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Chapter 1: Introduction: The Scientific Study of Life
- Levels of biological organization from smallest to largest: molecules → cells → tissues → organs → organ systems → organisms → populations → communities → ecosystems.
- There are five basic steps in the hypothesis-driven scientific method:
  1. **Hypothesis**
  2. **Prediction**
  3. **Experiment**
  4. **Observation**
  5. **Conclusion**

  - **Biologists organize the diversity of life into three domains:** Bacteria and (2) Archaea consist of single-celled prokaryotic organisms; (3) Eukarya is divided into at least four kingdoms: Protista consists primarily of single-celled eukaryotes; Fungi, Plantae, and Animalia consist mostly of multicellular eukaryotes that differ in how they obtain nutrients.
  - **The basis of life's unity and diversity is the genetic information in DNA molecules.**
  - **Darwin's theory of evolution based on natural selection is the core theme of biology.**

Chapter 2: The Chemical Basis of Life
- Matter consists of elements. Elements can combine to form compounds.
- Twenty-five elements are essential for life: Oxygen, carbon, hydrogen, and nitrogen are the most abundant.
- Atom is the smallest unit of matter that retains the properties of an element. Atoms consist of protons (+1 electrical charge) and neutrons (no charge), and electrons (-1 charge). Different isotopes of an element have varying numbers of neutrons.
- Atoms with incomplete electron shells tend to gain, lose, or share electrons, forming chemical bonds with other atoms.
- Ionic bonds are attractions between ions of opposite charges.
- Atoms in covalent bonds complete their outer electron shells by sharing electrons.
- Water is a polar molecule, with a slightly negative O end and two slightly positive H ends.

Chapter 3: The Molecules of Cells
- Organic compounds vary in (1) the size and shape of the carbon skeleton, and (2) the presence and location of functional groups.
- Cells make a huge number of polymers from a small set of monomers, linked together by dehydration synthesis.
- Carbohydrates. Monosaccharides provide cells with energy and molecular building blocks. Polysaccharides store energy in animals (as glycogen) and in plants (as starch). Cellulose in plant cell walls provides structure.
- Lipids are hydrophobic. They include fats (energy storage), waxes, phospholipids (cell membrane components), and steroids (such as cholesterol and some hormones). Most animal fats are saturated. Plant oils are mostly unsaturated (less hydrogen because of double bonds in the carbon skeleton).
- Proteins are important structural elements of cells and participate in most cellular activities. Amino acids, the monomers of proteins, come in 20 varieties and are linked by peptide bonds to form polypeptides.
- A peptide bond joins the carboxyl end of one amino acid with the amino group of the next:

  ![Peptide bond](image)

  - A protein consists of one or more polypeptides folded into a specific shape that determines the protein's function. Four structural levels may contribute to this shape: (1) the amino acid sequence (primary structure); (2) coiling or pleating held by hydrogen bonds (secondary structure); (3) the overall shape held by interactions among R groups (tertiary structure); and (4) association of more than one polypeptide (quaternary structure).
- Nucleic acids are polymers of nucleotides. DNA, the molecule of inheritance, is a double helix: two polynucleotide strands held together by hydrogen bonds between bases. DNA is transcribed into RNA, a single-stranded nucleic acid, which is then translated into the primary structure of proteins.

Chapter 4: A Tour of the Cell
- Prokaryotic cells are small and structurally simple:
- Eukaryotic cells are larger and more complex, with a nucleus and membrane-bound organelles.

Chapter 5: The Working Cell
- Energy is the capacity to do work.
- Kinetic energy (energy of motion) can be converted to potential energy (stored energy) and vice versa. Energy cannot be created or destroyed. Every energy transfer or transformation increases entropy (disorder).
- Endergonic reactions require an input of energy, and the products contain more energy than the reactants. Endergonic reactions release energy.
- Energy coupling, with ATP as the energy shuttle, uses an energy-providing process to drive an endergonic one.
- Enzymes are biological catalysts that lower the activation energy of reactions, thereby speeding them up.
Chapter 7: Photosynthesis: Using Light to Make Food

The overall equation for photosynthesis:

\[ 6 \text{CO}_2 + 6 \text{H}_2\text{O} \xrightarrow{Light \ energy} \text{Glucose} + 6 \text{O}_2 \]

Photosynthesis, which occurs mainly in chloroplasts in leaf cells, is a redox process in which water is oxidized and carbon dioxide is reduced.

