Biology
11th Edition by Mader, and Windelspecht
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Chapters/Sections	Essential Knowledge	Required content for the AP course	Illustrative examples covered in the textbook-teach at least one	Content not required for the AP Course
Chapter 1. A View of Life				
1.1 How to Define Life				2-5
1.2 Evolution, the Unifying Concept of Biology	1.A.1: Natural selection is a major mechanism of evolution	6-8		
1.3 How the Biosphere Is Organized				9-10
1.4 The Process of Science				11-16
Chapter 2. Basic Chemistry				
2.1 Chemical Elements				22-25
2.2 Molecules and Compounds	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	26-27		
2.3 Chemistry of Water	2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	28-31	2.A.3: • Cohesion (30–31); • Adhesion (30–31); • High specific heat capacity (29); • Heat of vaporization (29); • Universal solvent supports reactions (29–30)	
2.4 Acids and Bases				32-34
Chapter 3. The Chemistry of Organic Molecules				
3.1 Organic Molecules	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	38-40		
3.2 Carbohydrates	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	41-44		
3.3 Lipids	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	45-48		
3.4 Proteins	3.A.1: DNA, and in some cases RNA, is	49-53	3.A.1:	

	the primary source of heritable information. 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.		• Synthesis (49-53)	
3.5 Nucleic Acids	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	54-56		
Chapter 4. Cell Structure and Function				
4.1 Cellular Level of Organization	2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.	61-64		
4.2 Prokaryotic Cells	2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.	65-66		
4.3 Introducing Eukaryotic Cells	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	67-69	1.B.1: • Cytoskeleton (is a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) (68); • Membrane-bound organelles (mitochondria and/or chloroplasts) (67); • Endomembrane systems, including the nuclear envelope (67)	
4.4 The Nucleus and Ribosomes	2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 4.A.2: The structure and function of subcellular components, and their	70-71	2.B.3: • Nuclear Envelope (70–71)	

	interactions, provide essential cellular processes. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.			
4.5 The Endomembrane System	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	72-74	1.B.1: • Endomembrane systems, including the nuclear envelope (72-74) 2.B.3: • Endoplasmic Reticulum (72); • Golgi (72–73) 3.A.3 • Tay-Sachs (73)	
4.6 Other Vesicles and Vacuoles	2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	75		
4.7 The Energy-Related Organelles	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.	76-77	1.B.1: • Membrane-bound organelles (mitochondria and/or chloroplasts) (76–77) 2.B.3: • Chloroplasts (76–77); • Mitochondria (77)	

	4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.			
4.8 The Cytoskeleton	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	78-81	1.B.1: • Cytoskeleton (is a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) (78-81)	
Chapter 5. Membrane Structure and Function				
5.1 Plasma Membrane Structure and Function	2.B.1: Cell membranes are selectively permeable due to their structure. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression. 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. 3.D.3: Signal transduction pathways link signal reception with cellular response. 4.C.1: Variation in molecular units provides cells with a wider range of functions.	86-90	3.A.1 • Transport by proteins (88–89) 3.B.2 • Cytokines regulate gene expression to allow for cell replication and division. (90)	
5.2 Passive Transport Across a Membrane	2.B.1: Cell membranes are selectively permeable due to their structure. 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.	91-94	2.B.2: • Glucose transport (94)	
5.3 Active Transport Across a	2.B.2: Growth and dynamic homeostasis	95-97	2.B.2:	

Membrane	are maintained by the constant movement of molecules across membranes.		• Na^+/K^+ transport (95–96)	
5.4 Modification of Cell Surfaces	2.B.1: Cell membranes are selectively permeable due to their structure. 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	98-100	3.D.2: • Plasmodesmata between plant cells that allow material to be transported from cell to cell (100)	
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6.1 Cells and the Flow of Energy	2.A.1: All living systems require constant input of free energy.	105-106		
6.2 Metabolic Reactions and Energy Transformations	2.A.1: All living systems require constant input of free energy.	107-108		
6.3 Metabolic Pathways and Enzymes	2.A.1: All living systems require constant input of free energy. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 4.B.1: Interactions between molecules affect their structure and function.	109-113	3.A.1: • Enzymatic reactions (109–113)	
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Chapter 7. Photosynthesis				
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7.2 The Process of Photosynthesis	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes.	122-123		
7.3 Plants as Solar Energy Converters	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes. 4.C.1: Variation in molecular units provides cells with a wider range of functions.	124-127	2.A.2: • $NADP^+$ in photosynthesis (125–126) 4.C.1: • Chlorophylls (124)	

