 27.5 Blood Vessels Form the Circulation Pathway 550
- 27.6 The Human Respiratory System Delivers Air to the Lungs 553
- 27.7 Breathing Requires Pressure Changes in the Lungs 557
- 27.8 Red Blood Cells Carry Most Oxygen and Carbon Dioxide 558
- 27.9 Investigating Life: In (Extremely) Cold Blood 559

28 Regulating Temperature, Nutrients, and Body Fluids 564

- 28.1 Animal Bodies Maintain Homeostasis in Many Ways 565
- 28.2 Heat Gains and Losses Determine an Animal's Body Temperature 566
- 28.3 Digestive Systems Allow Animals to Maintain Nutrient and Energy Homeostasis 568
- 28.4 A Varied Diet Is Essential to Good Health 569
- 28.5 Eating Disorders Disrupt Nutrient Homeostasis 570
- 28.6 Most Animals Have a Specialized Digestive Tract 572
- 28.7 The Human Digestive System Consists of Several Organs 575
- 28.8 Animals Eliminate Nitrogenous Wastes and Regulate Water and Salts 580
- 28.9 The Urinary System Produces, Stores, and Eliminates Urine 581
- 28.10 Nephrons Remove Wastes and Adjust the Composition of Blood 582
- 28.11 Investigating Life: Sniffing Out the Origin of Feathers 584

29 The Immune System 590

- 29.1 Many Cells, Tissues, and Organs Defend the Body 591
- 29.2 Innate Defenses Are Nonspecific and Act Early 593

29.3 Adaptive Immunity Defends Against Specific Pathogens 595

29.4 Vaccines Jump-Start Immunity 600

29.5 Several Disorders Affect the Immune System 601

29.6 Investigating Life: The Hidden Cost of Hygiene 603

30 Animal Reproduction and Development 608

30.1 Animal Development Begins with Reproduction 609

30.2 Males Produce Sperm Cells 611

30.3 Females Produce Egg Cells 614

30.4 Sexual Activity May Transmit Disease 619

30.5 The Human Infant Begins Life as a Zygote 620

30.6 Investigating Life: The "Cross-Dressers" of the Reef 626

Appendix A Answers to Multiple Choice Questions A-1

Appendix B Brief Guide to Statistical Significance A-2

Appendix C Metric Units and Conversions A-5

Appendix D Periodic Table of the Elements A-6

Appendix E Amino Acid Structures A-7

Glossary G-1

Credits C-1

Index I-1