Photosynthesis occurs in two stages:
1. Light reactions: Solar energy is absorbed and converted to chemical energy in the form of ATP and NADPH within a network of membranous structures called thylakoids.
2. The Calvin cycle: A cyclic series of chemical reactions in the stroma of a chloroplast, using ATP and NADPH to make the energy-rich sugar G3P from CO₂.

Plants use the sugars they produce for cellular respiration and for producing other organic molecules. Plants are the ultimate source of food for virtually all other organisms.

- In animals, cytokinesis occurs by cleavage. In plants, a cell plate splits the cell in two.
- Anaphase, cell division, and chemical growth factors affect cell division. When the cell cycle control system malfunctions, a cell may become cancerous, dividing excessively.
- The chromosomes of somatic cells come in homologous pairs, which carry genes for the same characteristics at the same locations. In mammals, males have X and Y sex chromosomes, females have two X chromosomes.
- Cells with two sets of homologous chromosomes are diploid. Gametes—eggs and sperm—are haploid. Fertilization produces a diploid zygote, and repeated mitotic divisions produce an adult that will produce haploid gametes by meiosis.
- Meiosis is preceded by chromosome duplication. The two divisions of meiosis yield four haploid cells. Meiosis I starts with synapsis, the pairing of homologous chromosomes in which crossing over and exchange between chromatids occurs. Meiosis I separates each pair of homologous chromosomes. In meiosis II, sister chromatids separate.

Chapter 8: The Cellular Basis of Reproduction and Inheritance

- Offspring of organisms that reproduce sexually are genetic copies of the parent and each other. Offspring of sexual reproduction inherit traits from two parents.
- A prokaryotic cell, with its single chromosome, divides by binary fission.
- Each eukaryotic chromosome, carrying multiple genes, consists of one long DNA molecule packed around protein molecules.
- In interphase, a cell grows and duplicates its chromosomes, producing sister chromatids that are joined together. The cell divides during mitosis and cytokinesis (the mitotic phase).
- During the four main steps of mitosis—prophase, metaphase, anaphase, and telophase—chromosomes coil up, the nuclear envelope breaks down, a mitotic spindle forms with chromosomes at the metaphase plate, and sister chromatids separate and move to opposite poles of the cell, where new nuclei form.

Diagram of cellular respiration:

Diagram of photosynthesis:

Diagram of meiosis:

Diagram of mitosis:

Diagram of chromosome structure:

Diagram of sexual reproduction:
Chapter 9: Patterns of Inheritance

- Mendel discovered the basic principles of heredity by breeding garden peas. He deduced that an organism has two genes (alleles) for each inherited character, one from each parent. Mendel’s principle of segregation states that pairs of alleles separate during gamete formation and that fertilization restores pairs.

- A testcross mating with a recessive homozygote can determine the unknown genotype of an individual with a dominant phenotype.

- The inheritance of many human traits follows Mendel’s principles and the rules of probability. Geneticists can use family pedigrees to determine genotypes. Many inherited disorders are controlled by a single gene.

- When the phenotype of a heterozygote is in between the parental phenotypes, the alleles are said to display incomplete dominance. There may be multiple kinds of alleles for a characteristic, such as the three alleles for the ABO blood groups. The alleles determining the A and B blood factors are codominant; both are expressed in a heterozygote.

- The impact of a single gene on more than one characteristic is called pleiotropy. In polygenic inheritance, multiple genes may influence a single characteristic, creating a continuum of phenotypes.

