Campbell Biology in Focus Correlation for AP® Biology Curriculum Framework

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
1 Introduction: Evolution and the Foundations of Biology	1–17	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments. 3.A: Heritable information provides for continuity of life. 4.A: Interactions within biological systems lead to complex properties. 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	1.A.1. Natural selection is a major mechanism of evolution. 1.A.2: Natural selection acts on phenotypic variations in populations. 1.A.3: Evolutionary change is also driven by random processes. 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. 1.C.3: Populations of organisms continue to evolve. 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. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 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.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. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs. 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.	LO 1.1 [See SP 1.5, 2.2] LO 1.2 [See SP 2.2, 5.3] LO 1.3 [See SP 2.2] LO 1.4 [See SP 5.3] LO 1.5 [See SP 7.1] LO 1.6 [See SP 1.4, 2.1] LO 1.7 [See SP 2.1] LO 1.8 [See SP 6.4] LO 1.9 [See SP 5.3] LO 1.10 [See SP 5.2] LO 1.11 [See SP 4.2] LO 1.12 [See SP 7.1] LO 1.13 [See SP 1.1, 2.1] LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 2.1 [See SP 6.2] LO 2.2 [See SP 6.1] LO 2.3 [See SP 6.4] LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.10 [See SP 1.4, 3.1] LO 2.11 [See SP 1.1, 7.1, 7.2] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2] LO 3.15 [See SP 6.5] LO 3.16 [See SP 6.3] LO 3.17 [See SP 1.2]	• Graphical analysis of allele frequencies in a population 5 • Application of the Hardy-Weinberg equilibrium equation 1, 2, 5, 9, 10, 13, 369, 403, 404, 407, 408, 409, 410, 411, 412, 413, 414, 415 • Sickle-cell disease 58, 288, 414, 501 • Peppered moth 10 • DDT resistance in insects 861, 897 • Artificial selection 13, 15, 17, 371, 611 • Loss of genetic diversity within a crop species 883, 884, 885, 886, 887, 888, 889, 890, 891 • Overuse of antibiotics 374 • Analysis of sequence data sets 284 • Analysis of phylogenetic trees 10, 340, 358, 370, 377, 381, 383, 384, 385, 387, 388, 389, 390, 391, 392, 394, 395, 396, 397, 398, 447, 470, 486, 487, 488, 489, 490, 496, 497, 504, 505, 513, 531, 534, 543, 726 • Construction of phylogenetic trees based on sequence data 10, 384, 385, 390 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91, 97, 98 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92, 147, 484 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • Krebs cycle 139, 140, 141, 142, 143, 144, 145, 146, 147, 151, 152 • Glycolysis 139, 140, 141, 142, 143, 144, 145, 146, 147 • Calvin cycle 159, 163, 164, 165, 166, 167, 168, 169, 171 • Fermentation 150 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 644, 645, 646, 647, 648, 649, 650, 651 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 644, 645 *Illustrative examples continued on next page*

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
1 Introduction: Evolution and the Foundations of Biology (continued)	1–17				LO 4.4 [See SP 6.4] LO 4.5 [See SP 6.2] LO 4.6 [See SP 1.4] LO 4.7 [See SP 1.3] LO 4.25 [See SP 6.1] LO 4.26 [See SP 6.4] LO 4.27 [See SP 6.4]	• Seasonal reproduction in animals and plants 731 • Life history strategy (biennial plants, reproductive diapause) 839 • Change in the producer level can affect the number and size of other trophic levels. 499, 866, 867, 870, 872, 876 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 866, 867, 868 • $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 3 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Degradation 667 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 262, 263, 264, 265, 307, 308, 321, 322 • Sickle-cell disease 58, 288, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841 • Sex-linked genes reside on sex chromosomes (X in humans) 194, 195, 232, 233 • In mammals and flies, the Y chromosome is very small and carries few genes. 232, 234 • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. 232 • Some traits are sex limited, and expression depends on the sex of the individual, such as milk production in female mammals and pattern baldness in males. 220, 221, 232, 233, 234, 235, 649, 650, 747 • Prairie chickens 409, 889 • Corn rust affects on agricultural crops 523

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UNIT 1 Chemistry and Cells, pg. 18						
2 The Chemical Context of Life	19–39	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	1.C: Life continues to evolve within a changing environment. 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 4.A: Interactions within biological systems lead to complex properties.	1.C.3: Populations of organisms continue to evolve. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 4.1 [See SP 7.1] LO 4.2 [See SP 1.3] LO 4.3 [See SP 6.1, 6.4]	• Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 332, 333, 334, 335, 337, 339, 340, 341 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87
3 Carbon and the Molecular Diversity of Life	40–65	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 3.A: Heritable information provides for continuity of life. 4.A: Interactions within biological systems lead to complex properties. 4.B: Competition and cooperation are important aspects of biological systems.	2.A.2: Organisms capture and store free energy for use in biological processes. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 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.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.B.1: Interactions between molecules affect their structure and function. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2]	• $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Sickle-cell disease 58, 288, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841

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4 A Tour of the Cell	66–93	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	1.B: Organisms are linked by lines of descent from common ancestry. 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 3.A: Heritable information provides for continuity of life. 3.D: Cells communicate by generating, transmitting and receiving chemical signals. 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 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. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 2.B.1: Cell membranes are selectively permeable due to their structure. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 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.	LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 2.1 [See SP 6.2] LO 2.2 [See SP 6.1] LO 2.3 [See SP 6.4] LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.10 [See SP 1.4, 3.1] LO 2.11 [See SP 1.1, 7.1, 7.2] LO 2.13 [See SP 6.2] LO 2.14 [See SP 1.4] LO 2.15 [See SP 6.1] LO 2.16 [See SP 7.2] LO 2.17 [See SP 5.3] LO 2.18 [See SP 6.4] LO 2.19 [See SP 6.4] LO 2.20 [See SP 6.1] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.34 [See SP 6.2] LO 3.35 [See SP 1.1] LO 4.22 [See SP 6.2]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92, 132 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Krebs cycle 139, 140, 141, 142, 143, 144, 145, 146, 147 • Glycolysis 139, 140, 141, 142, 143, 144, 145, 146, 147 • Calvin cycle 159, 163, 164, 165, 166, 167, 168, 169, 171 • Fermentation 150 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 644, 645, 646, 647, 648, 649, 650, 651 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 644, 645 • Seasonal reproduction in animals and plants 731 • Change in the producer level can affect the number and size of other trophic levels. 499, 866, 867, 870, 872, 876 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 866, 867, 868 • $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Endoplasmic reticulum 67, 72, 73, 75, 76, 77, 92 • Mitochondria 67, 72, 73, 82, 84, 92 • Chloroplasts 67, 73, 80, 82, 83, 84, 92 • Golgi 67, 72, 73, 78, 81, 92, 98 • Nuclear envelope 67, 74, 75, 72, 73, 79, 81, 92 *Illustrative examples continued on next page*

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4 A Tour of the Cell (continued)	66–93					• Operons in gene regulation 295, 296 • Temperature regulation in animals 644, 645, 646, 647, 648, 649, 650, 651 • Plant responses to water limitations 577, 591, 592, 625, 634, 635 • Lactation in mammals 649, 650, 747 • Ripening of fruit 620, 625 • Diabetes mellitus in response to decreased insulin 680 • Dehydration in response to decreased anti-diuretic hormone (ADH) 661 • Graves' disease (hyperthyroidism) 651 • Blood clotting 697 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T cells and killer T cells. [See also 2.D.4] 717, 718, 719, 721, 722, 723 • Plasmodesmata between plant cells that allow material to be transported from cell to cell 73, 89 • Neurotransmitters 66, 648, 649, 650, 752, 753, 754, 755, 756, 757, 758, 759, 761, 764 • Plant immune response 637 • Morphogens in embryonic development 742, 743, 744, 745, 746, 747, 748 • Insulin 680 • Human growth hormone • Thyroid hormones 650, 651, 653 • Testosterone 111, 739 • Estrogen 650 • Different types of hemoglobin 216, 643, 695, 696 • Chlorophylls 157, 160, 161, 162, 163, 166, 171

