CollegeBoard

Name of textbook: *BIOLOGY AP* Edition* **Edition:** 7th Edition
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Big Idea 1: The process of evolution drives the diversity and unity of life.

Essential knowledge	Chapters/sections	Illustrative examples covered
1.a.1 Natural selection is a major mechanism of evolution	22.2, 23.1	• Graphical analysis of allele frequencies in a population • Application of the Hardy-Weinberg equilibrium equation
1.a.2 Natural selection acts on phenotypic variations in populations	23.2, 23.4	• Flowering time in relation to global climate change • Peppered moth • Sickle cell Anemia • DDT resistance in insects • Artificial selection • Loss of genetic diversity within a crop species • Overuse of antibiotics
1.A.3: Evolutionary change is also driven by random Processes	23.3	*No illustrative examples listed in Curriculum Framework*.
1.a.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics.	22.3, 26.2	• Graphical analyses of allele frequencies in a population • Analysis of sequence data sets • Analysis of phylogenetic trees • Construction of phylogenetic trees based on Sequence data
1.b.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	26.1, 26.3, 26.4, 26.5	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) • Membrane-bound organelles (mitochondria and/or chloroplasts) • Linear chromosomes • Endomembrane systems, including the nuclear Envelope
1.b.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	25.1, 25.2, , 25.3	• Number of heart chambers in animals • Opposable thumbs • Absence of legs in some sea mammals

Essential knowledge	Chapters/sections	Illustrative examples covered
1.c.1 Speciation and extinction have occurred throughout the Earth's history.	24.2, 24.3, 26.2	• Five major extinctions • Human impact on ecosystems and species extinction rates
1.c.2 Speciation may occur when two populations become reproductively isolated from each other.	24.1	*No illustrative examples listed in Curriculum Framework*.
1.c.3 Populations of organisms continue to evolve.	24.2	• Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) • Emergent diseases • Observed directional phenotypic change in a Population (Grants' observations of Darwin's finches in the Galapagos) • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system
1.d.1 There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.	4.1, 26.1,26.3, 26.4, 26.5	*No illustrative examples listed in Curriculum Framework*.
1.d.2 Scientific evidence from many different disciplines supports models of the origin of life.	26.6	*No illustrative examples listed in Curriculum Framework*.

Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.

Essential knowledge	Chapters/sections	Illustrative examples covered
2.a.1 All living systems require constant input of free energy.	8.1, 8.2, 8.3 9.1- 9.5 10.1, 10.2, 10.3 40.1, 40.2, 40.3, 40.4, 40.5 51.3 52.3, 52.4 53.2 54.1, 54.3	• Krebs cycle • Glycolysis • Calvin cycle • Fermentation • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) • Seasonal reproduction in animals and plants • Life-history strategy (biennial plants and reproductive diapause) • Change in the producer level can affect the number and size of other trophic levels • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels
2.a.2 Organisms capture and store free energy for use in biological processes.	9.1-9.5 10.1, 10.2, 10.3	• $NADP^+$ in photosynthesis • Oxygen in cellular respiration
2.a.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	3.1, 3.2, 3.3 4.1, 4.2 6.2	• Cohesion • Adhesion • High specific heat capacity • Universal solvent supports reactions • Heat of vaporization • Heat of fusion • Water's thermal conductivity • Root hairs • Cells of the alveoli • Cells of the villi • Microvilli
2.b.1 Cell membranes are selectively permeable due to their structure.	7.1, 7.2	*No illustrative examples listed in Curriculum Framework*.

