



# BRIEF CONTENTS

---

Preface x

1 Zoology: An Evolutionary and Ecological Perspective	1
2 Cells, Tissues, Organs, and Organ Systems of Animals	10
3 Cell Division and Inheritance	34
4 Evolution: History and Evidence	55
5 Evolution and Gene Frequencies	73
6 Ecology: Preserving the Animal Kingdom	86
7 Animal Classification, Phylogeny, and Organization	102
8 Animal-like Protists: The Protozoa	118
9 Multicellular and Tissue Levels of Organization	135
10 The Triploblastic, Acoelomate Body Plan	156
11 Molluscan Success	175
12 Annelida: The Metameric Body Form	195
13 The Pseudocoelomate Body Plan: Aschelminthes (Lophotrochozoan and Ecdysozoan Phyla)	211
14 The Arthropods: Blueprint for Success	228
15 The Hexapods and Myriapods: Terrestrial Triumphs	250
16 The Echinoderms	271
17 Hemichordata and Invertebrate Chordates	285
18 The Fishes: Vertebrate Success in Water	296
19 Amphibians: The First Terrestrial Vertebrates	317
20 Reptiles: Nonavian Diapsid Amniotes	334
21 Birds: Reptiles by Another Name	350
22 Mammals: Synapsid Amniotes	368
23 Protection, Support, and Movement	394
24 Communication I: Nervous and Sensory Systems	414
25 Communication II: The Endocrine System and Chemical Messengers	442
26 Circulation and Gas Exchange	461
27 Nutrition and Digestion	481
28 Temperature and Body Fluid Regulation	503
29 Reproduction and Development	524
30 The Chemical Basis of Animal Life*	
31 Energy and Enzymes: Life's Driving and Controlling Forces*	
32 How Animals Harvest Energy Stored in Nutrients*	
33 Embryology*	
34 Animal Behavior*	
Glossary	544
Credits	573
Index	576

\*This chapter is available at [www.mhhe.com/millerharley8e](http://www.mhhe.com/millerharley8e) (click on this book's cover).

# CONTENTS

Preface x

## CHAPTER 1

### ZOOLOGY: AN EVOLUTIONARY AND ECOLOGICAL PERSPECTIVE 1

Outline 1  
Concepts 1  
Zoology: An Evolutionary Perspective 2  
Zoology: An Ecological Perspective 5  
Summary 8  
Selected Key Terms 9  
Concept Review Questions 9  
Analysis and Application Questions 9

## CHAPTER 2

### CELLS, TISSUES, ORGANS, AND ORGAN SYSTEMS OF ANIMALS 10

Outline 10  
Concepts 10  
What Are Cells? 10  
Why Are Most Cells Small? 12  
Cell Membranes 12  
Movement across Membranes 14  
Cytoplasm, Organelles, and Cellular Components 18  
The Nucleus: Information Center 23  
Levels of Organization in Various Animals 24  
Tissues 24  
Organs 30  
Organ Systems 30  
Summary 32  
Selected Key Terms 32  
Concept Review Questions 32  
Analysis and Application Questions 33

## CHAPTER 3

### CELL DIVISION AND INHERITANCE 34

Outline 34  
Concepts 34  
Eukaryotic Chromosomes 35  
Mitotic Cell Division 36  
Meiosis: The Basis of Sexual Reproduction 38  
DNA: The Genetic Material 40  
Inheritance Patterns in Animals 46

Summary 52  
Selected Key Terms 53  
Concept Review Questions 53  
Analysis and Application Questions 54

## CHAPTER 4

### EVOLUTION: HISTORY AND EVIDENCE 55

Outline 55  
Concepts 55  
Pre-Darwinian Theories of Change 56  
Darwin's Early Years and His Journey 56  
Early Development of Darwin's Ideas of Evolution 57  
The Theory of Evolution by Natural Selection 60  
Microevolution, Macroevolution, and Evidence of Macroevolutionary Change 62  
Summary 71  
Selected Key Terms 72  
Concept Review Questions 72  
Analysis and Application Questions 72