- Linked genes tend to be inherited together. Crossing over can separate linked genes and produce recombinant chromosomes. Geneticists use recombination frequency data to map the relative positions of genes.

- Genes on the sex chromosomes are said to be sex-linked. Their inheritance pattern reflects the fact that females have two X chromosomes, but males have only one.

Chapter 10: Molecular Biology of the Gene

- DNA is a double-stranded helix consisting of two sugar-phosphate backbones and paired nitrogenous bases in the center.

- A ribosome in the cytoplasm is a complex molecule that synthesizes proteins. It occurs in the cytoplasm. Tripletts of nucleotide bases in mRNA, called codons, specify the amino acids of the polypeptide. A ribosome assembles with tRNA molecules carrying their amino acids.

- Mutations are changes in the DNA sequence caused by errors in DNA replication or by mutagens.

- Viruses are genes packaged in protein. In bacteria, viruses can replicate within and then burst out of a host cell (lysogenic cycle) or integrate into the host chromosome (lytic cycle).

- Many viruses cause disease when they invade animal or plant cells. HIV, the AIDS virus, is a retrovirus. It uses its RNA as a template for making DNA, which then inserts into a host chromosome.

Chapter 11: The Control of Gene Expression

- Gene expression is the flow of information from genes to proteins.

- Operons, found in prokaryotes, are clusters of genes with related functions. Regulatory proteins turn operons on or off in response to environmental changes.

- Differentiation of cells in multicellular eukaryotes results from selective gene expression.

- Most differentiated cells retain a complete set of genes, creating the potential for cloning plants and animals under special conditions. In nuclear transplantation, a donor cell nucleus is inserted into a nucleus-free egg. The purpose of reproductive cloning is to produce a cloned animal; the purpose of therapeutic cloning is to produce embryonic stem cells for medical uses.

- Gene expression can be controlled at any stage in the pathway from gene to functional protein.
Chapter 13: How Populations Evolve

- In his 1859 publication On the Origin of Species, Darwin made two proposals:
  1. Modern species descended from ancestral species.
  2. Natural selection is the mechanism of evolution.

- Darwin's theory of natural selection states that the individuals best suited for a particular environment are more likely to survive and reproduce, passing on their traits to offspring.

- Evidence for evolution comes from the fossil record, biogeography, comparative anatomy and embryology, and molecular biology:
  - A population is the smallest biological unit that can evolve.
  - The gene pool consists of all alleles in a population.

- Microevolution is a change in a population's gene pool over generations.

- The Hardy-Weinberg equilibrium shows the rates in allele frequency from generation to generation. The equilibrium includes a very large population size, no migration, no new mutations, random mating, and no natural selection.

- Causes of microevolution: genetic drift (a change in allele frequencies in a small population due to chance), gene flow due to migration, mutation, and natural selection. Natural selection accumulates and maintains favorable genotypes in a population.

- Stabilizing selection tends to favor intermediate forms; directional selection acts against one extreme; while diversifying selection favors extreme types over intermediate forms.

- Sexual selection leads to the evolution of characters that can give individuals an advantage in mating.

Chapter 14: The Origin of Species

- A species is a population or group of populations whose members can interbreed and produce fertile offspring. Most organisms are classified based on observable phenotypic traits.

- Prezygotic reproductive barriers prevent mating or fertilization between individuals of different species. Postzygotic barriers prevent the development of fertile adults.

- Allopatric speciation is the formation of a new species as a result of an ancestral population's isolation by a geographic barrier. Speciation occurs only when the gene pool undergoes changes that establish reproductive barriers.

- Adaptive radiation, the emergence of numerous species from a common ancestor, is often associated with the small and diverse habitats found in isolated areas.

- In sympatric speciation, fairly common in plants, new species may arise without geographic isolation.

- The punctuated equilibrium model suggests that species diverge in spurts of relatively rapid change, and then change little during the rest of their existence.

