Biology, 9th Edition
by Raven, Johnson, Mason, Losos, and Singer, © 2011 (McGraw-Hill)

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
Chapter 1. The Science of Biology				
1.1. The Science of Life				
1.2. The Nature of Science				
1.3. An Example of Scientific Inquiry: Darwin and Evolution	1.A.1 Natural selection is a major mechanism of evolution	8-11		
1.4. Unifying Themes in Biology				
Chapter 2. The Nature of Molecules and the Properties of Water				
2.1. The Nature of Atoms	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	18-21		
2.2. Elements Found in Living Systems	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	22		
2.3. The Nature of Chemical Bonds	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	23-24		
2.4. Water: A Vital Compound	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	25-27	Cohesion p27	
2.5. Properties of Water	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	28-29	High specific heat capacity p28; Universal solvent supports reactions p28; Heat of vaporization p28	
2.6. Acids and Bases	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	29-32		

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Chapter 3. The Chemical Building Blocks of Life				
3.1. Carbon: The Framework of Biological Molecules	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	34-37		
3.2. Carbohydrates: Energy Storage and Structural Molecules	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	38-40		
3.3. Nucleic Acids: Information Molecules	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	41-43		
3.4. Proteins: Molecules with Diverse Structures and Functions	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	44-52		
3.5. Lipids: Hydrophobic Molecules	4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	53-58		
Chapter 4. Cell Structure				
4.1. Cell Theory	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization; 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.	59-62		
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; 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	63-64		

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4.3. Eukaryotic 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; 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	65-68	Endomembrane systems, including the nuclear envelope p65; Nuclear Envelope p65	
4.4. The Endomembrane System	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	69-72	Endoplasmic Reticulum p70; Golgi p70	
4.5. Mitochondria and Chloroplasts: Cellular Generators	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	73-74	Membrane-bound organelles (mitochondria and/or chloroplasts) p73; Mitochondria p73; Chloroplasts p73	
4.6. The Cytoskeleton	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	75-78	Cytoskeleton (is a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) p75	
4.7. Extracellular Structures and Cell Movement	2.B.1 Cell membranes are selectively permeable due to their structure; 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes	79-81		
4.8. Cell-to-Cell Interactions	3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling; 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes	82-87	Plasmodesmata between plant cells that allow material to be transported from cell to cell p84	

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Chapter 5. Membranes				
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5.2. Phospholipids: The Membrane's Foundation	2.B.1 Cell membranes are selectively permeable due to their structure; 4.C.1: Variation in molecular units provides cells with a wider range of functions	92	Different types of phospholipids in cell membranes p92	
5.3. Proteins: Multifunctional Components	2.B.1 Cell membranes are selectively permeable due to their structure.	93-95		
5.4. Passive Transport Across Membranes	2.B.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.	96-98	Glucose transport p97	
5.5. Active Transport Across Membranes	2.B.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.	99-101	Na+/K+ transport p100	
5.6. Bulk Transport by Endocytosis and Exocytosis	2.B.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.	102-106		
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6.2. The Laws of Thermodynamics and Free Energy	2.A.1 All living systems require constant input of free energy.	109-111		
6.3. ATP: The Energy Currency of Cells	2.A.1 All living systems require constant input of free energy.	112		
6.4. Enzymes: Biological Catalysts	2.A.1 All living systems require constant input of free energy; 4.B.1: Interactions between molecules affect their structure and function	113-116		
6.5. Metabolism: The Chemical Description of Cell Function	2.A.1 All living systems require constant input of free energy.	117-121		
Chapter 7. How Cells Harvest Energy				
7.1. Overview of Respiration	2.A.2 Organisms capture and store free energy for use in biological processes.	122-126	Oxygen in cellular respiration p124	

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7.7. Regulation of Aerobic Respiration	2.A.2 Organisms capture and store free energy for use in biological processes.	138		
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7.9. Catabolism of Proteins and Fats	2.A.2 Organisms capture and store free energy for use in biological processes.	140-141		
7.10. Evolution of Metabolism	2.A.2 Organisms capture and store free energy for use in biological processes.	142		
Chapter 8. Photosynthesis				
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8.2. The Discovery of Photosynthetic Processes	2.A.2 Organisms capture and store free energy for use in biological processes.	149-150		
8.3. Pigments	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.	151-153	NADP+ in photosynthesis p151; Chlorophylls p152	
8.4. Photosystem Organization	2.A.2 Organisms capture and store free energy for use in biological processes.	154-155		
8.5. The Light-Dependent Reactions	2.A.2 Organisms capture and store free energy for use in biological processes.	156-159		
8.6. Carbon Fixation: The Calvin Cycle	2.A.2 Organisms capture and store free energy for use in biological processes.	160-162	Calvin Cycle p160	
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Chapter 9. Cell Communication				
9.1. Overview of Cell Communication	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.	168-170		
9.2. Receptor Types	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.	171-172		
9.3. Intracellular Receptors	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.	173	Second messengers such as: cyclic GMP, cyclic AMP calcium ions (Ca2+), and inositol triphosphate (IP3) p173	
9.4. Signal Transduction Through Receptor Kinases	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.	174-175	Action of platelet-derived growth factor (PDGF) p175; Receptor tyrosine kinases 174	176-178

