A Correlation of

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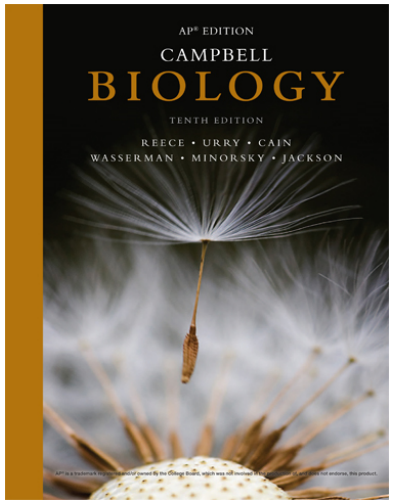

To the

Advanced Placement Biology Curriculum Framework

ALWAYS LEARNING PEARSON

Campbell Biology 10E, AP® Edition: Correlation for AP® Biology Curriculum Framework

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
1 Evolution, the Themes of Biology, and Scientific Inquiry	1–26	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. 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.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. 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.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. 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. 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 1.4 [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 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 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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Sickle-cell disease 82, 284, 355, 496, 497 • Peppered moth 14 • DDT resistance in insects 1271 • Artificial selection 469, 470, 830, 832 • Loss of genetic diversity within a crop species 1255, 1256, 1257, 1258, 1259, 1260, 1261, 1262, 1263, 1264 • Overuse of antibiotics 472 • Graphical analyses of allele frequencies in a population 278, 482, 559 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 473, 476 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
1 Evolution, the Themes of Biology, and Scientific Inquiry (*continued*)	1–26		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.	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.A.5: Communities are composed of populations of organisms that interact in complex ways. 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 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] 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]	• A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Krebs cycle 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Glycolysis 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Calvin cycle 189, 194, 195, 196, 197, 198, 200, 202, 204, 205, 206–207 • Fermentation 178 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 143, 146, 147, 148, 149, 150, 151, 152, 153, 158, 875, 876, 879, 880, 882, 883, 885, 887, 889, 994 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 874, 877, 878, 879, 881, 994 • Elevated floral temperatures in some plant species 204 • Seasonal reproduction in animals and plants 502, 1015, 1016, 1017 • Life-history strategy (biennial plants, reproductive diapaus) 1195, 1196, 1197, 1198, 1242, 1243 • Change in the producer level can affect the number and size of other trophic levels. 1186, 1187, 1188, 1189, 1191, 1192, 1193, 1197, 1198, 1210, 1211, 1213, 1238, 1239, 1241 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 185, 1234, 1236, 1237 • $NADP^+$ in photosynthesis 189, 195, 196, 198, 200, 209 • Oxygen in cellular respiration 41, 141, 147, 148, 152, 163, 164, 165, 166, 167, 168, 169, 172, 187, 189, 192, 195, 198, 205, 206–207 • Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 367, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
1 Evolution, the Themes of Biology, and Scientific Inquiry (*continued*)	1–26					• Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 307, 308 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Sex-linked genes reside on sex chromosomes (X in humans). 296 • In mammals and flies, the Y chromosome is very small and carries few genes. 296 • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. 295, 296, 298 • 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. 299, 300, 301 • Antibiotic resistance mutations 953, 955, 957 • Pesticide resistance mutations 832 • Sickle cell disorder and heterozygote advantage 82, 284, 355, 496 • Prairie chickens 489, 1262 • Potato blight causing the potato famine 861 • Corn rust effects on agricultural crops 445, 663 • Not all animals in a population stampede. 1135, 1139 • Not all individuals in a population in a disease outbreak are equally affected; some may not show symptoms, some may have mild symptoms, or some may be naturally immune and resistant to the disease. 1198

