

Integrated Principles of
ZOOLOGY

Ninth Edition

Updated Version



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Integrated Principles of
ZOOLOGY

Ninth Edition

Updated Version

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Preface

In this ninth edition of *Integrated Principles of Zoology*, as in previous editions, we stress the basic principles and assumptions that provide a basis for understanding the animal kingdom and its progenitors, the animal-like Protista. This edition is a statement of the status of the zoological sciences at this particular time, as we the authors view it. Certainly the present treatment will in some measure reveal our interests, background, and, inevitably, our biases. Nevertheless, we trust you will find a balanced and current textbook, framed firmly within an evolutionary perspective, which conveys our own fascination with the extraordinary world of animals.

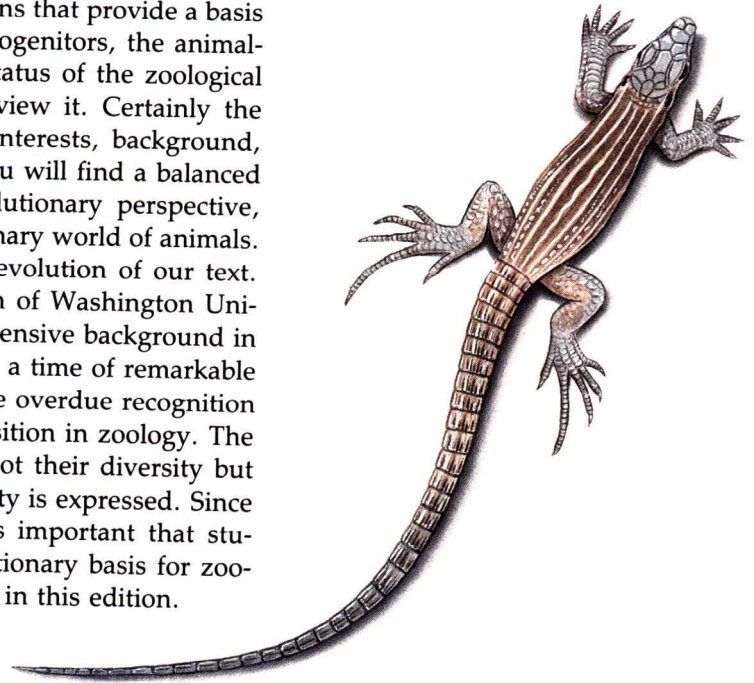
This ninth edition represents a transition in the evolution of our text. We welcome the association of coauthor Allan Larson of Washington University in St. Louis who brings to this textbook his extensive background in evolutionary and systematic zoology. Allan joins us at a time of remarkable resurgence of interest in systematics, together with the overdue recognition that systematics holds a unique and indispensable position in zoology. The most extraordinary collective property of animals is not their diversity but the many shared characters through which this diversity is expressed. Since classification permeates every course in zoology, it is important that students understand that systematics provides the evolutionary basis for zoological study. This theme has been strongly developed in this edition.

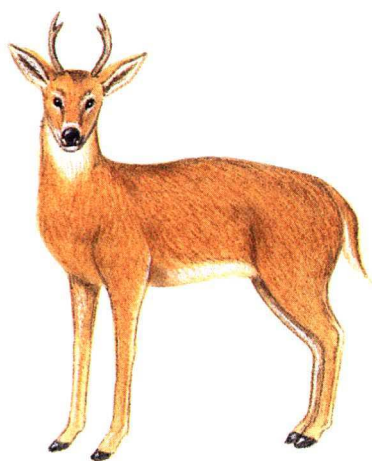
CHANGES WITH THIS EDITION

In addition to the broadening of authorship, two other major changes will be immediately apparent to previous users of this text. The first is a reorganization of the subject matter. The chapters on reproduction, development, genetics, and evolution now appear in Part Two, preceding the survey chapters of Part Three. The material in these chapters is accessible whether it precedes or follows the survey chapters, but those instructors who provide an initial grounding in these topics should like this new placement.

The second and more significant change in this edition is the inclusion of a cladistic perspective in the survey chapters of Part Three. Cladistics is no longer just another approach to systematics. Cladistics (also termed "phylogenetic systematics," or simply, "phylogenetics") has been widely adopted as a basis for determining the pattern of phylogenetic descent. The aim of cladistics is to produce classifications that exactly reflect true genealogical relationships. Because of the importance of the cladistic approach, which is new to most students, we devote considerable space in Chapter 12 to explaining the principles and rules of application of cladistics. Most of the survey chapters include cladograms of the group or groups being considered, together with the character states on which they are based.