Essential knowledge	Chapters/sections	Illustrative examples covered
2.b.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.	7.3, 7.4, 7.5	• Glucose transport • Na^+/K^+ transport
2.b.3 Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.	6.2, 6.3, 6.4, 6.5	• Endoplasmic reticulum • Mitochondria • Chloroplasts • Golgi • Nuclear envelope
2.c.1 Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.	40.2, 40.4, 40.5	• Operons in gene regulation • Temperature regulation in animals • Plant responses to water limitations • Lactation in mammals • Onset of labor in childbirth • Ripening of fruit • Diabetes mellitus in response to decreased insulin • Dehydration in response to decreased antidiuretic hormone (ADH) • Graves' disease (hyperthyroidism) • Blood clotting
2.C.2 Organisms respond to changes in their external environments.	40.5	• Photoperiodism and phototropism in plants • Hibernation and migration in animals • Taxis and kinesis in animals • Chemotaxis in bacteria, sexual reproduction in fungi • Nocturnal and diurnal activity: circadian rhythms • Shivering and sweating in humans
2.d.1 All biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy	50.2 52.1, 52.2, 52.3, 53.1, 53.2, 53.3, 53.4, 53.5 54.1, 542, 54.3, 54.4	• Cell density • Biofilms • Temperature • Water availability • Sunlight • Symbiosis (mutualism, commensalism, and parasitism) • Predator–prey relationships • Water and nutrient availability, temperature, salinity, and pH

Essential knowledge	Chapters/sections	Illustrative examples covered
		• Water and nutrient availability • Availability of nesting materials and sites • Food chains and food webs • Species diversity • Population density • Algal blooms
2.d.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	40.4, 40.5 55.1 (see illustrative examples for additional content)	• Gas exchange in aquatic and terrestrial plants • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, and one-way digestive systems • Respiratory systems of aquatic and terrestrial animals • Nitrogenous waste production and elimination in aquatic and terrestrial animals • Excretory systems in flatworms, earthworms, and vertebrates • Osmoregulation in bacteria, fish and protists • Osmoregulation in aquatic and terrestrial plants • Circulatory systems in fish, amphibians and mammals • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms)
2.d.3 Biological systems are affected by disruptions to their dynamic homeostasis.	40.4, 40.5 55.1	• Physiological responses to toxic substances • Dehydration • Immunological responses to pathogens, toxins, and allergens • Invasive and/or eruptive species • Human impact • Hurricanes, floods, earthquakes, volcanoes, and fires • Water limitation • Salination
2.d.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	39.5 43.1, 43.2, 43.3, 43.4, 43.5	• Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses • Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens

Essential knowledge	Chapters/sections	Illustrative examples covered
2.e.1 Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms.	19.2, 21.2 38.1, 38.2	• Morphogenesis of fingers and toes • Immune function • *C. elegans* development • Flower Development
2.e.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	38.1, 38.2 39.2, 39.3 24.1 11.1	• Circadian rhythms, or the physiological cycle of about 24 hours that is present in all eukaryotes and persists even in the absence of external cues • Diurnal/nocturnal and sleep/awake cycles • Jet lag in humans • Seasonal responses, such as hibernation, estivation, and migration • Release and reaction to pheromones • Visual displays in the reproductive cycle • Fruiting body formation in fungi, slime molds, and certain types of bacteria • Quorum sensing in bacteria
2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.	51.1, 51.2 39.2, 39.3 51.2 53.1	• Availability of resources leading to fruiting body formation in fungi and certain types of bacteria • Niche and resource partitioning • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; and mycorrhizae) • Biology of pollination • Hibernation • Estivation • Migration • Courtship

Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.

Essential knowledge	Chapters/sections	Illustrative examples covered
3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	5.5 27.1 16.1, 16.2 17.1, 17.2, 17.3, 17.4 18.1 20.1, 20.2, 20.3	• Addition of a poly-A tail • Addition of a GTP cap • Excision of introns • Enzymatic reactions • Transport by proteins • Synthesis • Degradation • Electrophoresis • Plasmid-based transformation • Restriction enzyme analysis of DNA • Polymerase Chain Reaction (PCR) • Genetically modified foods • Transgenic animals • Cloned animals • Pharmaceuticals, such as human insulin or factor X
3.A.2 In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis, or meiosis plus fertilization.	12.1, 12.2, 12.3 13.1, 13.2, 13.3	• Mitosis-promoting factor (MPF) • Action of platelet-derived growth factor (PDGF) • Cancer results from disruptions in cell cycle control
3.A.3 The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring	14.1, 14.2, 14.3, 14.4	• Sickle cell anemia • Tay-Sachs disease • Huntington's disease • X-linked color blindness • Trisomy 21/Down syndrome • Klinefelter's syndrome • Reproduction issues • Civic issues such as ownership of genetic information, privacy, historical contexts, etc.
3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.	15.1, 15.2, 15.3, 15.5	• Sex-linked genes reside on sex chromosomes (X in humans) • In mammals and flies, the Y chromosome is very small and carries few genes • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits