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
UNIT 1 The Chemistry of Life, p. 27						
2 The Chemical Context of Life	28–43	Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.	4.A: Interactions within biological systems lead to complex properties.	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.	LO 4.1 [See SP 7.1] LO 4.2 [See SP 1.3] LO 4.3 [See SP 6.1, 6.4] LO 4.4 [See SP 6.4] LO 4.5 [See SP 6.2] LO 4.6 [See SP 1.4]	no illustrative examples listed in *Course and Exam Description* (CED)
3 Water and Life	44–55	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.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. 4.A: Interactions within biological systems lead to complex properties.	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. 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	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 4.1 [See SP 7.1] LO 4.2 [See SP 1.3] LO 4.3 [See SP 6.1, 6.4] LO 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689
4 Carbon and the Molecular Diversity of Life	56–65	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.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. 4.A: Interactions within biological systems lead to complex properties. 4.B: Competition and cooperation are important aspects of biological systems.	1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 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. 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.	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 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 4.1 [See SP 7.1] LO 4.2 [See SP 1.3] LO 4.3 [See SP 6.1, 6.4] LO 4.4 [See SP 6.4] LO 4.5 [See SP 6.2] LO 4.6 [See SP 1.4] LO 4.17 [See SP 5.1]	• Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • $NADP^+$ in photosynthesis 189, 196, 197, 200, 209 • Oxygen in cellular respiration 41, 141, 147, 148, 152, 164, 166, 172, 187, 188, 189, 192, 195, 198, 200, 205 • Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689

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5 The Structure and Function of Large Biological Molecules	66–91	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.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.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 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.	1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 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.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule. 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.	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 1.25 [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 2.29 [See SP 1.1, 1.2] LO 2.30 [See SP 1.1, 1.2] 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 4.1 [See SP 7.1] LO 4.2 [See SP 1.3] LO 4.3 [See SP 6.1, 6.4] LO 4.4 [See SP 6.4] LO 4.5 [See SP 6.2] LO 4.6 [See SP 1.4] LO 4.17 [See SP 5.1]	• Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses 948 • Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects. 861, 862 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens. 121, 946–951, 953–955, 957–963 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347

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5 The Structure and Function of Large Biological Molecules (*continued*)	66–91					• Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 432, 424, 430, 770, 805, 830, 832 • Cloned animals 412, 413, 415, 416, 423, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272
UNIT 2 The Cell, p. 92						
6 A Tour of the Cell	93–123	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. 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.	1.A.3: Evolutionary change is also driven by random processes. 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.	LO 1.6 [See SP 1.4, 2.1] LO 1.7 [See SP 2.1] LO 1.8 [See SP 6.4] LO 1.14 [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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Krebs cycle 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Glycolysis 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Calvin cycle 189, 194, 195, 196, 197, 198, 200, 202, 204, 205, 206, 207 • Fermentation 178 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 143, 146, 147, 148, 149, 150, 151, 152, 153, 158, 159, 875, 876, 879, 880, 882, 883, 885, 887, 889, 994 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 874, 877, 878, 879, 881, 994

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
6 A Tour of the Cell (*continued*)	93–123		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.	4.C.1: Variation in molecular units provides cells with a wider range of functions.	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]	• Elevated floral temperatures in some plant species 204 • Seasonal reproduction in animals and plants 502, 1015, 1016, 1017 • Life-history strategy (biennial plants, reproductive diapause) 1195, 1196, 1197, 1198, 1242, 1243 • Change in the producer level can affect the number and size of other trophic levels 1186, 1187, 1188, 1189, 1191, 1192, 1193, 1197, 1198, 1210, 1211, 1213 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 1234, 1236, 1237 • $NADP^+$ in photosynthesis 189, 195, 196, 198, 200, 205 • Oxygen in cellular respiration 41, 141, 147, 148, 152, 163, 164, 165, 166, 167, 168, 169, 195, 198, 205, 206–207 • Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Endoplasmic reticulum 100, 101, 103, 105, 109, 122, 963 • Mitochondria 94, 100, 101, 107, 110, 111, 122, 529 • Chloroplasts 100, 101, 108, 110, 111, 112, 122 • Golgi 100, 101, 106, 122, 137, 138 • Nuclear envelope 100, 101, 102, 103, 105, 110 • Operons in gene regulation 361, 362, 363, 364, 365, 366 • Temperature regulation in animals 143, 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 76, 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Graves' disease (hyperthyroidism) 996, 1004, 1005 • Blood clotting 9, 297, 697, 930, 931, 998