Chapter 15: Tracing Evolutionary History

- Macroevolution is evolutionary change on a scale encompassing the origin of new taxonomic groups, continental drift, mass extinctions, evolution of existing structures, and changes in genes that control development.

- The geologic time scale chronicles macroevolution as recorded in the fossil record.

- Phylogeny is the evolutionary history of a group. A phylogenetic tree represents hypothesized evolutionary relationships based on data such as fossils, homologous structures, and molecular comparisons.

- Systematics is the study of biological diversity in an evolutionary context. It includes taxonomy, the naming and classifying of species and groups of species. The taxonomic hierarchy of categories is domain, kingdom, phylum, class, order, family, genus, species.

- cladistic analysis strives to identify clades, or monophyletic taxa. (evolutionary branches composed of an ancestor and all its descendents). In a cladogram, branch points are defined by shared derived characters unique to a group.

Chapter 16: The Origin and Evolution of Microbial Life: Prokaryotes and Protists

- Life originated 3.5 to 3.9 billion years ago. One hypothesis for the origin of life involves a sequence of events: abiotic synthesis of simple organic molecules, formation of polymers, development of self-replicating molecules, probably RNA, and enclosure of these molecules in membranes.

- Prokaryotes, Earth's oldest, and most numerous and widespread life forms, are classified into two domains: Bacteria and Archaea.

- Prokaryotes exhibit four modes of nutrition, based on energy source (light or chemical) and carbon source (CO2 or organic compounds): phototroph, chemotroph, lithotroph, and chemoheterotroph.

- Prokaryotes come in a variety of shapes and may be equipped with flagella or pili. Some bacteria can cause diseases such as food poisoning.

- Cyanobacteria are phototrophic prokaryotes.

- Eukaryotic cells evolved over 2 billion years ago. The nucleus and endomembranes probably arose from inclusions of the plasma membrane. Mitochondria and chloroplasts probably evolved from endosymbiotic bacteria:

Chapter 17: Plants, Fungi, and the Colonization of Land

- Most plants have roots, stems, and leaves—organs that function in absorption, support, and photosynthesis. Terrestrial adaptations include a protective cuticle, stomata for gas exchange, vascular tissues for transport, and support, and succulent produced in succulents, and developing endosperm protected and nourished on the parent plant.
Chapter 19: Human Evolution

- Humans are members of the primates, an order of mammals.
- A phylogenetic tree of primates:

  ![Phylogenetic Tree of Primates]

- There are two main groups of hominids: (1) the Australopithecines, which came first and are all extinct; and (2) members of the genus Homo, with all species extinct except Homo sapiens.
- Homo erectus spread out of Africa to other continents around 1.5 million years ago, giving rise to regionally diverse descendants, such as the Neanderthals. According to the multiregional hypothesis, modern humans evolved from these regionally diverse populations. Most paleoanthropologists support the "out of Africa" or replacement hypothesis, which contends that modern humans came from a second group that arose around 100,000 years ago and migrated out of Africa, replacing archaic peoples elsewhere.
- Human culture has evolved through three stages: scavenging-gathering-hunting; agriculture; and the machine age.

Chapter 20: Unifying Concepts of Animal Structure and Function

- Structure and function are correlated at each level in the hierarchy of an animal’s body: cell, tissue, organ, organ system, and animal.
- Animals have four kinds of tissue: (1) epithelial (covers body surfaces); (2) connective (supports other organs); (3) muscle (contracts); and (4) nervous (relays information).
- Each organ is made of several tissues. An organ system is a group of organs that work together to perform a vital function. There are 12 major organ systems: digestive, respiratory, circulatory, lymphatic, immune, exocrine, endocrine, reproductive, nervous, muscular, and skeletal and integumentary.
- All animals exchange materials with the environment. Larger organisms have extensively branched internal structures and a circulatory system that facilitates exchange between the environment and body cells (via interstitial fluid).
- Homeostasis is the body's tendency to maintain relatively constant internal conditions despite large fluctuations in the external environment.