With its emphasis on monophyletic groupings, cladistic classifications frequently conflict with the traditional arrangements of taxa in a Linnaean hierarchy of categories. Because cladists consider paraphyletic taxa inadmissi-





ble, they reject several well-known classical taxa such as bony fish (Osteichthyes), amphibians, and reptiles, because such groups do not include all their descendants. Obviously the consistent application of cladistic methods would destroy most traditional classifications—to the distress, it is certain, of many instructors and students. Consequently, we have retained the traditional Linnaean rankings in this text because this is still standard taxonomic practice, while noting where conflicts exist and suggesting alternative approaches that use only monophyletic taxa.

Each chapter of this edition has been carefully reworked to make the text as current and accurate as possible, and to simplify complex information. To help achieve this goal we have added numerous new illustrations and revised many others to enhance the text as a teaching tool. The principal revisions made in each of the five parts of the text are explained below.

Part One: Introduction to the Living Animal

In Chapter 1, completely rewritten and generously illustrated for this edition, we introduce and define the fundamental properties of animal life and explain the hierarchical properties of living systems and their evolution. Because a hierarchical perspective has become increasingly applicable to evolutionary theory in recent years, we believe it is important that students learn this perspective early in their study of the biological sciences. Chapter 2 (Chemistry of Life) has been greatly condensed by moving the sections on basic chemistry (atoms, elements, and molecules; bonding theory; acids, bases, salts, and buffers) to an appendix where it is available for reference by those who are unfamiliar with these concepts. Chapter 3 (Origin of Life) has been condensed and updated. The section on the primitive earth was rewritten to conform with current opinions regarding the primeval atmosphere, a section on hydrothermal vents as sources of energy was added, including appropriate modifications in the discussion of need for concentration, and a marginal note on the “RNA world” has been added. In Chapter 4 (The Cell as the Unit of Life) the discussions of mitosis and control of cell division were updated. Chapter 5 (Physiology of the Cell) has been considerably condensed throughout and the illustrations updated for the section on cellular respiration.

Part Two: Continuity and Evolution of Animal Life

Chapter 6 (The Reproductive Process) presents revised sections on both sexual and asexual reproduction with expanded explanations of parthenogenesis and hermaphroditism to provide more examples and the implications of these alternatives to biparental reproduction.

We moved the section on the hormones of reproduction to the chapter on the endocrine system (Chapter 38) where it has been combined with a previously separate discussion of the hormonal changes preceding birth to form a unified treatment of reproductive endocrinology. Chapter 7 (Principles of Development) received a particularly thorough revision to provide a much more comprehensive analysis of development that should give the student a better appreciation of the role of experimentation and discovery in the ongoing discipline of developmental biology. All themes in this chapter were revised and reillustrated, from the earliest events of development to the orchestration of genetic control, the latter including an explanation of homeotic genes.

Apart from several new illustrations, little was changed in the content of Chapter 8 (Principles of Inheritance). An animal example of intermediate

dominance was substituted for the four-o'clock flowers example. Our coverage of molecular genetics (Chapter 9), however, has been considerably revised. This includes an updated discussion of the structure of nucleosomes, substantial revision of the section on genetic engineering, with a discussion on the revolutionary polymerase chain reaction, and a revised discussion on oncogenes.

Chapter 10 (Organic Evolution) begins with an historical account of Charles Darwin's life and discoveries. The historical fates of the five important components of Darwin's evolutionary theory (as introduced in Chapter 1) are then followed to the present. Important challenges and revisions to Darwin's theories of perpetual change, common descent, multiplication of species, gradualism, and natural selection are discussed, ending with an assessment of the current scientific status of these theories. By presenting Darwinism as a composite of these five component theories, we emphasize that it has an elaborate structure. Contrary to many popular accounts that students may have encountered, Darwinism is not a single, simple statement that is easily confirmed or refuted. The five-part structure that we present helps to organize the important scientific challenges to Darwinism in a meaningful way. This knowledge prepares students to dismiss the arguments of creationists who misconstrue these controversies as challenges to the validity of organic evolution.

Part Three: The Diversity of Animal Life

Chapter 11 (Architectural Pattern of an Animal) is a short but important chapter that defines the organization and development of body plans distinguishing the major groups of animals. With the content reorganization of the text that placed the development chapter in Part Two, it was possible to remove the brief treatment of animal embryology that was previously included in this chapter. It is still important, however, that students have an understanding of three important developmental features before reading the diversity chapters: radial versus spiral cleavage, coelom formation, and the formation of germ layers. These topics are all covered in Chapter 7.

Chapter 12 (Classification and Phylogeny of Animals) presents a brief history of how animal diversity has been organized for systematic study, emphasizing the current use of Darwin's theory of common descent (Chapters 1 and 10) as the major principles underlying animal taxonomy. Continuing controversies between the schools of evolutionary taxonomy and phylogenetic systematics (cladistics) are presented, including a discussion of how these alternative taxonomic philosophies affect our study of evolution. By covering these controversies, we emphasize to students that the species and higher taxa that we recognize are not trivial facts of nature but constructs whose discovery is complex. We emphasize the process of scientific inquiry rather than the acceptance of a single end result. This leads the student to develop the critical thinking necessary for understanding current issues in ecology, evolution, and conservation biology, all of which depend on our taxonomic system. Chapter 12 is important also as a preface to the organizational structure of the remainder of this book.