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9.5. Signal Transduction Through G Protein-Coupled Receptors	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; 3.D.4. Changes in signal transduction pathways can alter cellular response.	179-180	Levels of cAMP regulate metabolic gene expression in bacteria.p179; G-protein linked receptors p179	181-184
Chapter 10. How Cells Divide				
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10.2. Eukaryotic Chromosomes	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.	189-191		
10.3. Overview of the Eukaryotic Cell Cycle	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.	192		
10.4. Interphase: Preparation for Mitosis	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.	193		
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10.6. Control of the Cell Cycle	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.	198-202	Mitosis promoting factor (MPF) p198; Cancer results from disruptions in cell cycle control p200; Changes in p53 activity can result in cancer p202	203-204
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11.1. Sexual Reproduction Requires Meiosis	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.C.2 Biological systems have multiple processes that increase genetic variation.	207-208		
11.2. Features of Meiosis	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.C.2 Biological systems have multiple processes that increase genetic variation.	209		
11.3. The Process of Meiosis	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.C.2 Biological systems have multiple processes that increase genetic variation.	210-214		
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Chapter 12. Patterns of Inheritance				
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12.2. Monohybrid Crosses: The Principle of Segregation	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.2: Environmental factors influence the expression of the genotype in an organism.	224-226	Height and weight in humans p233	227
12.3. Dihybrid Crosses: The Principle of Independent Assortment	3.A.3 The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring	228-229		
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12.5. The Testcross: Revealing Unknown Genotypes	3.A.3 The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring;	231		
12.6. Extensions to Mendel	3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics; 4.C.2: Environmental factors influence the expression of the genotype in an organism.	232-235	Darker fur in cooler regions of the body in certain mammal species p233	236
Chapter 13. Chromosomes, Mapping, and the Meiosis-Inheritance Connection				
13.1. Sex Linkage and the Chromosomal Theory of Inheritance	3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics	240		

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13.2. Sex Chromosomes and Sex Determination	3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics	241-243	X-linked Color Blindness p242; Sex-linked genes reside on sex chromosomes (X in humans) p241; In mammals and flies, the Y chromosome is very small and carries very few genes p242; In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males p241; Expression of the SRY gene triggers the male sexual development pathway in animals p242	
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13.4. Genetic Mapping	3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics	244-247		248
13.5. Selected Human Genetic Disorders	3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics; 3.C.1 Changes in genotype can result in changes in phenotype.	249-254	Sickle cell anemia p249; Sickle cell anemia p253; Huntington's Disease p249; Trisomy 21/Down Syndrome p250; Klinefelter Syndrome p251;	table 13.2
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14.3. Basic Characteristics of DNA Replication	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	263-265	Synthesis p263	
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14.5. Eukaryotic Replication	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information; 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	271-272		
14.6. DNA Repair	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information; 3.C.1 Changes in genotype can result in changes in phenotype.	273-276		
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15.2. The Genetic Code	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	282-283		table 15.1
15.3. Prokaryotic Transcription	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	284-286		
15.4. Eukaryotic Transcription	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	287-288	Enzymatic reactions p287	
15.5. Eukaryotic pre-mRNA Splicing	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	289-290	Addition of a poly-A tail Addition of a GTP cap p289; Excision of introns p289	
15.6. The Structure of tRNA and Ribosomes	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	291-292		
15.7. The Process of Translation	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	293-296		