- Negative feedback is a control mechanism in which a change triggers mechanisms that counteract the change.

Chapter 21: Nutrition and Digestion

- There are four stages of food processing: ingestion, digestion, absorption (into the body's cells), and elimination (of undigested materials).
- Digestion, the breakdown of macromolecules of food into monomers, occurs in compartments housing hydrolytic enzymes. Simple animals such as hydra have a gastrovascular cavity with one opening. Most other animals have an alimentary canal, running from mouth to anus, that includes specialized regions such as a crop, gizzard or stomach.
- Human digestion begins in the oral cavity where teeth and digestive enzymes start to break down food. Using peristalsis, the esophagus pushes food along to the stomach, where food is stored and broken down further with acid and enzymes. Virtually all chemical digestion and nutrient absorption occurs in the small intestine. The pancreas and the liver provide digestive enzymes and bile, respectively. The large intestine helps to reclaim water.

Chapter 22: Respiration: the Exchange of Gases

- Gas exchange involves breathing, transport of O₂ and CO₂ by the circulatory system, and the servicing of tissue cells.
- Animals require a moist surface for diffusion of gases between their cells and the surrounding air or water. There are four types of gas exchange mechanisms:
  1. Skin: respiratory organ in earthworms and flatworms.
  2. Gills: outfoldings of the body surface in fish and aquatic invertebrates. Countercurrent exchange maximizes oxygen transfer from water to blood.
  3. Tracheae: tiny branching internal air tubes in insects.
  4. Lungs: internal sacs in terrestrial vertebrates.
- The human respiratory system:

- Negative pressure breathing ventilates the lungs of mammals. Muscle contractions expand the rib cage and lower the diaphragm, creating a negative pressure, and...
Chapter 23: Circulation

- The circulatory system transports nutrients and O₂ to body cells, transports wastes, and plays a key role in homeostasis.
- The pulmonary circuit carries blood between the heart and lungs. The systemic circuit transports blood between the heart and body (systemic) capillaries.
- Blood flow through the human cardiovascular system:
  - Arteries carry blood under high pressure from the heart. Exchange between the blood and interstitial fluid occurs across the thin walls of capillaries. Blood moves back to the heart via veins with one-way valves.
  - The cardiac cycle is controlled via electrical signals from the pacemaker (SA node): It is composed of two phases: systole (contraction) and diastole (relaxation).
  - Diseases of the heart and blood vessels—such as heart attack and stroke—are more common in Americans than any other type of disease. Atherosclerosis is the buildup of lipids and other substances in the arteries.
  - Blood consists of plasma (water and dissolved salts and proteins) and cells: red blood cells (erythrocytes), which transport oxygen, white blood cells (leukocytes), which aid in defense, and platelets, which aid in clotting.
- The body is a network of fluid-collecting vessels and organs, including the lymph nodes that fight infections.
- The immune system is a large collection of cells that present a specific response to infection. Antigens are molecules that elicit immune reactions.
  - Two kinds of lymphocytes carry out the immune response:
    1. B cells, responsible for humoral immunity, secrete antibodies, which attach foreign antigens in body fluids.
    2. T cells, responsible for cell-mediated immunity, attack body cells infected with pathogens.
  - Antibodies recognize antigens through specific binding and can trigger destruction of the antigen-bearing molecule or cell.
- Antigens activate only lymphocytes with complementary receptors, a process called clonal selection. In the primary response (shown below) the selected lymphocytes multiply into clones of effector cells and memory cells. Memory cells mount a rapid secondary immune response upon subsequent exposures.