Essential knowledge	Chapters/sections	Illustrative examples covered
		are always expressed in males • Some traits are sex limited, and expression depends on the sex of the individual, such as milk production in female mammals and pattern baldness in males
3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	18.4, 19.2	• Promoters • Terminators • Enhancers
3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression.	11.1, 11.4 18.4 19.2 21.2	• Cytokines regulate gene expression to allow for cell replication and division • Mating pheromones in yeast trigger mating gene expression • Levels of cAMP regulate metabolic gene expression in bacteria • Expression of the SRY gene triggers the male sexual development pathway in animals • Ethylene levels cause changes in the production of different enzymes, allowing fruits to ripen • Seed germination and gibberellin • Mating pheromones in yeast trigger mating genes expression and sexual reproduction • Morphogens stimulate cell differentiation and development • Changes in p53 activity can result in cancer • HOX genes and their role in development
3.C.1 Changes in genotype can result in changes in phenotype.	15.4 16.2 17.7 23.4	• Antibiotic resistance mutations • Pesticide resistance mutations • Sickle cell disorder and heterozygote advantage
3.C.2 Biological systems have multiple processes that increase genetic variation.	18.3 13.4	*No illustrative examples listed in Curriculum Framework*.
3.C.3 Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.	18.1	• Transduction in bacteria • Transposons present in incoming DNA

Essential knowledge	Chapters/sections	Illustrative examples covered
3.D.1 Cell communication processes share common features that reflect a shared evolutionary history.	11.1, 11.2	• Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing) • Use of pheromones to trigger reproduction and developmental pathways • Response to external signals by bacteria that influences cell movement • Epinephrine stimulation of glycogen breakdown in mammals • Temperature determination of sex in some vertebrate organisms • DNA repair mechanisms
3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	11.1, 11.2	• Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells. and killer T-cells. [See also 2.D.4] • Plasmodesmata between plant cells that allow material to be transported from cell to cell • Neurotransmitters • Plant immune response • Quorum sensing in bacteria • Morphogens in embryonic development • Insulin • Human growth hormone • Thyroid hormones • Testosterone • Estrogen
3.D.3. Signal transduction pathways link signal reception with cellular response.	11.3	• G-protein linked receptors • Ligand-gated ion channels • Receptor tyrosine kinases • Ligand-gated ion channels • Second messengers, such as cyclic GMP, cyclic AMP, calcium ions (Ca^{2+}), and inositol triphosphate (IP_3)
3.D.4. Changes in signal transduction pathways can alter cellular response.	11.4	• Diabetes, heart disease, neurological disease, autoimmune disease, cancer, and cholera • Effects of neurotoxins, poisons, and pesticides • Drugs (Hypertensives, Anesthetics, Antihistamines, and Birth Control Drugs)

Essential knowledge	Chapters/sections	Illustrative examples covered
3.E.1. Individuals can act on information and communicate it to others.	51.2, 51.3	· Fight or flight response · Predator warnings · Protection of young · Plant-plant interactions due to herbivory · Avoidance responses • Herbivory responses • Territorial marking in mammals • Coloration in flowers • Bee dances • Birds songs • Territorial marking in mammals • Pack behavior in animals • Herd, flock, and schooling behavior in animals • Predator warning • Colony and swarming behavior in insects • Coloration • Parent and offspring interactions • Migration patterns • Courtship and mating behaviors • Foraging in bees and other animals • Avoidance behavior to electric fences, poisons, or traps
3.E.2. Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	48.1, 48.2, 48.3, 48.4, 48.5	• Acetylcholine • Epinephrine • Norepinephrine • Dopamine • Serotonin • GABA • Vision • Hearing • Muscle movement • Abstract thought and emotions • Neuro-hormone production • Forebrain (cerebrum), midbrain (brainstem), and hindbrain (cerebellum) • Right and left cerebral hemispheres in humans

Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.