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
6 A Tour of the Cell (*continued*)	93–123					• Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Cloned animals 412, 413, 415, 416, 421, 423, 424, 425, 426, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells. [See also 2.D.4] 220, 221, 953–955, 957–962 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 100, 118, 119, 120, 212, 796 • Neurotransmitters 994, 996, 997, 1062–1074 • Plant immune response 861, 862, 863 • Quorum sensing in bacteria 211, 212 • Morphogens in embryonic development 376, 377, 379, 380, 381, 382, 668, 1037–1042, 1044–1050 • Insulin 9, 76, 78, 105, 138, 213, 224, 909, 910, 911, 996, 998, 999 • Human growth hormone 999, 1002, 1003, 1004, 1005 • Thyroid hormones 218, 999, 1005 • Testosterone 62, 63, 218, 1009, 1025 • Estrogen 62, 63, 218, 1009 • Different types of phospholipids in cell membranes 74, 98, 110, 125, 126, 127 • Different types of hemoglobin 76, 81, 83, 355, 447, 594, 929, 942 • MHC proteins 963 • Chlorophylls 187, 191, 192, 193, 194, 195, 196, 197, 198 • Molecular diversity of antibodies in response to an antigen 953 • The antifreeze gene in fish 126

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7 Membrane Structure and Function	124–140	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. 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.	1.A.2: Natural selection acts on phenotypic variations in populations. 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 1.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.	LO 1.4 [See SP 5.3] LO 1.5 [See SP 7.1] 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 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]	• Sickle-cell disease 82, 284, 355, 496, 497 • Peppered moth 14 • DDT resistance in insects 1271 • Artificial selection 469, 470, 830, 832 • Loss of genetic diversity within a crop species 1255, 1256, 1257, 1258, 1259, 1260, 1261, 1262, 1263, 1264 • Overuse of antibiotics 472 • Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 613, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118 • Glucose transport 9, 198, 200, 909, 910 • Na^+/K^+ transport 135, 136
8 An Introduction to Metabolism	141–161	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 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Glycolysis 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Calvin cycle 189, 194, 195, 196, 197, 198, 200, 202, 204, 205, 206–207 • Fermentation 178 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 143, 146, 147, 148, 149, 150, 151, 152, 153, 158, 159, 875, 876, 879, 880, 882, 883, 885, 887, 889, 994 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 874, 877, 878, 879, 881, 994 • Elevated floral temperatures in some plant species 204 • Seasonal reproduction in animals and plants 502, 1015, 1016, 1017

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8 An Introduction to Metabolism (*continued*)	141–161					• Life-history strategy (biennial plants, reproductive diapause) 1195, 1196, 1197, 1198, 1242, 1243 • Change in the producer level can affect the number and size of other trophic levels. 1186, 1187, 1188, 1189, 1191, 1192, 1193, 1197, 1198, 1210, 1211, 1213 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 1234, 1236, 1237
9 Cellular Respiration and Fermentation	162–184	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 189, 195, 196, 198, 200, 209 • Oxygen in cellular respiration 41, 141, 147, 148, 152, 163, 164, 165, 166, 167, 168, 169, 172, 187, 189, 192, 195, 198, 205, 206–207
10 Photosynthesis	185–209	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 189, 195, 196, 198, 200, 209 • Oxygen in cellular respiration 41, 141, 147, 148, 152, 163, 164, 165, 166, 167, 168, 169, 172, 187, 189, 192, 195, 198, 205, 206–207
11 Cell Communication	210–231	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.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.D: Cells communicate by generating, transmitting and receiving chemical signals.	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. 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. 3.D.3: Signal transduction pathways link signal reception with cellular response. 3.D.4: Changes in signal transduction pathways can alter cellular response.	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 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 3.36 [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]	• Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Glucose transport 9, 198, 200, 909, 910 • Na^+/K^+ transport 135, 136 • Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing) 211, 212 • Use of pheromones to trigger reproduction and developmental pathways 644, 995, 1008, 1017 • Response to external signals by bacteria that influences cell movement 987

