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Part I *The Origin of Living Things*



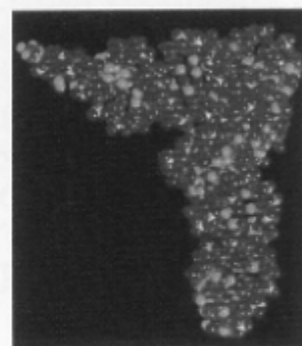
1 *The Science of Biology* 1

- 1.1 Biology is the science of life.
- 1.2 Scientists form generalizations from observations.
- 1.3 Darwin's theory of evolution illustrates how science works.
- 1.4 Four themes unify biology as a science.



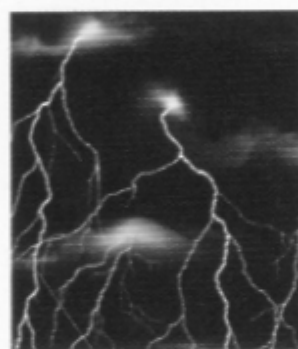
2 *The Nature of Molecules* 19

- 2.1 Atoms are nature's building material.
- 2.2 The atoms of living things are among the smallest.
- 2.3 Chemical bonds hold molecules together.
- 2.4 Water is the cradle of life.



3 *The Chemical Building Blocks of Life* 35

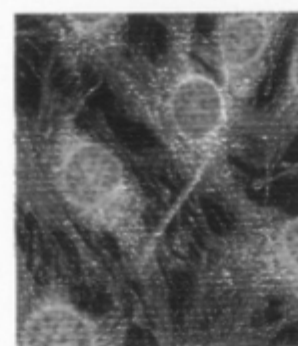
- 3.1 Molecules are the building blocks of life.
- 3.2 Proteins perform the chemistry of the cell.
- 3.3 Nucleic acids store and transfer genetic information.
- 3.4 Lipids make membranes and store energy.
- 3.5 Carbohydrates store energy and provide building materials.



4 *The Origin and Early History of Life* 61

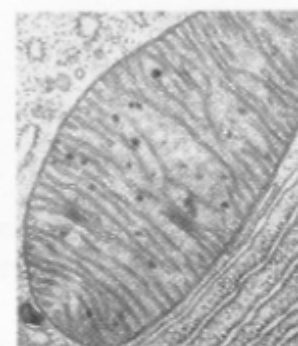
- 4.1 All living things share key characteristics.
- 4.2 There is considerable disagreement about the origin of life.
- 4.3 There are many hypotheses about the origin of cells.
- 4.4 Cells became progressively more complex as they evolved.
- 4.5 Scientists are beginning to take the possibility of extraterrestrial life seriously.

Part II *Biology of the Cell*



5 *Cell Structure* 79

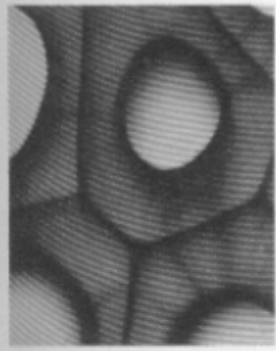
- 5.1 All organisms are composed of cells.
- 5.2 Eukaryotic cells are more structurally complex than prokaryotic cells.
- 5.3 Take a tour of a eukaryotic cell.
- 5.4 Not all eukaryotic cells are the same.



6 *Membranes* 105

- 6.1 Biological membranes are fluid layers of lipid.
- 6.2 Proteins embedded within cell membranes determine their character.
- 6.3 Passive transport across membranes moves down the concentration gradient.
- 6.4 Bulk transport utilizes endocytosis.
- 6.5 Active transport across membranes requires energy.

Part III *Genetic and Molecular Biology*



7 *Cell-Cell Interactions* 125

- 7.1 Cells signal one another with chemicals.
- 7.2 Proteins in the cell and on its surface receive signals from other cells.
- 7.3 Follow the journey of information into the cell.
- 7.4 Cell surface proteins mediate cell-cell interactions.



8 *Energy and Metabolism* 143

- 8.1 The laws of thermodynamics describe how energy changes.
- 8.2 Enzymes are biological catalysts.
- 8.3 ATP is the energy currency of life.
- 8.4 Metabolism is the chemical life of a cell.