7.4 Plants as Carbon Dioxide Fixers	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes.	128-129	2.A.1: • Calvin Cycle (128–129)	
7.5 Other Types of Photosynthesis	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes.	130-131		
Chapter 8. Cellular Respiration				
8.1 Cellular Respiration	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes.	136-137		
8.2 Outside the Mitochondria: Glycolysis	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes.	138-139	2.A.1: • Glycolysis (138–139)	
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8.4 Inside the Mitochondria	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes.	142-146	2.A.1: • Krebs Cycle (142) 2.A.2: • Oxygen in cellular respiration (144)	
8.5 Metabolic Pool	2.A.1: All living systems require constant input of free energy. 2.A.2: Organisms capture and store free energy for use in biological processes.	147-148		
Chapter 9. Th e Cell Cycle and Cellular Reproduction				
9.1 The Cell Cycle	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. 3.A.2: In eukaryotes, heritable information is passed to the next generation via	154-156	2.E.1: • Morphogenesis of fingers and toes (155) 3.B.2: • Cytokines regulate gene expression to allow for cell	

	processes that include the cell cycle and mitosis, or meiosis plus fertilization. 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.		replication and division. (155)	
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9.3 The Cell Cycle and Cancer	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. 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. 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression. 3.D.3: Signal transduction pathways link signal reception with cellular response. 3.D.4: Changes in signal transduction pathways can alter cellular response.	163-165	2.D.1: • Cell density (163) 3.A.2: • Cancer results from disruptions in cell cycle control (163–165) 3.B.2: • Changes in p53 activity can result in cancer. (164) 3.D.3: • Receptor tyrosine kinases (164-165) 3.D.4: • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera (163)	
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	is passed to the next generation via processes that include the cell cycle and mitosis, or meiosis plus fertilization. 3.C.2: Biological systems have multiple processes that increase genetic variation.			
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10.5 The Cycle of Life	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. 3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.	180-182		
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11.2 Mendel’s Laws	3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. 4.C.1: Variation in molecular units provides cells with a wider range of functions.	195-204	3.A.3: • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. (198–201); • Reproduction issues (201–204); • Cystic fibrosis (202–203); • Huntington’s Disease (204)	

			4.C.1: • Different types of hemoglobin (203)	
11.3 Extending the Range of Mendelian Genetics	3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. 3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics. 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression. 4.C.2: Environmental factors influence the expression of the genotype in an organism.	205-210	3.A.3: • Sickle cell anemia (206-207); • X-linked Color Blindness (209); • Reproduction issues (209–210) 3.A.4: • Sex-linked genes reside on sex chromosomes (X in humans). (208–209); • In mammals and flies, the Y chromosome is very small and carries very few genes. (209); • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. (209) 3.B.2: • Expression of the SRY gene triggers the male sexual development pathway in animals. (208)	
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	development of an organism, and these events are regulated by a variety of mechanisms. 3.B.1: Gene regulation results in differential gene expression, leading to cell specialization. 3.C.1: Changes in genotype can result in changes in phenotype.		• Enhancers (244)	
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15.3 Evidence for Evolution	1.A.1: Natural selection is a major mechanism of evolution. 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 3.C.1: Changes in genotype can result in changes in phenotype.	280-286	1.A.4: • Analysis of sequence data sets (285) 3.C.1: • Antibiotic resistance mutations (280); • Pesticide resistance mutations (280)	
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16.2 Natural Selection	1.A.1: Natural selection is a major mechanism of evolution. 1.A.2: Natural selection acts on phenotypic variations in populations.	296-299		
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17.3 Principles of Macroevolution	1.C.1: Speciation and extinction have occurred throughout the Earth's history. 1.C.2: Speciation may occur when two populations become reproductively isolated from each other. 1.C.3: Populations of organisms continue to evolve. 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.	318-323	3.B.2: • HOX genes play a role in development. (320–322)	
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18.1 Origin of Life	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.D.1: There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.	328-332		
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	and are widely distributed among organisms today. 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life. 2.A.2: Organisms capture and store free energy for use in biological processes. 3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.			
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19.2 The Three-Domain System	1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	351-353		
19.3 Phylogeny	1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	354-359	1.A.4: • Analysis of phylogenetic trees (355); • Construction of phylogenetic trees based on sequence data (358) 1.B.2: • mammalian evolution including opposable thumb (355) (plus other examples); • chordate development (356); • primate evolution (358-359)	
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	to evolve. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.C.3: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.		• Emergent diseases (369-371)	
20.2 The Prokaryotes	2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 3.C.2: Biological systems have multiple processes that increase genetic variation. 3.C.3: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.	371-373	2.D.2: • Osmoregulation in bacteria, fish, and protists (372) 3.C.3: • Transduction in bacteria (373)	
20.3 The Bacteria	1.A.2: Natural selection acts on phenotypic variations in populations. 1.C.3: Populations of organisms continue to evolve. 2.A.2: Organisms capture and store free energy for use in biological processes. 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. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. 3.D.4: Changes in signal transduction pathways can alter cellular response. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	374-377	1.A.2: • Overuse of antibiotics (376-377) 1.C.3: • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) (376–377) 2.D.1: • Algal blooms (377) 2.E.3: • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae (375, 377) 3.D.4: • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera (374); • Effects of neurotoxins, poisons, pesticides (376) 4.B.2: • Bacterial community in the rumen	