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5 Membrane Transport and Cell Signaling	94–115	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.B: Organisms are linked by lines of descent from common ancestry. 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments. 3.D: Cells communicate by generating, transmitting and receiving chemical signals.	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 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.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.	LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 2.10 [See SP 1.4, 3.1] LO 2.11 [See SP 1.1, 7.1, 7.2] LO 2.12 [See SP 1.4] LO 3.31 [See SP 7.2] LO 3.32 [See SP 3.1] LO 3.33 [See SP 1.4] LO 3.34 [See SP 6.2] LO 3.35 [See SP 1.1]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Glucose transport 167 • Na^+/K^+ transport 136 • DNA repair mechanisms 258 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T cells and killer T cells. [See also 2.D.4] 717, 718, 719, 721, 722, 723 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 73, 89 • Neurotransmitters 66, 648, 649, 650, 752, 753, 754, 755, 756, 757, 758, 759, 761, 764 • Plant immune response 637 • Morphogens in embryonic development 742, 743, 744, 745, 746, 747, 748 • Insulin 680 • Thyroid hormones 650, 651, 653 • Testosterone 111, 739 • Estrogen 650
6 An Introduction to Metabolism	116–134	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 4.B: Competition and cooperation are important aspects of biological systems.	2.A.1: All living systems require constant input of free energy. 4.B.1: Interactions between molecules affect their structure and function.	LO 2.1 [See SP 6.2] LO 2.2 [See SP 6.1] LO 2.3 [See SP 6.4] LO 4.17 [See SP 5.1]	• Krebs cycle 139, 140, 141, 142, 143, 144, 145, 146, 147 • Glycolysis 139, 140, 141, 142, 143, 144, 145, 146, 147 • Calvin cycle 159, 163, 164, 165, 166, 167, 168, 169, 171 • Fermentation 150 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 644, 645, 646, 647, 648, 649, 650, 651 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 644, 645 • Seasonal reproduction in animals and plants 731 • Change in the producer level can affect the number and size of other trophic levels. 499, 866, 867, 870, 872, 876 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 866, 867, 868

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7 Cellular Respiration and Fermentation	135–154	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.	2.A.2: Organisms capture and store free energy for use in biological processes.	LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2]	• $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171
8 Photosynthesis	155–173	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.	2.A.2: Organisms capture and store free energy for use in biological processes.	LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2]	• $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171
9 The Cell Cycle	174–190	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	3.A: Heritable information provides for continuity 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.	LO 3.7 [See SP 1.2] LO 3.9 [See SP 6.2] LO 3.10 [See SP 7.1] LO 3.11 [See SP 5.3]	• Mitosis-promoting factor (MPF) 185 • Action of platelet-derived growth factor (PDGF) 186 • Cancer results from disruptions in cell cycle control 186, 187, 188, 325, 326, 327
UNIT 2 Genetics pg. 191						
10 Meiosis and Sexual Life Cycles	192–205	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	3.A: Heritable information provides for continuity of life. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	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.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. 3.C.1: Changes in genotype can result in changes in phenotype. 3.C.2: Biological systems have multiple processes that increase genetic variation.	LO 3.7 [See SP 1.2] LO 3.9 [See SP 6.2] LO 3.10 [See SP 7.1] LO 3.11 [See SP 5.3] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2] LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Mitosis-promoting factor (MPF) 185 • Action of platelet-derived growth factor (PDGF) 186 • Cancer results from disruptions in cell cycle control 186, 187, 188, 325, 326, 327 • Sickle-cell disease 58, 288, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841 • Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 414

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11 Mendel and the Gene Idea	206–227	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	3.A: Heritable information provides for continuity of life. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 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.C.1: Changes in genotype can result in changes in phenotype.	LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2] LO 3.15 [See SP 6.5] LO 3.16 [See SP 6.3] LO 3.17 [See SP 1.2] LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2]	• Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Sickle-cell disease 58, 288, 406, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841 • Sex-linked genes reside on sex chromosomes (X in humans) 194, 195, 232, 233 • In mammals and flies, the Y chromosome is very small and carries few genes 232, 234 • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males 233, 234 • Some traits are sex limited, and expression depends on the sex of the individual, such as milk production in female mammals and pattern baldness in males 220, 221, 232, 233, 234, 235, 649, 650, 747 • Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 414
12 The Chromosomal Basis of Inheritance	228–244	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	3.A: Heritable information provides for continuity of life. 3.B: Expression of genetic information involves cellular and molecular mechanisms. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 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. 3.C.1: Changes in genotype can result in changes in phenotype.	LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2] LO 3.15 [See SP 6.5] LO 3.16 [See SP 6.3] LO 3.17 [See SP 1.2] LO 3.22 [See SP 6.2] LO 3.23 [See SP 1.4] LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2]	• Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Sickle-cell disease 58, 288, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841 • Sex-linked genes reside on sex chromosomes (X in humans). 194, 195, 232, 233 • In mammals and flies, the Y chromosome is very small and carries few genes. 232, 234 *Illustrative examples continued on next page*

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12 The Chromosomal Basis of Inheritance (continued)	228–244					• In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. 229, 231, 233, 234, 235 • Some traits are sex limited, and expression depends on the sex of the individual, such as milk production in female mammals and pattern baldness in males. 220, 221, 232, 233, 234, 235, 649, 650, 747 • Cytokines regulate gene expression to allow for cell replication and division. 176, 178, 179, 181, 183, 184, 198, 199, 200 • Ethylene levels cause changes in the production of different enzymes, allowing fruits to ripen. 620, 625 • Seed germination and gibberellin 600, 602, 603, 604, 605, 606, 623, 624 • Changes in p53 activity can result in cancer. 327 • HOX genes and their role in development 361 • Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 414
13 The Molecular Basis of Inheritance	245–267	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	3.A: Heritable information provides for continuity of life. 3.B: Expression of genetic information involves cellular and molecular mechanisms. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. 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. 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.	LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2] LO 3.18 [See SP 7.1] LO 3.19 [See SP 7.1] LO 3.20 [See SP 6.2] LO 3.21 [See SP 1.4] LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2] LO 3.29 [See SP 6.2] LO 3.30 [See SP 1.4]	• Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Sickle-cell disease 58, 288, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841 • Promoters 275, 296, 297, 300, 301, 302, 303 • Terminators 300 • Enhancers 300, 301, 302, 303 • Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 58, 414 • Transduction in bacteria 468

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14 Gene Expression: From Gene to Protein	268–292	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.A: Heritable information provides for continuity of life. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	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.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics. 3.C.2: Biological systems have multiple processes that increase genetic variation.	LO 2.31 [See SP 7.2] LO 2.32 [See SP 1.4] LO 2.33 [See SP 6.1] LO 2.34 [See SP 7.1] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.15 [See SP 6.5] LO 3.16 [See SP 6.3] LO 3.17 [See SP 1.2] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Morphogenesis of fingers and toes 315, 375, 542, 543 • Immune function 711, 712, 713, 714, 716, 717, 718, 719, 720, 721, 722, 723, 724 • Flower development 598, 599, 600, 603 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Sex-linked genes reside on sex chromosomes (X in humans). 194, 195, 232, 233 • In mammals and flies, the Y chromosome is very small and carries few genes. 232, 234 • Some traits are sex limited, and expression depends on the sex of the individual, such as milk production in female mammals and pattern baldness in males. 220, 221, 232, 233, 234, 235, 649, 650, 747
15 Regulation of Gene Expression	293–310	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.A: Heritable information provides for continuity of life. 3.B: Expression of genetic information involves cellular and molecular mechanisms. 4.B: Competition and cooperation are important aspects of biological systems. 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	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. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 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.1: Gene regulation results in differential gene expression, leading to cell specialization. 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression. 4.B.1: Interactions between molecules affect their structure and function. 4.C.2: Environmental factors influence the expression of the genotype in an organism.	LO 2.21 [See SP 4.1] LO 2.31 [See SP 7.2] LO 2.32 [See SP 1.4] LO 2.33 [See SP 6.1] LO 2.34 [See SP 7.1] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.7 [See SP 1.2] LO 3.9 [See SP 6.2] LO 3.10 [See SP 7.1] LO 3.11 [See SP 5.3] LO 3.18 [See SP 7.1] LO 3.19 [See SP 7.1] LO 3.20 [See SP 6.2] LO 3.21 [See SP 1.4] LO 3.22 [See SP 6.2] LO 3.23 [See SP 1.4] LO 4.17 [See SP 5.1] LO 4.23 [See SP 6.2] LO 4.24 [See SP 6.4]	• Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 196, 506, 511 • Nocturnal and diurnal activity: circadian rhythms 629, 771, 774, 775, 792 • Morphogenesis of fingers and toes 315, 375, 542, 543 • Immune function 711, 712, 713, 714, 716, 717, 718, 719, 720, 721, 722, 723, 724 • Flower development 598, 599, 600, 603 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Sex determination in reptiles 731

