



Contents

Preface xiii
 Laboratory Safety xvii
 Comparative Safety of Preservatives xix
 Handling and Care of Animals in the Laboratory xx
 Systematics and Classification xxii

1 Microscopy

Objectives 1
The Compound Microscope 1
 Parts of the Microscope 2
 Magnification 3
 Resolving Power 4
 Illumination 4
 Focusing 5
 Procedure for Use of the Compound Microscope 6
 Returning the Microscope after Use 6
 Special Precautions 7
 Exercises Using the Compound Microscope 7
 Estimating Magnification 7
 Measuring Microscopic Objects 7
 Measurements Using an Ocular Micrometer 8
The Stereoscopic Microscope 8
 Exercises Using the Stereomicroscope 8
Other Types of Microscopes 9
 Phase Contrast Microscopy 9
 Interference Microscopy 11
 Electron Microscopy 11
Key Terms 12
Internet Resources 12
Questions for Critical Thinking 12
Suggested Readings 12

2 Animal Cells and Tissues

Objectives 15
The Cell Theory 15
Basic Cell Structure 16

Animal Tissues 17
 Epithelial Tissue 18
 Connective Tissue 21
 Muscular Tissue 26
 Nervous Tissue 29
Key Terms 31
Internet Resources 32
Questions for Critical Thinking 32
Suggested Readings 32

3 Mitosis and Meiosis

Objectives 33
Introduction 33
Mitosis 34
 The Mitotic Apparatus 34
 Stages of Mitosis 36
 Timing in the Cell Cycle 38
Meiosis 40
 Gametogenesis 40
 Principle Stages of Meiosis 42
 Synapsis and Crossing Over 42
 Ways to Study Meiosis 43
Comparison of Mitosis and Meiosis 44
Key Terms 44
Internet Resources 45
Questions for Critical Thinking 45
Suggested Readings 45

4 Development

Objectives 47
Introduction 47
Component Processes of Development 48
 Growth 48
 Determination 48
 Differentiation 48
 Morphogenesis 48

Gametes	48
Embryonic Cleavage	49
Influence of Yolk	49
Patterns of Cleavage	49
Determinate and Indeterminate Development	50
Sea Star Embryology	51
Summary of Early Sea Star Development	52
Frog Development	53
Chick Development	58
Extraembryonic Membranes	59
Whole Mount of 24-Hour Chick Embryo	59
Whole Mount of 48-Hour Chick Embryo	61
Whole Mount of 72-Hour Chick Embryo	64
Later Stages of Chick Development	65
Living Chick Embryos (Optional Exercise)	65
Key Terms	68
Internet Resources	69
Questions for Critical Thinking	69
Suggested Readings	69

5 Protozoa

Objectives	71
Introduction	71
An Amoeba: <i>Amoeba proteus</i>	72
Phylum Sarcodina	72
Preparing a Wet Mount and Hanging Drop	72
Amoeboid Movement	74
Reproduction	74
Other Sarcodina	74
A Solitary Flagellate: <i>Euglena</i>	75
Phylum Euglenozoa	75
A Holozoic Flagellate: <i>Paranema</i>	76
Other Flagellates	77
Phylum Mastigophora	77
A Ciliate: <i>Paramecium caudatum</i>	81
Phylum Ciliophora (Ciliata)	81
Feeding	82
Cilia and Flagella	82
Reproduction	83
Other Ciliates	83
Phylum Apicomplexa	85
The Malaria Parasite: <i>Plasmodium</i>	85
Life Cycle of <i>Plasmodium</i>	86
Evolution of Multicellular Animals	88
Key Terms	89
Internet Resources	89
Questions for Critical Thinking	89
Suggested Readings	89

6 Porifera

Objectives	91
Introduction	91
Phylogeny	92
Classification	92
Class Demospongiae	93
Class Calcarea (Calcispongiae)	93
Class Hexactinellida (Hyalospongiae)	93
Morphology	93
Body Types	94
Asconoid Sponge	95
Syconoid Sponge	95
Leuconoid Sponge	96
Freshwater Sponges	98
Regeneration and Reconstitution (Optional Exercise)	99
Procedure	99
Collecting and Preserving Sponges	99
Key Terms	99
Internet Resources	100
Questions for Critical Thinking	100
Suggested Readings	100

7 Cnidaria

Objectives	101
Introduction	102
Classification	102
Class Hydrozoa (Hydroids and Siphonophores)	102
Class Scyphozoa (True Jellyfish)	102
Class Cubozoa (Sea Wasps or Box Jellyfish)	102
Class Anthozoa (Sea Anemones and Corals)	102
A Hydrozoan Polyp: <i>Hydra</i>	103
Class Hydrozoa	103
General Appearance and Morphology	103
Behavior	103
Cnidocytes and Nematocysts	103
Histological Structure	105
Cellular Structure	105
Nervous System	105
Feeding Behavior	106
Reproduction	106
Regeneration (Optional Exercise)	107
A Hydromedusa: <i>Gonionemus</i>	107
Class Hydrozoa	107
A Colonial Hydrozoan Polyp: <i>Obelia</i>	108
Class Hydrozoa	108
Alternation of Generations	109
A Colonial Hydrozoan: <i>Physalia</i>	109
Class Hydrozoa	109