## CHAPTER 5

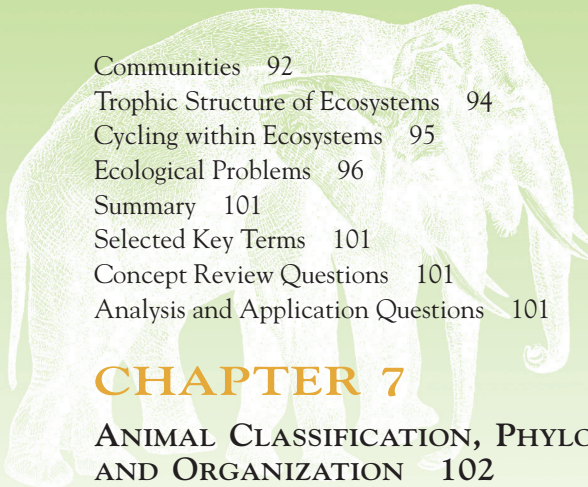
### EVOLUTION AND GENE FREQUENCIES 73

Outline 73  
Concepts 73  
Populations and Gene Pools 74  
Must Evolution Happen? 74  
Evolutionary Mechanisms 74  
Species and Speciation 80  
Rates of Evolution 81  
Molecular Evolution 83  
Mosaic Evolution 84  
Summary 84  
Selected Key Terms 84  
Concept Review Questions 85  
Analysis and Application Questions 85

## CHAPTER 6

### ECOLOGY: PRESERVING THE ANIMAL KINGDOM 86

Outline 86  
Concepts 86  
Animals and Their Abiotic Environment 86  
Biotic Factors: Populations 88  
Biotic Factors: Interspecific Interactions 89



Communities	92
Trophic Structure of Ecosystems	94
Cycling within Ecosystems	95
Ecological Problems	96
Summary	101
Selected Key Terms	101
Concept Review Questions	101
Analysis and Application Questions	101

## CHAPTER 7

### ANIMAL CLASSIFICATION, PHYLOGENY, AND ORGANIZATION 102

Outline	102
Concepts	102
Classification of Organisms	102
Evolutionary Relationships and Tree Diagrams	109
Patterns of Organization	109
Higher Animal Taxonomy	113
Summary	116
Selected Key Terms	116
Concept Review Questions	117
Analysis and Application Questions	117

## CHAPTER 8

### ANIMAL-LIKE PROTISTS: THE PROTOZOA 118

Outline	118
Concepts	118
Evolutionary Perspective of the Protists	118
Life within a Single Plasma Membrane	119
Symbiotic Lifestyles	121
Protists and Protozoan Taxonomy	121
Further Phylogenetic Considerations	132
Summary	133
Selected Key Terms	134
Concept Review Questions	134
Analysis and Application Questions	134

## CHAPTER 9

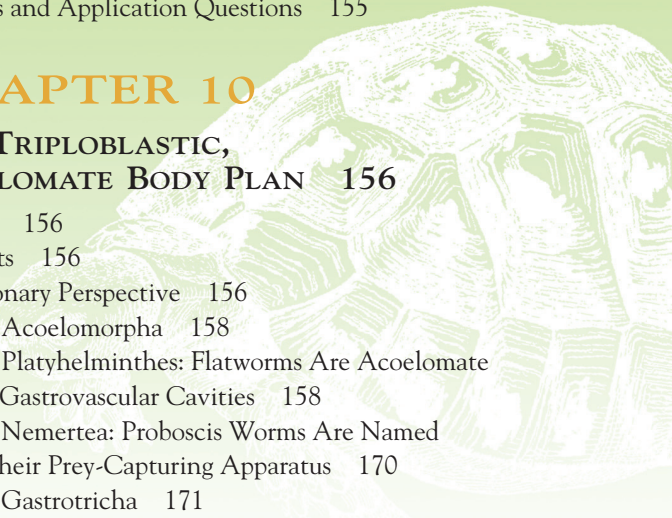
### MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION 135

Outline	135
Concepts	135
Evolutionary Perspective	135
Phylum Porifera	137
Phylum Cnidaria	142
Phylum Ctenophora	150
Further Phylogenetic Considerations	152
Summary	154
Selected Key Terms	155