Chapter 25: Control of the Internal Environment

- Thermoregulatory mechanisms, which help to maintain body temperature within narrow limits, include increases in metabolic rate, shivering, and sweating, and behavioral responses such as basking in the sun, burrowing, or migrating.
- Osmoregulation is the control of the gain and loss of water and dissolved solutes in an organism. The secretory system plays a role in osmoregulation and helps the body of nitrogenous wastes, in the form of ammonia, urea, or uric acid.
- The nephron is the functional unit of the human kidney.
- Major functions of the excretory system:
  - Reabsorption
  - Secretion
  - Excretion

Chapter 26: Chemical Regulation

- The endocrine system consists of a collection of hormone-secreting cells. A hormone is a regulatory chemical that travels via the bloodstream to target cells, where it may trigger changes by two main signaling mechanisms: (1) binding a plasma-membrane receptor, or (2) binding an intracellular receptor.
- The vertebrate endocrine system consists of more than a dozen glands, secreting over 50 hormones. The hypothalamus is the master control center, secreting some hormones that are stored and released from the posterior pituitary gland. It also regulates the anterior pituitary’s production of hormones, many of which regulate the activity of other endocrine glands.
- Hormones from the thyroid gland regulate development and metabolism. Blood calcium level is balanced by the hormones calcitonin and parathyroid hormone.
- The pancreas secretes insulin and glucagon, which have opposing effects in the control of blood glucose level.
- Hormones from the medulla and cortex of the adrenal glands help to maintain homeostasis by mediating short-term and long-term responses to stress, respectively.
- Estrogen, progesterone, and androgens are steroid sex hormones produced by the ovaries in females and the testes in males.

Chapter 27: Reproduction and Embryonic Development

- Fertilization triggers formation of a fertilization envelope and the start of embryonic development. Cleavage is the rapid cell divisions that produce a hollow ball of cells.
- In gastrulation, cells migrate inward, producing three cell layers: endoderm, mesoderm, and ectoderm. These three embryonic tissue give rise to specific organs.
- The embryo in the female reproductive tract.
- The path from ovulation to implantation:
  - Ovulation
  - Implantation
**Chapter 28: Nervous Systems**

- The nervous system receives sensory input, interprets it, and sends out appropriate motor commands.
- Neurons are the functional units of the nervous system. The structure of a motor neuron:

  ![Motor Neuron Diagram]

  - A neuron maintains a membrane potential across its membrane, with the interior of the cell negatively charged.
  - In a nerve signal, called an Action potential, ions move in and out of a neuron, creating a rapid change from resting potential to a positive potential and back again. Action potentials are self-propagated in a one-way chain reaction along a neuron.
  - A nerve signal may be passed to another neuron across a synapse. Chemical synapses make complex information processing possible. A variety of small molecules serve as neurotransmitters.
  - The vertebrate central nervous system includes the brain and spinal cord.
  - Functional divisions of the peripheral nervous system:

![Peripheral Nervous System Diagram]

- The hindbrain, midbrain, and the thalamus and hypothalamus of the forebrain function in conducting information to and from higher brain centers, keeping track of body position, regulating homeostatic functions, and sorting sensory information.
- The cerebrum of the forebrain is the largest and most complex part of the brain.
- The cerebral cortex contains specialized, interactive regions responsible for language, reasoning, personality traits, and integration of sensory information and motor responses.
- The hypothalamus, cerebellum, pons, and reticular formation regulate sleep and arousal.
- The limbic system is involved in emotions, memory, and learning.

**Chapter 29: The Senses**

- In sensory transduction, sensory receptors convert stimuli into electrical signals, which are transmitted via sensory neurons to the central nervous system.
- There are five categories of sensory receptors: (1) pain receptors; (2) thermoreceptors; (3) mechanoreceptors (touch, pressure, and sound); (4) chemoreceptors (taste and smell); and (5) electromagnetic receptors (photoreceptors).
- The cornea and lens focus light on photoreceptor cells in the retina. The lens changes shape to bring objects at different distances into sharp focus.
- Photoreceptor cells called rods are extremely sensitive to light; cones are photoreceptors that distinguish color.

**Chapter 30: How Animals Move**

- The outer ear channels sound waves to the eardrum, which passes vibrations through a chain of bones in the middle ear to the cochlea. Vibrating fluid bends hair cells in the organ of Corti, triggering nerve signals to the brain. The semicircular canals and the utricle and saccule are organs of balance located in the inner ear.
- Olfactory (odor) receptors lining the nasal cavity and taste receptors located on the tongue detect and respond to different categories of chemicals.