9 *How Cells Harvest Energy* 159

- 9.1 Cells harvest the energy in chemical bonds.
- 9.2 Cellular respiration oxidizes food molecules.
- 9.3 Catabolism of proteins and fats can yield considerable energy.
- 9.4 Cells can metabolize food without oxygen.
- 9.5 The stages of cellular respiration evolved over time.



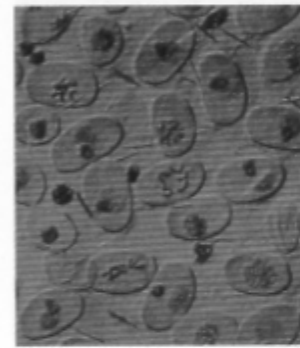
10 *Photosynthesis* 185

- 10.1 What is photosynthesis?
- 10.2 Learning about photosynthesis: An experimental journey.
- 10.3 Pigments capture energy from sunlight.
- 10.4 Cells use the energy and reducing power captured by the light-dependent reactions to make organic molecules.



11 *How Cells Divide* 207

- 11.1 Prokaryotes divide far more simply than do eukaryotes.
- 11.2 The chromosomes of eukaryotes are highly ordered structures.
- 11.3 Mitosis is a key phase of the cell cycle.
- 11.4 The cell cycle is carefully controlled.



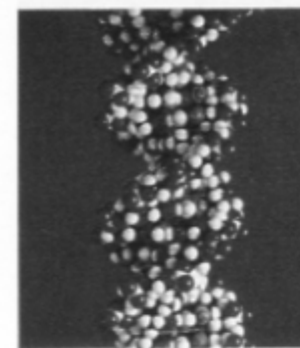
12 *Sexual Reproduction and Meiosis* 227

- 12.1 Meiosis produces haploid cells from diploid cells.
- 12.2 Meiosis has unique features.
- 12.3 The sequence of events during meiosis involves two nuclear divisions.
- 12.4 The evolutionary origin of sex is a puzzle.



13 *Patterns of Inheritance* 241

- 13.1 Mendel solved the mystery of heredity.
- 13.2 Human genetics follows Mendelian principles.
- 13.3 Genes are on chromosomes.



14 *DNA: The Genetic Material* 279

- 14.1 What is the genetic material?
- 14.2 What is the structure of DNA?
- 14.3 How does DNA replicate?
- 14.4 What is a gene?



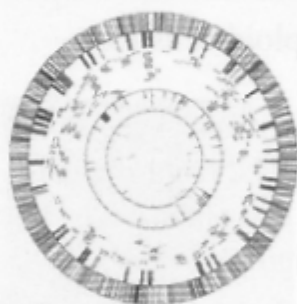
15 *Genes and How They Work* 301

- 15.1 The Central Dogma traces the flow of gene-encoded information.
- 15.2 Genes encode information in three-nucleotide code words.
- 15.3 Genes are first transcribed, then translated.
- 15.4 Eukaryotic gene transcripts are spliced.



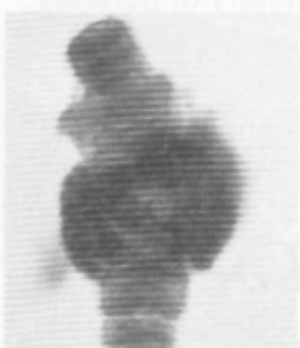
16 *Gene Technology* 319

- 16.1 Molecular biologists can manipulate DNA to clone genes.
- 16.2 Genetic engineering involves easily understood procedures.
- 16.3 Biotechnology is producing a scientific revolution.



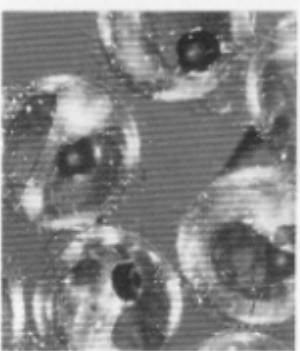
17 *Genomes* 343

- 17.1 Genomes can be mapped both genetically and physically.
- 17.2 Genome sequencing produces the ultimate physical map.
- 17.3 Being more complex does not necessarily require more genes.
- 17.4 Genomics is opening a new window on life.