			of animals (375)	
20.4 The Archaea	3.D.1: Cell communication processes share common features that reflect a shared evolutionary history. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	378-379	3.D.1: • Use of chemical messengers by microbes to communicate with nearby cells and to regulate specific pathways in response to population density (Quorum sensing) (378) 3.D.2: • Quorum sensing in bacteria (378) 4.B.2: • Bacterial community in and around deep sea vents (379)	
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22.2 Diversity of Fungi	2.C.2: Organisms respond to changes in their external environments. 2.E.2: Timing and coordination of physiological events are regulated by	406-410, 412-413	2.C.2: • Chemotaxis in bacteria, sexual reproduction in fungi (406-408)	411

	multiple mechanisms. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance. 4.B.4: Distribution of local and global ecosystems changes over time. 4.C.3: The level of variation in a population affects population dynamics.		2.E.2: • Fruiting body formation in fungi, slime molds, and certain types of bacteria (407–409) 2.E.3: • Availability of resources leading to fruiting body formation in fungi and certain types of bacteria (407–409, 412-413) 4.B.3 & 4.B.4: • Dutch Elm Disease (410) 4.C.3: • Corn rust affects on agricultural crops (413)	
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Chapter 23. Plant Evolution and Diversity				
23.1 The Green Algal Ancestor of Plants	1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	420-422	1.B.2: • evolutionary plant history (420-422)	
23.2 Evolution of Bryophytes: Colonization of Land				423-425
23.3 Evolution of Lycophytes: Vascular Tissue				426
23.4 Evolution of Pteridophytes: Megaphylls				427-429
23.5 Evolution of Seed Plants: Full Adaptation to Land				430-439
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24.1 Organs of Flowering Plants	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	444-446	4.A.4: • Root, stem, and leaf (444–446)	
24.2 Tissues of Flowering Plants	2.D.4: Plants and animals have a variety of chemical defenses against infections	447-450	2.D.4: • Plant defenses against	

	that affect dynamic homeostasis. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.		pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells by apoptosis, thus localizing the effects. (448) 4.A.4: • Root, stem, and leaf (447–449); • Plant vascular and leaf (449) 4.B.2: • Circulation of fluids (449–450)	
24.3 Organization and Diversity of Roots	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	450-452	4.A.4: • Root, stem, and leaf (450-452); • Plant vascular and leaf (450-452)	
24.4 Organization and Diversity of Stems	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	453-459	4.A.4: • Root, stem, and leaf (453–459); • Plant vascular and leaf (453–459)	
24.5 Organization and Diversity of Leaves	4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	459		460-461
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25.1 Plant Nutrition and Soil	2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	465-468	2.A.3: • Root hairs (467)	
25.2 Water and Mineral Uptake	2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	469-471	2.A.3: • Root hairs (469–471)	