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15.8. Summarizing Gene Expression	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	297-298		
15.9. Mutation: Altered Genes	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information; 3.C.1 Changes in genotype can result in changes in phenotype.	299-302		
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16.1. Control of Gene Expression	3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	304		
16.2. Regulatory Proteins	3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	305		306-307
16.3. Prokaryotic Regulation	3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	308-311	Operons in gene regulation p308; Promoters, Terminators, Enhancers p308	
16.4. Eukaryotic Regulation	3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	312-313		314-315
16.5. Eukaryotic Chromatin Structure	3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	316		
16.6. Eukaryotic Posttranscriptional Regulation	3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	317-319		320-322
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17.3. DNA Analysis	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	335-337, 349	Restriction enzyme analysis of DNA p335; Polymerase Chain Reaction (PCR) p339; Cloned animals p349	338, 340-341
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Chapter 18. Genomics				
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19.2. Cell Division	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	373	C. elegans development p373	374-375
19.3. Cell Differentiation	3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression; 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs	375-376; 379	Reproduction issues Civic issues such as ownership of genetic information, privacy, historical contexts, etc p379; Human Growth Hormone p378	377-378

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19.4. Nuclear Reprogramming	3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression; 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs	380-382		383
19.5. Pattern Formation	3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression; 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs	383-386; 389	Morphogens stimulate cell differentiation and development p386; HOX genes play a role in development p389	387-389
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Chapter 20. Genes Within Populations				
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20.2. Changes in Allele Frequency	1.A.1 Natural selection is a major mechanism of evolution	398-400	Application of Hardy-Weinberg Equation p399-402; Analysis of sequence data sets p398	
20.3. Five Agents of Evolutionary Change	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; 1.C.3 Populations of organisms continue to evolve.	401-404	Graphical analysis of allele frequencies in a population p402; Application of Hardy-Weinberg Equation p402; Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) p404	

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20.4. Fitness and Its Measurement	1.A.1 Natural selection is a major mechanism of evolution; 1.C.3 Populations of organisms continue to evolve.	404-405	Visual displays in reproductive cycle p405	
20.5. Interactions Among Evolutionary Forces	1.A.1 Natural selection is a major mechanism of evolution; 4.C.1: Variation in molecular units provides cells with a wider range of functions	406	Graphical analysis of allele frequencies in a population p406	
20.6. Maintenance of Variation	1.A.1 Natural selection is a major mechanism of evolution; 1.C.3 Populations of organisms continue to evolve.	407-408	Graphical analysis of allele frequencies in a population p407, 408, 409; Sickle cell anemia p408; Sickle cell disorder and heterozygote advantage p408	
20.7. Selection Acting on Traits Affected by Multiple Genes	1.A.1 Natural selection is a major mechanism of evolution	409-410	Graphical analysis of allele frequencies in a population p410; Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galapagos) p410	
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Chapter 21. The Evidence for Evolution				

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21.1. The Beaks of Darwin's Finches: Evidence of Natural Selection	1.A.1 Natural selection is a major mechanism of evolution; 1.A.2 Natural selection acts on phenotypic variations in populations; 1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics; 1.C.3 Populations of organisms continue to evolve; 1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.	418-419	Graphical analysis of allele frequencies in a population p419	
21.2. Peppered Moths and Industrial Melanism: More Evidence of Selection	1.A.1 Natural selection is a major mechanism of evolution; 1.A.2 Natural selection acts on phenotypic variations in populations; 1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics; 1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.	420-422	Graphical analysis of allele frequencies in a population p421, 422; Peppered moth p420-422	
21.3. Artificial Selection: Human-Initiated Change	1.A.1 Natural selection is a major mechanism of evolution; 1.A.2 Natural selection acts on phenotypic variations in populations; 1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics; 1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.	422-423	Artificial selection p422	
21.4. Fossil Evidence of Evolution	1.A.1 Natural selection is a major mechanism of evolution; 1.A.2 Natural selection acts on phenotypic variations in populations; 1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics; 1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.	424-427	Analysis of phylogenetic trees p427	

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21.5. Anatomical Evidence for Evolution	1.A.1 Natural selection is a major mechanism of evolution; 1.A.2 Natural selection acts on phenotypic variations in populations; 1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics; 1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.	428-429		
21.6. Convergent Evolution and the Biogeographical Record	1.A.1 Natural selection is a major mechanism of evolution; 1.A.2 Natural selection acts on phenotypic variations in populations; 1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics; 1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.	430-431		
21.7. Darwin's Critics	1.A.1 Natural selection is a major mechanism of evolution; 1.A.2 Natural selection acts on phenotypic variations in populations; 1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics; 1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.	432-434	Continental Drift p432	
Chapter 22. The Origin of Species				
22.1. The Nature of Species and the Biological Species Concept	1.C.2 Speciation may occur when two populations become reproductively isolated from each other.	437-440		
22.2. Natural Selection and Reproductive Isolation	1.A.3: Evolutionary change is also driven by random processes; 1.C.2 Speciation may occur when two populations become reproductively isolated from each other.	441-442		
22.3. The Role of Genetic Drift and Natural Selection in Speciation	1.A.3: Evolutionary change is also driven by random processes; 1.C.2 Speciation may occur when two populations become reproductively isolated from each other.	443		

