

CONTENTS

<i>Preface</i>	xxiii
<i>Acknowledgements</i>	xxx
<i>About the Author</i>	xxxiii
1. Welcome to Biology!	1
Check In	2
The Case of the Nonpaying Tenant	2
Check Up Section	3
Getting to Know Biology	3
What Is Life?	5
Order in a Universe of Chaos	9
Organizing Biodiversity: Hierarchy of Life	9
Taxonomy: The Science of Classification	11
Asking Hard Questions	17
The Development of Evolutionary Thinking	17
<i>Buffon and the Founding of Descent with Modification</i>	17
<i>Fossil Record</i>	19
<i>Changes and Catastrophes</i>	20
<i>Inheriting Acquired Traits</i>	20
<i>Darwin's Voyage: Natural Selection</i>	21
<i>Evolution and Economic Systems</i>	22
Scientific Thinking	23
Scientific Literacy	23
Induction/Deduction	25
Hypothesis Testing	25
Experimentation	25
Data Analysis	26
Math Gives Biology Power: Statistics	26
Results and Discussion	27
Summary	29
Check Out	29

UNIT 1	That's Life...	35
2.	Chemistry Comes Alive	37
	Check In	38
	The Case of the Mysterious Killer: A 用硝酸处理; 硝化 Nightmare	38
	Check Up Section	39
	Atoms and Elements that Make Up Life	39
	Elements	40
	Atoms and Subatomic Particles	40
	<i>Rutherford's Gold Foil Experiment</i>	42
	<i>Atomic Number and Atomic Mass</i>	42
	<i>Ions</i>	43
	<i>Isotopes</i>	43
	<i>Exposure to Radiation</i>	45
	The Elements of Living Systems	46
	Substances Combine to Form Complex Systems	46
	From Atoms to Molecules	46
	Valence Electrons: How Matter Is Combined?	47
	Factors Influencing Chemical Reactions	48
	Type of Chemical Bonds	49
	<i>Covalent Bonds</i>	49
	<i>Polar Covalent Bonds</i>	49
	<i>Ionic Bonds</i>	50
	<i>Hydrogen Bonds</i>	50
	<i>The Importance of Water</i>	50
	Acids and Bases	52
	Why Carbon?	55
	Macromolecules	56
	Building Up and Breaking Down Macromolecules	56
	<i>Carbohydrates</i>	56
	<i>Lipids</i>	58
	<i>Triglycerides</i>	59
	<i>Phospholipids</i>	60
	<i>Steroids</i>	60
	<i>Proteins</i>	61
	<i>Enzymes</i>	63
	<i>Nucleic acids</i>	64
	Summary	66
	Check Out	66
3.	The Cell As a City	73
	Check In	74
	The Case of the Meddling Houseguest: A Friendship Divided	74

Check Up Section	75
Culture, Biology, and Social Stratification	75
Exploring the Cell	77
The Microscope	77
Cell Theory	80
Types of Cells	81
The Role of Inheritance	86
Endosymbiosis	87
Cell Architecture: The Cell As a City	90
Plasma Membrane: The “Flexible” Border Patrol	91
Walls of the City	93
Cytoskeleton: The City Scaffolds	93
Nucleus: A City’s City Hall	95
Ribosomes, the City’s Factory	95
Endoplasmic Reticulum: A City’s Subway	96
Golgi Apparatus: A City’s Processing Plant	97
Lysosomes: A City’s Police Officer	98
Vacuoles: A City’s Warehouse	99
Plastids: The Cell City’s Paint Shops	100
Cell Junctions: The City’s Bridges	100
Cell Shape and Size	101
The Moving Crew: Rules and Procedures are City Law	102
<i>Passive Transport</i>	103
<i>Osmosis: A Special Case of Diffusion</i>	104
<i>Special Cases in Osmosis</i>	105
<i>Passive Transport with a Helper</i>	106
<i>Active Transport</i>	107
<i>Bulk Transport: A Bigger Moving Van</i>	107
Summary	110
Check Out	110
4. Energy Drives Life	117
Check In	118
The Case of a White Pine Memory	118
Check Up Section	119
Discovering Energy Exchange	119
Rules for Energy Exchange: Energy Laws	121
Photosynthesis: Building Up Molecules of Life	124
Chloroplasts: Where the Action Takes Place	124
<i>What Is Light?</i>	124
Pigments	126
The Light Reactions	126
<i>The water-splitting photosystem</i>	128
<i>The NADPH-producing photosystem</i>	129
How is Sugar Made?	130
Some Like it Hot	131