25.3 Transport Mechanisms in Plants	2.C.1: Organisms use negative feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	472-479	2.C.1: • Plant responses to water limitations (473-477) 2.D.2: • Osmoregulation in aquatic and terrestrial plants (475–478); • Gas exchange in aquatic and terrestrial plants (476–478) 2.E.3: • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae (472) 4.B.2: • Exchange of gases (477–478); • Circulation of fluids (474–479)	
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26.2 Plant Responses	2.C.2: Organisms respond to changes in their external environments. 2.D.4: Plants and animals have a variety	490-498	2.C.2: • Photoperiodism and phototropism in plants (494–496);	

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28.2 The Simplest Invertebrates				527-529
28.3 Diversity Among the Lophotrochozoans				530-538

28.4 Diversity of the Ecdysozoans				538-543
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29.4 The Amphibians	2.A.1: All living systems require constant input of free energy.	556	2.A.1: • Ectothermy is the use of external thermal energy to help regulate and maintain body temperature. (556)	557
29.5 The Reptiles	2.A.1: All living systems require constant input of free energy. 4.B.4: Distribution of local and global ecosystems changes over time.	558-559, 563	2.A.1: • Endothermy is the use of thermal energy generated by metabolism to maintain homeostatic body temperatures. (563); • Ectothermy is the use of external thermal energy to help regulate and maintain body temperature. (558) 4.B.4: • Meteor Impact on Dinosaurs (559)	560-562
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30.1 Evolution of Primates	1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	571-575	1.B.2: • primate evolution (571-575)	
30.2 Evolution of Humanlike Hominins				575-578
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31.2 Organs, Organ Systems, and Body Cavities				595-596
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32.2 Transport in Vertebrates	1.C.3: Populations of organisms continue to evolve. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	608-609	1.C.3: • A eukaryotic example that describes evolution of a structure of process such as heart chambers, limbs, brain, and immune system (608-609) 4.A.4: • Respiratory and circulatory (608-609) 4.B.2: • Circulation of fluids (608-609)	
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34.2 The Human Digestive System	2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	650-656	2.A.3: • Cells of the villi (652–653); • Microvilli (652–653) 4.A.4: • Stomach and small intestines (652–654) 4.B.2: • Digestion of food (650–655)	
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35.1 Gas Exchange Surfaces	2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	664-668	2.A.3: • Cells of the alveoli (668) 2.D.2: • Respiratory systems of aquatic and terrestrial animals (664–668) 4.B.2: • Exchange of gases (664–668)	
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			4.B.2: • Excretion of wastes (681–683)	
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37.1 Evolution of the Nervous System	1.C.3: Populations of organisms continue to evolve. 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	694-696	1.C.3: A eukaryotic example that describes evolution of a structure of process such as heart chambers, limbs, brain, and immune system (694–696)	
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37.4 The Peripheral Nervous System	3.D.1: Cell communication processes share common features that reflect a shared evolutionary history. 3.D.4: Changes in signal transduction pathways can alter cellular response. 3.E.1: Individuals can act on information and communicate it to others. 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	706-713	3.D.1: • Epinephrine stimulation of glycogen breakdown in mammals (713) 3.D.4: • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera (706-707) 3.E.1: • Fight or flight response (713) 3.E.2: • Acetylcholine (713); • Epinephrine (713); • Norepinephrine (713) 4.A.4: • Nervous and muscular (707–708)	
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38.4 Senses of Hearing and Balance	3.E.2: Animals have nervous systems that	726-730	3.E.2:	

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40.1 Animal Hormones	2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history. 3.D.3: Signal transduction pathways link signal reception with cellular response. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	753-756	3.D.1: • Epinephrine stimulation of glycogen breakdown in mammals (755-756) 3.D.3: • G-protein linked receptors (756); • Second messengers such as: cyclic GMP, cyclic AMP calcium ions (Ca^{2+}), and inositol triphosphate (IP_3) (756)	
40.2 Hypothalamus and Pituitary Gland	2.C.1: Organisms use negative feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.D.3: Biological systems are affected by	757-759	2.C.1: • Lactation in mammals (757); • Dehydration in response to decreased ADH (757)	

	disruptions to their dynamic homeostasis. 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.		2.D.3: • Dehydration (757) 3.D.2: • Human Growth Hormone (757–759) 3.E.2: • Neuro-hormone production (757)	
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41.2 Human Male Reproductive System	4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	775-778		
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42.1 Early Developmental Stages	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.	796-799		
42.2 Developmental Processes	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	800-804	2.E.1: • *C. elegans* development (802) 3.B.2:	