**Chapter 31: Plant Structure, Reproduction, and Development**

- Angiosperms (flowering plants) can be grouped into monocots or dicots based on the number of cotyledons (seed leaves) in the embryo and other differences.
- The body plan of a flowering plant (a dicot):

  ![Flowering Plant Diagram]

  - Terminal bud
  - Shoot system
  - Root system
  - Water uptake from soil
  - Photosynthesis sugar by a pressure-flow mechanism:

- Plant health depends on a complete set of essential inorganic nutrients.
- Fertile soil contains a mixture of small rock and clay particles that hold water and allow O2 to diffuse into plant roots. Humus (decaying organic material) enhances soil fertility.
- Most plants form mycorrhizae, mutualistic associations of plant roots and fungi. Many plants depend on bacteria to convert nitrogen into a form usable by the plant.
- Improving the protein content of crops is an important research goal. Using biotechnology, researchers are developing new varieties of crop plants.
Chapter 33: Control Systems in Plants

- Hormones, such as those listed below, regulate plant growth and development and coordinate the activities of plant cells.
  1. Auxin. Produced in the tips of shoots, stimulates or inhibits the elongation of shoots and roots and promotes growth in stem diameter.
  2. Cytokinins. Promote cell division. The ratio of auxin to cytokinins may coordinate the growth of roots and shoots.
  4. Abscisic acid (ABA). Inhibits the germination of seeds and closes stomata under water stress.
  5. Ethylene. Hastens ripening.
  6. Tropisms, such as phototropism, gravitropism, and thigmotropism, are growth responses that make a plant grow toward or away from a stimulus.
  7. An internal biological clock controls daily cycles, called circadian rhythms. The timing of flowering and other seasonal events are affected by photoperiod, the relative lengths of night and day. Phytochrome, a light-absorbing protein, may help plants set their biological clock and monitor photoperiod.
  8. Plants use chemicals to defend themselves against both herbivores and pathogens.

Chapter 34: The Biosphere: An Introduction to Earth's Diverse Environments

- Ecology is the scientific study of interactions between organisms and their environments. The environment includes abiotic (nonliving) and biotic (living) components. Ecologists study interactions at the organismal, population, community, and ecosystem levels.
- The global ecosystem is called the biosphere. Several abiotic factors, such as availability of sunlight and water, temperature, wind, and disturbances, affect the distribution and abundance of organisms.
- Organisms are adapted to the abiotic and biotic factors of their environment by natural selection.
- Climate influences the distribution of biological communities. Earth's global climate patterns are largely determined by variations in solar radiation, rainfall, and winds.
- Aquatic biomes include the oceans, estuaries, wetlands (both marine and freshwater), ponds, lakes, streams, and rivers.
- Terrestrial biomes include tropical forests, savannas, deserts, chaparrals, temperate grasslands, temperate deciduous forests, coniferous forest or taiga, and tundra.

Chapter 35: Population Dynamics

- A population consists of members of a species living in the same place at the same time. A population's density is the number of individuals per unit area or volume, and its pattern of dispersion (spacing) may be clumped, uniform, or random.
- Two idealized models of population growth (shown on graph below):
  1. The exponential growth curve is J-shaped, showing an acceleration in population growth in an unlimited environment.
  2. The logistic growth curve is S-shaped, showing a population leveling off at the carrying capacity, K, of the environment. A mixture of density-dependent and other abiotic factors may limit the growth of most populations.

- The human population has been growing almost exponentially for centuries. The ecological footprint estimates the amount of productive land needed to support a nation's resource (food, fuel, water, housing, waste disposal) needs.
- A population's age structure is a major factor in the growth rates of different countries. The demographic transition is the shift from high birth and death rates to low birth and death rates.

