

Contents

Preface **v**

Chapter 1

Can Science Cure the Common Cold? Introduction to the Scientific Method **1**

1.1 The Process of Science **2**

The Logic of Hypothesis Testing 3

The Experimental Method 5

Using Correlation to Test Hypotheses 10

Understanding Statistics 12

1.2 Evaluating Scientific Information **15**

Information from Anecdotes 16

Science in the News 16

Understanding Science from Secondary Sources 17

1.3 Is There a Cure for The Common Cold? **19**

Chapter Review **19**

Unit One

Chemistry and Cells

Chapter 2

Are We Alone in the Universe?

Water, Biochemistry, and Cells **22**

2.1 What Does Life Require? **24**

A Definition of Life 24

The Properties of Water 25

Organic Chemistry 27

Structure and Function of Macromolecules 29

2.2 Life on Earth **35**

Prokaryotic and Eukaryotic Cells 35

Cell Structure 35

The Tree of Life and Evolutionary Theory 40

Chapter Review **41**

Chapter 3

The Only Diet You Will Ever Need Nutrients, Enzymes and Metabolism, and Transport Across Membranes **44**



- 3.1 Nutrients 46**
 - Macronutrients 46
 - Micronutrients 50
 - Processed Versus Whole Foods 52
- 3.2 Enzymes and Metabolism 54**
 - Enzymes 54
 - Calories and Metabolic Rate 56
- 3.3 Transport Across Membranes 58**
 - Passive Transport: Diffusion, Facilitated Diffusion, and Osmosis 58
 - Active Transport: Pumping Substances Across the Membrane 59
 - Exocytosis and Endocytosis: Movement of Large Molecules Across the Membrane 60
- 3.4 Body Fat and Health 60**
 - Evaluating How Much Body Fat Is Healthful 62
 - Obesity 62
 - Anorexia and Bulimia 66
- Chapter Review 67**

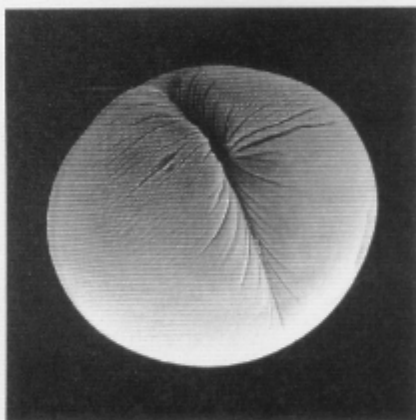
Chapter 4

Is the Earth Warming? The Greenhouse Effect, Cellular Respiration, and Photosynthesis 70

- 4.1 The Greenhouse Effect 72**
 - Water, Heat, and Temperature 72
 - Carbon Dioxide 73
 - The Greenhouse Effect, Organisms, and Their Environments 75
- 4.2 Cellular Respiration 77**
 - Structure and Function of ATP 77
 - A General Overview of Cellular Respiration 79
 - Glycolysis, the Krebs Cycle, and Electron Transport 80
 - Global Warming and Cellular Respiration 87
- 4.3 Photosynthesis 88**
 - A General Overview of Photosynthesis 88
 - The Light Reactions and the Calvin Cycle 89
 - Global Warming and Photosynthesis 92
- 4.4 Decreasing the Effects of Global Warming 95**
- Essay 4.1 Metabolism Without Oxygen: Anaerobic Respiration and Fermentation 82**
- Chapter Review 98**



Unit Two



Genetics

Chapter 5

Cancer DNA Synthesis, Mitosis, and Meiosis 100

- 5.1 What Is Cancer? 103
- 5.2 Cell Division Overview 105
 - DNA Replication 106
- 5.3 The Cell Cycle and Mitosis 108
 - Interphase 108
 - Mitosis 109
 - Cytokinesis 111
- 5.4 Cell Cycle Control and Mutation 112
 - Controls in the Cell Cycle 112
 - Mutations to Cell-Cycle Control Genes 113
- 5.5 Cancer Detection and Treatment 117
 - Detection Methods: Biopsy 117
 - Treatment Methods: Chemotherapy and Radiation 121
- 5.6 Meiosis 123
 - Interphase 127
 - Meiosis I 127
 - Meiosis II 127
 - Crossing Over and Random Alignment 130
- Essay 5.1 Cancer Risk Factors 118
- Chapter Review 133