18 *Control of Gene Expression* 361

- 18.1 Gene expression is controlled by regulating transcription.
- 18.2 Regulatory proteins read DNA without unwinding it.
- 18.3 Prokaryotes regulate genes by controlling transcription initiation.
- 18.4 Transcriptional control in eukaryotes operates at a distance.



19 *Cellular Mechanisms of Development* 381

- 19.1 Development is a regulated process.
- 19.2 Multicellular organisms employ the same basic mechanisms of development.
- 19.3 Aging can be considered a developmental process.



20 *Cancer Biology and Cell Technology* 405

- 20.1 Recombination alters gene location.
- 20.2 Mutations are changes in the genetic message.
- 20.3 Most cancer results from mutation of growth-regulating genes.
- 20.4 Reproductive cloning of animals, once thought impossible, isn't.
- 20.5 Therapeutic cloning is a promising but controversial possibility.

Part IV *Evolution*



21 *Genes Within Populations* 433

- 21.1 Genes vary in natural populations.
- 21.2 Why do allele frequencies change in populations?
- 21.3 Selection can act on traits affected by many genes.



22 *The Evidence for Evolution* 453

- 22.1 Evidence indicates that natural selection can produce evolutionary change.
- 22.2 Fossil evidence indicated that evolution has occurred.
- 22.3 Evidence for evolution can be found in other fields of biology.
- 22.4 The theory of evolution has proven controversial.



23 *The Origin of Species* 471

- 23.1 Species are the basic units of evolution.
- 23.2 Species maintain their genetic distinctiveness through barriers to reproduction.
- 23.3 We have learned a great deal about how species form.
- 23.4 Clusters of species reflect rapid evolution.



24 *Evolution of Genomes and Developmental Mechanisms* 491

- 24.1 Evolutionary history is written in genomes.
- 24.2 Developmental mechanisms are evolving.

Part V *Diversity of Life on Earth*



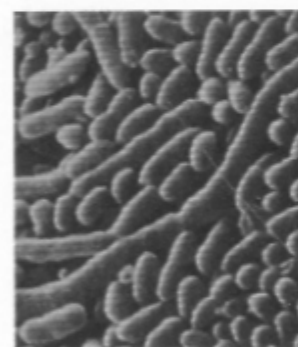
25 *Systematics and the Phylogenetic Revolution* 509

- 25.1 Biologists name organisms in a systematic way.
- 25.2 Scientists construct phylogenies to understand the evolutionary relationships among species.
- 25.3 Phylogenetics is the basis of all comparative biology.
- 25.4 All living organisms are grouped into one of a few major categories.
- 25.5 Molecular data are revolutionizing taxonomy.



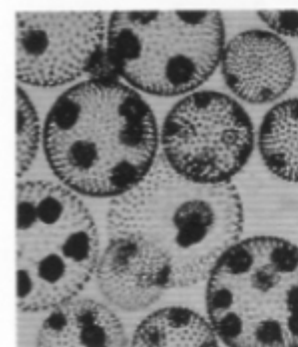
26 *Viruses* 531

- 26.1 Viruses are strands of nucleic acid encased within a protein coat.
- 26.2 Bacterial viruses exhibit two sorts of reproductive cycles.
- 26.3 HIV is a complex animal virus.
- 26.4 Nonliving infectious agents are responsible for many human diseases.



27 *Prokaryotes* 545

- 27.1 Prokaryotes are the smallest and most numerous organisms.
- 27.2 Prokaryotes exhibit considerable diversity in both structure and metabolism.
- 27.3 Prokaryotes are more complex than commonly supposed.
- 27.4 Prokaryotes are responsible for many diseases, but they also make important contributions to ecosystems.



28 *Protists* 561

- 28.1 Eukaryotes probably arose by endosymbiosis.
- 28.2 The kingdom Protista is by far the most diverse of any kingdom.
- 28.3 Protists can be categorized into six groups.



