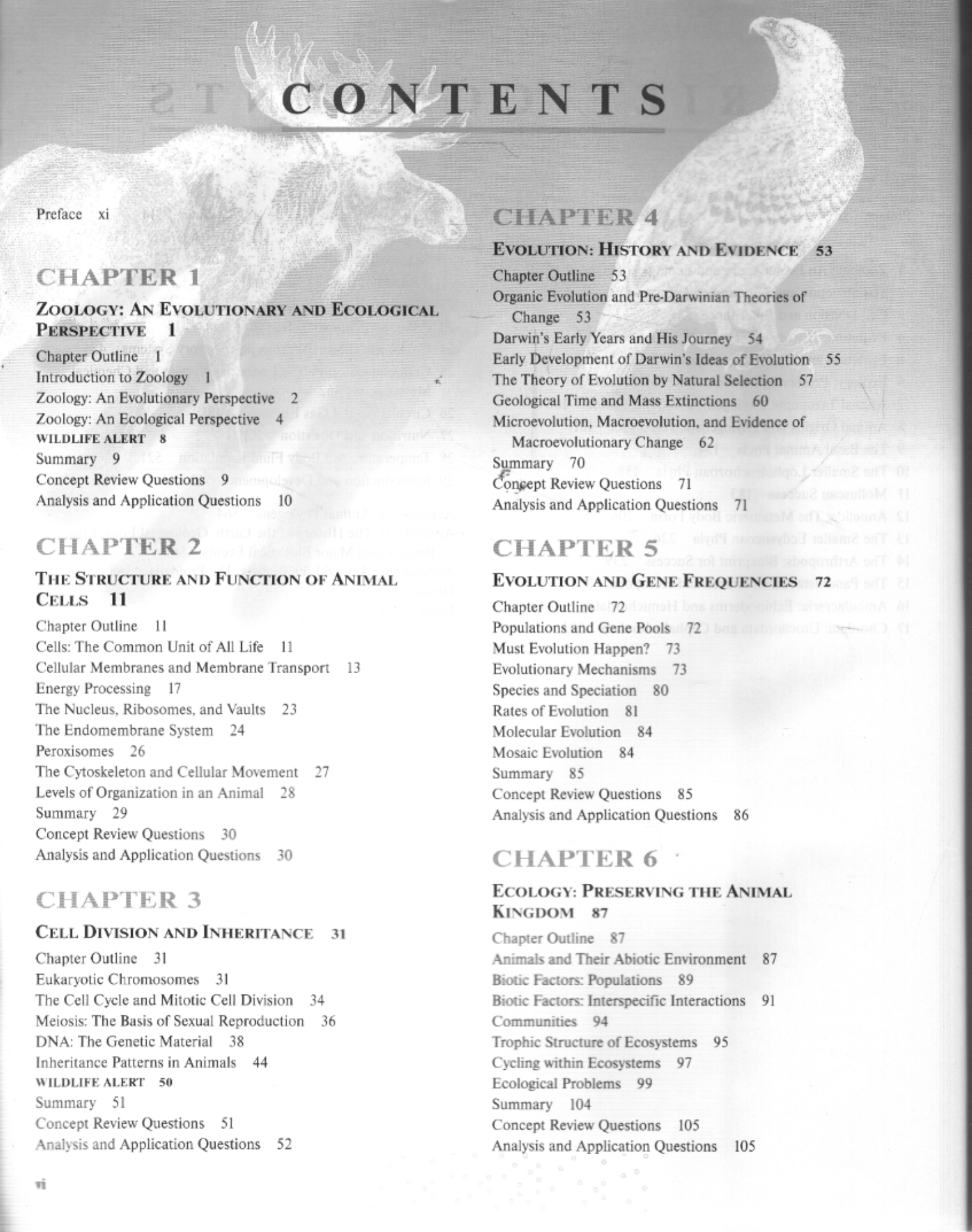


BRIEF CONTENTS

Preface xi

I Zoology: An Evolutionary and Ecological Perspective	1
2 The Structure and Function of Animal Cells	11
3 Cell Division and Inheritance	31
4 Evolution: History and Evidence	53
5 Evolution and Gene Frequencies	72
6 Ecology: Preserving the Animal Kingdom	87
7 Animal Taxonomy, Phylogeny, and Organization	106
8 Animal Origins and Phylogenetic Highlights	121
9 The Basal Animal Phyla	134
10 The Smaller Lophotrochozoan Phyla	158
III Molluscan Success	183
12 Annelida: The Metameric Body Form	206
13 The Smaller Ecdysozoan Phyla	226
14 The Arthropods: Blueprint for Success	239
15 The Pancrustacea: Crustacea and Hexapoda	257
16 Ambulacraria: Echinoderms and Hemichordates	284
17 Chordata: Urochordata and Cephalochordata	303