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22.4. The Geography of Speciation	1.A.3: Evolutionary change is also driven by random processes; 1.C.2 Speciation may occur when two populations become reproductively isolated from each other.	444-445		
22.5. Adaptive Radiation and Biological Diversity	1.C.2 Speciation may occur when two populations become reproductively isolated from each other.	446-450		
22.6. The Pace of Evolution	1.C.1 Speciation and extinction have occurred throughout the Earth's history.	451		
22.7. Speciation and Extinction Through Time	1.C.1 Speciation and extinction have occurred throughout the Earth's history; 4.B.4: Distribution of local and global ecosystems changes over time.	452-455	Five major extinctions p452; Human impact on ecosystems and species extinction rates p453; Meteor Impact on Dinosaurs p453	
Chapter 23. Systematics and the Phylogenetic Revolution				
23.1. Systematics	1.B.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	456-457		
23.2. Cladistics	1.B.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	458-460	Construction of phylogenetic trees based on sequence data p458	
23.3. Systematics and Classification	1.B.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	461-463		
23.4. Phylogenetics and Comparative Biology	1.B.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	464-467		468-469
23.5. Phylogenetics and Disease Evolution				470-473
Chapter 24. Genome Evolution				
24.1. Comparative Genomics	1.B.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	474-476		

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
24.2. Whole-Genome Duplications	1.B.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	477-480	Linear chromosomes p477; Transposons present in incoming DNA p480	
24.3. Evolution Within Genomes	1.B.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	481-482		483-484
24.4. Gene Function and Expression Patterns				484
24.5. Nonprotein-Coding DNA and Regulatory Function	1.B.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	485		
24.6. Genome Size and Gene Number	1.B.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	486		
24.7. Genome Analysis and Disease Prevention and Treatment				487-488
24.8. Crop Improvement Through Genome Analysis				489
Chapter 25. Evolution of Development				492-506
25.1. Overview of Evolutionary Developmental Biology				
25.2. One or Two Gene Mutations, New Form				
25.3. Same Gene, New Function				
25.4. Different Genes, Convergent Function				
25.5. Gene Duplication and Divergence				
25.6. Functional Analysis of Genes Across Species				
25.7. Diversity of Eyes in the Natural World: A Case Study				
Chapter 26. The Tree of Life				
26.1. Origins of Life	1.D.1 There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.	508-510		511

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
26.2. Classification of Organisms	1.B.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	512-513		
26.3. Grouping Organisms	1.B.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	514-519		
26.4. Making Sense of the Protists				520
26.5. Origin of Plants				520-522
26.6. Sorting out the Animals				522-525
Chapter 27. Viruses				528-543
27.1. The Nature of Viruses				
27.2. Bacteriophages: Bacterial Viruses				
27.3. Human Immunodeficiency Virus (HIV)				
27.4. Other Viral Diseases			Emergent diseases p539	
27.5. Prions and Viroids: Subviral Particles				
Chapter 28. Prokaryotes				
28.1. The First Cells				546-547
28.2. Prokaryotic Diversity				547-550
28.3. Prokaryotic Cell Structure				551-553
28.4. Prokaryotic Genetics	3.C.2 Biological systems have multiple processes that increase genetic variation.	554-558	Overuse of antibiotics p558; Plasmid-based transformation p557; Antibiotic & Pesticide resistance mutations p558; Transduction in bacteria p556	
28.5. Prokaryotic Metabolism				559
28.6. Human Bacterial Disease				560-562
28.7. Beneficial Prokaryotes				563-565
Chapter 29. Protists				567-587
29.1. Eukaryotic Origins and Endosymbiosis				
29.2. Defining Protists				
29.3. Diplomonads and Parabasalids: Flagellated Protists Lacking Mitochondria				