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16 Development, Stem Cells, and Cancer	311–329	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.A: Heritable information provides for continuity of life. 3.B: Expression of genetic information involves cellular and molecular mechanisms. 3.C: The processing of genetic information is imperfect and is a source of genetic variation. 4.A: Interactions within biological systems lead to complex properties.	2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 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.1: DNA, and in some cases RNA, is the primary source of heritable information. 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. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.31 [See SP 7.2] LO 2.32 [See SP 1.4] LO 2.33 [See SP 6.1] LO 2.34 [See SP 7.1] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.18 [See SP 7.1] LO 3.19 [See SP 7.1] LO 3.20 [See SP 6.2] LO 3.21 [See SP 1.4] LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2] LO 4.7 [See SP 1.3]	• Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Morphogenesis of fingers and toes 315, 375, 542, 543 • Immune function 711, 712, 713, 714, 716, 717, 718, 719, 720, 721, 722, 723, 724 • Flower development 598, 599, 600, 603 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 52, 102, 104, 105 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Promoters 275, 296, 297, 300, 301, 302, 303 • Terminators 300 • Enhancers 300, 301, 302, 303 • Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 414
17 Viruses 330	330–342	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	3.A: Heritable information provides for continuity of life. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 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. 3.C.3: Viral replication results in genetic variation and viral infection can introduce genetic variation into the hosts.	LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.15 [See SP 6.5] LO 3.16 [See SP 6.3] LO 3.17 [See SP 1.2] LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2] LO 3.29 [See SP 6.2] LO 3.30 [See SP 1.4]	• Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Sex-linked genes reside on sex chromosomes (X in humans). 194, 195, 232, 233 • In mammals and flies, the Y chromosome is very small and carries few genes. 232, 234 • Some traits are sex limited, and expression depends on the sex of the individual, such as milk production in female mammals and pattern baldness in males. 220, 221, 232, 233, 234, 235, 649, 650, 747 *Illustrative examples continued on next page*

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	330–342					• Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 414 • Transduction in bacteria 468 • Transposons present in incoming DNA 350, 351
18 Genomes and Their Evolution	343–363	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	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.C.2: Biological systems have multiple processes that increase genetic variation.	LO 2.31 [See SP 7.2] LO 2.32 [See SP 1.4] LO 2.33 [See SP 6.1] LO 2.34 [See SP 7.1] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Morphogenesis of fingers and toes 315, 375, 542, 543 • Immune function 711, 712, 713, 714, 716, 717, 718, 719, 720, 721, 722, 723, 724 • Flower development 598, 599, 600, 603
UNIT 3 Evolution, pg. 364						
19 Descent with Modification	365–380	Big Idea 1: The process of evolution drives the diversity and unity of life	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 1.D: The origin of living systems is explained by natural processes.	1.A.1. Natural selection is a major mechanism of evolution. 1.A.3: Evolutionary change is also driven by random processes. 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. 1.C.3: Populations of organisms continue to evolve. 1.D.1: There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence. 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.	LO 1.1 [See SP 1.5, 2.2] LO 1.2 [See SP 2.2, 5.3] LO 1.3 [See SP 2.2] LO 1.6 [See SP 1.4, 2.1] LO 1.7 [See SP 2.1] LO 1.8 [See SP 6.4] LO 1.9 [See SP 5.3] LO 1.10 [See SP 5.2] LO 1.11 [See SP 4.2] LO 1.12 [See SP 7.1] LO 1.13 [See SP 1.1, 2.1] LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 1.27 [See SP 1.2] LO 1.28 [See SP 3.3] LO 1.29 [See SP 6.3] LO 1.30 [See SP 6.5] LO 1.31 [See SP 4.4] LO 1.32 [See SP 4.1]	• Application of the Hardy-Weinberg equilibrium equation 1, 2, 5, 9, 10, 13, 369, 403, 404, 407, 408, 409, 410, 411, 412, 413, 414, 415 • Analysis of sequence data sets 284 • Analysis of phylogenetic trees 10, 340, 358, 370, 377, 381, 383, 384, 385, 387, 388, 389, 390, 391, 392, 394, 395, 396, 397, 398, 447, 470, 486, 487, 488, 489, 490, 496, 497, 504, 505, 513 • Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
20 Phylogeny	381–398	Big Idea 1: The process of evolution drives the diversity and unity of life	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment.	1.A.2: Natural selection acts on phenotypic variations in populations. 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. 1.C.3: Populations of organisms continue to evolve.	LO 1.4 [See SP 5.3] LO 1.5 [See SP 7.1] LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3]	• Sickle-cell disease 58, 288, 406, 414, 501 • Peppered moth 10 • DDT resistance in insects 861, 897 • Artificial selection 13, 15, 17, 371, 611 • Loss of genetic diversity within a crop species 883, 884, 885, 886, 887, 888, 889, 890, 891 • Overuse of antibiotics 374 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773
21 The Evolution of Populations	399–417	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 3.A: Heritable information provides for continuity of life. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	1.A.1. Natural selection is a major mechanism of evolution. 1.A.2: Natural selection acts on phenotypic variations in populations. 1.A.3: Evolutionary change is also driven by random processes. 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.C.3: Populations of organisms continue to evolve. 3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. 3.C.2: Biological systems have multiple processes that increase genetic variation.	LO 1.1 [See SP 1.5, 2.2] LO 1.2 [See SP 2.2, 5.3] LO 1.3 [See SP 2.2] LO 1.4 [See SP 5.3] LO 1.5 [See SP 7.1] LO 1.6 [See SP 1.4, 2.1] LO 1.7 [See SP 2.1] LO 1.8 [See SP 6.4] LO 1.9 [See SP 5.3] LO 1.10 [See SP 5.2] LO 1.11 [See SP 4.2] LO 1.12 [See SP 7.1] LO 1.13 [See SP 1.1, 2.1] LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 1.25 [See SP 1.2]	• Application of the Hardy-Weinberg equilibrium equation 1, 2, 5, 9, 10, 13, 369, 403, 404, 407, 408, 409, 410, 411, 412, 413, 414, 415 • Sickle-cell disease 58, 288, 414, 501 • Peppered moth 10 • DDT resistance in insects 861, 897 • Artificial selection 13, 15, 17, 371, 611 • Loss of genetic diversity within a crop species 883, 884, 885, 886, 887, 888, 889, 890, 891 • Analysis of sequence data sets 284 • Analysis of phylogenetic trees 10, 340, 358, 370, 377, 381, 383, 384, 385, 387, 388, 389, 390, 391, 392, 394, 395, 396, 397, 398, 447, 470, 486, 487, 488, 489, 490, 496, 497, 504, 505, 513 • Construction of phylogenetic trees based on sequence data 383, 388, 389, 390 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 *Illustrative examples continued on next page*

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21 The Evolution of Populations (continued)	399–417				LO 1.26 [See SP 5.3] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773 • Sickle-cell disease 58, 288, 406, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841
22 The Origin of Species	418–435	Big Idea 1: The process of evolution drives the diversity and unity of life	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment.	1.A.3: Evolutionary change is also driven by random processes. 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. 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.	LO 1.6 [See SP 1.4, 2.1] LO 1.7 [See SP 2.1] LO 1.8 [See SP 6.4] LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.20 [See SP 5.1] LO 1.21 [See SP 4.2] LO 1.22 [See SP 6.4] LO 1.23 [See SP 4.1] LO 1.24 [See SP 7.2] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3]	• Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Five major extinctions 447 • Human impact on ecosystems and species extinction rates 824, 825, 826, 827, 828, 877, 878, 879, 883, 884, 885, 886, 887, 893, 896, 897, 898, 902, 903 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773
23 Broad Patterns of Evolution	436–456	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 1.D: The origin of living systems is explained by natural processes. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	1.A.1. Natural selection is a major mechanism of evolution. 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.C.1: Speciation and extinction have occurred throughout the Earth's history. 1.C.3: Populations of organisms continue to evolve. 1.D.1: There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence. 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life. 3.C.1: Changes in genotype can result in changes in phenotype.	LO 1.1 [See SP 1.5, 2.2] LO 1.2 [See SP 2.2, 5.3] LO 1.3 [See SP 2.2] LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 1.20 [See SP 5.1] LO 1.21 [See SP 4.2] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 1.27 [See SP 1.2] LO 1.28 [See SP 3.3] LO 1.29 [See SP 6.3] LO 1.30 [See SP 6.5] LO 1.31 [See SP 4.4] LO 1.32 [See SP 4.1]	• Application of the Hardy-Weinberg equilibrium equation 1, 2, 5, 9, 10, 13, 369, 403, 404, 407, 408, 409, 410, 411, 412, 413, 414, 415 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Five major extinctions 447 • Human impact on ecosystems and species extinction rates 549, 824, 825, 826, 827, 828, 877, 878, 879, 883, 884, 885, 886, 887, 893, 896, 897, 898, 902, 903 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 *Illustrative examples continued on next page*