18 The Fishes: Vertebrate Success in Water	314
19 Amphibians: The First Terrestrial Vertebrates	336
20 Nonavian Reptiles: Diapsid Amniotes	355
21 Birds: The Avian Reptiles	373
22 Mammals: Synapsid Amniotes	392
23 Protection, Support, and Movement	418
24 Communication I: Nervous and Sensory Systems	435
25 Communication II: The Endocrine System and Chemical Messengers	462
26 Circulation and Gas Exchange	481
27 Nutrition and Digestion	501
28 Temperature and Body Fluid Regulation	521
29 Reproduction and Development	542
Appendix A: Animal Phylogeny	564
Appendix B: The History of the Earth: Geological Eons, Eras, Periods, and Major Biological Events	566
Appendix C: Animal-Like Protists: The Protozoa	568
Glossary	573
Index	599



CONTENTS

Preface xi

CHAPTER 1

ZOOLOGY: AN EVOLUTIONARY AND ECOLOGICAL PERSPECTIVE 1

Chapter Outline 1

Introduction to Zoology 1

Zoology: An Evolutionary Perspective 2

Zoology: An Ecological Perspective 4

WILDLIFE ALERT 8

Summary 9

Concept Review Questions 9

Analysis and Application Questions 10

CHAPTER 2

THE STRUCTURE AND FUNCTION OF ANIMAL CELLS 11

Chapter Outline 11

Cells: The Common Unit of All Life 11

Cellular Membranes and Membrane Transport 13

Energy Processing 17

The Nucleus, Ribosomes, and Vaults 23

The Endomembrane System 24

Peroxisomes 26

The Cytoskeleton and Cellular Movement 27

Levels of Organization in an Animal 28

Summary 29

Concept Review Questions 30

Analysis and Application Questions 30

CHAPTER 3

CELL DIVISION AND INHERITANCE 31

Chapter Outline 31

Eukaryotic Chromosomes 31

The Cell Cycle and Mitotic Cell Division 34

Meiosis: The Basis of Sexual Reproduction 36

DNA: The Genetic Material 38

Inheritance Patterns in Animals 44

WILDLIFE ALERT 50

Summary 51

Concept Review Questions 51

Analysis and Application Questions 52

CHAPTER 4

EVOLUTION: HISTORY AND EVIDENCE 53

Chapter Outline 53

Organic Evolution and Pre-Darwinian Theories of Change 53

Darwin's Early Years and His Journey 54

Early Development of Darwin's Ideas of Evolution 55

The Theory of Evolution by Natural Selection 57

Geological Time and Mass Extinctions 60

Microevolution, Macroevolution, and Evidence of Macroevolutionary Change 62

Summary 70

Concept Review Questions 71

Analysis and Application Questions 71

CHAPTER 5

EVOLUTION AND GENE FREQUENCIES 72

Chapter Outline 72

Populations and Gene Pools 72

Must Evolution Happen? 73

Evolutionary Mechanisms 73

Species and Speciation 80

Rates of Evolution 81

Molecular Evolution 84

Mosaic Evolution 84

Summary 85

Concept Review Questions 85

Analysis and Application Questions 86

CHAPTER 6

ECOLOGY: PRESERVING THE ANIMAL KINGDOM 87

Chapter Outline 87

Animals and Their Abiotic Environment 87

Biotic Factors: Populations 89

Biotic Factors: Interspecific Interactions 91

Communities 94

Trophic Structure of Ecosystems 95

Cycling within Ecosystems 97

Ecological Problems 99

Summary 104

Concept Review Questions 105

Analysis and Application Questions 105

CHAPTER 7

ANIMAL TAXONOMY, PHYLOGENY, AND ORGANIZATION 106

- Chapter Outline 106
- Taxonomy and Phylogeny 106
- Patterns of Organization 115
- Summary 119
- Concept Review Questions 120
- Analysis and Application Questions 120

CHAPTER 8

ANIMAL ORIGINS AND PHYLOGENETIC HIGHLIGHTS 121

- Chapter Outline 121
- Earth's Beginning and Evidence of Early Life 121
- Life's Beginning and the First 3 Billion Years 122
- Multicellularity and Animal Origins 126
- Phylogenetic Highlights of Animalia 129
- Summary 132
- Concept Review Questions 132
- Analysis and Application Questions 133