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
29.4. Euglenozoa: A Diverse Group in Which Some Members Have Chloroplasts				
29.5. Alveolata: Protists with Submembrane Vesicles				
29.6. Stramenopila: Protists with Fine Hairs				
29.7. Rhodophyta: Red Algae			Potato blight, p582	
29.8. Choanoflagellida: Possible Animal Ancestors				
29.9. Protists Without a Clade				
Chapter 30. Green Plants				588-613
30.1. Defining Plants				
30.2. Chlorophytes and Charophytes: Green Algae				
30.3. Bryophytes: Dominant Gametophyte Generation				
30.4. Tracheophyte Plants: Roots, Stems, and Leaves				
30.5. Lycophytes: Dominant Sporophyte Generation and Vascular Tissue				
30.6. Pterophytes: Ferns and Their Relatives				
30.7. The Evolution of Seed Plants				
30.8. Gymnosperms: Plants with "Naked Seeds"				
30.9. Angiosperms: The Flowering Plants			Biology of pollination p609	
Chapter 31. Fungi				614-632
31.1. Defining Fungi				
31.2. Microsporidia: Unicellular Parasites				
31.3. Chytridiomycota and Relatives: Fungi with Flagellated Zoospores				
31.4. Zygomycota: Fungi that Produce Zygotes			Mating pheromones in yeast trigger mating gene expression. P620	
31.5. Glomeromycota: Asexual Plant Symbionts				
31.6. Basidiomycota: The Club (Basidium) Fungi				

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
31.7. Ascomycota: The Sac (Ascus) Fungi				
31.8. Ecology of Fungi			Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae p627	
31.9. Fungal Parasites and Pathogens				
Chapter 32. Overview of Animal Diversity				633-648
32.1. Some General Features of Animals				
32.2. Evolution of the Animal Body Plan				
32.3. The Classification of Animals				
32.4. The Roots of the Animal Tree of Life				
Chapter 33. Noncoelomate Invertebrates				649-665
33.1. Parazoa: Animals That Lack Specialized Tissues				
33.2. Eumetazoa: Animals with True Tissues				
33.3. The Bilaterian Acoelomates				
33.4. The Pseudocoelomates				
Chapter 34. Coelomate Invertebrates				666-692
34.1. Phylum Mollusca: The Mollusks				
34.2. Phylum Nemertea: The Ribbon Worms				
34.3. Phylum Annelida: The Annelids				
34.4. The Lophophorates: Bryozoa and Brachiopoda				
34.5. Phylum Arthropoda: The Arthropods				
34.6. Phylum Echinodermata: The Echinoderms				
Chapter 35. Vertebrates				693-728
35.1. The Chordates				
35.2. The Nonvertebrate Chordates				
35.3. The Vertebrate Chordates				
35.4. Fishes				
35.5. Amphibians				
35.6. Reptiles				

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
35.7. Birds				
35.8. Mammals				
35.9. Evolution of the Primates				
Chapter 36. Plant Form				
36.1. Organization of the Plant Body: An Overview	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	730-732		
36.2. Plant Tissues	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	733-738	Root, stem, and leaf	
36.3. Roots: Anchoring and Absorption Structures	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	739-742	Root, stem, and leaf p739; Root hairs p740	
36.4. Stems: Support for Above-Ground Organs	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	743-746		
36.5. Leaves: Photosynthetic Organs	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	747-751		
Chapter 37. Vegetative Plant Development				753-768
37.1. Embryo Development				
37.2. Seeds				
37.3. Fruits				
37.4. Germination				
Chapter 38. Transport in Plants				
38.1. Transport Mechanisms	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	769-772		
38.2. Water and Mineral Absorption	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	773-775		
38.3. Xylem Transport	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	776-777		

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
38.4. The Rate of Transpiration	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	778-779		
38.5. Water-Stress Responses	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	780		
38.6. Phloem Transport	4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	781-785		
Chapter 39. Plant Nutrition and Soils				
39.1. Soils: The Substrates on Which Plants Depend	2.D.3 Biological systems are affected by disruptions to their dynamic homeostatis	789	Salination p789	786-788
39.2. Plant Nutrients				790-791
39.3. Special Nutritional Strategies				792-794
39.4. Carbon–Nitrogen Balance and Global Change				795-796
39.5. Phytoremediation				797-801
Chapter 40. Plant Defense Responses				
40.1. Physical Defenses	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	802-804	Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells by apoptosis, thus localizing the effects p803-804; Herbivory responses p803	

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
40.2. Chemical Defenses	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	805-808	Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells by apoptosis, thus localizing the effects p805-808	
40.3. Animals that Protect Plants				809-810
40.4. Systemic Responses to Invaders			Plant immune response p810	810-812
Chapter 41. Sensory Systems in Plants				814-838
41.1. Responses to Light			circadian rhythms p818; 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 p818	
41.2. Responses to Gravity				
41.3. Responses to Mechanical Stimuli				
41.4. Responses to Water and Temperature				
41.5. Hormones and Sensory Systems			Ethylene levels cause changes in the production of different enzymes, allowing fruit ripening. p835; Gibberellin promotes seed germination in plants p836	
Chapter 42. Plant Reproduction				