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
	436–456				LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2]	• Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773 • Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 414
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24 Early Life and the Diversification of Prokaryotes	458–480	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.D: The origin of living systems is explained by natural processes. 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.A: Heritable information provides for continuity of life. 3.D: Cells communicate by generating, transmitting and receiving chemical signals.	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. 1.D.1: There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence. 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 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.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.D.3: Signal transduction pathways link signal reception with cellular response. 3.D.4: Changes in signal transduction pathways can alter cellular response.	LO 1.9 [See SP 5.3] LO 1.10 [See SP 5.2] LO 1.11 [See SP 4.2] LO 1.12 [See SP 7.1] LO 1.13 [See SP 1.1, 2.1] LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.27 [See SP 1.2] LO 1.28 [See SP 3.3] LO 1.29 [See SP 6.3] LO 1.30 [See SP 6.5] LO 1.31 [See SP 4.4] LO 1.32 [See SP 4.1] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.22 [See SP 1.3, 3.2] LO 2.23 [See SP 4.2, 7.2] LO 2.24 [See SP 5.1] LO 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.36 [See SP 1.5] LO 3.37 [See SP 6.1] LO 3.38 [See SP 1.5] LO 3.39 [See SP 6.2]	• Analysis of sequence data sets 284 • Analysis of phylogenetic trees 10, 340, 358, 370, 377, 381, 383, 384, 385, 387, 388, 389, 390, 391, 392, 394, 395, 396, 397, 398, 447, 470, 486, 487, 488, 489, 490, 496, 497, 504, 505, 513 • Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Cell density 186 • Temperature 120, 644, 645, 646, 647, 873 • Water availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Sunlight 6, 159, 160, 161, 162, 163, 164, 167, 168, 171 • Symbiosis (mutualism, commensalism, parasitism) 475, 586, 845, 846, 850, 851 • Predator-prey relationships 528, 751, 768, 841, 848, 853, 854 • Water and nutrient availability, temperature, salinity, pH 30, 31, 32, 33, 34, 35, 36 • Water and nutrient availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Food chains and food webs 853, 854, 855 • Species diversity 549, 851, 852, 853, 856, 857, 858, 859, 860, 883 • Population density 832, 833, 834, 836, 837, 838, 839, 840, 841, 842, 852, 853 • Algal blooms 896 • 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 629, 631, 771, 773, 774, 775, 792 • Diurnal/nocturnal and sleep/wake cycles 771, 774, 775, 792 *Illustrative examples continued on next page*

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24 Early Life and the Diversification of Prokaryotes (continued)	458–480					• Visual displays in the reproductive cycle 195, 196, 333, 334, 335, 337, 498, 501, 506, 507, 511, 600, 737, 740, 742 • Fruiting body formation in fungi, slime molds and certain types of bacteria 498 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • G protein-linked receptors 110 • Ligand-gated ion channels 110 • Receptor tyrosine kinases 112, 113 • Ligand-gated ion channels 110 • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera 680 • Drugs (hypertensives, anesthetics, antihistamines and birth control drugs) 775
25 The Origin and Diversification of Eukaryotes	481–503	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 4.A: Interactions within biological systems lead to complex properties.	1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. 1.C.3: Populations of organisms continue to evolve. 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. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. 2.C.2: Organisms respond to changes in their external environments. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 2.1 [See SP 6.2] LO 2.2 [See SP 6.1] LO 2.3 [See SP 6.4] LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2] LO 2.13 [See SP 6.2] LO 2.14 [See SP 1.4] LO 2.21 [See SP 4.1] LO 4.4 [See SP 6.4] LO 4.5 [See SP 6.2] LO 4.6 [See SP 1.4] LO 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773 • Krebs cycle 139, 140, 141, 142, 143, 144, 145, 146, 147, 151, 152 • Glycolysis 139, 140, 141, 142, 143, 144, 145, 146, 147 • Calvin cycle 159, 163, 164, 165, 166, 167, 168, 169, 171 • Fermentation 150 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 644, 645, 646, 647, 648, 649, 650, 651 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 644, 645 • Seasonal reproduction in animals and plants 731 *Illustrative examples continued on next page*

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25 The Origin and Diversification of Eukaryotes (continued)	481–503					• Change in the producer level can affect the number and size of other trophic levels 499, 866, 867, 870, 872, 876 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 866, 867, 868 • $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171 • Endoplasmic reticulum 67, 72, 73, 75, 76, 77, 92 • Mitochondria 67, 72, 73, 82, 84, 92 • Chloroplasts 67, 73, 80, 82, 83, 84, 92 • Golgi 67, 72, 73, 78, 81, 92, 98 • Nuclear envelope 67, 74, 75, 72, 73, 79, 81, 92 • Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 511 • Nocturnal and diurnal activity: circadian rhythms 629, 771, 774, 775, 792
26 The Colonization of Land by Plants and Fungi	504–527	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 1.D: The origin of living systems is explained by natural processes. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.B: Expression of genetic information involves cellular and molecular mechanisms. 3.D: Cells communicate by generating, transmitting and receiving chemical signals.	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. 1.C.1: Speciation and extinction have occurred throughout the Earth's history. 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life. 2.C.2: Organisms respond to changes in their external environments. 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.20 [See SP 5.1] LO 1.21 [See SP 4.2] LO 1.32 [See SP 4.1] LO 2.21 [See SP 4.1] LO 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2] LO 3.22 [See SP 6.2] LO 3.23 [See SP 1.4] LO 3.34 [See SP 6.2] LO 3.35 [See SP 1.1]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92, 147, 484 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Five major extinctions 447 • Human impact on ecosystems and species extinction rates 549, 824, 825, 826, 827, 828, 877, 878, 879, 883, 884, 885, 886, 887, 893, 896, 897, 898, 902, 903 • Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 511 • Nocturnal and diurnal activity: circadian rhythms 771, 774, 775, 792 • 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 629, 631, 771, 773, 774, 775, 792 *Illustrative examples continued on next page*

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
26 The Colonization of Land by Plants and Fungi (continued)	504–527					• Diurnal/nocturnal and sleep/wake cycles 771, 774, 775, 792 • Visual displays in the reproductive cycle 195, 196, 333, 334, 335, 337, 498, 501, 506, 507, 511, 600, 737, 740, 742 • Fruiting body formation in fungi, slime molds and certain types of bacteria 498 • Cytokines regulate gene expression to allow for cell replication and division 176, 178, 179, 181, 183, 184, 198, 199, 200 • Ethylene levels cause changes in the production of different enzymes, allowing fruits to ripen 620, 625 • Seed germination and gibberellin 600, 602, 603, 604, 605, 606, 623, 624 • Changes in p53 activity can result in cancer 327 • HOX genes and their role in development 361 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T cells and killer T cells [See also 2.D.4] 717, 718, 719, 721, 722, 723 • Neurotransmitters 66, 648, 649, 650, 752, 753, 754, 755, 756, 757, 758, 759, 761, 764 • Plant immune response 637 • Morphogens in embryonic development 742, 743, 744, 745, 746, 747, 748 • Insulin 680 • Thyroid hormones 650, 651, 653 • Testosterone 111, 739 • Estrogen 650
27 The Rise of Animal Diversity	528–551	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.	1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. 1.C.3: Populations of organisms continue to evolve. 2.C.2: Organisms respond to changes in their external environments.	LO 1.9 [See SP 5.3] LO 1.10 [See SP 5.2] LO 1.11 [See SP 4.2] LO 1.12 [See SP 7.1] LO 1.13 [See SP 1.1, 2.1] LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 2.21 [See SP 4.1]	• Analysis of sequence data sets 284 • Analysis of phylogenetic trees 10, 340, 358, 370, 377, 381, 383, 384, 385, 387, 388, 389, 390, 391, 392, 394, 395, 396, 397, 398, 447, 470, 486, 487, 488, 489, 490, 496, 497, 504, 505, 513 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Number of heart chambers in animals 685, 687, 688, 689, 690 • Absence of legs in some sea mammals 543, 375, 377 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773 *Illustrative examples continued on next page*

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	528–551					• Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 511 • Nocturnal and diurnal activity: circadian rhythms 771, 774, 775, 792
UNIT 5 Plant Form and Function pg. 552						
28 Plant Structure and Growth	553–570	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.B: Expression of genetic information involves cellular and molecular mechanisms. 4.A: Interactions within biological systems lead to complex properties.	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.B.1: Gene regulation results in differential gene expression, leading to cell specialization. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	LO 2.31 [See SP 7.2] LO 2.32 [See SP 1.4] LO 2.33 [See SP 6.1] LO 2.34 [See SP 7.1] LO 3.18 [See SP 7.1] LO 3.19 [See SP 7.1] LO 3.20 [See SP 6.2] LO 3.21 [See SP 1.4] LO 4.7 [See SP 1.3]	• Morphogenesis of fingers and toes 315, 375, 542, 543 • Immune function 711,712, 713, 714, 716, 717, 718, 719, 720, 721, 722, 723, 724 • Flower development 598, 599, 600, 603 • Promoters 275, 296, 297, 300, 301, 302, 303 • Terminators 300 • Enhancers 300, 301, 302, 303
29 Resource Acquisition, Nutrition, and Transport in Vascular Plants	571–596	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.	2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 2.B.1: Cell membranes are selectively permeable due to their structure. 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.10 [See SP 1.4, 3.1] LO 2.11 [See SP 1.1, 7.1, 7.2] LO 2.15 [See SP 6.1] LO 2.16 [See SP 7.2] LO 2.17 [See SP 5.3] LO 2.18 [See SP 6.4] LO 2.19 [See SP 6.4] LO 2.20 [See SP 6.1] LO 2.29 [See SP 1.1, 1.2] LO 2.30 [See SP 1.1, 1.2] LO 4.7 [See SP 1.3] LO 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Operons in gene regulation 295, 296 • Temperature regulation in animals 644, 645, 646, 647 • Plant responses to water limitations 577, 591, 592, 625, 634, 635 • Lactation in mammals 649, 650, 747 • Ripening of fruit 620, 625 • Diabetes mellitus in response to decreased insulin 680 • Dehydration in response to decreased antidiuretic hormone (ADH) 661 • Graves' disease (hyperthyroidism) 651 • Blood clotting 697 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses 713 *Illustrative examples continued on next page*