CHAPTER 9

THE BASAL ANIMAL PHyla 134

- Chapter Outline 134
- Evolutionary Perspective 134
- Phylum Porifera 136
- Phylum Cnidaria 141
- Phylum Ctenophora 151
- WILDLIFE ALERT 153
- Further Phylogenetic Considerations 154
- Summary 156
- Concept Review Questions 157
- Analysis and Application Questions 157

CHAPTER 10

THE SMALLER LOPHOTROCHOZOAN PHyla 158

- Chapter Outline 158
- Evolutionary Perspective 158
- Platyzoa: Phylum Platyhelminthes 160
- Platyzoa: Smaller Phyla 171
- Other Lophotrochozoans 176
- Further Phylogenetic Considerations 179
- Summary 181
- Concept Review Questions 181
- Analysis and Application Questions 182

CHAPTER 11

MOLLUSCAN SUCCESS 183

- Chapter Outline 183
- Evolutionary Perspective 183
- Molluscan Characteristics 184
- Class Gastropoda 186
- Class Bivalvia 190
- Class Cephalopoda 194
- Class Polyplacophora 199
- Class Scaphopoda 200
- Class Monoplacophora 200
- Class Solenogastres 201
- Class Caudofoveata 201
- Further Phylogenetic Considerations 202
- WILDLIFE ALERT 202
- Summary 204
- Concept Review Questions 205
- Analysis and Application Questions 205

CHAPTER 12

ANNELIDA: THE METAMERIC BODY FORM 206

- Chapter Outline 206
- Evolutionary Perspective 206
- Annelid Structure and Function 209
- Clade (Class) Errantia 214
- Clade (Class) Sedentaria 215
- Basal Annelid Groups 221
- Further Phylogenetic Considerations 222
- Summary 224
- Concept Review Questions 225
- Analysis and Application Questions 225

CHAPTER 13

THE SMALLER ECDYSOZOAN PHyla 226

- Chapter Outline 226
- Evolutionary Perspective 226
- Phylum Nematoda (Roundworms) 227
- Other Ecdysozoan Phyla 234
- Further Phylogenetic Considerations 236
- Summary 238
- Concept Review Questions 238
- Analysis and Application Questions 238

CHAPTER 14

THE ARTHROPODS: BLUEPRINT FOR SUCCESS 239

- Chapter Outline 239
- Evolutionary Perspective 239

Metamerism and Tagmatization	241
The Exoskeleton	241
The Hemocoel	242
Metamorphosis	243
Subphylum Trilobitomorpha	244
Subphylum Chelicerata	244
Subphylum Myriapoda	253
Further Phylogenetic Considerations	254
Summary	255
Concept Review Questions	255
Analysis and Application Questions	256

CHAPTER 15

THE PANCRUSTACEA: CRUSTACEA AND HEXAPODA 257

Chapter Outline	257
Evolutionary Perspective	257
Subphylum Crustacea	258
WILDLIFE ALERT	266
Subphylum Hexapoda	268
Further Phylogenetic Considerations	279
Summary	282
Concept Review Questions	283
Analysis and Application Questions	283

CHAPTER 16

AMBULACRARIA: ECHINODERMS AND HEMICHORDATES 284

Chapter Outline	284
Evolutionary Perspective	284
Phylum Echinodermata	285
Phylum Hemichordata	295
WILDLIFE ALERT	296
Further Phylogenetic Considerations	299
Summary	301
Concept Review Questions	302
Analysis and Application Questions	302

CHAPTER 17

CHORDATA: UROCHORDATA AND CEPHALOCHORDATA 303

Chapter Outline	303
Evolutionary Perspective	303
Phylum Chordata	304
Further Phylogenetic Considerations	310
Summary	312
Concept Review Questions	312
Analysis and Application Questions	313

CHAPTER 18

THE FISHES: VERTEBRATE SUCCESS IN WATER 314

Chapter Outline	314
Evolutionary Perspective	314
Survey of Fishes	317
Evolutionary Pressures	324
WILDLIFE ALERT	330
Further Phylogenetic Considerations	331
Summary	334
Concept Review Questions	334
Analysis and Application Questions	335

CHAPTER 19

AMPHIBIANS: THE FIRST TERRESTRIAL VERTEBRATES 336

Chapter Outline	336
Evolutionary Perspective	336
Survey of Amphibians	338
Evolutionary Pressures	341
Amphibians in Peril	350
WILDLIFE ALERT	351
Further Phylogenetic Considerations	352
Summary	353
Concept Review Questions	354
Analysis and Application Questions	354