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
11 Cell Communication (*continued*)	210–231					• Epinephrine stimulation of glycogen breakdown in mammals 210, 220–224, 997–999, 1006–1007, 1075 • Temperature determination of sex in some vertebrate organisms 1015 • DNA repair mechanisms 325, 326, 327 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells. [See also 2.D.4] 220, 221, 953–955, 957–962 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 100, 118, 119, 120, 212, 796 • Neurotransmitters 994, 996, 997, 1062–1074 • Plant immune response 861, 862, 863 • Quorum sensing in bacteria 211, 212 • Morphogens in embryonic development 376, 377, 379, 380, 381, 382, 668, 1037–1042, 1044–1050 • Insulin 9, 76, 78, 105, 138, 213, 224, 909, 910, 911, 996, 998, 999 • Human growth hormone 999, 1002, 1003, 1004, 1005 • Thyroid hormones 218, 999, 1005 • Testosterone 62, 63, 218, 1009, 1025 • Estrogen 62, 63, 218, 1009 • G-protein linked receptors 214, 215, 222, 998 • Ligand-gated ion channels 217, 1072, 1073, 1074 • Receptor tyrosine kinases 216–217, 218, 219 • Second messengers, such as cyclic GMP, cyclic AMP calcium ions (Ca^{2+}), and inositol triphosphate (IP_3) 220, 221, 364, 838, 997, 1072, 1074 • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera 412, 422, 578, 910, 911, 965, 988, 989 • Effects of neurotoxins, poisons, pesticides 156, 1271 • Drugs (Hypertensives, Anesthetics, Antihistamines and Birth Control Drugs) 931, 965, 1032
12 The Cell Cycle	232–250	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.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.	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.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.	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 3.7 [See SP 6.4] LO 3.8 [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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
12 The Cell Cycle (*continued*)	232–250					• Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Mitosis-promoting factor (MPF) 235, 236, 237, 238, 239, 240, 244, 245 • Action of platelet-derived growth factor (PDGF) 245, 246 • Cancer results from disruptions in cell cycle control 247, 383, 385, 386, 387 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26
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13 Meiosis and Sexual Life Cycles	252–266	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. 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. 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 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 3.7 [See SP 6.4] LO 3.8 [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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Sickle-cell disease 82, 284, 355, 496, 497 • Peppered moth 14 • DDT resistance in insects 1271 • Artificial selection 469, 470, 830 • Loss of genetic diversity within a crop species 1255, 1256, 1257, 1258, 1259, 1260, 1261, 1262, 1263, 1264 • Overuse of antibiotics 472 • Mitosis-promoting factor (MPF) 235, 236, 237, 238, 239, 240, 244, 245 • Action of platelet-derived growth factor (PDGF) 245, 246 • Cancer results from disruptions in cell cycle control 247, 383, 385, 386, 387 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
13 Meiosis and Sexual Life Cycles (*continued*)	252–266				LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Antibiotic resistance mutations 953, 955, 957 • Pesticide resistance mutations 832 • Sickle cell disorder and heterozygote advantage 82, 284, 355, 496
14 Mendel and the Gene Idea	267–291	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 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Sex-linked genes reside on sex chromosomes (X in humans). 296 • In mammals and flies, the Y chromosome is very small and carries few genes. 296 • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. 295, 296, 298 • 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. 299, 300, 301 • Antibiotic resistance mutations 953, 955, 957 • Pesticide resistance mutations 832 • Sickle cell disorder and heterozygote advantage 82, 284, 355, 496

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
15 The Chromosomal Basis of Inheritance	292–311	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.2: A variety of intercellular and intracellular signal transmissions mediate gene expression. 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 3.1 [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 3.22 [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] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Cytokines regulate gene expression to allow for cell replication and division. 234, 237, 239, 240, 241, 242, 258, 259 • Mating pheromones in yeast trigger mating gene expression. 653 • Levels of cAMP regulate metabolic gene expression in bacteria. 220, 221, 364 • Ethylene levels cause changes in the production of different enzymes, allowing fruits to ripen. 847, 848 • Seed germination and gibberellin. 632, 639, 640, 643, 645, 646, 822, 823, 824, 825, 845, 846, 847, 851 • Mating pheromones in yeast trigger mating genes expression and sexual reproduction. 653 • Morphogens stimulate cell differentiation and development. 381, 382 • Changes in p53 activity can result in cancer. 385, 386 • HOX genes and their role in development. 420, 458, 539, 669, 671, 677, 684, 714, 715, 716, 719 • Antibiotic resistance mutations 953, 955, 957 • Pesticide resistance mutations 832 • Sickle cell disorder and heterozygote advantage 82, 284, 355, 496

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
16 The Molecular Basis of Inheritance	312–332	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.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 3.29 [See SP 6.2] LO 3.30 [See SP 1.4]	• Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Promoters 340, 341, 342, 343, 346, 369, 371, 806 • Terminators 340, 367 • Enhancers 367, 368, 371 • Transduction in bacteria 211, 213, 395, 396, 397, 573, 574 • Transposons present in incoming DNA 375, 413, 415, 416, 418, 419, 445, 447, 449, 450, 451, 454, 457
17 Gene Expression: From Gene to Protein	333–359	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.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment.	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.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.	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 2.31 [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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
17 Gene Expression: From Gene to Protein (*continued*)	333–359	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.	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 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]	• Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Morphogenesis of fingers and toes 229, 523, 668, 724, 725, 732, 1057 • Immune function 948–955 • *C. elegans* development 228, 442, 1052, 1053 • Flower development 640, 641, 642, 643, 644, 773, 774, 775, 817, 819, 820, 821, 853, 854 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Sex-linked genes reside on sex chromosomes (X in humans). 296 • In mammals and flies, the Y chromosome is very small and carries few genes. 296