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
	571–596		2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 4.A: Interactions within biological systems lead to complex properties.			• Plant defenses against pathogens include molecular recognition systems with systemic responses 713 • Infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects 714, 722, 723 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens 712, 714, 716, 717, 718, 719
30 Reproduction and Domestication of Flowering Plants	597–616	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.A: Heritable information provides for continuity of life. 3.C: The processing of genetic information is imperfect and is a source of genetic variation.	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.1: DNA, and in some cases RNA, is the primary source of heritable information. 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.1: Changes in genotype can result in changes in phenotype. 3.C.2: Biological systems have multiple processes that increase genetic variation.	LO 2.31 [See SP 7.2] LO 2.32 [See SP 1.4] LO 2.33 [See SP 6.1] LO 2.34 [See SP 7.1] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.7 [See SP 1.2] LO 3.9 [See SP 6.2] LO 3.10 [See SP 7.1] LO 3.11 [See SP 5.3] LO 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Morphogenesis of fingers and toes 315, 375, 542, 543 • Immune function 711, 712, 713, 714, 716, 717, 718, 719, 720, 721, 722, 723, 724 • Flower development 598, 599, 600, 603 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 • Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Synthesis 256, 333 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Mitosis-promoting factor (MPF) 185 • Action of platelet-derived growth factor (PDGF) 186 • Cancer results from disruptions in cell cycle control 187 • Antibiotic resistance mutations 469 • Sickle-cell disorder and heterozygote advantage 414
31 Plant Responses to Internal and External Signals	617–639	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis	1.A: Change in the genetic makeup of a population over time is evolution. 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.	1.A.1. Natural selection is a major mechanism of evolution. 2.A.2: Organisms capture and store free energy for use in biological processes. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.C.2: Organisms respond to changes in their external environments.	LO 1.1 [See SP 1.5, 2.2] LO 1.2 [See SP 2.2, 5.3] LO 1.3 [See SP 2.2] LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.15 [See SP 6.1] LO 2.16 [See SP 7.2] LO 2.17 [See SP 5.3] LO 2.18 [See SP 6.4]	• Application of the Hardy-Weinberg equilibrium equation 1, 2, 5, 9, 10, 13, 369, 403, 404, 407, 408, 409, 410, 411, 412, 413, 414, 415 • $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 *Illustrative examples continued on next page*

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
31 Plant Responses to Internal and External Signals (continued)	617–639		2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.	2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms.	LO 2.19 [See SP 6.4] LO 2.20 [See SP 6.1] LO 2.21 [See SP 4.1] LO 2.29 [See SP 1.1, 1.2] LO 2.30 [See SP 1.1, 1.2] LO 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2]	• Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Operons in gene regulation 295, 296 • Temperature regulation in animals 644, 645, 646, 647 • Plant responses to water limitations 577, 591, 592, 625, 634, 635 • Lactation in mammals 649, 650, 747 • Ripening of fruit 620, 625 • Diabetes mellitus in response to decreased insulin 680 • Dehydration in response to decreased antidiuretic hormone (ADH) 661 • Graves' disease (hyperthyroidism) 651 • Blood clotting 697 • Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 196, 511 • Nocturnal and diurnal activity: circadian rhythms 771, 774, 775, 792 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses 713 • Plant defenses against pathogens include molecular recognition systems with systemic responses 713 • Infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects 714, 722, 723 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens 712, 714, 716, 717, 718, 719 • 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 629, 631, 771, 773, 774, 775, 792 • Diurnal/nocturnal and sleep/wake cycles 771, 774, 775, 792 • Visual displays in the reproductive cycle 195, 196, 333, 334, 335, 337, 498, 501, 506, 507, 511, 600, 737, 740, 742 • Fruiting body formation in fungi, slime molds and certain types of bacteria 498

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UNIT 6 Animal Form and Function, pg.640						
32 Homeostasis and Endocrine Signaling	641–664	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment. 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.E: Transmission of information results in changes within and between biological systems.	1.A.1. Natural selection is a major mechanism of evolution. 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 1.C.3: Populations of organisms continue to evolve. 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. 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. 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.C.2: Organisms respond to changes in their external environments. 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.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 homeostasis. 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.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	LO 1.1 [See SP 1.5, 2.2] LO 1.2 [See SP 2.2, 5.3] LO 1.3 [See SP 2.2] LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.10 [See SP 1.4, 3.1] LO 2.11 [See SP 1.1, 7.1, 7.2] LO 2.12 [See SP 1.4] LO 2.15 [See SP 6.1] LO 2.16 [See SP 7.2] LO 2.17 [See SP 5.3] LO 2.18 [See SP 6.4] LO 2.19 [See SP 6.4] LO 2.20 [See SP 6.1] LO 2.21 [See SP 4.1] LO 2.22 [See SP 1.3, 3.2] LO 2.23 [See SP 4.2, 7.2] LO 2.24 [See SP 5.1] LO 2.25 [See SP 6.2] LO 2.26 [See SP 5.1] LO 2.27 [See SP 7.1] LO 2.28 [See SP 1.4] LO 2.31 [See SP 7.2] LO 2.32 [See SP 1.4] LO 2.33 [See SP 6.1] LO 2.34 [See SP 7.1] LO 3.43 [See SP 6.2, 7.1] LO 3.44 [See SP 1.2] LO 3.45 [See SP 1.2] LO 3.46 [See SP 1.2] LO 3.47 [See SP 1.1] LO 3.48 [See SP 1.1] LO 3.49 [See SP 1.1] LO 3.50 [See SP 1.1]	• Application of the Hardy-Weinberg equilibrium equation 1, 2, 5, 9, 10, 13, 369, 403, 404, 407, 408, 409, 410, 411, 412, 413, 414, 415 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Glucose transport 167 • Na^+/K^+ transport 136 • Operons in gene regulation 295, 296 • Temperature regulation in animals 644, 645, 646, 647, 648, 649, 650, 651 • Plant responses to water limitations 577, 591, 592, 625, 634, 635 • Lactation in mammals 649, 650, 747 • Ripening of fruit 620, 625 • Diabetes mellitus in response to decreased insulin 680 • Dehydration in response to decreased antidiuretic hormone (ADH) 661 • Graves' disease (hyperthyroidism) 651 • Blood clotting 697 • Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 511 *Illustrative examples continued on next page*

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32 Homeostasis and Endocrine Signaling (continued)	641–664					• Nocturnal and diurnal activity: circadian rhythms 771, 774, 775, 792 • Cell density 186 • Temperature 644, 645, 646, 647 • Water availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Sunlight 6, 159, 160, 161, 162, 163, 164, 167, 168, 171 • Symbiosis (mutualism, commensalism, parasitism) 475, 586, 845, 846, 850, 851 • Predator-prey relationships 528, 751, 768, 841, 848, 853, 854 • Water and nutrient availability, temperature, salinity, pH 30, 31, 32, 33, 34, 35, 36 • Water and nutrient availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Food chains and food webs 853, 854, 855 • Species diversity 549, 851, 852, 853, 856, 857, 858, 859, 860, 883 • Population density 832, 833, 834, 836, 837, 838, 839, 840, 841, 842, 852, 853 • Algal blooms 896 • Gas exchange in aquatic and terrestrial plants 591, 592 • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems 668, 670, 671, 672, 674, 675 • Respiratory systems of aquatic and terrestrial animals 700, 701, 702, 703, 705, 706, 707 • Nitrogenous waste production and elimination in aquatic and terrestrial animals 654, 655, 656, 657, 659, 660, 661 • Excretory systems in flatworms, earthworms and vertebrates 654, 655, 656, 657, 659, 660, 661 • Osmoregulation in bacteria, fish and protists 654 • Osmoregulation in aquatic and terrestrial plants 575, 577 • Circulatory systems in fish, amphibians and mammals 216, 685, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 698 • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms) 644, 645, 646, 647, 648, 649, 650, 651 • Invasive and/or eruptive species 585, 886 • Human impact 824, 825, 826, 827, 828, 877, 878, 879, 883, 884, 885, 886, 887, 893, 896, 897, 898, 902, 903 • Morphogenesis of fingers and toes 315, 375, 542, 543 • Immune function 711,712, 713, 714, 716, 717, 718, 719, 720, 721, 722, 723, 724 • Flower development 598, 599, 600, 603 • Acetylcholine 764, 765 • Epinephrine 764, 765 • Norepinephrine 764, 765 • Dopamine 764, 765 • Serotonin 764, 765 • GABA 764, 765 • Vision 773, 776, 785 • Hearing 776, 777, 783, 784, 785 *Illustrative examples continued on next page*

