

# CONTENTS

|                                                       |    |
|-------------------------------------------------------|----|
| <b>CHAPTER 1</b>                                      |    |
| The Biological Revolution                             | 1  |
| Living matter uses energy and creates order           | 2  |
| The brain, the hand, and<br>the industrial revolution | 5  |
| The scientific revolution                             | 9  |
| Life turns on itself                                  | 10 |
| Knowledge and action                                  | 12 |

## **PART ONE**

### **The Cell** 17

|                                          |    |
|------------------------------------------|----|
| <b>CHAPTER 2</b>                         |    |
| The Unit of Life                         | 18 |
| A cell theory                            | 19 |
| The modern concept                       | 22 |
| Seeing is believing . . . and vice versa | 23 |
| The electron microscope                  | 24 |
| A "typical" cell                         | 25 |
| The membrane system of the cell          | 25 |
| The cell interior                        | 36 |
| Cell organelles                          | 39 |
| Nucleus and cell division                | 42 |
| The cell at work                         | 47 |

|                                                        |    |
|--------------------------------------------------------|----|
| <b>CHAPTER 3</b>                                       |    |
| From Generation to Generation                          | 52 |
| Heredity, the source of likeness and<br>of variability | 52 |
| The behavior of chromosomes                            | 53 |
| The discrete nature of the gene                        | 57 |
| Genes come in groups                                   | 63 |
| Genes interact with each other                         | 68 |
| Manifold effects of genes                              | 68 |
| Incomplete dominance                                   | 68 |
| Multiple alleles                                       | 68 |
| Interaction between alleles                            | 69 |
| Interaction between sets of<br>different alleles       | 70 |

|                                          |    |
|------------------------------------------|----|
| Modifying genes                          | 70 |
| Quantitative inheritance                 | 70 |
| Chromosomes determine sex                | 73 |
| Gene groups are arranged in linear order | 75 |
| What is a gene?                          | 80 |
| Mutation                                 | 81 |
| One gene, one enzyme                     | 82 |
| The chemistry of the gene                | 83 |
| Haploid organisms and gene recombination | 90 |
| Genetics and man                         | 90 |
| Genetics and human society               | 92 |

## CHAPTER 4

|                                                                      |     |
|----------------------------------------------------------------------|-----|
| The Molecules of Life                                                | 95  |
| Atoms, ions, and molecules                                           | 97  |
| Water and life                                                       | 103 |
| The carbohydrates—Ready energy and protection                        | 109 |
| The lipids—High energy content and surface activity                  | 116 |
| Nucleic acids—Biological information storage, retrieval and transfer | 119 |
| Proteins—Specificity of structure and control                        | 125 |

## CHAPTER 5

|                                      |     |
|--------------------------------------|-----|
| The Flow of Molecules and of Energy  | 132 |
| What is metabolism?                  | 133 |
| Enzymes—Catalysis and control        | 135 |
| On entering the cell                 | 137 |
| From radiant energy to living matter | 141 |
| From food to fuel                    | 145 |
| How is metabolism studied?           | 153 |
| The cell is not a bag of enzymes     | 154 |

## CHAPTER 6

|                                                                     |     |
|---------------------------------------------------------------------|-----|
| The Flow of Information                                             | 158 |
| Enzyme specificity—The key to metabolic regulation                  | 159 |
| How the information is duplicated                                   | 160 |
| How the message is transcribed                                      | 163 |
| How the transcribed message is translated                           | 164 |
| The linear language folds itself into a three-dimensional structure | 170 |
| How large structures are formed from smaller ones                   | 171 |
| How the cell switches the production of enzymes on and off          | 173 |
| How enzyme activity is regulated                                    | 175 |
| How cellular structures might regulate metabolic activities         | 176 |

## PART TWO

### The Emergence of Form 179

#### CHAPTER 7

|                                              |     |
|----------------------------------------------|-----|
| The Shape of Things to Come                  | 181 |
| The component processes of development       | 182 |
| The embryo grows                             | 182 |
| Its cells specialize                         | 183 |
| The organism takes shape                     | 184 |
| How animals develop                          | 186 |
| Origin and maturation of germ cells          | 186 |
| The sperm—Small and mobile                   | 188 |
| The indispensable egg                        | 191 |
| Egg and sperm unite                          | 191 |
| Cleavage—Partitioning the zygote             | 192 |
| An egg in action                             | 193 |
| The cells are rearranged during gastrulation | 194 |
| Origins of the nervous system                | 195 |
| Embryonic induction                          | 196 |
| An eye is formed                             | 198 |
| "Space capsules" for development             | 200 |
| An inner "space capsule"                     | 200 |
| The course of human development              | 202 |
| How a flowering plant develops               | 204 |
| Origin of gametes and fertilization          | 204 |
| A common pattern of embryo development       | 205 |
| Summary                                      | 208 |