Concept Review Questions	155
Analysis and Application Questions	155

## CHAPTER 10

### THE TRIPLOBLASTIC, ACOELOMATE BODY PLAN 156



Outline	156
Concepts	156
Evolutionary Perspective	156
Phylum Acoelomorpha	158
Phylum Platyhelminthes: Flatworms Are Acoelomate with Gastrovascular Cavities	158
Phylum Nemertea: Proboscis Worms Are Named for Their Prey-Capturing Apparatus	170
Phylum Gastrotricha	171
Phylum Cycliophora: A Relatively New Phylum	172
Further Phylogenetic Considerations	172
Summary	173
Selected Key Terms	174
Concept Review Questions	174
Analysis and Application Questions	174

## CHAPTER 11

### MOLLUSCAN SUCCESS 175

Outline	175
Concepts	175
Evolutionary Perspective	175
Molluscan Characteristics	176
Class Gastropoda	178
Class Bivalvia	181
Class Cephalopoda	185
Class Polyplacophora	189
Class Scaphopoda	190
Class Monoplacophora	190
Class Aplacophora	190
Further Phylogenetic Considerations	191
Summary	193
Selected Key Terms	194
Concept Review Questions	194
Analysis and Application Questions	194

## CHAPTER 12

### ANNELIDA: THE METAMERIC BODY FORM 195

Outline	195
Concepts	195
Evolutionary Perspective	195
Class Polychaeta	198
Class Clitellata	203

Further Phylogenetic Considerations 207  
Summary 209  
Selected Key Terms 210  
Concept Review Questions 210  
Analysis and Application Questions 210

## CHAPTER 13

### THE PSEUDOCOELOMATE BODY PLAN: ASCHELMINTHES (LOPHOTROCHOZOAN AND ECDYSOZOAN PHYLA) 211

Outline 211  
Concepts 211  
Evolutionary Perspective 211  
General Characteristics 212  
Aschelminthes That Do Not  
Molt (Lophotrochozoan Phyla) 212  
Aschelminthes That Molt  
(Ecdysozoan Phyla) 217  
Further Phylogenetic Considerations 226  
Summary 226  
Selected Key Terms 226  
Concept Review Questions 226  
Analysis and Application Questions 227

## CHAPTER 14

### THE ARTHROPODS: BLUEPRINT FOR SUCCESS 228

Outline 228  
Concepts 228  
Evolutionary Perspective 228  
Metamerism and Tagmatization 229  
The Exoskeleton 230  
The Hemocoel 231  
Metamorphosis 232  
Subphylum Trilobitomorpha 232  
Subphylum Chelicerata 232  
Subphylum Crustacea 240  
Further Phylogenetic Considerations 247  
Summary 248  
Selected Key Terms 248  
Concept Review Questions 248  
Analysis and Application Questions 248

## CHAPTER 15

### THE HEXAPODS AND MYRIAPODS: TERRESTRIAL TRIUMPHS 250

Outline 250  
Concepts 250  
Evolutionary Perspective 250

Subphylum Myriapoda 251  
Subphylum Hexapoda 254  
Further Phylogenetic Considerations 267  
Summary 269  
Selected Key Terms 270  
Concept Review Questions 270  
Analysis and Application Questions 270

## CHAPTER 16

### THE ECHINODERMS 271

Outline 271  
Concepts 271  
Evolutionary Perspective 271  
Echinoderm Characteristics 272  
Class Asterozoa 274  
Class Ophiurozoa 276  
Class Echinozoa 278  
Class Holothurozoa 279  
Class Crinozoa 280  
Further Phylogenetic Considerations 281  
Summary 283  
Selected Key Terms 284  
Concept Review Questions 284  
Analysis and Application Questions 284

## CHAPTER 17

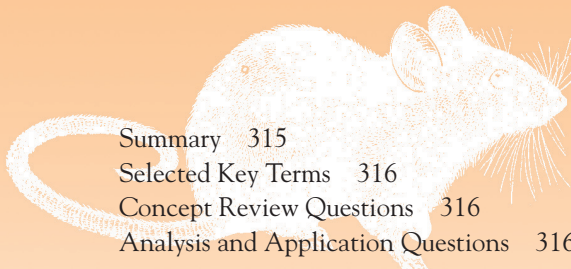
### HEMICHORDATA AND INVERTEBRATE CHORDATES 285