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	641–664					• Muscle movement 773, 793, 794, 795, 796, 797, 798, 799, 800 • Abstract thought and emotions 773, 775, 776 • Neuro-hormone production 649, 650, 651, 652 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 772, 773, 775, 776 • Right and left cerebral hemispheres in humans 773
33 Animal Nutrition	665–683	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	1.B: Organisms are linked by lines of descent from common ancestry. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 4.B: Competition and cooperation are important aspects of biological systems.	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 4.B.1: Interactions between molecules affect their structure and function. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 2.15 [See SP 6.1] LO 2.16 [See SP 7.2] LO 2.17 [See SP 5.3] LO 2.18 [See SP 6.4] LO 2.19 [See SP 6.4] LO 2.20 [See SP 6.1] LO 4.17 [See SP 5.1] LO 4.18 [See SP 1.4]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • Operons in gene regulation 295, 296 • Temperature regulation in animals 644, 645, 646, 647 • Plant responses to water limitations 577, 591, 592, 625, 634, 635 • Lactation in mammals 649, 650, 747 • Ripening of fruit 620, 625 • Diabetes mellitus in response to decreased insulin 680 • Dehydration in response to decreased antidiuretic hormone (ADH) 661 • Graves' disease (hyperthyroidism) 651 • Blood clotting 697 • Exchange of gases 684, 700, 701, 702, 703, 705, 706, 707 • Circulation of fluids 687, 688, 689, 690, 691, 692, 693, 694 • Digestion of food 668, 669, 670, 671, 672, 673, 674, 675, 677, 678, 670, 680 • Excretion of wastes 654, 655, 656, 657, 659, 660, 661, 662 • Bacterial community in the rumen of animals 677
34 Circulation and Gas Exchange	684–710	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.D: Cells communicate by generating, transmitting and receiving chemical signals. 4.B: Competition and cooperation are important aspects of biological systems.	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. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	LO 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2] LO 3.31 [See SP 7.2] LO 3.32 [See SP 3.1] LO 3.33 [See SP 1.4] LO 4.18 [See SP 1.4]	• 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 629, 631, 771, 773, 774, 775, 792 • Diurnal/nocturnal and sleep/wake cycles 771, 774, 775, 792 • Visual displays in the reproductive cycle 195, 196, 333, 334, 335, 337, 498, 501, 506, 507, 511, 600, 737, 740, 742 • Fruiting body formation in fungi, slime molds and certain types of bacteria 498 • DNA repair mechanisms 258 • Exchange of gases 684, 700, 701, 702, 703, 705, 706, 707 • Circulation of fluids 687, 688, 689, 690, 691, 692, 693, 694 *Illustrative examples continued on next page*

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	684–710	Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties				• Digestion of food 668, 669, 670, 671, 672, 673, 674, 675, 677, 678, 670, 680 • Excretion of wastes 654, 655, 656, 657, 659, 660, 661, 662 • Bacterial community in the rumen of animals 677 • Bacterial community in and around deep-sea vents 474
35 The Immune System	711–728	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 3.D: Cells communicate by generating, transmitting and receiving chemical signals.	2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history.	LO 2.29 [See SP 1.1, 1.2] LO 2.30 [See SP 1.1, 1.2] LO 3.31 [See SP 7.2] LO 3.32 [See SP 3.1] LO 3.33 [See SP 1.4]	• Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses 713 • Plant defenses against pathogens include molecular recognition systems with systemic responses 713 • Infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects 714, 722, 723 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens 712, 714, 716, 717, 718, 719 • DNA repair mechanisms 258
36 Reproduction and Development	729–750	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.A: Heritable information provides for continuity of life. 3.B: Expression of genetic information involves cellular and molecular mechanisms.	2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 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. 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.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. 3.B.1: Gene regulation results in differential gene expression, leading to cell specialization.	LO 2.15 [See SP 6.1] LO 2.16 [See SP 7.2] LO 2.17 [See SP 5.3] LO 2.18 [See SP 6.4] LO 2.19 [See SP 6.4] LO 2.20 [See SP 6.1] LO 2.21 [See SP 4.1] LO 2.38 [See SP 5.1] LO 2.39 [See SP 6.1] LO 2.40 [See SP 7.2] LO 3.7 [See SP 1.2] LO 3.9 [See SP 6.2] LO 3.10 [See SP 7.1] LO 3.11 [See SP 5.3] LO 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2] LO 3.18 [See SP 7.1] LO 3.19 [See SP 7.1] LO 3.20 [See SP 6.2] LO 3.21 [See SP 1.4]	• Operons in gene regulation 295, 296 • Temperature regulation in animals 644, 645, 646, 647 • Plant responses to water limitations 577, 591, 592, 625, 634, 635 • Lactation in mammals 649, 650, 747 • Ripening of fruit 620, 625 • Diabetes mellitus in response to decreased insulin 680 • Dehydration in response to decreased antidiuretic hormone (ADH) 661 • Graves' disease (hyperthyroidism) 651 • Blood clotting 697 • Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 511 • Nocturnal and diurnal activity: circadian rhythms 629, 771, 774, 775, 792 • Hibernation 807, 842, 890 • Migration 807, 842, 890 • Courtship 810, 811, 890 • Niche and resource partitioning 585, 846 • Biology of pollination 548 • Mitosis-promoting factor (MPF) 185 • Action of platelet-derived growth factor (PDGF) 186 • Cancer results from disruptions in cell cycle control 187 • Sickle-cell disease 58, 288, 406, 414, 501 • X-linked color blindness 233 • Trisomy 21/Down syndrome 242 • Klinefelter syndrome 241 • Reproduction issues 737, 748, 841 • Promoters 275, 296, 297, 300, 301, 302, 303 • Terminators 300 • Enhancers 300, 301, 302, 303

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37 Neurons, Synapses, and Signaling	751–767	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.A: Change in the genetic makeup of a population over time is evolution. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.D: Cells communicate by generating, transmitting and receiving chemical signals. 3.E: Transmission of information results in changes within and between biological systems.	1.A.2: Natural selection acts on phenotypic variations in populations. 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.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.	LO 1.4 [See SP 5.3] LO 1.5 [See SP 7.1] LO 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2] LO 3.31 [See SP 7.2] LO 3.32 [See SP 3.1] LO 3.33 [See SP 1.4] LO 3.34 [See SP 6.2] LO 3.35 [See SP 1.1] LO 3.43 [See SP 6.2, 7.1] LO 3.44 [See SP 1.2] LO 3.45 [See SP 1.2] LO 3.46 [See SP 1.2] LO 3.47 [See SP 1.1] LO 3.48 [See SP 1.1] LO 3.49 [See SP 1.1] LO 3.50 [See SP 1.1]	• Sickle-cell disease 58, 288, 406, 414, 501 • Peppered moth 10 • DDT resistance in insects 861, 897 • Artificial selection 13, 15, 17, 371, 611 • Loss of genetic diversity within a crop species 883, 884, 885, 886, 887, 888, 889, 890, 891 • 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 629, 631, 771, 773, 774, 775, 792 • Diurnal/nocturnal and sleep/wake cycles 771, 774, 775, 792 • Visual displays in the reproductive cycle 195, 196, 333, 334, 335, 337, 498, 501, 506, 507, 511, 600, 737, 740, 742 • Fruiting body formation in fungi, slime molds and certain types of bacteria 498 • DNA repair mechanisms 258 • Neurotransmitters 66, 648, 649, 650, 752, 753, 754, 755, 756, 757, 758, 759, 761, 764 • Plant immune response 637 • Morphogens in embryonic development 742, 743, 744, 745, 746, 747, 748 • Insulin 680 • Thyroid hormones 650, 651, 653 • Testosterone 111, 739 • Estrogen 650 • Acetylcholine 764, 765 • Epinephrine 764, 765 • Norepinephrine 764, 765 • Dopamine 764, 765 • Serotonin 764, 765 • GABA 764, 765 • Vision 773, 776, 785 • Hearing 776, 777, 783, 784, 785 • Muscle movement 652, 773, 793, 794, 795, 796, 797, 798, 799, 800 • Abstract thought and emotions 773, 775, 776 • Neuro-hormone production 649, 650, 651, 652 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 772, 773, 775, 776 • Right and left cerebral hemispheres in humans 773