#### CHAPTER 8

|                                                               |     |
|---------------------------------------------------------------|-----|
| Developmental Processes and Their Controls                    | 210 |
| The cell's inner controls                                     | 210 |
| The nuclear control center                                    | 210 |
| Genes in action                                               | 216 |
| The cytoplasmic environment                                   | 221 |
| Cellular interactions                                         | 225 |
| The life history of muscle                                    | 226 |
| Cells that recognize their neighbors                          | 233 |
| Environmental controls                                        | 235 |
| Embryonic polarity                                            | 235 |
| Meristems and the control of post-embryonic plant development | 236 |
| Photoperiodic effects                                         | 239 |
| Senescence                                                    | 240 |
| Cell death in morphogenesis and senescence                    | 241 |
| Cells out of control                                          | 242 |
| Congenital defects                                            | 243 |
| Cancer                                                        | 246 |
| Summary                                                       | 248 |

**PART THREE****Why Organisms Behave  
As They Do****251****CHAPTER 9****The Versatile World of Microbes 253**

|                                                                   |     |
|-------------------------------------------------------------------|-----|
| Eucaryotes, procaryotes and viruses                               | 253 |
| The roles of bacteria in nature                                   | 254 |
| Isolation of pure cultures                                        | 255 |
| The procaryotic cell                                              | 255 |
| Genetic material                                                  | 256 |
| The cytoplasm and ribosomes                                       | 258 |
| The cell membrane                                                 | 258 |
| The cell wall                                                     | 259 |
| Flagella and fimbriae                                             | 260 |
| Resting stages                                                    | 261 |
| Diversity of procaryotes                                          | 261 |
| The major groups of procaryotes                                   | 262 |
| Metabolism of bacteria                                            | 262 |
| Phototrophs                                                       | 263 |
| Chemotrophs                                                       | 264 |
| The growth of bacteria                                            | 265 |
| Replication and distribution of DNA                               | 268 |
| Metabolic control in bacteria                                     | 270 |
| Viruses                                                           | 272 |
| Life history of a phage                                           | 273 |
| Temperate phage and lysogeny                                      | 275 |
| Plant and animal viruses                                          | 276 |
| Sexuality of bacteria                                             | 276 |
| Methodology of bacterial genetics                                 | 277 |
| Conjugation                                                       | 277 |
| Transduction                                                      | 280 |
| Microbiology and medicine                                         | 281 |
| Poliomyelitis—Conquest of a viral disease<br>by mass immunization | 282 |
| Microbiology and industrial technology                            | 282 |

**CHAPTER 10****Plants—The Food Providers 284**

|                                 |     |
|---------------------------------|-----|
| Structure of a green land plant | 285 |
| Plant cells and cell walls      | 285 |
| Plant tissues and organs        | 287 |
| Structure of xylem and phloem   | 289 |
| Plant organ systems             | 292 |

|                                                                     |     |
|---------------------------------------------------------------------|-----|
| Structure and growth of a root—<br>Making it underground            | 292 |
| Structure and growth of a stem—<br>Connecting roots and leaves      | 295 |
| Cellulose and lignin—Paper and pollution                            | 297 |
| Photosynthesis—How leaves work                                      | 298 |
| Importance of leaves                                                | 298 |
| Carbon dioxide and the rate<br>of photosynthesis                    | 301 |
| Polluted air                                                        | 302 |
| Light and photosynthesis—<br>Shade plants versus sun plants         | 302 |
| Moving chloroplasts around                                          | 303 |
| Obtaining water and minerals—<br>How roots work                     | 303 |
| Importance of soil—The good earth                                   | 303 |
| Hydroponics                                                         | 304 |
| Essential elements—<br>The salt of the earth                        | 304 |
| The root system and water absorption                                | 306 |
| Water absorption—<br>Root hairs and “fungus roots”                  | 307 |
| Diffusion and osmosis                                               | 309 |
| Turgor pressure                                                     | 310 |
| Transport of water and food—<br>How stems work                      | 312 |
| Root pressure and transpiration—<br>Up the stem with water          | 312 |
| Transport of food—<br>Down and up the stem with sugar               | 313 |
| Using aphids to measure phloem transport                            | 313 |
| Mechanism of phloem transport                                       | 314 |
| Integrating plant activities by regulating<br>growth—Plant hormones | 314 |
| Auxins and phototropism                                             | 315 |
| How auxins stimulate cell enlargement                               | 317 |
| Inhibitory effects of auxins                                        | 317 |
| Auxin effects on fruit growth<br>and abscission                     | 318 |
| Auxin effects on organ formation                                    | 319 |
| Auxins in weed control                                              | 319 |
| Gibberellins                                                        | 320 |
| Cytokinins                                                          | 321 |
| Ethylene                                                            | 322 |
| Abscisic acid                                                       | 323 |
| Hormonal interactions                                               | 323 |
| Plant growth regulators and human affairs                           | 323 |