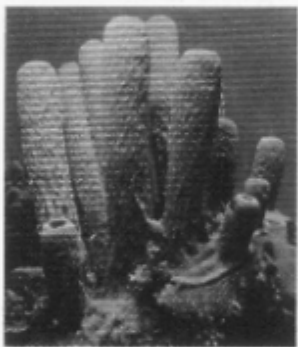
29 *Overview of Plant Diversity* 579

- 29.1 Plants have multicellular haploid and diploid stages in their life cycles.
- 29.2 Nonvascular plants are relatively unspecialized but successful in many terrestrial environments.
- 29.3 Seedless vascular plants have well-developed conducting tissues in their sporophytes.
- 29.4 Seeds protect and aid in the dispersal of plant embryos.



30 *Fungi* 599

- 30.1 The fungi share several key characteristics.
- 30.2 There are four major groups of fungi.
- 30.3 Fungi participate in many symbioses.



31 *Overview of Animal Diversity* 617

- 31.1 Animals are multicellular heterotrophs without cell walls.
- 31.2 Animals are a very diverse kingdom.
- 31.3 The animal body plan has undergone many changes.
- 31.4 The way we classify animals is being reevaluated.



32 *Noncoelomate Invertebrates* 633

- 32.1 The classification of invertebrates is currently being reevaluated.
- 32.2 The simplest animals are not bilaterally symmetrical.
- 32.3 Acoelomates are solid worms that lack a body cavity.
- 32.4 Pseudocoelomates have a simple body cavity.



33 *Coelomate Invertebrates* 651

- 33.1 Mollusks were among the first coelomates.
- 33.2 Annelids were the first segmented animals.
- 33.3 Lophophorates appear to be a transitional group.
- 33.4 Arthropods are the most diverse of all animal groups.
- 33.5 Echinoderms are radially symmetrical as adults.



34 *Vertebrates* 683

- 34.1 Attaching muscles to an internal framework greatly improves movement.
- 34.2 Nonvertebrate chordates have a notochord but no backbone.
- 34.3 The evolution of vertebrates involved invasions of sea, land, and air.
- 34.4 Evolution among the primates has focused on brain size and locomotion.

Part VI *Plant Form and Function*



35 *Plant Form* 729

- 35.1 Meristems elaborate the plant body plan after germination.
- 35.2 Plants have three basic tissues, each composed of several cell types.
- 35.3 Root cells differentiate as they become distanced from the dividing root apical meristem.
- 35.4 Stems are the backbone of the shoot, transporting nutrients and supporting the aerial plant organs.
- 35.5 Leaves are adapted to support basic plant functions.



36 *Vegetative Plant Development* 755

- 36.1 Plant embryo development establishes a basic body plan.
- 36.2 The seed protects the dormant embryo from water loss.
- 36.3 Fruit formation enhances the dispersal of seeds.
- 36.4 Germination initiates post-seed development.



37 *Transport in Plants* 767

- 37.1 Water and minerals move upward through the xylem.
- 37.2 Dissolved sugars and hormones are transported in the phloem.



38 *Plant Nutrition* 781

- 38.1 Plants require a variety of nutrients in addition to the direct products of photosynthesis.
- 38.2 Global change could alter the balance among photosynthesis, respiration, and use of nutrients acquired through the soil.
- 38.3 Some plants have novel strategies for obtaining nutrients.
- 38.4 Plants can remove harmful chemicals from the soil.



39 *Plant Defense Responses* 795

- 39.1 Morphological and physiological features protect plants from invasion.
- 39.2 Some plant defenses act by poisoning the invader.
- 39.3 Some plants have coevolved with bodyguards.
- 39.4 Systemic responses also protect plants from invaders.



40 *Sensory Systems in Plants* 807

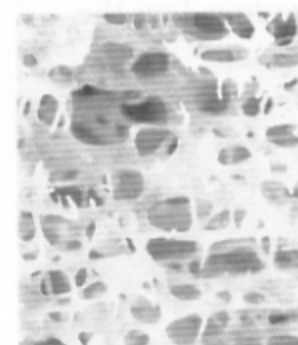
- 40.1 Plants respond to light.
- 40.2 Plants respond to gravity.
- 40.3 Plants respond to touch.
- 40.4 Water and temperature elicit plant responses.
- 40.5 The hormones that guide growth are keyed to the environment.