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
38 Nervous and Sensory Systems	768–791	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.D: Cells communicate by generating, transmitting and receiving chemical signals. 3.E: Transmission of information results in changes within and between biological systems.	2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.C.2: Organisms respond to changes in their external environments. 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. 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.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	LO 2.15 [See SP 6.1] LO 2.16 [See SP 7.2] LO 2.17 [See SP 5.3] LO 2.18 [See SP 6.4] LO 2.19 [See SP 6.4] LO 2.20 [See SP 6.1] LO 2.21 [See SP 4.1] LO 2.25 [See SP 6.2] LO 2.26 [See SP 5.1] LO 2.27 [See SP 7.1] LO 2.29 [See SP 1.1, 1.2] LO 2.30 [See SP 1.1, 1.2] LO 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2] LO 3.31 [See SP 7.2] LO 3.32 [See SP 3.1] LO 3.33 [See SP 1.4] LO 3.43 [See SP 6.2, 7.1] LO 3.44 [See SP 1.2] LO 3.45 [See SP 1.2] LO 3.46 [See SP 1.2] LO 3.47 [See SP 1.1] LO 3.48 [See SP 1.1] LO 3.49 [See SP 1.1] LO 3.50 [See SP 1.1]	• Operons in gene regulation 295, 296 • Temperature regulation in animals 644, 645, 646, 647 • Plant responses to water limitations 577, 591, 592, 625, 634, 635 • Lactation in mammals 649, 650, 747 • Ripening of fruit 620, 625 • Diabetes mellitus in response to decreased insulin 680 • Dehydration in response to decreased antidiuretic hormone (ADH) 661 • Graves' disease (hyperthyroidism) 651 • Blood clotting 697 • Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 511 • Nocturnal and diurnal activity: circadian rhythms 629, 771, 774, 775, 792 • Gas exchange in aquatic and terrestrial plants 591, 592 • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems 668, 670, 671, 672, 674, 675 • Respiratory systems of aquatic and terrestrial animals 700, 701, 702, 703, 705, 706, 707 • Nitrogenous waste production and elimination in aquatic and terrestrial animals 654, 655, 656, 657, 659, 660, 661 • Excretory systems in flatworms, earthworms and vertebrates 654, 655, 656, 657, 659, 660, 661 • Osmoregulation in bacteria, fish and protists 654 • Osmoregulation in aquatic and terrestrial plants 575, 577 • Circulatory systems in fish, amphibians and mammals 687, 688, 689, 690, 691, 692, 693, 694 • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms) 644, 645, 646, 647, 648, 649, 650, 651 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses 713 • Plant defenses against pathogens include molecular recognition systems with systemic responses 713 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens 712, 714, 716, 717, 718, 719 • 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 629, 631, 771, 773, 774, 775, 792 *Illustrative examples continued on next page*

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38 Nervous and Sensory Systems (continued)	768–791					• Diurnal/nocturnal and sleep/wake cycles 771, 774, 775, 792 • Visual displays in the reproductive cycle 195, 196, 333, 334, 335, 337, 498, 501, 506, 507, 511, 600, 737, 740, 742 • Fruiting body formation in fungi, slime molds and certain types of bacteria 498 • Acetylcholine 764, 765 • Epinephrine 764, 765 • Norepinephrine 764, 765 • Dopamine 764, 765 • Serotonin 764, 765 • GABA 764, 765 • Vision 773, 776, 785 • Hearing 776, 777, 783, 784, 785 • Muscle movement 773, 793, 794, 795, 796, 797, 798, 799, 800 • Abstract thought and emotions 773, 775, 776 • Neuro-hormone production 649, 650, 651, 652 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 772, 773, 775, 776 • Right and left cerebral hemispheres in humans 773
39 Motor Mechanisms and Behavior	792–816	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes	1.A: Change in the genetic makeup of a population over time is evolution. 1.B: Organisms are linked by lines of descent from common ancestry. 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 3.A: Heritable information provides for continuity of life. 3.E: Transmission of information results in changes within and between biological systems.	1.A.2: Natural selection acts on phenotypic variations in populations. 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 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. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	LO 1.4 [See SP 5.3] LO 1.5 [See SP 7.1] LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2] LO 2.38 [See SP 5.1] LO 2.39 [See SP 6.1] LO 2.40 [See SP 7.2] LO 3.1 [See SP 6.5] LO 3.2 [See SP 4.1] LO 3.3 [See SP 1.2] LO 3.4 [See SP 1.2] LO 3.5 [See SP 6.4] LO 3.6 [See SP 6.4] LO 3.43 [See SP 6.2, 7.1] LO 3.44 [See SP 1.2] LO 3.45 [See SP 1.2] LO 3.46 [See SP 1.2] LO 3.47 [See SP 1.1] LO 3.48 [See SP 1.1] LO 3.49 [See SP 1.1] LO 3.50 [See SP 1.1]	• Sickle-cell disease 58, 288, 406, 414, 501 • Peppered moth 10 • DDT resistance in insects 861, 897 • Artificial selection 13, 15, 17, 371, 611 • Loss of genetic diversity within a crop species 883, 884, 885, 886, 887, 888, 889, 890, 891 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 3, 84, 86, 87, 89, 91 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 87, 89, 90, 92 • Linear chromosomes 5, 178, 179, 180, 181, 183 • Endomembrane systems, including the nuclear envelope 4, 60, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 89, 92 • 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 629, 631, 771, 773, 774, 775, 792 • Visual displays in the reproductive cycle 195, 196,333, 334, 335, 337, 498, 501, 506, 507, 511, 600, 737, 740, 742 • Fruiting body formation in fungi, slime molds and certain types of bacteria 498 • Hibernation 807, 842, 890 • Migration 807, 842, 890 • Courtship 810, 811, 890 • Niche and resource partitioning 846 • Addition of a poly-A tail 277, 718 • Addition of a GTP cap 110, 113, 282, 283, 325 • Excision of introns 278, 718 *Illustrative examples continued on next page*

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39 Motor Mechanisms and Behavior (continued)	792–816					• Enzymatic reactions 52, 116, 125, 126, 127, 129, 130, 131, 132, 280 • Transport by proteins 89, 94, 95, 97 • Electrophoresis 263 • Plasmid-based transformation 262, 263, 264, 265 • Restriction enzyme analysis of DNA 262, 263 • Polymerase chain reaction (PCR) 264, 265 • Genetically modified foods 611, 613 • Cloned animals 307, 308, 321, 322 • Acetylcholine 764, 765 • Epinephrine 764, 765 • Norepinephrine 764, 765 • Dopamine 764, 765 • Serotonin 764, 765 • GABA 764, 765 • Vision 773, 776, 785 • Hearing 776, 777, 783, 784, 785 • Muscle movement 773, 793, 794, 795, 796, 797, 798, 799, 800 • Abstract thought and emotions 773, 775, 776 • Neuro-hormone production 649, 650, 651, 652 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 772, 773, 775, 776 • Right and left cerebral hemispheres in humans 773
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40 Population Ecology and the Distribution of Organisms	818–844	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	1.C: Life continues to evolve within a changing environment. 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 4.A: Interactions within biological systems lead to complex properties. 4.B: Competition and cooperation are important aspects of biological systems. 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	1.C.2: Speciation may occur when two populations become reproductively isolated from each other. 1.C.3: Populations of organisms continue to evolve. 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. 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.	LO 1.22 [See SP 6.4] LO 1.23 [See SP 4.1] LO 1.24 [See SP 7.2] LO 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] LO 2.22 [See SP 1.3, 3.2] LO 2.23 [See SP 4.2, 7.2] LO 2.24 [See SP 5.1] LO 4.11 [See SP 1.4, 4.1] LO 4.12 [See SP 2.2] LO 4.13 [See SP 6.4] LO 4.19 [See SP 5.2] LO 4.20 [See SP 6.3] LO 4.21 [See SP 6.4] LO 4.25 [See SP 6.1] LO 4.26 [See SP 6.4] LO 4.27 [See SP 6.4]	• Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 19 • Emergent diseases 339, 340 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 9, 10, 399 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 377, 375, 542, 543, 687, 772, 773 • Cell density 186 • Temperature 644, 645, 646, 647 • Water availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Sunlight 6, 159, 160, 161, 162, 163, 164, 167, 168, 171 • Symbiosis (mutualism, commensalism, parasitism) 475, 586, 846, 846, 850, 851 • Predator-prey relationships 528, 751, 768, 841, 848, 853, 854 • Water and nutrient availability, temperature, salinity, pH 30, 31, 32, 33, 34, 35, 36 • Water and nutrient availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Food chains and food webs 853, 854, 855 *Illustrative examples continued on next page*