Cellular Respiration: Breaking It All Down	132
Step 1: Glycolysis, the Upfront Investment	132
Step 2: Moving Money	134
<i>The Energy Shuttle</i>	134
Step 3: Breaking Bonds and Giving Credit	134
<i>The Krebs Cycle</i>	134
Step 4: Cash is King – Getting Money Exchanged	135
<i>Electron Transport Chain</i>	135
Bioprocessing: Where does the Cash Get Used?	139
Beer, Wine, and Muscle Pain	141
<i>Anaerobic respiration</i>	141
<i>Fermentation</i>	141
Alcohol and Cellular Respiration: Is it OK for Me to Drink Heavily Just in College?	142
Summary	144
Check Out	144
<hr/>	
UNIT 2 Is it all in the Genes?	151
5. Molecular Genetics	153
Check In	154
The Case of Out-of-Place Color	154
Early Ideas about Genetics	154
Check Up Section	155
DNA As an Inherited Substance	159
<i>The Structure of DNA</i>	159
How Does Eukaryotic DNA Reproduce Itself?	165
Mitosis	165
Molecular Processes during Mitosis	168
Why Go through It All? Prokaryotic Cell Division Is More Simple	170
DNA Is the Universal Language	171
What Do Proteins Do?	172
Gene Expression: How Proteins Are Made	173
<i>Reading the Message: Translation</i>	176
Gene Regulation	179
Errors in Gene Regulation: A Focus on Cancer	182
Summary	183
Check Out	184
6. Inheriting Genes	191
Check In	192
The Case of the Vampire Diary	192
Check Up Section	193
Unraveling the Mystery of Inheritance	193

Mendel's Laws	195
Law of Dominance	195
Law of Segregation	195
Law of Independent Assortment	196
Testcross	200
Meiosis: How Sex Cells Are Formed	201
The Phases of Meiosis	205
Male and Female Gametes	207
Sex: A Cost–Benefit Analysis	209
Determining Sex	210
Mendelian Traits: Single Gene Characteristics	212
Not So Mendelian Genetics	214
Incomplete Dominance	215
Multiple Alleles	215
Polygenic Inheritance	216
Pleiotropy	218
Tracing Gene Flow in Families: Pedigree Analysis	218
Tracing Gene Flow in Groups: Population Genetics	219
Gene Technology: Solving Problems Using Genetics	222
The Things We've Handed Down: Should We Tamper With Our Genes?	225
Summary	226
Check Out	227
<hr/>	
UNIT 3 We Are Not Alone!	233
7. Evolution Gives our Biodiversity	235
Check In	236
The Case of the Quiet Island	236
Check Up Section	237
What Are the Origins of Life?	237
Natural Selection and Biodiversity	240
Types of Natural Selection	242
Speciation Increases Biodiversity	245
Extinction	246
Extinction and Biodiversity	250
Evidence for Evolution	250
Modern Day Evolution	251
The Fossil Record	252
Homology	253
Molecular Evidence	255
Biogeography	255
Evolutionary Design: There is No One Right Answer	256
Sexual Selection	261

Summary	261
Check Out	261
8. Before Plants and Animals: Viruses, Bacteria, Protists, and Fungi	267
Check In	268
The Case of the First Rabies Survivor	268
Check Up Section	237
Discovering Pathogens and Ways to Treat Them	269
Viruses: To Live or Not to Live . . .	272
Features	272
<i>Size of viruses</i>	273
Viruses: The Internal Terrorist	275
Some Interesting Viruses	277
<i>Herpes Virus</i>	277
<i>Rhabdovirus</i>	278
<i>Rhinovirus</i>	278
<i>Myxovirus</i>	278
<i>Papillomavirus</i>	279
<i>Oncovirus</i>	280
<i>Retrovirus</i>	281
Prokaryotes: The Little Things in Life	282
Features	282
Shapes, Sizes, and Types	285
Prokaryote Nutrition	287
Bacterial Reproduction	288
Prokaryote Diversity	289
<i>Archaeobacteria</i>	289
The Misfit Kingdom: Protista	293
Classification	294
Algae	294
Protozoans	296
Slime Molds	297
A Favorite Fungus	298
Features and Types	298
Summary	301
Check Out	301
9. Getting to Land: The Incredible Plants	307
Check In	308
The Case of the Wet Village	308
Check Up Section	309
The Village's Move to Land: A History	309
Evidence for Green-Algae Ancestry	311