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
42.1. Reproductive Development	2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	839-841		
42.2. Flower Production	2.C.2 Organisms respond to changes in their external environments; 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; 2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms; 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.	842-847	Photoperiodism and phototropism in plants p842	
42.3. Structure and Evolution of Flowers				848-850
42.4. Pollination and Fertilization				851-856
42.5. Asexual Reproduction				857-858
42.6. Plant Life Spans		Life-history strategy (biennial plants, reproductive diapause) p860		859-862
Chapter 43. The Animal Body and Principles of Regulation				
43.1. Organization of the Vertebrate Body		863-864		
43.2. Epithelial Tissue		865-867		
43.3. Connective Tissue		868-869		
43.4. Muscle Tissue		870-871		
43.5. Nerve Tissue		872		
43.6. Overview of Vertebrate Organ Systems		872		

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
43.7. Homeostasis	2.A.1 All living systems require constant input of free energy; 2.C.1 Organisms use negative feedback mechanisms to maintain their internal environments and respond to external environmental changes.	876-877	Endothermy is the use of thermal energy generated by metabolism to maintain homeostatic body temperatures p876	
43.8. Regulating Body Temperature	2.A.1 All living systems require constant input of free energy; 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.	878-885	Ectothermy is the use of external thermal energy to help regulate and maintain body temperature p880; Temperature regulation in animals p880; Onset of labor in childbirth p878; Hibernation and migration in animals p883; Shivering and sweating in humans p883; Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms p881	
Chapter 44. The Nervous System				
44.1. Nervous System Organization	3.E.2**.** Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	887-889		
44.2. The Mechanism of Nerve Impulse Transmission	3.E.2**.** Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	890-895	Ligand-gated ion channels p892	

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
44.3. Synapses: Where Neurons Communicate with Other Cells	3.E.2. Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	896-900	Epinephrine stimulation of glycogen breakdown in mammals p899; Neurotransmitters p896; Acetylcholine, Epinephrine, Norepinephrine, Dopamine Serotonin, and GABA p898	
44.4. The Central Nervous System: Brain and Spinal Cord			Forebrain (cerebrum), midbrain (brainstem), and hindbrain (cerebellum), Right and left cerebral hemispheres in humans p902	901-908
44.5. The Peripheral Nervous System: Sensory and Motor Neurons	3.E.2. Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	909-910		911-913
Chapter 45. Sensory Systems				
45.1. Overview of Sensory Receptors	3.E.2. Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	915-916		
45.2. Mechanoreceptors: Touch and Pressure	3.E.2. Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	917-919		
45.3. Hearing, Vibration, and Detection of Body Position			Hearing p920	920-924
45.4. Chemoreceptors: Taste, Smell, and pH				925-927
45.5. Vision			Vision p928	928-932
45.6. The Diversity of Sensory Experiences				933-936

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
Chapter 46. The Endocrine System				
46.1. Regulation of Body Processes by Chemical Messengers	2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	938-939, 942	Release and reaction to pheromones p938	940-941
46.2. Actions of Lipophilic Versus Hydrophilic Hormones	2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	943-945		
46.3. The Pituitary and Hypothalamus: The Body's Control Centers	2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	946-950	Neuro-hormone production p947	
46.4. The Major Peripheral Endocrine Glands	2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	951-954	Graves' disease (hyperthyroidism) p951; Human Growth Hormone p953; Thyroid hormones p953; Testosterone and Estrogen p956	
46.5. Other Hormones and Their Effects	2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	955-960	Diabetes mellitus in response to decreased insulin p955; Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera p957	
Chapter 47. The Musculoskeletal System				961-980
47.1. Types of Skeletal Systems				
47.2. A Closer Look at Bone				
47.3. Joints and Skeletal Movement				
47.4. Muscle Contraction			Nervous and muscular p972	
47.5. Modes of Animal Locomotion				
Chapter 48. The Digestive System				
48.1. Types of Digestive Systems	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.	982-983	Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems p982	