Outline 285  
Concepts 285  
Evolutionary Perspective 285  
Phylum Hemichordata 286  
Phylum Chordata 289  
Further Phylogenetic Considerations 293  
Summary 295  
Selected Key Terms 295  
Concept Review Questions 295  
Analysis and Application Questions 295

## CHAPTER 18

### THE FISHES: VERTEBRATE SUCCESS IN WATER 296

Outline 296  
Concepts 296  
Evolutionary Perspective 296  
Survey of Fishes 299  
Evolutionary Pressures 305  
Further Phylogenetic Considerations 313



Summary	315
Selected Key Terms	316
Concept Review Questions	316
Analysis and Application Questions	316

## CHAPTER 19

### AMPHIBIANS: THE FIRST TERRESTRIAL VERTEBRATES 317

Outline	317
Concepts	317
Evolutionary Perspective	317
Survey of Amphibians	318
Evolutionary Pressures	321
Amphibians in Peril	331
Further Phylogenetic Considerations	332
Summary	332
Selected Key Terms	333
Concept Review Questions	333
Analysis and Application Questions	333

## CHAPTER 20

### REPTILES: NONAVIAN DIAPSID AMNIOTES 334

Outline	334
Concepts	334
Evolutionary Perspective	334
Survey of the Reptiles	336
Evolutionary Pressures	340
Further Phylogenetic Considerations	347
Summary	348
Selected Key Terms	348
Concept Review Questions	348
Analysis and Application Questions	349

## CHAPTER 21

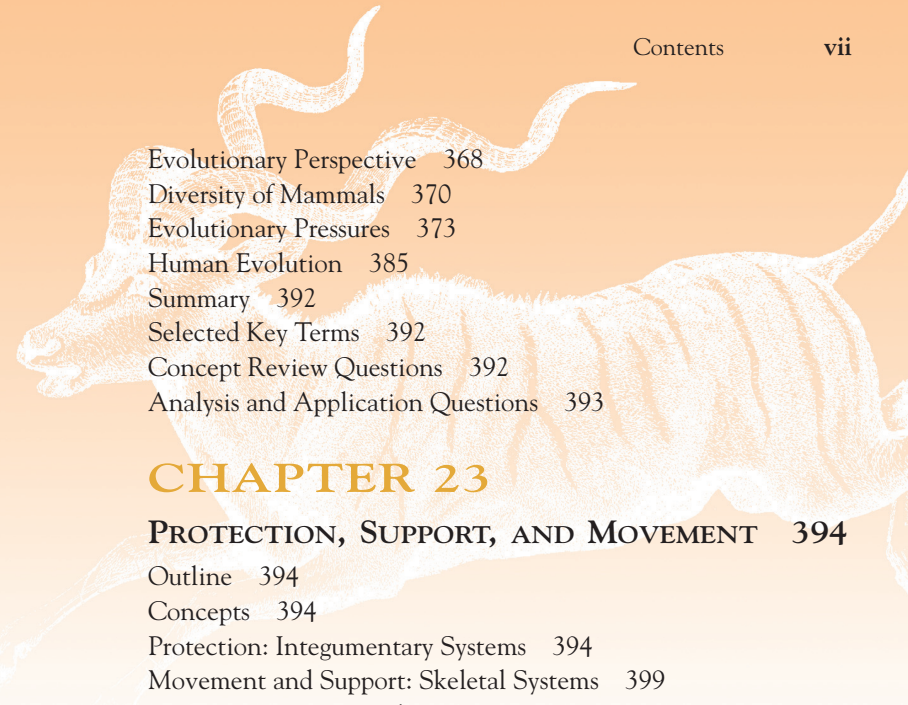
### BIRDS: REPTILES BY ANOTHER NAME 350

Outline	350
Concepts	350
Evolutionary Perspective	350
Evolutionary Pressures	353
Summary	367
Selected Key Terms	367
Concept Review Questions	367
Analysis and Application Questions	367