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42.4 The Aging Process				811-814
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43.1 Inheritance Influences Behavior	2.C.2: Organisms respond to changes in their external environments. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.	820-821		
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43.3 Animal Communication	2.C.2: Organisms respond to changes in their external environments.	826-830	2.E.2: • Release and reaction to	

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Chapter 44. Population Ecology				
44.1 Scope of Ecology	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.	839		
44.2 Demographics of Populations	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	840-842	2.D.1: • Temperature (840); • Sunlight (840); • Population density (840)	

	and free energy. 4.A.5: Communities are composed of populations of organisms that interact in complex ways.			
44.3 Population Growth Models	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. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.	843-845		
44.4 Regulation of Population Size	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. 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.	846-848	2.D.1: • Population density (847) 2.D.3: • Hurricanes, floods, earthquakes, volcanoes, fires (847)	
44.5 Life History Patterns	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. 4.A.5: Communities are composed of populations of organisms that interact in complex ways.	848-850		
44.6 Human Population Growth	4.A.5: Communities are composed of populations of organisms that interact in complex ways.	851-853		
Chapter 45. Community and				

Ecosystem Ecology				
45.1 Ecology of Communities	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. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. 3.E.1: Individuals can act on information and communicate it to others. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.	858-867	2.D.1: • Predator-prey relationships (860–864); • Symbiosis (mutualism, commensalism, parasitism) (864–866) 2.E.3: • Niche and resource partitioning (860); • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae (866); 3.E.1: • Coloration (863–864) 4.A.5: • Graphical representation of field data (860); • Predator/prey relationships spreadsheet model (863); • Symbiotic relationship (864–866)	
45.2 Community Development	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. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance. 4.B.4: Distribution of local and global ecosystems changes over time.	868-869	4.B.4: • Continental Drift (868)	
45.3 Dynamics of an Ecosystem	2.A.1: All living systems require constant input of free energy. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. 2.D.1: All biological systems from cells	870-879	2.A.1: • Change in the producer level can affect the number and size of other trophic levels. (870, 873); • Food chains and food webs (870–874); • Change in energy	

	and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.		resources levels such as sunlight can affect the number and size of the trophic levels. (873) 2.D.1: • Water and nutrient availability, temperature, salinity, pH (870); • Water availability (875) 4.A.5: • Global climate change models (879)	
Chapter 46. Major Ecosystems of the Biosphere				
46.1 Climate and the Biosphere	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. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	884-886		
46.2 Terrestrial Ecosystems	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. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	887-896		
46.3 Aquatic Ecosystems	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. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. 4.B.4: Distribution of local and global ecosystems changes over time.	897-904	4.B.4: • El Niño (904)	

Chapter 47. Conservation of Biodiversity				
47.1 Conservation Biology and Biodiversity	1.A.2: Natural selection acts on phenotypic variations in populations. 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. 4.C.3: The level of variation in a population affects population dynamics. 4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.	908-909	1.A.2: • Loss of genetic diversity within a crop species (908) 4.C.3: • California condor (908); • Black-footed ferrets (909)	
47.2 Value of Biodiversity	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. 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. 4.C.3: The level of variation in a population affects population dynamics. 4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.	910-913	2.D.1; • Species diversity (910–913) 2.D.3: • Water limitation (912)	
47.3 Causes of Extinction	1.C.1: Speciation and extinction have occurred throughout the Earth's history. 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance. 4.B.4: Distribution of local and global ecosystems changes over time. 4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.	913-918	1.C.1: • Human impact on ecosystems and species extinction rates (913–914) 2.D.3: • Invasive and/or eruptive species (913–915); • Human Impact (913–918) 4.A.5: • Introduction of species (913–915); • Global climate change models (915–916) 4.B.3: • Kudzu (914–915); • Loss of keystone species (918)	

			4.B.4: • Logging, slash and burn agriculture, urbanization, mono-cropping, infrastructure development (dams, transmission lines, roads), and global climate change threaten ecosystems and life on Earth. (913–917); • An introduced species can exploit a new niche free of predators or competitors, thus exploiting new resources. (913–915)	
47.4 Conservation Techniques	4.B.4: Distribution of local and global ecosystems changes over time.	918-920	4.B.4: • Logging, slash and burn agriculture, urbanization, mono-cropping, infrastructure development (dams, transmission lines, roads), and global climate change threaten ecosystems and life on Earth. (918)	