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
48.2. The Mouth and Teeth: Food Capture and Bulk Processing	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.	984		
48.3. The Esophagus and the Stomach: The Early Stages of Digestion	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.	985-986	Stomach and small intestines p985-987; Digestion of food p985	
48.4. The Intestines: Breakdown, Absorption, and Elimination	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.	987-990	Cells of the villi p987; Microvilli p987	
48.5. Variations in Vertebrate Digestive Systems			Bacterial community in the rumen of animals p991	990-992
48.6. Neural and Hormonal Regulation of the Digestive Tract				993
48.7. Accessory Organ Function			Insulin p994	994
48.8. Food Energy, Energy Expenditure, and Essential Nutrients				995-999
Chapter 49. The Respiratory System				
49.1. Gas Exchange Across Respiratory Surfaces	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1001-1003	Respiratory systems of aquatic and terrestrial animals p1002	
49.2. Gills, Cutaneous Respiration, and Tracheal Systems	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1004-1005	Exchange of gases p1004	
49.3. Lungs	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1006-1008	Cells of the alveoli p1008; Respiratory and circulatory p1008	

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
49.4. Structures and Mechanisms of Ventilation in Mammals	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.	1009-1011		
49.5. Transport of Gases in Body Fluids				1012-1016
Chapter 50. The Circulatory System				
50.1. The Components of Blood	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1018-1021	Blood clotting p1021; Circulation of fluids p1018	
50.2. Invertebrate Circulatory Systems	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1022		
50.3. Vertebrate Circulatory Systems	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1023-1025	A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, brain, and immune system p1023; Circulatory systems in fish, amphibians, and mammals p1023	
50.4. The Four-Chambered Heart and the Blood Vessels	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1026-1029		
50.5. Characteristics of Blood Vessels				1030-1033
50.6. Regulation of Blood Flow and Blood Pressure				1034-1036
Chapter 51. Osmotic Regulation and the Urinary System				
51.1. Osmolarity and Osmotic Balance	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1038-1039	Territorial marking in mammals p1134	

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
51.2. Osmoregulatory Organs	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1040-1041	Excretory systems in flatworms, earthworms, and vertebrates p1040; Osmoregulation in bacteria, fish and protists p1042; Birds songs p1140	
51.3. Evolution of the Vertebrate Kidney	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1042-1043		
51.4. Nitrogenous Wastes: Ammonia, Urea, and Uric Acid	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	1044	Nitrogenous waste production and elimination in aquatic and terrestrial animals p1044; Excretion of wastes p1044	
51.5. The Mammalian Kidney	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments; 2.d.3 Biological systems are affected by disruptions to their dynamic homeostatis; 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	1045-1049	Excretory systems in flatworms, earthworms, and vertebrates p1045; Dehydration p1047; Bee dances p1146; Kidney and bladder p1047	
51.6. Hormonal Control of Osmoregulatory Functions	2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments; 2.d.3 Biological systems are affected by disruptions to their dynamic homeostatis; 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	1050-1053		
Chapter 52. The Immune System				

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
52.1. Innate Immunity	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis; 3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	1055-1060	Immunological responses to pathogens, toxins and allergens p1057; Vertebrate immune systems have non-specific and non-heritable defense mechanisms against pathogens; Pack behavior in animals p1158; Herd, flock, and schooling behavior in animals p1158; Predator warning p1159;	
52.2. Adaptive Immunity	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis; 3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	1061-1065		
52.3. Cell-Mediated Immunity	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis; 3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	1066-1067	Immune cells interact by cell-cell contact, antigen-presenting-cells (APCs), helper T-cells, killer T-cells p1066-1068	
52.4. Humoral Immunity and Antibody Production	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis; 3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling; 4.C.1: Variation in molecular units provides cells with a wider range of functions.	1068-1074	Immunological responses to pathogens, toxins and allergens p1068; Molecular diversity of antibodies in response to an antigen p1069	

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
52.5. Autoimmunity and Hypersensitivity	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis; 3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	1075-1076	Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera p1075	
52.6. Antibodies in Medical Treatment and Diagnosis	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	1077-1078		
52.7. Pathogens That Evade the Immune System	2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	1079-1082		
Chapter 53. The Reproductive System				1084-1104
53.1. Animal Reproductive Strategies				
53.2. Vertebrate Fertilization and Development				
53.3. Structure and Function of the Human Male Reproductive System				
53.4. Structure and Function of the Human Female Reproductive System				
53.5. Contraception and Infertility Treatments				
Chapter 54. Animal Development				
54.1. Fertilization	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.	1106-1107		1108-1109
54.2. Cleavage and the Blastula Stage	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.	1110-1111		