|                                                              |            |  |  |
|--------------------------------------------------------------|------------|--|--|
| <b>CHAPTER 11</b>                                            |            |  |  |
| <b>The Mobile Animals</b>                                    | <b>325</b> |  |  |
| An approach to the study of animal function                  | 326        |  |  |
| An emphasis on man and the vertebrates                       | 327        |  |  |
| Basic body plans                                             | 327        |  |  |
| Skin                                                         | 330        |  |  |
| Human skin                                                   | 330        |  |  |
| Other skins                                                  | 332        |  |  |
| The skeleton                                                 | 334        |  |  |
| The human skeleton                                           | 336        |  |  |
| The insect skeleton                                          | 340        |  |  |
| Muscle                                                       | 341        |  |  |
| Movement without muscles                                     | 341        |  |  |
| Structure of muscle cells—                                   |            |  |  |
| Fibrous cells and fibrous molecules                          | 342        |  |  |
| How muscles move things                                      | 344        |  |  |
| Activation of muscle cells                                   | 345        |  |  |
| Regulation of degree of contraction                          | 347        |  |  |
| Cardiac muscle and some other special muscles                | 349        |  |  |
| <br><b>CHAPTER 12</b>                                        |            |  |  |
| <b>Food and Energy for the Animal Way of Life</b>            | <b>351</b> |  |  |
| Nutrition                                                    | 352        |  |  |
| A complete diet—Wool, wood, milk or fish                     | 352        |  |  |
| Nutritional requirements of man                              | 352        |  |  |
| Feeding mechanisms                                           | 355        |  |  |
| Digestion                                                    | 357        |  |  |
| Human digestive system                                       | 357        |  |  |
| Digestion in other vertebrates—                              |            |  |  |
| Some specializations                                         | 362        |  |  |
| Digestion in insects                                         | 363        |  |  |
| The breath of life                                           | 364        |  |  |
| Human respiratory system                                     | 365        |  |  |
| Transport of oxygen and carbon dioxide                       | 366        |  |  |
| Control of respiration                                       | 367        |  |  |
| Some problems in human respiration                           | 367        |  |  |
| Air pollution                                                | 368        |  |  |
| Respiration in vertebrates other than man                    | 370        |  |  |
| Respiration in insects                                       | 373        |  |  |
| Moving the blood                                             | 374        |  |  |
| The human circulatory system                                 | 375        |  |  |
| Diseases of the human circulatory system                     | 384        |  |  |
| A second circulatory system—                                 |            |  |  |
| The lymphatic system                                         | 385        |  |  |
| Some other circulatory systems                               | 386        |  |  |
| Regulating the water supply                                  | 387        |  |  |
| Human excretory system                                       | 387        |  |  |
| Kidney diseases                                              | 390        |  |  |
| Osmoregulation and excretion in some other vertebrates       | 390        |  |  |
| Osmoregulation and excretion in insects                      | 392        |  |  |
| Osmoregulation in vertebrates—                               |            |  |  |
| A second look                                                | 393        |  |  |
| Temperature regulation                                       | 393        |  |  |
| Temperature regulation in homeotherms                        | 394        |  |  |
| Temperature regulation in poikilotherms                      | 396        |  |  |
| <br><b>CHAPTER 13</b>                                        |            |  |  |
| <b>Controlling the Animal Way of Life—The Nervous System</b> | <b>400</b> |  |  |
| Nervous control systems                                      | 401        |  |  |
| Structure of nerve cells                                     | 401        |  |  |
| True nerve cells                                             | 401        |  |  |
| The supporting cast—Glial cells                              | 404        |  |  |
| How nerve cells function                                     | 405        |  |  |
| Conduction of nerve impulses                                 | 405        |  |  |
| Rate of impulse conduction                                   | 407        |  |  |
| The neural language                                          | 408        |  |  |
| Synapses                                                     | 408        |  |  |
| The human nervous system                                     | 410        |  |  |
| How nerve cells are arranged                                 | 410        |  |  |
| The central nervous system—Spinal cord                       | 411        |  |  |
| The emerging importance of the brain                         | 413        |  |  |
| Autonomic nerves                                             | 414        |  |  |
| Receptors and sense organs                                   | 416        |  |  |
| Decoding the sensory message                                 | 418        |  |  |
| Sensations                                                   | 419        |  |  |
| How receptors work                                           | 420        |  |  |
| Adaptation                                                   | 420        |  |  |
| Major sense organs of man                                    | 420        |  |  |
| The central nervous system—The brain                         | 421        |  |  |
| Hindbrain—The medulla                                        | 424        |  |  |
| Hindbrain—The cerebellum                                     | 425        |  |  |
| Midbrain                                                     | 426        |  |  |
| Forebrain                                                    | 427        |  |  |
| Drugs and the brain—A two-edged sword                        | 430        |  |  |
| Evolution of nervous systems                                 | 432        |  |  |
| Nerve nets                                                   | 432        |  |  |
| Flatworm nervous systems                                     | 433        |  |  |
| Insect nervous systems                                       | 434        |  |  |
| <br><b>CHAPTER 14</b>                                        |            |  |  |
| <b>Animal Behavior</b>                                       | <b>438</b> |  |  |
| The survival value of behavior                               | 438        |  |  |
| Built-in behavior—Reflexes and instincts                     | 439        |  |  |
| The role of environment in the development of behavior       | 441        |  |  |
| Biological clocks                                            | 442        |  |  |
| Motivation                                                   | 444        |  |  |
| Learning                                                     | 445        |  |  |
| Memory                                                       | 448        |  |  |
| Some patterns of animal behavior                             | 449        |  |  |
| Social behavior                                              | 449        |  |  |
| Migration, homing and orientation                            | 451        |  |  |
| Human behavior—Some prospects                                | 453        |  |  |