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
	818–844					• Species diversity 851, 852, 853, 856, 857, 858, 859, 860, 883 • Population density 832, 833, 834, 836, 837, 838, 839, 852, 853 • Algal blooms 896 • Symbiotic relationship 475, 845, 846, 850, 851 • Introduction of species 549, 886 • Global climate change models 500, 898, 899 • Loss of keystone species 854 • Kudzu 886 • Continental drift 443, 444 • Prairie chickens 409, 889
41 Species Interactions	845–863	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 3.E: Transmission of information results in changes within and between biological systems. 4.A: Interactions within biological systems lead to complex properties. 4.B: Competition and cooperation are important aspects of biological systems. 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	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. 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.E.1: Individuals can act on information and communicate it to others. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 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.2: Environmental factors influence the expression of the genotype in an organism. 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.	LO 2.1 [See SP 6.2] LO 2.2 [See SP 6.1] LO 2.3 [See SP 6.4] LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2] LO 2.22 [See SP 1.3, 3.2] LO 2.23 [See SP 4.2, 7.2] LO 2.24 [See SP 5.1] LO 3.40 [See SP 5.1] LO 3.41 [See SP 1.1] LO 3.42 [See SP 7.1] LO 4.8 [See SP 3.3] LO 4.9 [See SP 6.4] LO 4.10 [See SP 1.3] LO 4.11 [See SP 1.4, 4.1] LO 4.12 [See SP 2.2] LO 4.13 [See SP 6.4] LO 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4] LO 4.19 [See SP 5.2] LO 4.20 [See SP 6.3] LO 4.21 [See SP 6.4] LO 4.23 [See SP 6.2] LO 4.24 [See SP 6.4] LO 4.25 [See SP 6.1] LO 4.26 [See SP 6.4] LO 4.27 [See SP 6.4]	• Krebs cycle 139, 140, 141, 142, 143, 144, 145, 146, 147, 151, 152 • Glycolysis 139, 140, 141, 142, 143, 144, 145, 146, 147 • Calvin cycle 159, 163, 164, 165, 166, 167, 168, 169, 171 • Fermentation 150 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 644, 645, 646, 647, 648, 649, 650, 651 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 644, 645 • Seasonal reproduction in animals and plants 731 • Change in the producer level can affect the number and size of other trophic levels. 499, 866, 867, 870, 872, 876 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 866, 867, 868 • $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171 • Cell density 186 • Temperature 120, 644, 645, 646, 647 • Water availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Sunlight 6, 159, 160, 161, 162, 163, 164, 167, 168, 171 • Symbiosis (mutualism, commensalism, parasitism) 475, 586, 845, 846, 850, 851 • Predator-prey relationships 528, 751, 768, 841, 848, 853, 854 • Water and nutrient availability, temperature, salinity, pH 30, 31, 32, 33, 34, 35, 36 • Water and nutrient availability 820, 821, 822, 823, 824, 825, 826, 827, 828, 829 • Food chains and food webs 853, 854, 855 • Species diversity 851, 852, 853, 856, 857, 858, 859, 860, 883 *Illustrative examples continued on next page*

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
41 Species Interactions (continued)	845–863					• Population density 832, 833, 834, 836, 837, 838, 839, 852, 853 • Algal blooms 896 • Predator warnings 848 • Protection of young 391, 392, 733, 811 • Territorial marking in mammals 841 • Bee dances 805 • Birds songs 778 • Territorial marking in mammals 804, 841 • Herd, flock, and schooling behavior in animals 807, 808, 809 • Predator warning 528 • Parent and offspring interactions 811, 813 • Migration patterns 807, 842, 890 • Courtship and mating behaviors 810, 811, 890 • Foraging in bees and other animals 805 • Pack behavior in animals 807, 808 • Stomach and small intestines 671, 672, 673, 674, 675, 677, 678 • Kidney and bladder 657, 659, 660, 661 • Root, stem and leaf 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569 • Respiratory and circulatory 685, 687, 688, 689, 690, 691, 692, 693, 700, 701, 702, 703, 705, 706 • Plant vascular and leaf 571, 572, 573, 574, 575, 577, 578, 581, 586, 587, 589, 591, 592, 593, 594 • Predator-prey relationships spreadsheet model 528, 751, 768, 841, 848, 853, 854 • Symbiotic relationship 845, 846, 850, 851 • Introduction of species 549, 886 • Global climate change models 898, 899 • Loss of keystone species 854 • Kudzu 886 • Logging, slash and burn agriculture, urbanization, monocropping, infrastructure development (dams, transmission lines, roads), and global climate change threaten ecosystems and life on Earth. 883, 885 • Continental drift 443, 444 • Sex determination in reptiles 731 • Prairie chickens 409, 889

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
42 Ecosystems and Energy	864–881	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 4.A: Interactions within biological systems lead to complex properties.	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. 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.6: Interactions among living systems and with their environment result in the movement of matter and energy.	LO 2.1 [See SP 6.2] LO 2.2 [See SP 6.1] LO 2.3 [See SP 6.4] LO 2.4 [See SP 1.4, 3.1] LO 2.5 [See SP 6.2] LO 2.6 [See SP 2.2] LO 2.7 [See SP 6.2] LO 2.8 [See SP 4.1] LO 2.9 [See SP 1.1, 1.4] LO 2.25 [See SP 6.2] LO 2.26 [See SP 5.1] LO 2.27 [See SP 7.1] LO 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Krebs cycle 139, 140, 141, 142, 143, 144, 145, 146, 147, 151, 152 • Glycolysis 139, 140, 141, 142, 143, 144, 145, 146, 147 • Calvin cycle 159, 163, 164, 165, 166, 167, 168, 169, 171 • Fermentation 150 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 644, 645, 646, 647, 648, 649, 650, 651 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 644, 645 • Seasonal reproduction in animals and plants 731 • Change in the producer level can affect the number and size of other trophic levels. 499, 866, 867, 870, 872, 876 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 866, 867, 868 • $NADP^+$ in photosynthesis 159, 164, 167, 168, 171 • Oxygen in cellular respiration 125, 137, 138, 144, 157, 158, 159, 162, 164, 167, 168, 171 • Cohesion 30 • Adhesion 31 • High specific heat capacity 31, 58 • Universal solvent supports reactions 33 • Heat of vaporization 31 • Water's thermal conductivity 31 • Root hairs 555, 562, 563, 564, 581, 584 • Cells of the alveoli 703 • Cells of the villi 674 • Microvilli 72, 87 • Gas exchange in aquatic and terrestrial plants 591, 592 • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems 668, 670, 671, 672, 674, 675 • Respiratory systems of aquatic and terrestrial animals 700, 701, 702, 703, 705, 706, 707 • Nitrogenous waste production and elimination in aquatic and terrestrial animals 654, 655, 656, 657, 659, 660, 661 • Excretory systems in flatworms, earthworms and vertebrates 654, 655, 656, 657, 659, 660, 661 • Osmoregulation in bacteria, fish and protists 654 • Osmoregulation in aquatic and terrestrial plants 575, 577 • Circulatory systems in fish, amphibians and mammals 216, 685, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 698 • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms) 644, 645, 646, 647, 648, 649, 650, 651

Chapters/ Sections	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
43 Global Ecology and Conservation Biology	882–905	Big Idea 1: The process of evolution drives the diversity and unity of life Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties	1.C: Life continues to evolve within a changing environment. 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. 4.A: Interactions within biological systems lead to complex properties. 4.B: Competition and cooperation are important aspects of biological systems. 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	1.C.1: Speciation and extinction have occurred throughout the Earth's history. 2.C.2: Organisms respond to changes in their external environments. 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.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.	LO 1.20 [See SP 5.1] LO 1.21 [See SP 4.2] LO 2.21 [See SP 4.1] LO 4.11 [See SP 1.4, 4.1] LO 4.12 [See SP 2.2] LO 4.13 [See SP 6.4] LO 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4] LO 4.19 [See SP 5.2] LO 4.25 [See SP 6.1] LO 4.26 [See SP 6.4] LO 4.27 [See SP 6.4]	• Five major extinctions 447 • Human impact on ecosystems and species extinction rates 549, 824, 825, 826, 827, 828, 877, 878, 879, 883, 884, 885, 886, 887, 893, 896, 897, 898, 902, 903 • Photoperiodism and phototropism in plants 618, 619, 626, 627, 628, 630, 631, 632, 633 • Hibernation and migration in animals 807, 842, 890 • Chemotaxis in bacteria, sexual reproduction in fungi 511 • Nocturnal and diurnal activity: circadian rhythms 629, 771, 774, 775, 792 • Predator-prey relationships spreadsheet model 528, 751, 768, 841, 848, 853, 854 • Symbiotic relationship 845, 846, 850, 851 • Introduction of species 549, 886 • Global climate change models 898, 899 • Loss of keystone species 854 • Kudzu 886 • Prairie chickens 409, 889