CHAPTER 20

NONAVIAN REPTILES: DIAPSID AMNIOTES 355

Chapter Outline	355
Evolutionary Perspective	355
Survey of the Nonavian Reptiles	357
WILDLIFE ALERT	362
Evolutionary Pressures	364
Further Phylogenetic Considerations	371
Summary	371
Concept Review Questions	372
Analysis and Application Questions	372

CHAPTER 21

BIRDS: THE AVIAN REPTILES 373

Chapter Outline	373
Evolutionary Perspective	373
Evolutionary Pressures	376
WILDLIFE ALERT	390
Summary	391
Concept Review Questions	391
Analysis and Application Questions	391

CHAPTER 22

MAMMALS: SYNAPSID AMNIOTES 392

- Chapter Outline 392
- Evolutionary Perspective 392
- Diversity of Mammals 394
- Evolutionary Pressures 397
- WILDLIFE ALERT 408
- Human Evolution 409
- Summary 416
- Concept Review Questions 416
- Analysis and Application Questions 417

CHAPTER 23

PROTECTION, SUPPORT, AND MOVEMENT 418

- Chapter Outline 418
- Integumentary Systems 418
- Skeletal Systems 422
- Nonmuscular Movement and Muscular Systems 427
- Summary 433
- Concept Review Questions 434
- Analysis and Application Questions 434

CHAPTER 24

COMMUNICATION I: NERVOUS AND SENSORY SYSTEMS 435

- Chapter Outline 435
- Neurons: The Basic Functional Units of the Nervous System 435
- Neuron Communication 437
- Invertebrate Nervous Systems 439
- Vertebrate Nervous Systems 442
- Sensory Reception 446
- Invertebrate Sensory Receptors 448
- Vertebrate Sensory Receptors 451
- Summary 460
- Concept Review Questions 461
- Analysis and Application Questions 461

CHAPTER 25

COMMUNICATION II: THE ENDOCRINE SYSTEM AND CHEMICAL MESSENGERS 462

- Chapter Outline 462
- The Evolution and Diversity of Chemical Messengers 462
- Hormones and Their Feedback Systems 463
- Mechanisms of Hormone Action 465
- Endocrine Glands 466

- Invertebrate Endocrine Control 466
- Endocrine Systems of Fishes and Amphibians 469
- Endocrine Systems of Amniotes 471
- Some Hormones Are Not Produced by Endocrine Glands 478
- Evolution of Endocrine Systems 478
- Summary 479
- Concept Review Questions 479
- Analysis and Application Questions 480

CHAPTER 26

CIRCULATION AND GAS EXCHANGE 481

- Chapter Outline 481
- Transport Systems in Invertebrates 481
- Transport Systems in Vertebrates 483
- Vertebrate Circulatory Systems 485
- The Mammalian Circulatory System 487
- Lymphatic Systems 489
- Gas Exchange 489
- Vertebrate Respiratory Systems 492
- The Mammalian Respiratory System 495
- Summary 499
- Concept Review Questions 500
- Analysis and Application Questions 500

CHAPTER 27

NUTRITION AND DIGESTION 501

- Chapter Outline 501
- Evolution of Heterotrophy 501
- The Metabolic Fates of Nutrients in Heterotrophs 502
- Digestion 503
- Animal Strategies for Getting and Using Food 504
- Diversity in Digestive Structures: Invertebrates 506
- Diversity in Digestive Structures: Vertebrates 507
- The Mammalian Digestive System 512
- Summary 519
- Concept Review Questions 520
- Analysis and Application Questions 520

CHAPTER 28

TEMPERATURE AND BODY FLUID REGULATION 521

- Chapter Outline 521
- Homeostasis and Temperature Regulation 521
- Control of Water and Electrolytes 528
- Invertebrate Excretory Systems 530
- Vertebrate Excretory Systems 532
- Summary 540
- Concept Review Questions 541
- Analysis and Application Questions 541

CHAPTER 29

REPRODUCTION AND DEVELOPMENT 542

Chapter Outline 542

Asexual Reproduction in Invertebrates 542

Sexual Reproduction in Invertebrates 544

Sexual Reproduction in Vertebrates 546

The Human Male Reproductive System 549

The Human Female Reproductive System 551

Prenatal Development and Birth in a Human 556

Summary 561

Concept Review Questions 561

Analysis and Application Questions 562

Appendix A: Animal Phylogeny 564

Appendix B: The History of the Earth: Geological Eons, Eras,
Periods, and Major Biological Events 566

Appendix C: Animal-Like Protists: The Protozoa 568

Evolutionary Perspective 568

Protozoans: Major Ecological Roles 568

Supergroup Excavata 568

Supergroup Amoebozoa 570

Supergroup Chromalveolata 571

Glossary 573

Index 599