**CHAPTER 15****The Hormones In Human Reproduction 454**

|                                                 |     |
|-------------------------------------------------|-----|
| Reproduction—The general scheme                 | 454 |
| Why sex?                                        | 456 |
| The reproductive system in the human female     | 457 |
| The ovary as timepiece                          | 458 |
| A description of menstruation                   | 461 |
| The reproductive system in the human male       | 462 |
| Sex hormones and human behavior                 | 462 |
| Mechanism of sex hormone action                 | 464 |
| Hormones, receptors and second messengers       | 464 |
| Prostaglandins                                  | 466 |
| Conception and contraception—Population control | 467 |
| Coitus                                          | 467 |
| The “safe period”                               | 469 |
| Birth control methods                           | 469 |
| How the “Pill” was developed                    | 470 |
| Sterility and venereal disease                  | 471 |
| Homosexuality and transvestism                  | 474 |

**CHAPTER 16****The Web of Life 476**

|                                     |     |
|-------------------------------------|-----|
| Time and succession                 | 477 |
| Nature's machinery                  | 479 |
| The cycle of nutrients              | 480 |
| Limiting factors                    | 483 |
| The flow of energy                  | 483 |
| The importance of primary producers | 485 |
| Ecosystems of the world             | 486 |
| The seas                            | 487 |
| Seashores and estuaries             | 488 |
| Rivers and streams                  | 489 |
| Lakes and ponds                     | 490 |
| Freshwater marshes                  | 490 |
| Deserts                             | 490 |
| Tundra                              | 491 |
| Grasslands                          | 492 |
| Forests                             | 492 |
| Order in diversity                  | 493 |

**CHAPTER 17****Ecology and Man 494**

|                                               |     |
|-----------------------------------------------|-----|
| Human population growth                       | 495 |
| Doubling time                                 | 496 |
| The demographic transition                    | 498 |
| The quality of human life                     | 498 |
| Hunters, food gatherers, and agriculturalists | 500 |
| Ecosystem diversity and stability             | 500 |
| Control by chemicals                          | 501 |
| Toward a balance                              | 503 |

**PART FOUR****Populations 505****CHAPTER 18****Evolution In Action 507**

|                            |     |
|----------------------------|-----|
| Industrial melanism        | 507 |
| Sources of variation       | 510 |
| No selection, no evolution | 510 |
| Sequential evolution       | 511 |
| The modern view            | 513 |