The invertebrate chapters (Chapters 13 through 26) were thoroughly updated, and many new illustrations have been added, both artwork and photographs. The classifications in each chapter were positioned following other coverage of the particular group, in most cases immediately preceding the summary at the end of the chapter. The discussions of phylogenetic relationships were rewritten from a cladistic viewpoint, and cladograms have been



presented where possible. Some other revisions in these chapters include the following: coverage of the phylum Loricifera (Chapter 17), and transfer of the Priapulida back to the pseudocoelomate grouping (Chapter 18); addition of some coverage of conotoxins (Chapter 18); arthropod cuticle (Chapter 20); crustacean cuticle and ecdysis, and acceptance of the crustacean class Maxillopoda (containing subclasses Ostracoda, Mystacocarida, Copepoda, Tantulocarida, Branchiura, and Cirripedia) (Chapter 21); insect flight, physiology of insect metamorphosis, and control of insect pests (Chapter 22); acceptance of the lophophorates as deuterostome phyla (Chapter 24); inclusion of the class Concentricycloidea in the phylum Echinodermata, and return to the concept of subphyla Pelmatozoa and Eleutherozoa in the Echinodermata, in accordance with recent cladistic opinion (Chapter 25).

Important revisions in organization and content were made in the six chordate chapters (Chapters 27 through 32). As with the invertebrate chapters, cladograms have been added to show the inferred branching events in the group's history and the origin of some of the principal shared derived characters. The traditional phylogenetic trees have been retained but redrawn to agree with cladistic analysis as closely as possible. Much of the text on ancestry and relationships has been rewritten. Some of the more extensive text revisions in these chapters were protochordate biology (Chapter 27); evolution and classification of bony fishes (Chapter 28); tetrapod origin and evolution, and paedomorphosis in salamanders (Chapter 29); origin, adaptive radiation, and classification of amniotes (Chapter 30); *Archaeopteryx* and origin of modern birds (Chapter 31); mammalian evolution, feeding specializations in mammals, and reproductive cycles in mammals (Chapter 32). The chordate, fish, and amphibian chapters especially benefited from new artwork prepared by artists Bill Ober and Claire Garrison.

Part Four: Activity of Life

Part Four consists of six chapters dealing with the functional systems of animals and a closing chapter on animal behavior. For Chapter 33 (Support, Protection, and Movement) we have revised the discussions of hydrostatic skeletons and muscular movement, and we have expanded the latter to include explanations of the distinction between fast and slow fibers, and of the importance of tendons in energy storage. In Chapter 35, coverage of immunity and the immune response was again revised to reflect recent information.



Other topics in Part Four that received comprehensive revisions were the autonomic nervous system (Chapter 37) and mechanisms of hormone action and the endocrinology of reproduction (Chapter 38). We revised the opening section in Chapter 39 (Animal Behavior) to distinguish between proximate and ultimate causation, and to explain the different experimental approaches to animal behavior. The treatment of principles of classical ethology was condensed. In a new section entitled “The Control of Behavior,” we explain why “instinct theory” has fallen out of fashion, and provide two clear examples of genetic transmission of specific innate behaviors: inheritance of hygienic behavior in honeybees, which shows simple Mendelian inheritance, and confused nesting behavior of hybrid lovebirds, an example of a more complex inheritance of intermediate behavior.



Part Five: The Animal and its Environment

The animal environment and the principles of ecology are the themes of the final two chapters of the book. We condensed much of the opening section of Chapter 40 (The Biosphere and Animal Distribution), which deals with the fitness of the earth's environment. The section on the explanations for the disjunct distributions of animals—distribution by dispersal or by vicariance—was completely rewritten to include a graphic example of how the hypothesis of vicariance biogeography might be tested. Several sections of Chapter 41 (Animal Ecology) were revised, and we added a discussion of keystone species, using two examples from the marine environment.

TEACHING AND LEARNING AIDS

VOCABULARY DEVELOPMENT

Key words are boldfaced and the derivations of generic names of animals are given where they first appear in the text. In addition, the derivation of many technical and zoological terms are provided in the text; in this way students gradually become familiarized with the more common roots that recur in many technical terms. An extensive glossary of more than 1000 terms provides the pronunciation, derivation, and definition of each term. More than 60 new terms were added to the glossary for this edition.

CHAPTER PROLOGUES

Each chapter opens with an essay, placed in the margin alongside of the chapter introduction, that draws out some theme or fact relating to the subject of the chapter. Some present biological, particularly evolutionary principles; others (especially those in the survey sections) illuminate distinguishing characteristics of the group treated in the chapter. Each is intended to present an important concept drawn from the chapter in an interesting manner that will facilitate learning by students, as well as engage their interest and pique their curiosity.