A Scyphozoan Medusa: <i>Aurelia</i>	110
Class Scyphozoa	110
Reproduction and Life Cycle	112
An Anthozoan Polyp: <i>Metridium</i>	113
Class Anthozoa	113
Reproduction and Life Cycle	114
Corals	114
Class Anthozoa	114
Collecting and Preserving Cnidaria	115
Key Terms	115
Internet Resources	116
Questions for Critical Thinking	116
Suggested Readings	116

8 Introduction to Animal Morphology

Objectives	119
Introduction	119
Organization of the Animal Body	120
Body Symmetry	120
Grade of Tissue Construction	120
Body Cavity	120
Segmentation	121
Cephalization	121
Hints for Dissection	122
Key Terms	123
Internet Resources	124
Questions for Critical Thinking	124

9 Platyhelminthes

Objectives	125
Introduction	126
Classification	126
Class Turbellaria (Free-living Flatworms)	126
Class Trematoda (Flukes)	126
Class Monogenea (Flukes)	127
Class Cestoda (Tapeworms)	127
Free-living Flatworms: Class Turbellaria	127
A Planarian: <i>Dugesia</i>	127
The Flukes: Class Trematoda	131
The Human Liver Fluke: <i>Clonorchis (Opisthorchis) sinensis</i>	131
The Sheep Liver Fluke: <i>Fasciola hepatica</i>	134
The Tapeworms: Class Cestoda	136
Dog and Cat Tapeworms: <i>Dipylidium caninum</i> and <i>Taenia pisiformis</i>	137
Adaptations for Parasitism	139
Collecting and Preserving Flatworms	141
Key Terms	142
Internet Resources	142

Questions for Critical Thinking	142
Suggested Readings	142

10 Roundworms and Rotifers

Objectives	145
Introduction	145
Classification	147
Phylum Nematoda (Nemathelminthes or Roundworms)	147
Phylum Rotifera (Rotifers)	147
Phylum Nematoda	147
A Parasitic Roundworm: <i>Ascaris lumbricoides</i>	147
A Parasitic Roundworm: <i>Trichinella spiralis</i>	151
Hookworms: <i>Ancylostoma duodenale</i> and <i>Necator americanus</i>	151
Pinworm: <i>Enterobius vermicularis</i>	152
Free-living Nematodes	152
<i>Caenorhabditis</i> : An Important Research Animal	152
The Vinegar Eel: <i>Anguillula aceti</i>	154
Collecting Free-living Nematodes	155
Phylum Rotifera	155
A Rotifer: <i>Philodina</i>	155
Collecting Rotifers	157
Key Terms	157
Internet Resources	157
Questions for Critical Thinking	157
Suggested Readings	158

11 Mollusca

Objectives	159
Introduction	159
Classification	160
Class Solenogastres	160
Class Caudofoveata	160
Class Polyplacophora (Amphineura)	161
Class Monoplacophora	161
Class Bivalvia (Pelecypoda)	161
Class Scaphopoda	162
Class Gastropoda	162
Class Cephalopoda	162
A Freshwater Mussel	162
Class Bivalvia (Pelecypoda)	162
Feeding, Digestion, and Respiration	163
Muscles	166
Circulation	166
Excretion, Osmoregulation, and Reproduction	167
Nervous Coordination	168
Helix: The Garden Snail (Demonstration)	168
Class Gastropoda	168
A Squid: <i>Loligo</i>	170
Class Cephalopoda	170

External Anatomy 170
 Internal Anatomy (Demonstration) 172
 Reproduction 173
Octopus (Demonstration) 173
 Class Cephalopoda 173
Collecting and Preserving Molluscs 173
 Chitons 173
 Gastropods 174
 Bivalves 174
Key Terms 174
Internet Resources 175
Questions for Critical Thinking 175
Suggested Readings 175

12 Annelida

Objectives 177
Introduction 177
Classification 178
 Class Polychaeta (Polychaete Worms) 178
 Class Oligochaeta (Bristleworms) 178
 Class Hirudinea (Leeches) 178
A Marine Annelid: *Nereis virens* 179
 Class Polychaeta 179
 External Anatomy 179
 Cross Section 181
The Earthworm 181
 Class Oligochaeta 181
 External Anatomy 182
 Internal Anatomy 183
 Cross Sections 185
Leeches 187
 Class Hirudinea 187
 External Anatomy 187
 Internal Anatomy (Demonstration) 188
Collecting and Preserving Annelids 188
Key Terms 189
Internet Resources 190
Questions for Critical Thinking 190
Suggested Readings 190