What are Plants?	312
Plant Structure Refinements to Help Them Live on Land	312
Divisions of Plants	314
Bryophytes	314
Tracheophytes	316
Seedless Plants	316
Seed Plants	316
Gymnosperms	317
Angiosperms	318
Flowers, Fruit, and Plant Reproduction	319
Monocots and Dicots	323
Plant Tissues	324
Plant Growth	326
Transport of Water and Nutrients in Plants	327
Plant Responses to the Environment	330
Hormones and Tropisms	330
Plant Defenses	332
Summary	332
Check Out	333
10. Moving on Land and in the Sea: Animal Diversity	339
Check In	340
The Case of the Homey Homeotherm	340
Check Up Section	341
Unity and Diversity of Animals	341
Four Ways to Classify Animals	344
Specialized Cells	344
Symmetry	344
Molting	344
Body Cavity Formation	345
The Major Phyla	345
Porifera: The Scattered Sponges	345
Cnidarians: Creatures with an Open Cavity	347
Jellyfish	349
Sea anemones	350
Hydras	350
Corals	350
Worms	351
Flatworms	351
Roundworms	352
Segmented Worms	353
Mollusks	353
Arthropods	355
Arachnids	356

Crustaceans	357
Insects	358
Echinoderms	360
Chordates	361
Subphyla: Lancelets and Tunicates	361
Vertebrates	362
<i>Fish</i>	362
<i>Amphibians, the First on Dry Land</i>	364
<i>Vertebrates: Reptiles, More Efficient on Land</i>	365
<i>Vertebrates: Birds, the Other Reptile</i>	367
<i>Vertebrates: Mammals, Homeotherms That Thrive on Land and in the Sea</i>	368
<i>Human Evolution</i>	369
Summary	372
Check Out	372

UNIT 4 The Dynamic Animal Body 379

11. Animal Organization	381
Check In	382
The Case of a Saved Star	382
Check Up Section	383
Orientation to the Human Body	383
Complementarity	386
Homeostasis Is Vital for Carrying Out Life Functions	388
Negative Feedback	389
Positive Feedback	390
Systems of Homeostasis: Interplay between Endocrine and Nervous Controls	393
Discovery of Homeostasis	393
The Major Types of Tissues	395
Epithelial	396
<i>Simple Epithelial Tissues</i>	399
<i>Stratified Epithelial Tissue</i>	399
Connective Tissue: An Overview	400
<i>Types of Connective Tissue</i>	401
Muscle	403
Nervous	404
The Language of Anatomy	405
Animal Organization	405
Surface Regions	406
Anatomical Position	408
Directional Terms	408
Body Planes: Imaginary Lines on the Human Body	410
The Abdominopelvic Regions	410

Organ Systems	411
Summary	415
Check Out	415
12. Nutrition and Digestion	421
Check In	422
The Case of the Sweet Breath Date	422
Check Up Section	423
Eating Disorders	423
Anorexia and Bulimia	423
The Obesity Epidemic	424
Why Is Obesity Rising?	426
Nutrients	427
The Micronutrients	427
Minerals	431
Water	433
Macronutrients	434
Proteins	435
Lipids	435
Carbohydrates	437
How Is Weight Gained and Lost?: Food, Energy, Metabolism, and Weight	440
Energy Is measured in Calories	440
Basal Metabolic Rate	441
The Digestive System: How Humans Break Down and Absorb Food	442
The Alimentary Canal: A Tour of the Digestive System	442
Digestion	443
<i>Mouth</i>	445
<i>Esophagus</i>	446
<i>Stomach</i>	449
<i>Small Intestine</i>	451
<i>Large Intestine</i>	456
Common Diseases of the Digestive System	458
<i>Heartburn</i>	458
Ulcers and Stomach Cancer	458
Colon Cancer	459
Summary	460
Check Out	460
13. The Heart Lung Machine: Circulation and Respiration	467
Check In	468
The Case of his Daughter's Heart	468