MARGINAL NOTES

Marginal notes, which appear throughout the book, augment the text material and offer interesting sidelights without interrupting the narrative. We prepared many new marginal notes for this edition and revised many of the existing notes.

FOR REVIEW

Each chapter ends with a concise summary, a list of review questions, and annotated selected references. The review questions enable the student to self-test retention and understanding of the more important chapter material.

HISTORICAL APPENDIX

The historical appendix, unique to this textbook, lists key discoveries in zoology, and separately describes books and publications that have greatly influenced the development of zoology. Many readers have found this appendix an invaluable reference to consult long after their formal training in zoology ended.

ART PROGRAM

The appearance and usefulness of this edition have been further enhanced with many new full color paintings by William C. Ober and Claire W. Garrison. Bill's artistic skills, knowledge of biology, and experience gained from an earlier career as a practicing physician have enriched this text through five of its editions. Claire practiced pediatric and obstetric nursing before turning to scientific illustration as a full-time career. Texts illustrated by Bill and Claire have received national recognition and won awards from the Association of Medical Illustrators, American Institute of Graphic Arts, Chicago Book Clinic, Printing Industries of America, and Bookbuilders West. They are also recipients of the Art Directors' Award.



SUPPLEMENTS

INSTRUCTOR'S RESOURCE GUIDE

The Resource Guide has been broadly revised and expanded for this edition. The guide provides a chapter outline, Test Bank, commentary and lesson plan, a listing of resource references, and a listing of films and videotapes for each chapter. We trust this will be of particular value to first-time users of the text, although experienced teachers may also find much of value.

LABORATORY MANUAL

The laboratory manual by Cleveland P. Hickman, Jr. and Frances M. Hickman, *Laboratory Studies in Integrated Zoology*, now in its eighth edition, has been extensively rewritten and reillustrated. It was designed to accompany a year-long course in zoology, but it can be adapted conveniently for semester or term courses by judicious selection of exercises. The popular wall chart, "Chief taxonomic subdivisions and organ systems of animals," has been re-designed for this edition.

COMPUTERIZED TEST BANK

For the first time ever with this edition, the test questions contained in the *Instructor's Resource Guide* are available on *Computest*, a computerized test generation system. Using this system, instructors can create tests and quizzes quickly and easily. Instructors can sort questions by type or level of difficulty, and can also add their own questions to the bank of questions provided.

TRANSPARENCY ACETATES

100 full color transparency acetates of important textual illustrations are available with this edition. Labeling is clear, dark, and bold for easy reading.

ANIMAL DIVERSITY SLIDES

A set of 50 animal diversity slides, photographed by the authors and Bill Ober on their various excursions, are offered in this unique textbook supplement. Both invertebrates and vertebrates are represented. Descriptions, including specific names of each animal and brief overview of the animal's ecology and/or behavior, accompany the slides.

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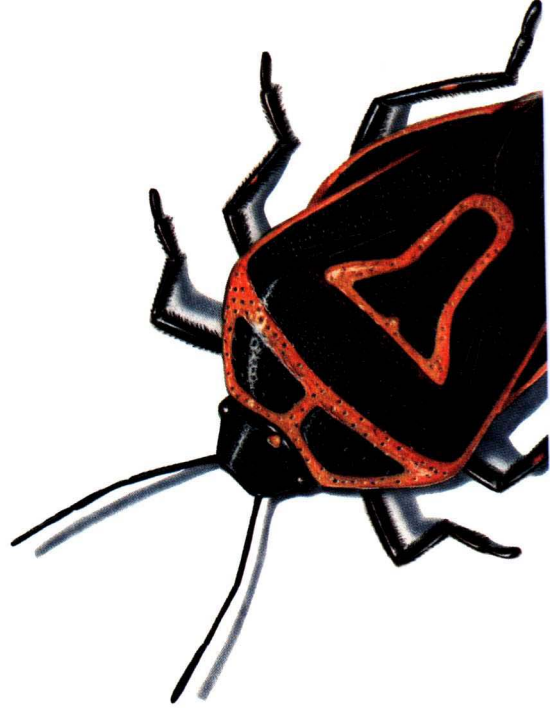




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CLEVELAND P. HICKMAN, Jr.
LARRY S. ROBERTS
ALLAN LARSON

Contents



PART ONE *Life and Its Continuity*

- 1 Life: Biological Principles and the Science of Zoology, 3
- 2 Chemistry of Life, 26
- 3 Origin of Life, 37
- 4 The Cell as the Unit of Life, 53
- 5 Physiology of the Cell, 79

PART TWO *Continuity and Evolution of Animal Life*

- 6 The Reproductive Process, 101
- 7 Principles of Development, 121
- 8 Principles of Inheritance, 153
- 9 Molecular Genetics, 172
- 10 Organic Evolution, 199