Chapter 6

Are You Only as Smart as Your Genes? Mendelian and Quantitative Genetics 136

- 6.1 The Inheritance of Traits 138
 - Genes and Chromosomes 139
 - Diversity in Offspring: Segregation, Independent Assortment, Crossing Over, and Random Fertilization 142
- 6.2 Mendelian Genetics: When the Role of Genes Is Clear 146
 - Genotype and Phenotype 148
 - Genetic Diseases in Humans 149
 - Using Punnett Squares to Predict Offspring Genotypes 150
- 6.3 Quantitative Genetics: When Genes and Environment Interact 153
 - Quantitative Traits 153
 - Why Traits Are Quantitative 154
 - Using Heritability to Analyze Inheritance 156
 - Calculating Heritability in Human Populations 157

6.4 Genes, Environment, and the Individual 159

The Use and Misuse of Heritability 160

How Do Genes Matter? 162

Essay 6.1 Gregor Mendel 147**Chapter Review 163****Chapter 7****DNA Detective Extensions of Mendelism,
Sex Linkage, Pedigree Analysis, and DNA
Fingerprinting 166****7.1 Extensions of Mendelian Genetics 168****7.2 Sex Determination and Sex Linkage 172**

Sex Determination 172

Meiosis and Sex Chromosomes 174

Sex Linkage 176

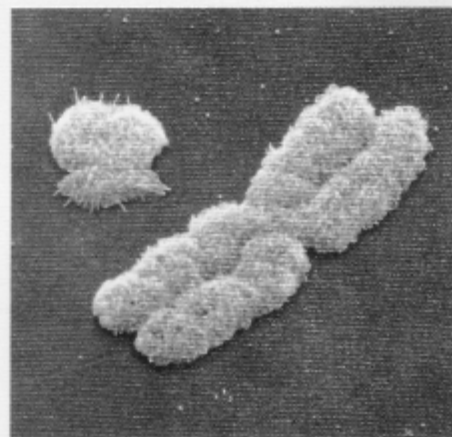
7.3 Pedigrees 178**7.4 DNA Fingerprinting 181**

Polymerase Chain Reaction (PCR) 182

Restriction Fragment Length Polymorphism
(RFLP) Analysis 183

Gel Electrophoresis 183

Meiosis and DNA Fingerprinting 185

Essay 7.1 Blood Group Genetics 171**Essay 7.2 Chromosomal Anomalies 174****Essay 7.3 X Inactivation 178****Chapter Review 190****Chapter 8****Genetic Engineering Transcription, Translation, and
Genetically Modified Organisms 192****8.1 Genetic Engineers 194****8.2 Protein Synthesis and Gene Expression 194**

From Gene to Protein 195

Transcription 197

Translation 197

Mutations 200

Regulating Gene Expression 202

8.3 Producing Recombinant Proteins 204

Cloning a Gene Using Bacteria 204

FDA Regulations 207

Basic Versus Applied Research 207

- 8.4 Genetic Engineers Can Modify Foods 208**
 Why Genetically Modify Crop Plants? 208
 Modifying Crop Plants with the Ti Plasmid and Gene Gun 210
 Effect of GMOs on Health 210
 GM Crops and the Environment 213
- 8.5 Genetic Engineers Can Modify Humans 215**
 The Human Genome Project 215
 Gene Therapy 216
 Cloning Humans 218
- Essay 8.1 Stem Cells 220**
Chapter Review 221