**CHAPTER 19****Races and Species 514**

|                           |     |
|---------------------------|-----|
| The Galapagos archipelago | 514 |
| Darwin's finches          | 516 |
| Geographic isolation      | 518 |
| Isolating mechanisms      | 519 |
| Character divergence      | 521 |

**CHAPTER 20****The Origin of Life 524**

|                                                    |     |
|----------------------------------------------------|-----|
| Origin of the solar system                         | 525 |
| Evolution of the earth's atmosphere                | 525 |
| Primitive earth—Its temperature and energy sources | 525 |
| The earliest fossils                               | 526 |
| Laboratory studies                                 | 528 |
| Polymer synthesis                                  | 529 |
| Biological organization                            | 529 |
| Origin of eucaryotes—Symbiosis and evolution       | 531 |
| Spontaneous generation                             | 532 |
| The search for extraterrestrial life               | 532 |

**CHAPTER 21****Cataloging Nature 534**

|                                                              |     |
|--------------------------------------------------------------|-----|
| Understanding diversity                                      | 535 |
| Who is related to whom—Homology provides the key             | 535 |
| The problem of convergence                                   | 537 |
| Clues from reproduction and early development                | 538 |
| Clues from the electron microscope, chromosomes and behavior | 538 |
| Clues from biochemistry—Molecular taxonomy                   | 539 |
| Clues from newly discovered organisms                        | 541 |
| Fragile family trees—Phylogenies                             | 541 |
| How to catalog organisms                                     | 544 |
| A vocabulary for classification                              | 545 |

|                                   |     |
|-----------------------------------|-----|
| Some problems of systematics      | 547 |
| Systematics in the service of man | 549 |
| The kingdoms of organisms         | 550 |

## CHAPTER 22 Unfolding Diversity 553

|                                        |     |
|----------------------------------------|-----|
| The fossil record                      | 554 |
| Timespans of the earth's history       | 555 |
| Early life                             | 557 |
| The Paleozoic era                      | 557 |
| The appearance of marine invertebrates | 558 |
| The first land plants                  | 558 |
| Primitive landscapes                   | 559 |
| Animal life on land                    | 559 |
| The age of fishes                      | 560 |
| Early amphibians                       | 561 |
| The rise of reptiles                   | 562 |
| The Mesozoic era                       | 562 |
| The flowering plants                   | 562 |
| The age of reptiles                    | 563 |
| The first birds                        | 563 |
| Early mammals                          | 565 |
| The Cenozoic era                       | 565 |
| The age of mammals                     | 565 |
| Modern mammals                         | 566 |

## PART FIVE The Diversity of Life 569

### CHAPTER 23 Plants 571

|                                                                   |     |
|-------------------------------------------------------------------|-----|
| The "double life" of a plant—<br>Alternation of generations       | 572 |
| Algae—The grass of many waters                                    | 575 |
| Green algae—Division Chlorophyta                                  | 576 |
| Love thy neighbor—Algal symbioses                                 | 580 |
| Plentiful food—Divisions Chrysophyta<br>and Pyrrophyta            | 580 |
| Seaweeds—Divisions Phaeophyta and<br>Rhodophyta                   | 584 |
| Fungi—The filamentous way of life                                 | 588 |
| Water molds and bread molds—<br>Classes Oomycetes and Zygomycetes | 589 |
| Sac fungi—Class Ascomycetes                                       | 590 |
| Lichens—Collective security                                       | 591 |
| Club fungi—Class Basidiomycetes                                   | 592 |
| Sexless fungi—Class Fungi Imperfecti                              | 595 |
| Slime molds—Division Gymnomycota                                  | 595 |
| Invading the land                                                 | 596 |
| Mosses and Liverworts—<br>Division Bryophyta                      | 597 |
| Vascular plants—Division Tracheophyta                             | 600 |

|                                                      |     |
|------------------------------------------------------|-----|
| Primitive vascular plants—<br>Subdivision Psilopsida | 602 |
| Club mosses—Subdivision Lycopsidea                   | 602 |
| Horsetails—Subdivision Sphenopsida                   | 602 |
| Ferns—Subdivision Pteropsida                         | 604 |
| Seed plants—Subdivision Spermopsida                  | 607 |
| Importance of seeds                                  | 607 |
| Conifers and their relatives—<br>The gymnosperms     | 608 |
| Flowering plants—Class Angiospermae                  | 613 |
| Secrets of success                                   | 613 |
| What is a flower?                                    | 613 |
| Teaming up with insects—<br>Improved pollination     | 615 |
| Fruit peddling—Improved<br>distribution of seeds     | 619 |
| Plant parenthood—Double fertilization                | 619 |
| Nonwoody plants                                      | 620 |
| The fast life of a flowering plant                   | 620 |
| The development of resistance to<br>drought and cold | 620 |
| Genetic flexibility                                  | 621 |
| Two subclasses—Dicots and monocots                   | 621 |
| The importance of flowering plants to man            | 622 |