PART THREE *The Diversity of Animal Life*

- 11 Architectural Pattern of an Animal, 241
- 12 Classification and Phylogeny of Animals, 258
- 13 The Animal-like Protista, 278
- 14 The Mesozoa and Parazoa, 310
- 15 The Radiate Animals, 327
- 16 The Acoelomate Animals, 360
- 17 The Pseudocoelomate Animals, 388
- 18 The Molluscs, 412
- 19 The Segmented Worms, 448
- 20 The Arthropods, 471
- 21 The Aquatic Mandibulates, 489
- 22 The Terrestrial Mandibulates: Uniramians, 513
- 23 The Lesser Protostomes, 547
- 24 The Lophophorate Animals, 560
- 25 The Echinoderms, 568
- 26 The Lesser Deuterostomes, 594
- 27 The Chordates: General Characteristics, Protochordates, and Ancestry of the Earliest Vertebrates, 603
- 28 The Fishes, 625
- 29 The Early Tetrapods and Modern Amphibians, 658
- 30 The Reptiles, 681
- 31 The Birds, 703
- 32 The Mammals, 733



PART FOUR *Activity of Life*

- 33 Support, Protection, and Movement, 769
- 34 Homeostasis: Osmotic Regulation, Excretion, and Temperature Regulation, 792
- 35 Internal Fluids: Immunity, Circulation, and Gas Exchange, 816
- 36 Digestion and Nutrition, 846
- 37 Nervous Coordination: Nervous System and Sense Organs, 865
- 38 Chemical Coordination: Endocrine System, 896
- 39 Animal Behavior, 920

PART FIVE *The Animal and its Environment*

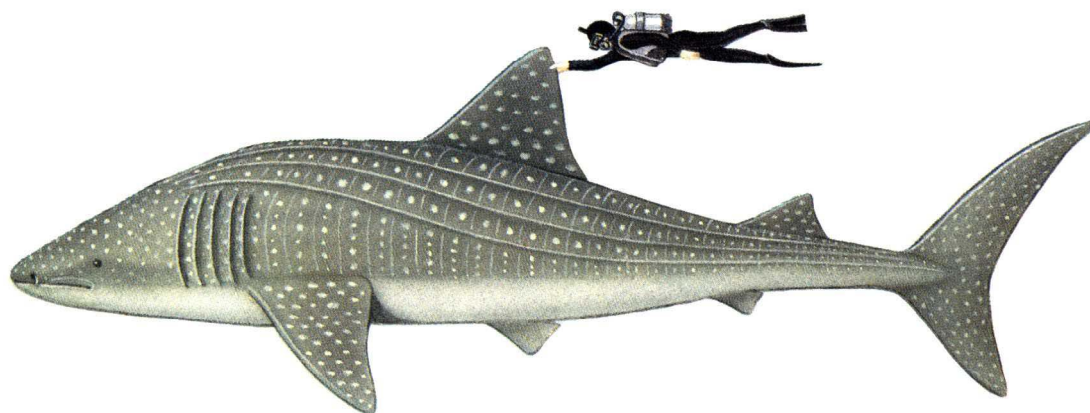
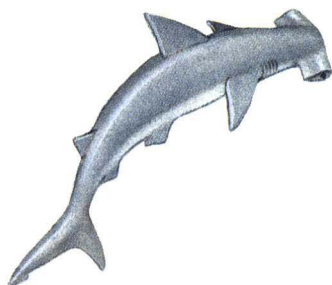
- 40 The Biosphere and Animal Distribution, 945
- 41 Animal Ecology, 966

APPENDIX A Development of Zoology, A-1

APPENDIX B Basic Structure of Matter, B-1

GLOSSARY G-1

CREDITS Credits for Part and Chapter Opener Photographs, C-1



Detailed Contents

PART ONE *Life and Its Continuity*

1 *Life: Biological Principles and the Science of Zoology*, 3

Fundamental Properties of Life, 3
Can Life be Defined? 3
General Features of Living Systems, 5
Life Obeys Physical Laws, 12
Zoology as a Part of Biology, 12
Principles of Science, 13
Nature of Science, 13
Scientific Method, 14
Physiological Versus Evolutionary Sciences, 16
Theories of Heredity and Evolution, 17
Darwin's Theory of Evolution, 17
Mendelian Heredity and the Chromosomal Theory of Inheritance, 20
Summary, 24

2 *Chemistry of Life*, 26

Water and Life, 26
Organic Molecules, 29
Carbohydrates: Nature's Most Abundant Organic Substance, 29
Lipids: Fuel Storage and Building Material, 31
Amino Acids and Proteins, 33
Nucleic Acids, 35
Summary, 35