Unit Three



Evolution

Chapter 9

Where Did We Come From? The Evidence for Evolution 224

- 9.1 What Is Evolution? 226**
 The Process of Evolution 226
 The Theory of Evolution 227
- 9.2 Charles Darwin and the Theory of Evolution 229**
 Early Views of Evolution 229
 The Voyage of the *Beagle* 229
 Developing the Hypothesis of Common Descent 230
- 9.3 Evaluating the Evidence for Common Descent 231**
 Biological Classification Suggests Evolutionary Relationships 234
 Evidence of Homology 237
 Evidence from Biogeography 242
 Evidence from the Fossil Record 244
- 9.4 Are Alternatives to the Theory of Evolution Equally Valid? 250**
 The Static Model and Transformation Hypotheses 250
 The Separate Types and Common Descent Hypotheses 250
 The Best Scientific Explanation for the Diversity of Life 251
- Essay 9.1 Argument from Design 232**
Essay 9.2 The Origin of Life 252
Chapter Review 253

Chapter 10

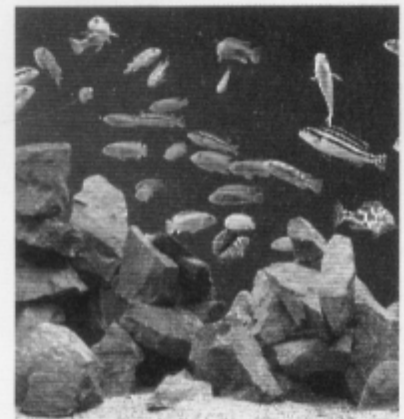
An Evolving Enemy Natural Selection 256

- 10.1 AIDS and HIV 258**
 AIDS Is a Disease of the Immune System 258
 HIV Causes AIDS 259
 The Course of HIV Infection 261

10.2 The Theory of Natural Selection	262
Four Observations and an Inference	263
Testing Natural Selection	266
The Modern Understanding of Natural Selection	267
Subtleties of Natural Selection	268
10.3 Natural Selection and HIV	272
HIV Fits Darwin's Observations	272
The Evolutionary Arms Race	272
10.4 How Understanding Evolution Can Help Prevent AIDS	273
Single Drug Therapy Selects for Drug Resistance	273
Combination Drug Therapy Can Slow HIV Evolution	275
Problems with Combination Drug Therapy	276
Preventing AIDS	277
Essay 10.1 The Evidence Linking HIV to AIDS	259
Chapter Review	279

Chapter 11

Who Am I? Species and Races	282
11.1 What Is a Species?	284
The Biological Species Concept	284
The Process of Speciation	288
11.2 The Race Concept in Biology	293
11.3 Humans and the Race Concept	295
The Morphological Species Concept	296
Modern Humans: A History	297
Genetic Evidence of Divergence	298
Human Races Are Not Biological Groups	300
Human Races Have Never Been Truly Isolated	303
11.4 Why Human Groups Differ	306
Natural Selection	306
Convergent Evolution	308
Genetic Drift	309
Sexual Selection	312
Assortative Mating	312
11.5 Race in Human Society	313
Essay 11.1 The Hardy-Weinberg Theorem	304
Chapter Review	314



Chapter 12

Prospecting for Biological Gold	Biodiversity and Classification	316
12.1 Biological Classification	318	
How Many Species Exist?	318	
Kingdoms and Domains	320	

12.2 The Diversity of Life 323

Bacteria and Archaea 323

Protista 325

Animalia 328

Fungi 331

Plantae 332

12.3 Learning About Species 336

Fishing for Useful Products 337

Understanding Ecology 337

Reconstructing Evolutionary History 338

Learning from the Shamans 340

Essay 12.1 Diversity's Rocky Road 334**Chapter Review 342****Unit Four****Ecology****Chapter 13****Is the Human Population Too Large?****Population Ecology 344****13.1 A Growing Human Population 346**