41 *Plant Reproduction* 831

- 41.1 The environment influences reproduction.
- 41.2 Flowers are highly evolved for reproducing.
- 41.3 Many plants can clone themselves by asexual reproduction.
- 41.4 How long do plants and plant organs live?

Part VII *Animal Form and Function*



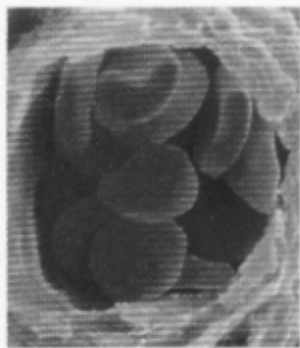
42 *The Animal Body and How It Moves* 855

- 42.1 The bodies of vertebrates are organized into functional systems.
- 42.2 Epithelial tissue forms membranes and glands.
- 42.3 Connective tissues contain abundant extracellular material.
- 42.4 Muscle tissue provides for movement, and nerve tissue provides for control.
- 42.5 Coordinated efforts of organ systems are necessary for locomotion.
- 42.6 Muscle contraction powers animal locomotion.



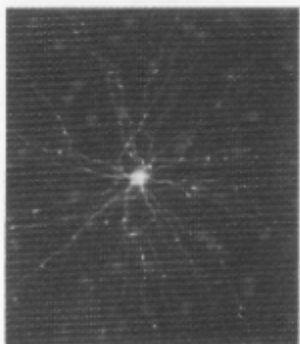
43 *Fueling Body Activities: Digestion* 887

- 43.1 Animals employ a digestive system to prepare food for assimilation by cells.
- 43.2 Food is ingested, swallowed, and transported to the stomach.
- 43.3 The small and large intestines have very different functions.
- 43.4 Neural, hormonal, and accessory organ regulation controls digestion.
- 43.5 All animals require food energy and essential nutrients.



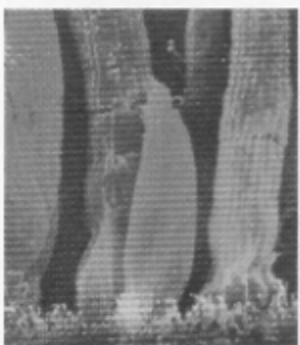
44 *Circulation and Respiration* 907

- 44.1 Circulatory systems are the transportation highways of the animal body.
- 44.2 The circulatory and respiratory systems evolved together in vertebrates.
- 44.3 The cardiac cycle drives the cardiovascular system.
- 44.4 Respiration has evolved to maximize the rate of gas diffusion.
- 44.5 Mammalian breathing is a dynamic process.



45 *The Nervous System* 939

- 45.1 The nervous system consists of neurons and supporting cells.
- 45.2 Nerve impulses are produced on the axon membrane.
- 45.3 Neurons form junctions called synapses with other cells.
- 45.4 The central nervous system consists of the brain and spinal cord.
- 45.5 The peripheral nervous system consists of sensory and motor neurons.



46 *Sensory Systems* 969

- 46.1 Animals employ a wide variety of sensory receptors.
- 46.2 Mechanical and chemical receptors sense the body's condition.
- 46.3 Auditory receptors detect pressure waves in the air.
- 46.4 Optic receptors detect light over a broad range of wavelengths.
- 46.5 Some vertebrates use heat, electricity, or magnetism for orientation.



47 *The Endocrine System* 991

- 47.1 Regulation is often accomplished by chemical messengers.
- 47.2 Lipophilic and polar hormones regulate their target cells by different means.
- 47.3 The hypothalamus controls the secretions of the pituitary gland.
- 47.4 Endocrine glands secrete hormones that regulate many body functions.



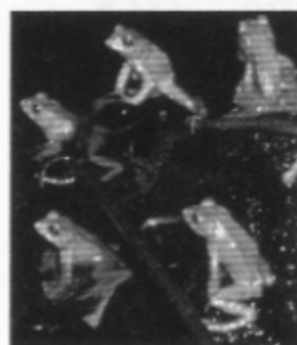
48 *The Immune System* 1013

- 48.1 Many body's most effective defenses are nonspecific.
- 48.2 Specific immune defenses require the recognition of antigens.
- 48.3 T cells organize attacks against invading microbes.
- 48.4 B cells label specific cells for destruction.
- 48.5 The immune system can be defeated.