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
54.3. Gastrulation	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.	1112		1113-1115
54.4. Organogenesis	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.	1116-1117		1118-1121
54.5. Vertebrate Axis Formation				1122-1124
54.6. Human Development			Lactation in mammals p1128	1125-1131
Chapter 55. Behavioral Biology				
55.1. The Natural History of 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.	1132-1133		
55.2. Nerve Cells, Neurotransmitters, Hormones, and 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.	1134		
55.3. Behavioral Genetics	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.	1135-1136		
55.4. Learning	2.C.2 Organisms respond to changes in their external environments.	1137-1138		
55.5. The Development of Behavior	2.C.2 Organisms respond to changes in their external environments.	1139-1140		

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
55.6. Animal Cognition			Parent and offspring interactions p1142	1141
55.7. Orientation and Migratory Behavior		1142-143	Coloy and swarming behavior in insects p1142; Migration patterns p1142	
55.8. Animal Communication	2.C.2 Organisms respond to changes in their external environments; 3.E.1. Individuals can act on information and communicate it to others.	1144-1146	Courtship p1144; Courtship and mating behaviorsp1142; Foraging in bees and other animals p1146; dances p1146	
55.9. Behavioral Ecology	2.C.2 Organisms respond to changes in their external environments; 3.E.1. Individuals can act on information and communicate it to others.	1147-1148		
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Chapter 56. Ecology of Individuals and Populations				
56.1. The Environmental Challenges	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	1162-1164		
56.2. Populations: Groups of a Single Species in One Place	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	1165-1167		

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
56.3. Population Demography and Dynamics	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	1168-1170		
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Chapter 57. Community Ecology				
57.1. Biological Communities: Species Living Together	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	1186-1187	Global climate change models p1187	

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57.2. The Ecological Niche Concept	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; 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	1188-1191	Population density p1189; Niche and resource partitioning p1188	
57.3. Predator–Prey Relationships	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	1192-1195	Predator/prey relationships spreadsheet model p1192	
57.4. The Many Types of Species Interactions	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	1196-1201	Symbiosis (mutualism, commensalism, parasitism) p1198; Predator-prey relationships p1198; Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae p1197; Graphical representation of field data p1201	

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57.5. Ecological Succession, Disturbance, and Species Richness	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.	1202-1205	Species diversity p1203; Hurricanes, floods, earthquakes, volcanoes, fires p1202	
Chapter 58. Dynamics of Ecosystems				
58.1. Biogeochemical Cycles	2.A.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	1208-1213	Water and nutrient availability p1209; Algal blooms p1213; Global climate change models p1209	
58.2. The Flow of Energy in Ecosystems	2.A.1 All living systems require constant input of free energy; 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	1214-1218	Change in the producer level can affect the number and size of other trophic levels p1217; Change in energy resources levels such as sunlight can affect the number and size of the trophic levels p1217; Sunlight p1217; Food chains and food webs p1215	
58.3. Trophic-Level Interactions	2.A.1 All living systems require constant input of free energy; 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	1219-1222		
58.4. Biodiversity and Ecosystem Stability				1223-1225
58.5. Island Biogeography				1226-1228
Chapter 59. The Biosphere				

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59.1. Ecosystem Effects of Sun, Wind, and Water	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.	1230-1234	Temperature p1230	
59.2. Earth's Biomes	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.	1235-1237		
59.3. Freshwater Habitats	4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	1238-1240		
59.4. Marine Habitats	4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	1241-1244	El Nino p1243	
59.5. Human Impacts on the Biosphere: Pollution and Resource Depletion	2.D.3 Biological systems are affected by disruptions to their dynamic homeostatis; 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.	1245-1249	DDT resistance in insects p1245; Physiological responses to toxic substances p1248; Logging, slash and burn agriculture, urbanization, mono-cropping, infrastructure development (dams, transmission lines, roads), and global climate change threaten ecosystems and life on Earth. p1246	

	Essential Knowledge covered	Required content for the AP Course	Illustrative examples covered in this textbook - teach at least one	Content not required for the AP Course
59.6. Human Impacts on the Biosphere: Climate Change	2.D.3 Biological systems are affected by disruptions to their dynamic homeostatis; 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.	1250-1254		
Chapter 60. Conservation Biology				
60.1. Overview of the Biodiversity Crisis	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.	1256-1260	Human Impact p1260	
60.2. The Value of Biodiversity	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.	1261-1263		
60.3. Factors Responsible for Extinction	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.	1264-1273	Invasive and/or eruptive species p1269; Human Impact p1264; Introduction of species p1269; Loss of keystone species p1272; An introduced species can exploit a new niche free of predators or competitors, thus exploiting new resources. p1270	
60.4. Approaches for Preserving Endangered Species and Ecosystems	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.	1275-1278	California condor p1276	