### CHAPTER 24 Animals 625

|                                                           |     |
|-----------------------------------------------------------|-----|
| Major trends in animal evolution                          | 627 |
| Phylum Protozoa                                           | 627 |
| Simplest protozoans—Class Flagellata                      | 629 |
| Amoebas and their relatives—<br>Class Sarcodina           | 630 |
| Malarial organisms and their kin—<br>Class Sporozoa       | 632 |
| The ciliates—Class Ciliata                                | 634 |
| Sponges, filters of the ocean—<br>Phylum Porifera         | 636 |
| Hydras, jellyfish, corals—<br>Phylum Coelenterata         | 639 |
| Classes of coelenterates                                  | 641 |
| Ancestors and descendants of the coelenterates            | 645 |
| Flatworms—Phylum Platyhelminthes                          | 646 |
| Planarians—Class Turbellaria                              | 647 |
| The road to parasitism                                    | 647 |
| Flukes—Class Trematoda                                    | 649 |
| Tapeworms—Class Cestoda                                   | 650 |
| Ribbon worms—Phylum Nemertinea                            | 650 |
| Two routes to one-way traffic                             | 651 |
| Roundworms and others—<br>Phylum Aschelminthes            | 653 |
| Earthworms, leeches, and marine worms—<br>Phylum Annelida | 655 |
| The significance of segmentation                          | 658 |
| Snails, clams, and squids—<br>Phylum Mollusca             | 659 |

|                                            |     |
|--------------------------------------------|-----|
| Chitons—Class Amphineura                   | 661 |
| Snails—Class Gastropoda                    | 661 |
| Bivalves—Class Pelecypoda                  | 663 |
| Squids and octopods—Class Cephalopoda      | 663 |
| Evolutionary origins of mollusks           | 666 |
| A link to the arthropods—                  |     |
| Phylum Onychophora                         | 666 |
| A brief lesson in animal geography         | 667 |
| Insects, spiders and crustaceans—          |     |
| Phylum Arthropoda                          | 668 |
| Some evolutionary trends in the arthropods | 670 |
| Crabs, lobsters, and shrimps—              |     |
| Class Crustacea                            | 670 |
| Spiders and their kin—Class Arachnida      | 675 |
| Insects—Class Insecta                      | 679 |
| Kinships among the arthropods              | 688 |
| A possible crossroad—Lophophorate phyla    | 689 |
| Starfishes, sea urchins and sea lilies—    |     |
| Phylum Echinodermata                       | 690 |
| Chordate characteristics                   | 693 |
| Sea squirts and amphioxus—                 |     |
| Invertebrate chordates                     | 694 |
| The origin of chordates and vertebrates    | 696 |
| Animals with backbones—                    |     |
| Subphylum Vertebrata                       | 698 |
| Fishes—Superclass Pisces                   | 699 |
| Newts and frogs—Class Amphibia             | 703 |
| Turtles, snakes, lizards, and crocodiles—  |     |
| Class Reptilia                             | 705 |
| Birds—Class Aves                           | 707 |

|                                            |     |
|--------------------------------------------|-----|
| Porpoises, pangolins, and people—          |     |
| Class Mammalia                             | 712 |
| Some afterthoughts on kinships and success | 717 |

|                                 |            |
|---------------------------------|------------|
| <b>CHAPTER 25</b>               |            |
| <b>Mankind Evolving</b>         | <b>719</b> |
| Man as an animal                | 720        |
| Prosimians—The first primates   | 722        |
| “Improved” primates—The monkeys | 722        |
| Anthropoid apes                 | 723        |
| The first toolmaker             | 725        |
| Early wanderers                 | 726        |
| The man who became extinct      | 727        |
| The races of modern man         | 730        |
| The origin of the races         | 732        |
| Is man still evolving?          | 732        |
| <br>Glossary                    | <br>735    |
| <br>Appendices                  | <br>763    |
| <br>Credits and acknowledgments | <br>773    |
| <br>Index                       | <br>778    |