## CHAPTER 22

### MAMMALS: SYNAPSID AMNIOTES 368

Outline	368
Concepts	368



Evolutionary Perspective	368
Diversity of Mammals	370
Evolutionary Pressures	373
Human Evolution	385
Summary	392
Selected Key Terms	392
Concept Review Questions	392
Analysis and Application Questions	393

## CHAPTER 23

### PROTECTION, SUPPORT, AND MOVEMENT 394

Outline	394
Concepts	394
Protection: Integumentary Systems	394
Movement and Support: Skeletal Systems	399
Movement: Nonmuscular Movement and Muscular Systems	403
Summary	412
Selected Key Terms	412
Concept Review Questions	412
Analysis and Application Questions	413

## CHAPTER 24

### COMMUNICATION I: NERVOUS AND SENSORY SYSTEMS 414

Outline	414
Concepts	414
Neurons: The Basic Functional Units of the Nervous System	415
Neuron Communication	416
Invertebrate Nervous Systems	419
Vertebrate Nervous Systems	421
Sensory Reception	426
Invertebrate Sensory Receptors	427
Vertebrate Sensory Receptors	431
Summary	439
Selected Key Terms	440
Concept Review Questions	441
Analysis and Application Questions	441

## CHAPTER 25

### COMMUNICATION II: THE ENDOCRINE SYSTEM AND CHEMICAL MESSENGERS 442

Outline	442
Concepts	442
Chemical Messengers	443
Hormones and Their Feedback Systems	443
Mechanisms of Hormone Action	444
Some Hormones of Invertebrates	445

An Overview of the Vertebrate Endocrine System	448
Endocrine Systems of Vertebrates Other Than Birds or Mammals	449
Endocrine Systems of Birds and Mammals	451
Some Hormones Are Not Produced by Endocrine Glands	458
Evolution of Endocrine Systems	459
Summary	459
Selected Key Terms	459
Concept Review Questions	459
Analysis and Application Questions	460

## CHAPTER 26

### CIRCULATION AND GAS EXCHANGE 461

Outline	461
Concepts	461
Internal Transport and Circulatory Systems	461
Gas Exchange	470
Summary	479
Selected Key Terms	479
Concept Review Questions	479
Analysis and Application Questions	480

## CHAPTER 27

### NUTRITION AND DIGESTION 481

Outline	481
Concepts	481
Evolution of Nutrition	481
The Metabolic Fates of Nutrients in Heterotrophs	482
Digestion	485
Animal Strategies for Getting and Using Food	486
Diversity in Digestive Structures: Invertebrates	489
Diversity in Digestive Structures: Vertebrates	490
The Mammalian Digestive System	495
Summary	502
Selected Key Terms	502
Concept Review Questions	502
Analysis and Application Questions	502

## CHAPTER 28

### TEMPERATURE AND BODY FLUID REGULATION 503

Outline	503
Concepts	503
Homeostasis and Temperature Regulation	503
Control of Water and Solutes (Osmoregulation and Excretion)	510
Invertebrate Excretory Systems	511
Vertebrate Excretory Systems	514
Summary	522

Selected Key Terms	522
Concept Review Questions	523
Analysis and Application Questions	523

## CHAPTER 29

### REPRODUCTION AND DEVELOPMENT 524

Outline	524
Concepts	524
Asexual Reproduction in Invertebrates	524
Sexual Reproduction in Invertebrates	527
Sexual Reproduction in Vertebrates	528
Examples of Reproduction among Various Vertebrate Classes	528
The Human Male Reproductive System Is Typical of Male Mammals	530
The Human Female Reproductive System Is Typical of Female Mammals	533
Prenatal Development and Birth in a Human	539
Summary	542
Selected Key Terms	543
Concept Review Questions	543
Analysis and Application Questions	543