Check Up Section	469
Blood: Life's Force	469
What is Blood?	470
Why Blood?	473
Cardiovascular System: Heart and Vessels	476
Heart	476
Movement of Blood in the Heart and Vessels	477
Heart Beats: Electricity Activity	479
Diseases of the Cardiovascular System	480
Heart Attack: Myocardial Infarction	480
Arteriosclerosis	481
Heart Valve Disease	482
Cardiovascular Disease: Treatment Progress	483
Blood Vessels	483
Blood Pressure	484
The Respiratory System	487
What Is Respiration?	487
Anatomy of the Respiratory System	489
Exchange in the Lungs	491
Lung Compliance	494
Gas Transport in Blood	494
Diseases of the Respiratory System	495
Respiratory Acidosis	495
The Bends	496
Carbon Monoxide Poisoning	496
Altitude Sickness	497
Lung Cancer	497
Chronic Obstructive Pulmonary Disease	499
Controls of Heart and Lung Actions	499
Summary	501
Check Out	502
14. Regulation: Nervous, Musculoskeletal, and Endocrine Systems	509
Check In	510
The Case of the Burning Arm	510
Check Up Section	511
The Nervous System	511
Regulation	511
Pain	511
Nerves	513
Organization of the Nervous System	516
Do Nerves Use Electricity?	517
Nerve Impulses	517
Neurotransmitters	518

Special Senses	520
Gustation	521
Olfaction	524
Vision	525
Changing Light into Nerve Impulses	526
Hearing	527
Touch	529
The Brain	530
The Muscular System	535
Characteristics of Muscles	535
Muscle Cell Organization	536
Sliding Filament Theory	536
Rigor Mortis	537
Fast vs. Slow Twitch Fibers	537
Skeletal System	542
Skeletons	542
Functions of Bones	542
Morphology of Bones	542
The Human Skeleton	543
Bone Remodeling and Disease	549
Endocrine System	551
Glands and Basics	551
Hormones Regulate Homeostasis	554
<i>Calcium and Bones</i>	554
<i>Blood Sugar and Diabetes</i>	554
<i>Metabolism</i>	555
<i>Control atop the Kidneys</i>	556
<i>Pineal Gland</i>	557
<i>Reproduction</i>	558
<i>Pheromones</i>	558
<i>Pain and Paracrine glands</i>	559
Summary	560
Check Out	560
15. A War against the Enemy – Skin’s Defenses and the Immune Attack	567
Check In	568
The Case of the Recurring Chemistry Nightmare	568
Check Up Section	569
The Immune System’s War	569
Physical Barriers: First Line of Defense	570
Border Patrol: The Skin and Mucous Membranes	570
The Border’s Construction: Skin Structure and Function	572
The Outside Border: Epidermis	573
The Inside Border: Dermis and Hypodermis	573
The Role of the Border: Skin Functions	576

Malfunctions of the Border: Skin and Disease	578
Internal Borders: Stomach and Respiratory Tract Defenses	579
Nonspecific Immunity: The Second Line of Defense	579
The Start of Warfare: Inflammation	580
The Tanks: Cells of the Immune System	581
Neutrophils	581
Macrophages	581
Lymphocytes	583
Chemical Warfare	583
Specific Immunity: The Third Line of Defense	584
Rebuilding after the War: Regeneration of Tissues	589
Preventing Future Attacks: Acquired Immunity	592
Defense Stations: The Lymphatic System	594
Malfunctions in our Immune Defenses	597
Our Immune System Attacks its own Troops:	
Autoimmune Disease	597
Our Immune System Overreacts to Terror: Allergies	598
Spies and Corruption of our Immune Defenses	598
Summary	600
Check Out	601
16. Urogenital Functions in Maintaining Continuity	607
Check In	608
The Case of the Stone Baby	608
Check Up Section	609
The Urinary System	609
Regulating Water Balance	610
Kidneys	611
Functions of the Kidneys	612
Special Cells of the Kidneys: Nephrons	613
The Kidney has a Three-Step Process to Make Urine	615
Urine Indicates a Person's Health	616
Excretion is Expensive	617
Why Uric Acid?	618
Controlling Kidney Functions	619
Malfunctions of the Kidneys	619
Reproduction: An Introduction	620
Types: Sexual and Asexual	620
External and Internal Fertilization	622
Male Reproductive System	623
Male Structures	623
Tracing a Sperm's Travel	625
Making Semen	625
Female Reproduction	626
Female Structures	626