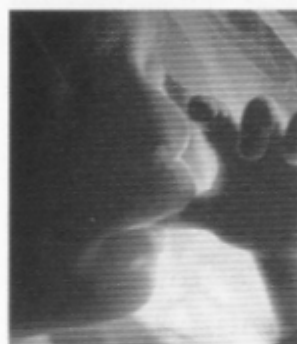
49 *Maintaining the Internal Environment* 1039

- 49.1 The regulatory systems of the body maintain homeostasis.
- 49.2 The extracellular fluid concentration is constant in most vertebrates.
- 49.3 The functions of the vertebrate kidney are performed by nephrons.



50 *Sex and Reproduction* 1061

- 50.1 Animals employ both sexual and asexual reproductive strategies.
- 50.2 The evolution of reproduction among the vertebrates has led to internalization of fertilization and development.
- 50.3 Male and female reproductive systems are specialized for different functions.



51 *Vertebrate Development* 1081

- 51.1 Fertilization is the initial event in development.
- 51.2 Cell cleavage and the formation of a blastula set the stage for later development.
- 51.3 Gastrulation forms the three germ layers of the embryo.
- 51.4 Body architecture is determined during the next stages of embryonic development.
- 51.5 Human development is divided into trimesters.

Part VIII *Ecology and Behavior*



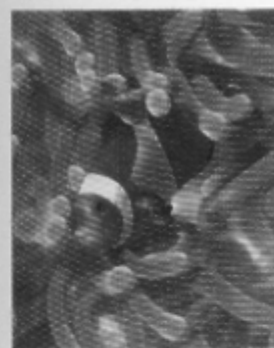
52 *Behavioral Biology* 1105

- 52.1 Many behavioral patterns are innate.
- 52.2 Learning influences behavior.
- 52.3 Communication is a key element of many animal behaviors.
- 52.4 Evolutionary forces shape behavior.



53 *Population Ecology* 1137

- 53.1 Organisms must cope with a varied environment.
- 53.2 Populations are individuals of the same species that live in the same place.
- 53.3 Population dynamics depend critically upon age distribution.
- 53.4 Life histories often reflect trade-offs between reproduction and survival.
- 53.5 Population growth is limited by the environment.
- 53.6 The human population has grown explosively in the last three centuries.



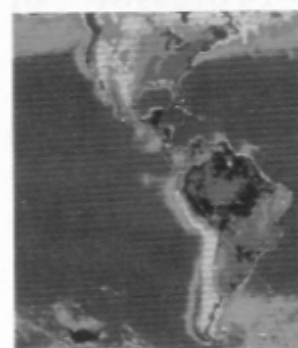
54 *Community Ecology* 1161

- 54.1 Biological communities are composed of species that occur together.
- 54.2 Interactions among competing species shape ecological niches.
- 54.3 Predation has ecological and evolutionary effects.
- 54.4 Species within a community interact in many ways.
- 54.5 Ecological succession may increase the species richness of communities.



55 *Dynamics of Ecosystems* 1183

- 55.1 Chemicals cycle within ecosystems.
- 55.2 Energy flows through ecosystems.
- 55.3 Interactions occur among different trophic levels.
- 55.4 Biodiversity promotes ecosystem stability.



56 *The Biosphere* 1203

- 56.1 Climate shapes the character of ecosystems.
- 56.2 Biomes are widespread terrestrial ecosystems.
- 56.3 Aquatic ecosystems cover much of the earth.
- 56.4 Human activity is placing the biosphere under increasing stress.



57 *Conservation Biology* 1227

- 57.1 The new science of conservation biology is focused on conserving biodiversity.
- 57.2 The extinction crisis is a result of many factors.
- 57.3 Successful recovery efforts need to be multidimensional.

Glossary G-1
Credits C-1
Index I-1

Writing Style

Students of biology are responsible for an ever-growing volume of information, and that amount of detail is reflected in today's textbooks, which are increasingly becoming encyclopedic references as opposed to teaching tools.