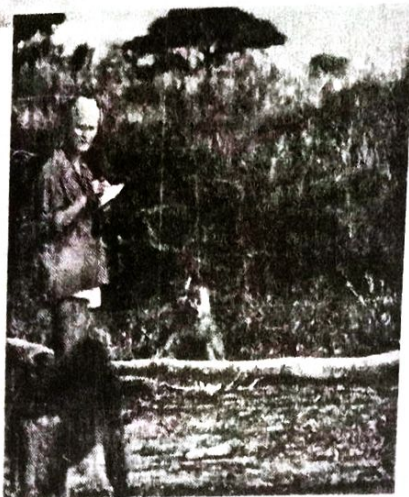


TABLE OF CONTENTS

About the Authors ix
Preface x

PART ONE



Introduction to Living Animals

CHAPTER 1

Life: Biological Principles and the Science of Zoology 1

- 1.1 Fundamental Properties of Life 2
- 1.2 Zoology as a Part of Biology 9
- 1.3 Principles of Science 9
- 1.4 Theories of Evolution and Heredity 13
- Summary 17

CHAPTER 2

The Origin and Chemistry of Life 19

- 2.1 Water and Life 20
- 2.2 Organic Molecular Structure of Living Systems 22
- 2.3 Chemical Evolution 25
- 2.4 Origin of Living Systems 28
- 2.5 Precambrian Life 30
- Summary 32

CHAPTER 3

Cells as Units of Life 35

- 3.1 Cell Concept 36
- 3.2 Organization of Cells 38
- 3.3 Mitosis and Cell Division 49
- Summary 53

CHAPTER 4

Cellular Metabolism 55

- 4.1 Energy and the Laws of Thermodynamics 56
- 4.2 The Role of Enzymes 57
- 4.3 Enzyme Regulation 59
- 4.4 Chemical Energy Transfer by ATP 60
- 4.5 Cellular Respiration 61
- 4.6 Metabolism of Lipids 67
- 4.7 Metabolism of Proteins 68
- Summary 69

PART TWO



Continuity and Evolution of Animal Life

CHAPTER 5

Genetics: A Review 71

- 5.1 Mendel's Investigations 72
- 5.2 Chromosomal Basis of Inheritance 72
- 5.3 Mendelian Laws of Inheritance 76
- 5.4 Gene Theory 85
- 5.5 Storage and Transfer of Genetic Information 85
- 5.6 Gene Mutations 95
- 5.7 Molecular Genetics of Cancer 96
- Summary 96

CHAPTER 6

Organic Evolution 99

- 6.1 Origins of Darwinian Evolutionary Theory 100
- 6.2 Darwinian Evolutionary Theory: The Evidence 103
- 6.3 Revisions of Darwin's Theory 121

- 6.4 Microevolution: Genetic Variation and Change Within Species 122
 6.5 Macroevolution: Major Evolutionary Events 128
Summary 130

CHAPTER 7

The Reproductive Process 133

- 7.1 Nature of the Reproductive Process 134
 7.2 The Origin and Maturation of Germ Cells 138
 7.3 Reproductive Patterns 142
 7.4 Structure of Reproductive Systems 143
 7.5 Endocrine Events That Orchestrate Reproduction 145
Summary 152

CHAPTER 8

Principles of Development 154

- 8.1 Early Concepts: Preformation Versus Epigenesis 155
 8.2 Fertilization 156
 8.3 Cleavage and Early Development 159
 8.4 An Overview of Development Following Cleavage 161
 8.5 Mechanisms of Development 163
 8.6 Gene Expression During Development 166
 8.7 Developmental Patterns in Animals 169
 8.8 Evolutionary Developmental Biology 174
 8.9 Vertebrate Development 174
 8.10 Development of Systems and Organs 177
Summary 180

PART THREE



Diversity of Animal Life

CHAPTER 9

Architectural Pattern of an Animal 183

- 9.1 Hierarchical Organization of Animal Complexity 184
 9.2 Animal Body Plans 185
 9.3 Components of Animal Bodies 189

- 9.4 Complexity and Body Size 194
Summary 195

CHAPTER 10

Taxonomy and Phylogeny of Animals 197

- 10.1 Linnaeus and Taxonomy 198
 10.2 Species 200
 10.3 Taxonomic Characters and Phylogenetic Reconstruction 205
 10.4 Theories of Taxonomy 207
 10.5 Major Divisions of Life 213
 10.6 Major Subdivisions of the Animal Kingdom 213
Summary 214

CHAPTER 11

Unicellular Eukaryotes 216

- 11.1 Naming and Identifying Unicellular Eukaryotic Taxa 217
 11.2 Form and Function 221
 11.3 Major Unicellular Eukaryotic Taxa 227
 11.4 Phylogeny and Adaptive Diversification 241
Summary 244