Population Structure 346

Population Growth 347

The Demographic Transition 349

13.2 Limits to Population Growth 350

Carrying Capacity and Logistic Growth 350

Earth's Carrying Capacity for Humans 351

13.3 The Future of the Human Population 353

A Possible Population Crash? 353

Avoiding Disaster 355

Chapter Review 356**Chapter 14****Is Earth Experiencing a Biodiversity Crisis?****Community Ecology, Ecosystem Ecology, and
Conservation Biology 358****14.1 The Sixth Extinction 360**

Measuring Extinction Rates 361

Habitat Loss and Food Chains 363

Other Human Causes of Extinction 367

14.2 The Consequences of Extinction 368

Loss of Resources 368

Disruption of Ecological Communities 370



Changed Ecosystems 376

Psychological Effects 378

14.3 Saving Species 379

Protecting Habitat 379

Protection from Environmental Disasters 381

Protection from Loss of Genetic Diversity 382

14.5 Protecting Biodiversity Versus Meeting Human Needs 386

Chapter Review 388

Chapter 15

Where Do You Live? Climate and Biomes 390

15.1 Global and Regional Climate 392

Temperature 393

Precipitation 398

15.2 Terrestrial Biomes 400

Forests and Shrublands 400

Grasslands 405

Desert 406

Tundra 408

15.3 Aquatic Biomes 409

Freshwater 409

Saltwater 411

15.5 Human Habitats 414

Energy and Natural Resources 414

Waste Production 415

Essay 15.1 Wildfire! 405

Chapter Review 418



Animal Structure and Function

Unit Five

Chapter 16

Organ Donation Tissues, Organs, and Organ Systems 420

16.1 Tissues 422

Epithelial Tissue 422

Connective Tissue 423

Muscle Tissue 425

Nervous Tissue 426

Tissue Donation 427

16.2 Organs and Organ Systems 428

Organs: The Liver as a Model Organ 429

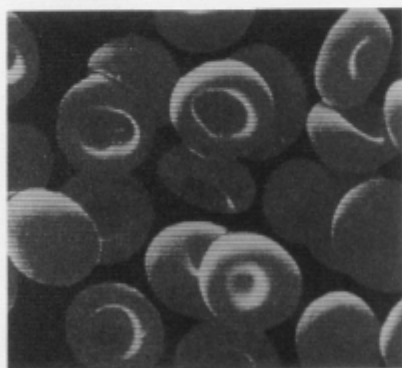
Organ Systems: The Digestive System 429

16.3 Regulating the Internal Environment 436

Negative Feedback 436

Positive Feedback 437

Organ Donation 438

Essay 16.1 Focus on Evolution: The Digestive System 432**Chapter Review 439****Chapter 17****Clearing the Air Respiratory, Circulatory, and Excretory Systems 442****17.1 Effects of Smoke on the Respiratory System 444**

What Happens When You Take a Breath? 445

Gas Exchange 450

Smoke Particles and Lung Function 452

How Do We Know That Tobacco Smoke Kills? 454

17.2 Spreading the Effects of Smoke: The Cardiovascular System 455

Structure of the Cardiovascular System 455

Movement of Materials Through the Cardiovascular System 460

Smoke and Cardiovascular Disease 460

17.3 Removing of Toxins from the Body: The Excretory System 462

Kidney Structure and Function 462

Smoking and the Excretory System 463

Essay 17.1 Focus on Evolution: The Respiratory and Circulatory Systems 446**Chapter Review 465****Chapter 18****Will Mad Cow Disease Become an Epidemic?****Immune System, Bacteria, Viruses, and Other Pathogens 468****18.1 Infectious Agents 470**