13 Arthropoda and Onychophora

Objectives 191
Introduction 192
Exoskeleton 192
 Appendages 192
Classification 192
 Subphylum Trilobita (Trilobitomorpha) 192
 Subphylum Chelicerata 193
 Subphylum Crustacea 193
 Subphylum Uniramia 194

Subphylum Chelicerata 194
 The Horseshoe Crab: *Limulus* 194
 A Spider: *Argiope* 197
Subphylum Crustacea, Class Branchiopoda 202
 A Water Flea: *Daphnia* 202
 External Anatomy 202
 Internal Anatomy 203
Subphylum Crustacea, Class Malacostraca 204
 The Crayfish: *Procambarus* 204
 External Anatomy 204
 Internal Anatomy 208
Subphylum Uniramia, Class Insecta 212
 A Cockroach: *Periplaneta americana* 212
 External Anatomy 213
 Internal Anatomy 214
 A Grasshopper: *Romalea microptera* 218
 External Anatomy 218
 Internal Anatomy 220
Insect Metamorphosis 221
Collecting and Preserving Arthropods 223
Phylum Onychophora 223
 External Anatomy 223
 Internal Anatomy 223
Key Terms 224
Internet Resources 225
Questions for Critical Thinking 225
Suggested Readings 225

14 Echinodermata

Objectives 227
Introduction 227
Classification 228
 Class Echinoidea 228
 Class Holothuroidea 229
 Class Crinoidea 229
 Class Asteroidea 229
 Class Ophiuroidea 229
 Class Concentricycloidea 229
The Common Sea Star: *Asterias* 229
 Class Asteroidea 229
 External Anatomy 229
 Internal Anatomy 230
A Sea Urchin 233
 Class Echinoidea 233
A Sea Cucumber 234
 Class Holothuroidea 234
Collecting and Preserving Echinoderms 235
Key Terms 235
Internet Resources 235
Questions for Critical Thinking 235
Suggested Readings 235

15 Chordata

- Objectives** 237
- Introduction** 237
- Classification** 238
 - Subphylum Urochordata (Tunicates or Sea Squirts) 238
 - Subphylum Cephalochordata (Lancelets) 238
 - Subphylum Vertebrata (Vertebrates) 238
- Subphylum Urochordata, Tunicates or Sea Squirts** 238
 - The Tunicate Larva 238
 - The Adult Tunicate 239
- Collecting and Preserving Tunicates** 240
- A Lancelet: *Branchiostoma*** 241
 - Subphylum Cephalochordata 241
 - External Anatomy 241
 - Internal Anatomy 241
 - Cross Sections 243
- Collecting and Preserving Lancelets** 244
- Key Terms** 244
- Internet Resources** 245
- Questions for Critical Thinking** 245
- Suggested Readings** 245

16 Shark Anatomy

- Objectives** 247
- The Dogfish Shark: *Squalus acanthias*** 247
 - External Anatomy 248
 - Internal Anatomy 250
- Key Terms** 264
- Internet Resources** 264
- Questions for Critical Thinking** 264
- Suggested Readings** 264

17 Perch Anatomy

- Objectives** 267
- The Yellow Perch: *Perca flavescens*** 267
 - External Anatomy 268
 - Internal Anatomy 269
- Key Terms** 277
- Internet Resources** 277
- Questions for Critical Thinking** 278
- Suggested Readings** 278

18 Frog Anatomy

- Objectives** 279
- Rana pipiens* or *Rana catesbeiana*** 279
 - External Anatomy and Behavior 280
 - Skeletal System 281

- Muscular System (Optional) 284
- Oral Cavity 287
- Internal Anatomy 288
- Digestive System 290
- Respiratory System 290
- Circulatory System 290
- Urogenital System 293
- Nervous System 297

- Key Terms** 302
- Internet Resources** 302
- Questions for Critical Thinking** 302
- Suggested Readings** 302

19 Fetal Pig Anatomy

- Objectives** 305
- The Fetal Pig: *Sus scrofa*** 305
 - External Anatomy 306
 - Skeletal System 308
 - Muscular System 312
 - General Internal Anatomy 312
 - Neck Region 312
 - The Coelom and Its Divisions 316
 - The Urogenital System 321
 - Circulatory System 324
 - Nervous System 330
- Key Terms** 335
- Internet Resources** 335
- Questions for Critical Thinking** 335
- Suggested Readings** 335

20 Rat Anatomy

- Objectives** 337
- Introduction** 337
 - External Anatomy 338
 - Skeletal System 339
 - Muscular System (Optional) 339
 - Internal Anatomy 340
 - Digestive System 341
 - Respiratory System 343
 - Circulatory System 344
 - Urogenital System 349
 - Nervous System 350
- Key Terms** 353
- Internet Resources** 353
- Questions for Critical Thinking** 354
- Suggested Readings** 354

- Index** 355