Chapter 36: Communities and Ecosystems

- A community includes all the organisms inhabiting an area. The biodiversity of a community includes the species richness and relative abundance of different species.
- Interspecific competition occurs if two species require the same limited resource. A species' niche is its role in the community.
- The reciprocal adaptation of predators and prey is known as coevolution. A prey species may gain protection from camouflage and mimicry. A keystone predator reduces the density of the strongest competitors in a community.
- A symbiotic species lives in or on a host species. In parasitism, one organism benefits at the expense of the other. Mutualism benefits both partners.
- Disturbances are episodes that destroy organisms and alter the availability of resources. The sequence of changes in a community after a disturbance is called ecological succession.
- An ecosystem is a biological community and the abiotic factors with which that community interacts. Energy flows from the sun, through plants to animals and decomposers, and is lost as heat. Chemicals are recycled between an ecosystem's living community and the abiotic environment.
- A food chain is the stepwise transfer of food from producers to primary, secondary, and higher-level consumers.

- The global water cycle involves precipitation, evaporation, and transpiration.
- The carbon cycle involves photosynthesis and respiration; the nitrogen cycle relies on bacteria that convert atmospheric N₂ compounds that plants can use.
- The phosphorus cycle depends on the weathering of rock. Human disruption of ecosystems can alter nutrient cycling and cause eutrophication of ponds and lakes.

Chapter 37: Behavioral Adaptations to the Environment

- Behavioral biologists look at (1) proximate causes to understand behavior in terms of immediate interactions with the environment; and (2) ultimate causes, the evolutionary causes of a behavior.
- Animal behavior often involves a combination of genes (inborn behavior) and environment (learning). Fixed action patterns (FAPs) are unchangeable, innate behaviors, often triggered by sign stimuli.
- Learning is a change in behavior resulting from experience. Types of learning include habituation, imprinting, association, imitation, and problem solving.
- Cognitive ethologists study animal cognition, the ability of an animal to perceive, store, process, and use information.
- Daily (circadian) rhythms appear to be timed by an internal biological clock. Animals may orient their movements using stimuli or landmarks. Some animals may form cognitive maps of their surroundings. Animals that migrate, like the monarch butterfly, may navigate using sun, stars, landmarks, or Earth's magnetism.
- Behavioral ecologists study feeding behavior in terms of optimal foraging.
- Sociobiologists study social behavior in the context of evolution.
- Competitive behavior includes agonistic behavior, dominance hierarchies, and territoriality. Mating behavior often involves elaborate courtship rituals.
- Social behavior depends on signaling, using sounds, scents, displays, or touch.
- Altruistic behavior, which reduces an individual's fitness while increasing the reproductive potential of another, may be explained by kin selection, helping others that share the same genes.
- Both genes and culture contribute to human social behavior.

Chapter 38: Conservation Biology

- Conservation biology seeks to counter the loss of biodiversity.
- Habitat destruction is the greatest threat to biodiversity. Competition with introduced species and overexploitation of wildlife threaten many species.
- The explosive growth of the human population and of technology threatens the biosphere. Human destruction of the environment includes spills, acid rain, ozone depletion, and biological magnification of pesticides.
- Deforestation and burning of fossil fuels have increased concentrations of CO₂, contributing to the greenhouse effect and global warming.
- Biodiversity hot spots are small areas with a large concentration of species, many of which are endemic (found nowhere else).
- Habitat loss fragments populations, often leading to a species' designation as endangered or threatened. Conservation biology seeks to identify and preserve critical habitat factors.
- Conservation efforts increasingly consider whole ecosystems and landscapes (interacting ecosystems). Human activities create many edges, or boundaries, between ecosystems. Movement corridors connect otherwise isolated habitat patches.
- Two strategies for restoring degraded habitats are bioremediation, using living organisms to detoxify ecosystems, and augmenting of ecosystem processes, identifying and restoring key factors.
- The goal of sustainable development is the long-term prosperity of human societies and the ecosystems that support them.