Bacteria 470

Viruses 474

Eukaryotic Pathogens 476

Prions 478

18.2 Epidemics 479

Exposure to Infected Body Fluids 480

Transmission Through an Intermediate Host 480

Inhalation 481

Ingestion 481

18.3 The Body's Response to Infection: The Immune System 482

First Line of Defense: Skin and Mucous Membranes 482

Second Line of Defense: White Blood Cells, Proteins, and
Inflammation 483

Third Line of Defense: Lymphocytes 483

Making B and T Cells 485

Humoral and Cell-Mediated Immunity 488

There Is No Immune Response to Prions 490

18.4 Preventing the Spread of Prion Diseases 491**Essay 18.1** Focus on Evolution: Antibiotic Resistance 473**Chapter Review 491****Chapter 19****Sex Differences and Athleticism Endocrine, Skeletal,
and Muscular Systems 494****19.1 The Endocrine System 496**

Hormones 496

Endocrine Glands 498

19.2 The Skeletal System 500

The Human Skeleton 500

Bone Structure and Remodeling 503

19.3 The Muscular System 506

Muscle Interaction with Bones 506

19.4 Other Sex Differences That Influence Athleticism 509

Body Fat Differences 509

Cardiovascular Differences 510

Group Differences and Individual Differences 510

Essay 19.1 Focus on Evolution: The Skeletal System 501**Chapter Review 512****Chapter 20****Is There Something in the Water? Reproductive and
Developmental Biology 514****20.1 Principles of Animal Reproduction 516**

Asexual Reproduction 516

Sexual Reproduction 517

Environmental Contaminants and Sexual Reproduction 519

20.2 Human Reproduction 520

Human Reproductive Systems 520

Gametogenesis 523

The Menstrual Cycle 530



20.3 Human Development 535

Fertilization 535

Human Embryonic Development 537

Pregnancy 539

Childbirth 541

20.4 Is the Water Safe to Drink? 542**Essay 20.1** Focus on Evolution: The Evolution of Two Different-Sized Gametes 518**Chapter Review 543****Chapter 21****Attention Deficit Disorder Brain Structure and Function 546****21.1 The Nervous System 548****21.2 The Brain 553**

Cerebrum 554

Thalamus and Hypothalamus 554

Cerebellum 555

Brain Stem 555

ADD and Brain Structure and Function 556

21.3 Neurons 557

Neuron Structure 557

Neuron Function 558

Neurotransmission and Alzheimer's, Depression, Parkinson's, and ADD 562

Ritalin® 562

21.4 The Environment and ADD 566**Essay 21.1** Focus on Evolution: The Nervous System 552**Chapter Review 568****Unit Six****Plant Biology****Chapter 22****Feeding the World Plant Structure and Growth 570****22.1 Plants as Food 572**

The Evolution of Agriculture: Food Plant Diversity 572

Plant Structure 574

Plant Reproduction 577

22.2 Plant Growth Requirements 582

How Plants Grow 582

Maximizing Plant Growth: Water, Nutrients, and Pest Control 585

Designing Better Plants: Hybrids and Genetic Engineering 593

22.3 The Future of Agriculture 593

Modern Agriculture Causes Environmental Damage 593

How to Reduce the Damage 595

Essay 22.1 Focus on Evolution: Plant Reproduction 578**Chapter Review 599****Chapter 23****Growing a Green Thumb Plant Physiology 602****23.1 The Right Plant for the Place: Water Relations 604**

Transpiration 604

Adaptations That Affect Transpiration 607

Overwatering 610

Water Inside Plant Cells 611

23.2 A Beautiful Garden: Sap Translocation, Photoperiodism, and Flower and Fruit Production 613

Translocation of Sugars and Nutrients 613

Managing Translocation 614

Photoperiodism 617

23.3 Pleasing Forms: Tropisms and Hormones 619

Tropisms 619

Hormones 620

Essay 23.1 Focus on Evolution: Plants on Land 606**Chapter Review 623****Appendix: Metric System Conversions A-1****Answers to Learning the Basics ANS-1****Glossary G-1****Credits CR-1****Index I-1**