Tracing an Egg’s Travel	628
External Structures: Outside the Cervix	629
Hormones of Female Reproduction	630
Menarche and Menopause	631
What Happens After an Egg Meets Sperm?	632
<i>Fertilization</i>	632
Embryology	632
Stages of Pregnancy	634
<i>First Trimester</i>	634
<i>Second Trimester</i>	634
<i>Third Trimester</i>	636
Birth and After	636
Malfunctions of the Reproduction System	638
Males Cancers	638
<i>Prostate Cancer</i>	638
<i>Testicular Cancer</i>	638
<i>Penile Cancer</i>	639
Inflammations in Male Organs	639
Infertility	639
Contraception	640
Female Cancers	640
Summary	643
Check Out	643

UNIT 5 **A Small Hole Sinks a Big Ship – Our Fragile Ecosystem** 649

17. Population Dynamics and Communities that Form	651
Check In	652
The Case of the Terrible Toads	652
Check Up Section	653
Ecology is based on Studying Populations	653
Order in a Population	653
Population Demographics	655
Population as a Unit of Study	655
Population Growth	656
Human Population Structure	657
Survivorship Curves and Life History Strategies	660
Characteristics of Communities	663
Roles	663
Interactions within Communities	664
Competition	664
Predator–Prey Relationships	665

Defenses Evolve	666
Physical Prey Defenses	667
Mechanical defenses	667
Camouflage	667
Warning Coloration	667
Behavioral Prey Defenses	668
Group Behavior	668
Alarm Call	668
Plants and Herbivory	669
Symbiosis	670
Summary	674
Check Out	674
18. Ecosystems and Biomes	681
Check In	682
The Case of the Hitchhiker	682
Check Up Section	683
Major Biomes of the World	684
What Are Biomes?	684
Topography Affects Land Areas	685
A Drive through the Biomes	688
Terrestrial Biomes	688
Aquatic Biomes	698
Freshwater Biomes	698
Estuaries	700
Marine Biomes	701
Ecosystems	702
Ecosystems Make Up Biomes	702
Energy Flow through Ecosystems	702
Energy Pyramids: Not Cutting Out the Middle Man	704
Vegetarians Cut Out the Middle Man	705
Ecosystem Disturbance and Ecological Succession: Communities Change over Time	706
Summary	708
Check Out	708
19. Biosphere: Life Links to Earth	715
Check In	716
The Case of the Big Blast	716
Check Up Section	717
The Earth, the Sun, and Atmosphere	717
The Earth's Boundaries for Life	717
Atmosphere: A Layer of Protection	718
Solar Radiation: Heat from the Sun	719

Seasonal Changes in Temperature	719
Global Atmospheric Circulation Affects Climate	720
Winds: Movement Under Pressure	721
Hydrosphere: Global Transport and Climate Control	723
The Earth's Waters	723
Ocean Circulation	723
Ocean–Atmospheric Interactions: El Nino	724
Biogeochemical Cycles	725
Water Cycle	726
Carbon Cycle	728
Greenhouse Effect and Global Climate Change	729
Nitrogen Cycle	730
Eutrophication	732
Phosphorous Cycle	732
Human Influences on the Biosphere	733
Deforestation	733
Engineering of Waterways	734
<i>Mississippi and Atchafalaya Rivers</i>	734
<i>Three Gorges Dam</i>	735
Pollution	736
Bioaccumulation/Biomagnification	737
Ozone	739
Summary	740
Check Out	741

UNIT 6 **Biology and Society** 747

20. The Evolution of Social Behavior: Sociobiology	749
Check In	750
The Case of the Nuclear Ant Hill	750
Check Up Section	751
Defining Sociobiology	751
Animal Behavior	751
Types of Behaviors	753
Learning	753
Behaviorism	754
<i>Imprinting</i>	754
<i>Habituation</i>	755
<i>Classical Conditioning</i>	755
<i>Operant Conditioning</i>	756
<i>Insight</i>	757
Cognitivism	758
Sociobiology and Society	758

Aggression	760
Human and Animal Kindness	760
Kin Selection	761
What about Helping in Unrelated Organisms?	762
Debate on the Nature of Animal Society	763
Group Cooperation vs. Selfish Genes	764
Summary	766
Check Out	766
<i>Glossary</i>	773
<i>Index</i>	821