Essential knowledge	Chapters/sections	Illustrative examples covered
4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	5.1, 5.2, 5.3, 5.4, 5.5	*No illustrative examples listed in Curriculum Framework*.
4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.	6.2, 6.3, 6.4, 6.5	*No illustrative examples listed in Curriculum Framework*.
4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	21.2	*No illustrative examples listed in Curriculum Framework*.
4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	48.4 (refer to illustrative examples for more)	• Stomach and small intestines • Kidney and bladder • Root, stem and leaf • Respiratory and circulatory • Nervous and muscular • Plant vascular and leaf
4.A.5: Communities are composed of populations of organisms that interact in complex ways.	52.1, 52.3, 52.4, 52.5, 52.6 53.1, 53.2	• Predator/prey relationships spreadsheet model • Symbiotic relationship • Graphical representation of field data • Introduction of species • Global climate change models
4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	53.2 54.1, 54.2, 54.3, 54.4, 55.4	*No illustrative examples listed in Curriculum Framework*.
4.B.1: Interactions between molecules affect their structure and function.	5.4 8.4, 8.5	*No illustrative examples listed in Curriculum Framework*.

Essential knowledge	Chapters/sections	Illustrative examples covered
4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	6.4, 40.1, 40.2 (refer to illustrative examples)	• Exchange of gases • Circulation of fluids • Digestion of food • Excretion of wastes • Bacterial community in the rumen of animals • Bacterial community in and around deep sea vents
4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.	53.1	• Loss of keystone species • Kudzu • Dutch elm disease
4.B.4: Distribution of local and global ecosystems changes over time.	25.4 55.1 54.5	• Dutch elm disease • Potato blight • Small pox [historic example for Native Americans] • El Nino • Continental drift • Meteor impact on dinosaurs
4.C.1: Variation in molecular units provides cells with a wider range of functions.	5.1, 5.2, 5.3, 5.4, 5.5 19.5	• Different types of phospholipids in cell membranes • Different types of hemoglobin • MHC proteins • Chlorophylls • Molecular diversity of antibodies in response to an antigen • The antifreeze gene in fish
4.C.2: Environmental factors influence the expression of the genotype in an organism.	14.3	• Height and weight in humans • Flower color based on soil pH • Seasonal fur color in arctic animals • Sex determination in reptiles • Density of plant hairs as a function of herbivory • Effect of adding lactose to a Lac + bacterial culture • Effect of increased UV on melanin production in animals • Presence of the opposite mating type on pheromones production in yeast and other fungi • Darker fur in cooler regions of the body in certain mammal species • Alterations in timing of flowering due to climate changes

Essential knowledge	Chapters/sections	Illustrative examples covered
4.C.3: The level of variation in a population affects population dynamics.	23.1, 23.2, 23.3	*Campbell Biology* offers many examples for this area, such as: • California condors • Black-footed ferrets • Prairie chickens • Potato blight causing the potato famine • Corn rust affects on agricultural crops • Tasmanian devils and infectious cancer • Not all animals in a population stampede • Not all individuals in a population in a disease outbreak are equally affected; some may not show symptoms, some may have mild symptoms, or some may be naturally immune and resistant to the disease
4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.	14.3 23.1 53.2 55.1	*No illustrative examples listed in Curriculum Framework*.

Sections that are not covered will depend on which illustrative examples the teacher chooses.
Visit http://www.pearsonschool.com/APCampbellBiology ("AP Bio Exam Redesign" section) to see which Concepts in *Campbell BIOLOGY AP* Edition, 9th Edition* are included in the Essential Knowledge and Objective outlined in the Curriculum Framework.