CHAPTER 12

Sponges and Placozoans 246

- 12.1 Origin of Animals (Metazoa) 247
 12.2 Phylum Porifera: Sponges 247
 12.3 Phylum Placozoa 257
Summary 258

CHAPTER 13

Cnidarians and Ctenophores 260

- 13.1 Phylum Cnidaria 261
 13.2 Phylum Ctenophora 282
 13.3 Phylogeny and Adaptive Diversification 286
Summary 287

CHAPTER 14

Acoelomorpha, Platyzoa, and Mesozoa 289

- 14.1 Phylum Acoelomorpha 290
 14.2 Clades Within Protostomia 291
 14.3 Phylum Platyhelminthes 293
 14.4 Phylum Gastrotricha 306
 14.5 Clade Gnathifera 308
 14.6 Phylum Gnathostomulida 309
 14.7 Phylum Micrognathozoa 309
 14.8 Phylum Rotifera 309
 14.9 Phylum Acanthocephala 313
 14.10 Phylum Mesozoa 314
 14.11 Phylogeny 316
Summary 316

CHAPTER 15

Polyzoa and Kryptrochozoa 319

- 15.1 Clade Polyzoa 321
- 15.2 Phylum Cycliophora 321
- 15.3 Phylum Entoprocta 321
- 15.4 Phylum Ectoprocta (Bryozoa) 322
- 15.5 Clade Kryptrochozoa 325
- 15.6 Clade Brachiozoa 325
- 15.7 Phylum Brachiopoda 325
- 15.8 Phylum Phoronida 326
- 15.9 Phylum Nemertea (Rhynchocoela) 327
- 15.10 Phylogeny and Adaptive Diversification 329
- Summary 330

CHAPTER 16

Molluscs 332

- 16.1 Molluscs 333
- 16.2 Form and Function 335
- 16.3 Classes of Molluscs 338
- 16.4 Phylogeny and Adaptive Diversification 358
- Summary 361

CHAPTER 17

Annelids and Allied Taxa 363

- 17.1 Phylum Annelida, Including Pogonophorans (Siboglinids) and Echiurans 364
- 17.2 Phylum Sipuncula 381
- 17.3 Evolutionary Significance of a Coelom and Metamerism 382
- 17.4 Phylogeny and Adaptive Diversification 382
- Summary 383

CHAPTER 18

Smaller Ecdysozoans 385

- 18.1 Phylum Nematoda: Roundworms 386
- 18.2 Phylum Nematomorpha 394
- 18.3 Phylum Loricifera 395
- 18.4 Phylum Kinorhyncha 395
- 18.5 Phylum Priapulida 396
- 18.6 Clade Panarthropoda 397
- 18.7 Phylum Onychophora 397
- 18.8 Phylum Tardigrada 398
- 18.9 Phylogeny and Adaptive Diversification 399
- Summary 400

CHAPTER 19

Trilobites, Chelicerates, and Myriapods 402

- 19.1 Phylum Arthropoda 403
- 19.2 Subphylum Trilobita 406
- 19.3 Subphylum Chelicerata 407
- 19.4 Subphylum Myriapoda 414
- 19.5 Phylogeny and Adaptive Diversification 417
- Summary 419

CHAPTER 20

Crustaceans 421

- 20.1 Subphylum Crustacea 423
- 20.2 A Brief Survey of Crustaceans 431
- 20.3 Phylogeny and Adaptive Diversification 437
- Summary 441

CHAPTER 21

Hexapods 443

- 21.1 Class Insecta 444
- 21.2 Insects and Human Welfare 462
- 21.3 Phylogeny and Adaptive Diversification 468
- Summary 469

CHAPTER 22

Chaetognaths, Echinoderms, and Hemichordates 471

- 22.1 Phylum Chaetognatha 473
- 22.2 Form and Function 473
- 22.3 Phylum Xenoturbellida 474
- 22.4 Clade Ambulacraria 474
- 22.5 Phylum Echinodermata 474
- 22.6 Phylogeny and Adaptive Diversification 489
- 22.7 Phylum Hemichordata 491
- 22.8 Phylogeny and Adaptive Diversification 494
- Summary 495

CHAPTER 23

Chordates 498

- 23.1 The Chordates 499
- 23.2 Five Chordate Hallmarks 502
- 23.3 Ancestry and Evolution 503
- 23.4 Subphylum Urochordata (Tunicata) 504
- 23.5 Subphylum Cephalochordata 506
- 23.6 Subphylum Vertebrata 506
- Summary 513