3 *Origin of Life*, 37

Historical Perspective, 38
Renewal of Inquiry:
Oparin-Haldane Hypothesis, 39
Primitive Earth, 40
Origin of Earth's Atmosphere, 40
Chemical Evolution, 42
Sources of Energy, 42
Prebiotic Synthesis of Small Organic Molecules, 43
Formation of Polymers, 44

Origin of Living Systems, 45
Origin of Metabolism, 46
Appearance of Photosynthesis and Oxidative Metabolism, 47
Precambrian Life, 48
Prokaryotes and the Age of Cyanobacteria (Blue-Green Algae), 48
Appearance of the Eukaryotes, 49
Summary, 51

4 *The Cell as the Unit of Life*, 53

Cell Concept, 53
How Cells are Studied, 54
Organization of Cells, 56
Prokaryotic and Eukaryotic Cells, 56
Components of Eukaryotic Cells and Their Functions, 57
Surfaces of Cells and Their Specializations, 62
Membrane Structure and Function, 63
Structure of the Cell Membrane, 63
Function of the Cell Membrane, 65
Mitosis and Cell Division, 70
Cell Cycle, 70
Structure of Chromosomes, 71
Phases in Mitosis, 72
Cytokinesis: Cytoplasmic Division, 75
Flux of Cells, 75
Summary, 76

5 *Physiology of the Cell*, 79

Energy and the Laws of Thermodynamics, 79
Free Energy, 80
The Role of Enzymes, 81
Enzymes and Activation Energy, 81
Nature of Enzymes, 82
Action of Enzymes, 82
Specificity of Enzymes, 83
Enzyme-Catalyzed Reactions, 83
Chemical Energy Transfer by ATP, 84
Cellular Respiration, 86

How Electron Transport is Used to Trap Chemical Bond Energy, 86
Aerobic Versus Anaerobic Metabolism, 86
General Description of Respiration, 87
Glycolysis, 88
Acetyl Coenzyme A: Strategic Intermediate in Respiration, 89
Krebs Cycle: Oxidation of Acetyl Coenzyme A, 89
Electron Transport Chain, 90
Efficiency of Oxidative Phosphorylation, 90
Anaerobic Glycolysis: Generating ATP without Oxygen, 92
Metabolism of Lipids, 93
Metabolism of Proteins, 94
Management of Metabolism, 95
Summary, 96



PART TWO Continuity and Evolution of Animal Life

6 The Reproductive Process, 101

Nature of the Reproductive Process, 101

Asexual Reproduction: Reproduction without Gametes, 102

Sexual Reproduction: Reproduction with Gametes, 103

What Good Is Sex? 106

Plan of Reproductive Systems, 107

Human Reproductive System, 108

Formation of Reproductive Cells, 110

Origin and Migration of Germ Cells, 110

Meiosis: Nuclear Division of Germ Cells, 111

Gametogenesis, 113

Gametes and Their Specializations, 115

Reproductive Patterns, 117

Maternal Support of the Embryo, 117

Breeding Cycles, 118

Summary, 118

7 Principles of Development, 121

Early Concepts: Preformation Versus Epigenesis, 121

Fertilization, 123

Oocyte Maturation, 123

Fertilization and Activation, 123

Cleavage and Early

Development, 126

Patterns of Cleavage, 126

Blastulation, 131

Gastrulation and the Formation of

Germ Layers, 132

Formation of the Coelom, 133

Mechanisms of Development, 134

Nuclear Equivalence, 134

Cytoplasmic Localization:

Significance of the Cortex, 135

Nuclear Transplantation

Experiments, 135

Embryonic Induction, 137

Gene Expression during

Development, 138

Amniotes and the Amniotic Egg, 139

Mammalian Development, 140

Development of Systems and Organs, 143

Pregnancy and Birth, 147

Summary, 150



8 Principles of Inheritance, 153

Mendel's Investigations, 153

Chromosomal Basis of Inheritance, 155

Mendelian Laws of Inheritance, 155

Mendel's First Law, 155

Mendel's Second Law, 159

Multiple Alleles, 161

Gene Interaction, 162

Sex Determination and Sex-Linked Inheritance, 164

Autosomal Linkage and Crossing Over, 168

Chromosomal Aberrations, 169

9 Molecular Genetics, 172

Chemical Structure of Nucleic Acids, 172

Physical Structure of Genetic Material, 176

Prokaryotes, Plasmids, and Viruses, 176

Eukaryotes, 176

Gene Theory, 179

Gene Concept, 179

One Gene—One Polypeptide Hypothesis, 179

Storage and Transfer of Genetic Information, 180

Base Pairing, 181

DNA Replication, 181

Transcription and the role of Messenger RNA, 182

Translation: Final State in Information Transfer, 185

Regulation of Gene Function, 187

Genetic Engineering, 188

Sources of Phenotypic Variation, 193

Gene Mutations, 193

Molecular Genetics of Cancer, 194

Oncogenes, Growth Factors, and

Tumor Suppressor Genes, 194

Summary, 195

10 Organic Evolution, 199

Historical Development of the Idea of Organic Evolution, 199

Pre-Darwinian Evolutionary Ideas, 199

Darwin's Great Voyage of Discovery, 201

Darwinian Evolutionary Theory: the Evidence, 204

Perpetual Change, 204

Common Descent, 209

Multiplication of Species, 212

Gradualism, 216

Natural Selection, 218

Revisions of Darwin's Theory, 220

Neo-Darwinism, 220

Emergence of Modern Darwinism: the Synthetic Theory, 220

Microevolution: Genetic Variation and Change Within Species, 221

Genetic Equilibrium, 222

How Genetic Equilibrium is Upset, 223

Measuring Genetic Variation

Within Populations, 226

Quantitative Variation, 227

Macroevolution: Major Evolutionary Events, 228

Speciation and Extinction through Geological Time, 229

Mass Extinctions, 230

Human Evolution, 231

Evolutionary Radiation of the Primates, 232

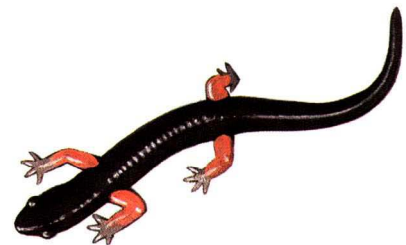
The First Hominids, 233

Emergence of *Homo*, the True Human, 234

Homo Sapiens: Modern Hominids, 234

The Unique Human Position, 235

Summary, 235



PART THREE *The Diversity of Animal Life*

11 *Architectural Pattern of an Animal*, 241

The Hierarchical Organization of Animal Complexity, 241

Complexity and Body Size, 243

Extracellular Components of the Metazoan Body, 244

Types of Tissues, 244

Epithelial Tissue, 245

Connective Tissue, 250

Muscular Tissue, 250

Nervous Tissue, 250

Animal Body Plans, 250

Animal Symmetry, 252

Body Cavities, 253

Metamerism (Segmentation), 255

Cephalization, 255

Summary, 256

12 *Classification and Phylogeny of Animals*, 258

Linnaeus and the Development of Classification, 258

Taxonomic Characters and

Phylogeny Reconstruction, 260

Using Character Variation to

Reconstruct Phylogeny, 260

Sources of Phylogenetic

Information, 262

Theories of Taxonomy, 262

Traditional Evolutionary

Taxonomy, 263

Phylogenetic Systematics/

Cladistics, 265

Current State of Animal

Taxonomy, 266

Species, 267

Criteria for Species

Recognition, 267

Typological Species Concept, 268

Biological Species Concept, 269

Alternatives to the Biological

Species Concept, 269

Dynamism of Species

Concepts, 271

Major Divisions of Life, 272

Major Subdivisions of the Animal

Kingdom, 274

Summary, 275

13 *The Animal-Like Protista*, 278

The Protozoan Phyla, 279

Form and Function, 280

Representative Types, 288

Phylogeny and Adaptive Radiation, 305

Summary, 308

14 *The Mesozoa and Parazoa*, 310

Origin of Metazoa, 310

Phylum Mesozoa, 311

Phylogeny of Mesozoans, 313

Phylum Placozoa, 313

Phylum Porifera: Sponges, 314

Form and Function, 315

Class Calcarea (Calcispongiae), 322

Class Hexactinellida

(Hyalospongiae): Glass

Sponges, 322

Class Demospongiae, 322

Class Sclerospongiae, 323

Phylogeny and Adaptive

Radiation, 323

Summary, 325

15 *The Radiate Animals*, 327

Phylum Cnidaria, 328

Form and Function, 330

Class Hydrozoa, 332

Class Scyphozoa, 338

Class Cubozoa, 341

Class Anthozoa, 342

Phylum Ctenophora, 352

Class Tentaculata, 353

Other Ctenophores, 355

Phylogeny and Adaptive

Radiation, 356

Phylogeny, 356

Adaptive Radiation, 356

Summary, 357

16 *The Acoelomate Animals*, 360

Phylum Platyhelminthes, 361

Class Turbellaria, 362

Class Monogenea, 368

Class Trematoda, 368

Class Cestoda, 374

Phylum Nemertea

(Rhynchocoela), 379

Form and Function, 380

Phylum Gnathostomulida, 383

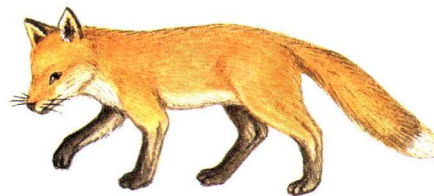
Phylogeny and Adaptive

Radiation, 383

Phylogeny, 383

Adaptive Radiation, 384

Summary, 385



17 *The Pseudocoelomate Animals*, 388

The Pseudocoelomates, 389

Phylum Rotifera, 390

Phylum Gastrotricha, 394

Phylum Kinorhyncha, 396

Phylum Loricifera, 396

Phylum Priapulida, 397

Phylum Nematoda:

Roundworms, 397

Phylum Nematomorpha, 404

Phylum Acanthocephala, 405

Phylum Entoprocta, 407

Phylogeny and Adaptive

Radiation, 408

Summary, 409

18 *The Molluscs*, 412

The Molluscs, 412

Form and Function, 414

Classes of Molluscs, 418

Phylogeny and Adaptive

Radiation, 440

Summary, 445

19 *The Segmented Worms*, 448

Phylum Annelida, 448

Body Plan, 450

Class Polychaeta, 451

Class Oligochaeta, 457

Class Hirudinea: the Leeches, 464

Evolutionary Significance of

Metamerism, 466

Phylogeny and Adaptive

Radiation, 467

Summary, 469

- 20 The Arthropods, 471**
 Phylum Arthropoda, 472
 Why Have Arthropods Achieved
 Such Great Diversity and
 Abundance? 473
 Subphylum Trilobita, 475
 Subphylum Chelicerata, 475
 Phylogeny and Adaptive
 Radiation, 484
 Summary, 486
- 21 The Aquatic Mandibulates, 489**
 Subphylum Crustacea, 489
 General Nature of a
 Crustacean, 489
 Form and Function, 490
 Brief Résumé of the
 Crustaceans, 501
 Class Cephalocarida, 502
 Class Remipedia, 502
 Class Branchiopoda, 502
 Class Maxillopoda, 503
 Class Malacostraca, 506
 Phylogeny and Adaptive
 Radiation, 509
 Summary, 511
- 22 The Terrestrial Mandibulates:
 Uniramians, 513**
 Class Chilopoda, 513
 Class Diplopoda, 514
 Class Paupoda, 515
 Class Symphyla, 516
 Class Insecta, 516
 Distribution, 516
 Adaptability, 517
 External Form and Function, 517
 Internal Form and Function, 522
 Metamorphosis and Growth, 530
 Diapause, 531
 Defense, 532
 Behavior and Communication, 533
 Insects and Human Welfare, 537
 Beneficial Insects, 537
 Harmful Insects, 538
 Control of Insects, 538
 Phylogeny and Adaptive
 Radiation, 543
 Summary, 544
- 23 The Lesser Protostomes, 547**
 The Lesser Protostomes, 547
 Phylum Sipuncula, 547
 Phylum Echiura, 549
 Phylum Pogonophora, 550
 Phylum Pentastomida, 552
 Phylum Onychophora, 553
 Phylum Tardigrada, 556
 Summary, 558



- 24 The Lophophorate Animals, 560**
 The Lophophorates, 560
 Phylum Phoronida, 561
 Phylum Ectoprocta (Bryozoa), 562
 Phylum Brachiopoda, 564
 Phylogeny and Adaptive
 Radiation, 565
 Summary, 566
- 25 The Echinoderms, 568**
 The Echinoderms, 568
 Class Asteroidea, 571
 Class Ophiuroidea, 579
 Class Echinoidea, 581
 Class Holothuroidea, 584
 Class Crinoidea, 587
 Class Concentricycloidea, 588
 Phylogeny and Adaptive
 Radiation, 589
 Summary, 592
- 26 The Lesser Deuterostomes, 594**
 Phylum Chaetognatha, 594
 Form and Function, 595
 Phylum Hemichordata, 596
 Class Enteropneusta, 597
 Class Pterobranchia, 599
 Phylogeny and Adaptive
 Radiation, 600
 Summary, 602
- 27 The Chordates: General
 Characteristics,
 Protochordates, and Ancestry
 of the Earliest Vertebrates, 603**
 The Chordates, 603
 Traditional and Cladistic
 Classification of the
 Chordates, 605
 Four Chordate Hallmarks, 608
 Notochord, 608
 Dorsal Tubular Nerve Cord, 608
 Pharyngeal Pouches and Gill
 Slits, 609
 Postanal Tail, 609
 Ancestry and Evolution, 609
 Subphylum Urochordata
 (Tunicata), 610
 Subphylum Cephalochordata, 614
 Subphylum Vertebrata, 615
 Adaptations that Have Guided
 Vertebrate Evolution, 616
 The Search for the Vertebrate
 Ancestral Stock, 617
 Garstang's Hypothesis of Chordate
 Larval Evolution, 618
 Position of Amphioxus, 619
 The Ammocoete Larva of the
 Lamprey as a Model of the
 Primitive Vertebrate Body
 Plan, 619
 The Earliest Vertebrates: Jawless
 Ostracoderms, 620
 Early Jawed Vertebrates, 621
 Evolution of Modern Fishes and
 Tetrapods, 623
 Summary, 623