## CHAPTER 30\*

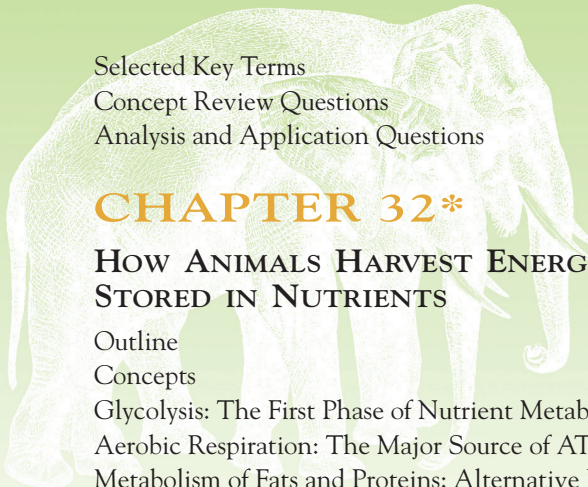
### THE CHEMICAL BASIS OF ANIMAL LIFE

Outline
Concepts
Atoms and Elements: Building Blocks of All Matter
Compounds and Molecules: Aggregates of Atoms
Acids, Bases, and Buffers
The Molecules of Animals
Summary
Selected Key Terms
Concept Review Questions
Analysis and Application Questions

## CHAPTER 31\*

### ENERGY AND ENZYMES: LIFE'S DRIVING AND CONTROLLING FORCES

Outline
Concepts
What Is Energy?
The Laws of Energy Transformations
Activation Energy
Enzymes: Biological Catalysts
Cofactors and Coenzymes
ATP: The Cell's Energy Currency
Summary



Selected Key Terms  
Concept Review Questions  
Analysis and Application Questions

## CHAPTER 32\*

### HOW ANIMALS HARVEST ENERGY STORED IN NUTRIENTS

Outline  
Concepts  
Glycolysis: The First Phase of Nutrient Metabolism  
Aerobic Respiration: The Major Source of ATP  
Metabolism of Fats and Proteins: Alternative Food Molecules  
Control of Metabolism  
The Metabolic Pool  
Summary  
Selected Key Terms  
Concept Review Questions  
Analysis and Application Questions

## CHAPTER 33\*

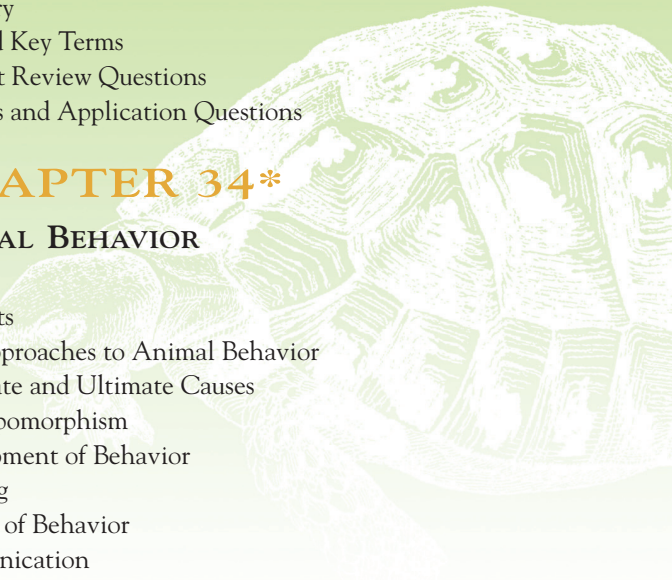
### EMBRYOLOGY

Outline  
Concepts  
Fertilization  
Embryonic Development, Cleavage, and Egg Types  
The Primary Germ Layers and Their Derivatives  
Echinoderm Embryology

Vertebrate Embryology  
Summary  
Selected Key Terms  
Concept Review Questions  
Analysis and Application Questions

## CHAPTER 34\*

### ANIMAL BEHAVIOR



Outline  
Concepts  
Four Approaches to Animal Behavior  
Proximate and Ultimate Causes  
Anthropomorphism  
Development of Behavior  
Learning  
Control of Behavior  
Communication  
Behavioral Ecology  
Social Behavior  
Summary  
Selected Key Terms  
Concept Review Questions  
Analysis and Application Questions

**Glossary 544**

**Credits 573**

**Index 576**