CHAPTER 24

Fishes 516

- 24.1 Ancestry and Relationships of Major Groups of Fishes 517
- 24.2 Living Jawless Fishes 517
- 24.3 Chondrichthyes: Cartilaginous Fishes 522
- 24.4 Osteichthyes: Bony Fishes and Tetrapods 526
- 24.5 Structural and Functional Adaptations of Fishes 531
- Summary 541

CHAPTER 25

Early Tetrapods and Modern Amphibians 543

- 25.1 Devonian Origin of Tetrapods 544
- 25.2 Modern Amphibians 546
- Summary 559

CHAPTER 26**Amniote Origins and Nonavian Reptiles 562**

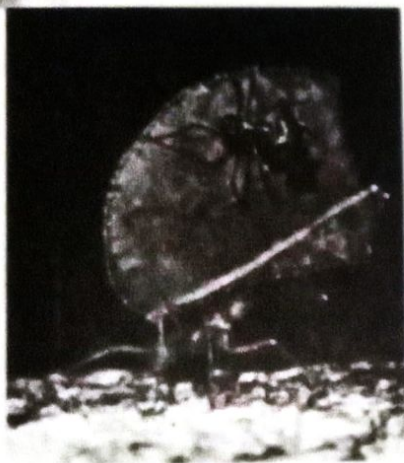
- 26.1 Origin and Early Evolution of Amniotes 563
 26.2 Characteristics and Natural History of Reptilian Groups 568
 Summary 582

CHAPTER 27**Birds 584**

- 27.1 Origin and Relationships 585
 27.2 Structural and Functional Adaptations for Flight 588
 27.3 Flight 596
 27.4 Migration and Navigation 599
 27.5 Social Behavior and Reproduction 601
 27.6 Bird Populations and Their Conservation 604
 Summary 605

CHAPTER 28**Mammals 610**

- 28.1 Origin and Evolution of Mammals 611
 28.2 Structural and Functional Adaptations of Mammals 614
 28.3 Humans and Mammals 627
 28.4 Human Evolution 628
 Summary 636

PART FOUR**Activity of Life****CHAPTER 29****Support, Protection, and Movement 639**

- 29.1 Integument 640
 29.2 Skeletal Systems 643
 29.3 Animal Movement 648
 Summary 658

CHAPTER 30**Homeostasis: Osmotic Regulation, Excretion, and Temperature Regulation 660**

- 30.1 Water and Osmotic Regulation 661
 30.2 Invertebrate Excretory Structures 665
 30.3 Vertebrate Kidneys 667
 30.4 Temperature Regulation 672
 Summary 677

CHAPTER 31**Homeostasis: Internal Fluids and Respiration 680**

- 31.1 Internal Fluid Environment 681
 31.2 Composition of Blood 682
 31.3 Circulation 684
 31.4 Respiration 691
 Summary 700

CHAPTER 32**Digestion and Nutrition 702**

- 32.1 Feeding Mechanisms 703
 32.2 Digestion 706
 32.3 Organization and Regional Function of Alimentary Canals 708
 32.4 Regulation of Food Intake 713
 32.5 Nutritional Requirements 715
 Summary 717

CHAPTER 33**Nervous Coordination: Nervous System and Sense Organs 720**

- 33.1 Neurons: Functional Units of Nervous Systems 721
 33.2 Synapses: Junctions Between Nerves 725
 33.3 Evolution of Nervous Systems 727
 33.4 Sense Organs 733
 Summary 744

CHAPTER 34**Chemical Coordination: Endocrine System 746**

- 34.1 Mechanisms of Hormone Action 747
 34.2 Invertebrate Hormones 749
 34.3 Vertebrate Endocrine Glands and Hormones 751
 Summary 761

CHAPTER 35**Immunity 764**

- 35.1 Susceptibility and Resistance 765
 35.2 Innate Defense Mechanisms 765

- 35.3 Immunity in Invertebrates 769
- 35.4 Acquired Immune Response in Vertebrates 769
- 35.5 Blood Group Antigens 775
- Summary* 775

CHAPTER 36

Animal Behavior 778

- 36.1 Describing Behavior: Principles of Classical Ethology 780
- 36.2 Control of Behavior 781
- 36.3 Social Behavior 784
- Summary* 794

CHAPTER 38

Animal Ecology 816

- 38.1 The Hierarchy of Ecology 817
- 38.2 Extinction and Biodiversity 829
- Summary* 832

Glossary G-1

Index I-1

PART FIVE



Animals and Their Environments

CHAPTER 37

Animal Distributions 797

- 37.1 Principles of Historical Biogeography 798
- 37.2 Distribution of Life on Earth 804
- Summary* 814