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
17 Gene Expression: From Gene to Protein (*continued*)	333–359					• In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. 295, 296, 298 • 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. 299, 300, 301
18 Regulation of Gene Expression	360–391	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.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.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. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs. 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 6.4] LO 3.8 [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 4.7 [See SP 1.3] 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 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Morphogenesis of fingers and toes 229, 523, 668, 724, 725, 732, 1057 • Immune function 948–955 • *C. elegans* development 228, 442, 1052, 1053 • Flower development 640, 641, 642, 643, 644, 773, 774, 775, 817, 819, 820, 821, 853, 854 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
18 Regulation of Gene Expression (*continued*)	360–391					• Mitosis-promoting factor (MPF) 235, 236, 237, 238, 239, 240, 244, 245 • Action of platelet-derived growth factor (PDGF) 245, 246 • Cancer results from disruptions in cell cycle control 247, 383, 385, 386, 387 • Promoters 340, 341, 342, 343, 346, 369, 371, 806 • Terminators 340, 367 • Enhancers 367, 368, 371 • Height and weight in humans 742, 743, 744, 746, 999, 1002, 1003, 1004, 1005 • Flower color based on soil pH 280 • Sex determination in reptiles 1015 • Density of plant hairs as a function of herbivory 862, 863 • Effect of adding lactose to a Lac + bacterial culture 363, 364 • Presence of the opposite mating type on pheromones production in yeast and other fungi 649, 652, 653, 655–660
19 Viruses	392–407	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. 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. 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 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 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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Addition of a poly-A tail 215, 221, 222, 226, 348, 350, 351 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Sex-linked genes reside on sex chromosomes (X in humans). 296 • In mammals and flies, the Y chromosome is very small and carries few genes. 296 • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. 295, 296, 298

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
19 Viruses (*continued*)	392–407					• 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. 299, 300, 301 • Antibiotic resistance mutations 953, 955, 957 • Pesticide resistance mutations 832 • Sickle cell disorder and heterozygote advantage 82, 284, 355, 496, 497 • Transduction in bacteria 211, 213, 395, 396, 397, 573, 574 • Transposons present in incoming DNA 375, 413, 415, 416, 418, 419, 445, 447, 449, 450, 451, 454, 457
20 DNA Tools and Biotechnology	408–435	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.	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.	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.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. 3.C.2: Biological systems have multiple processes that increase genetic variation. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	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 3.22 [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] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2] LO 4.7 [See SP 1.3]	• Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Promoters 340, 341, 342, 343, 346, 369, 371, 806 • Terminators 340, 367 • Enhancers 367, 368, 371 • Cytokines regulate gene expression to allow for cell replication and division. 234, 237, 239, 240, 241, 242, 258, 259 • Mating pheromones in yeast trigger mating gene expression. 653 • Levels of cAMP regulate metabolic gene expression in bacteria. 220, 221, 364

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
20 DNA Tools and Biotechnology (*continued*)	408–435					• Ethylene levels cause changes in the production of different enzymes, allowing fruits to ripen. 847, 848 • Seed germination and gibberellin. 632, 639, 640, 643, 645, 646, 822, 823, 824, 825, 845, 846, 847, 851 • Mating pheromones in yeast trigger mating genes expression and sexual reproduction. 653 • Morphogens stimulate cell differentiation and development. 381, 382 • Changes in p53 activity can result in cancer. 385, 386 • HOX genes and their role in development. 420, 458, 539, 669, 671, 677, 684, 714, 715, 716, 719 • Antibiotic resistance mutations 953, 955, 957 • Pesticide resistance mutations 832 • Sickle cell disorder and heterozygote advantage 82, 284, 355, 496, 497
21 Genomes and Their Evolution	436–460	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.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.3: Evolutionary change is also driven by random processes. 2.E.1: Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms. 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 1.6 [See SP 1.4, 2.1] LO 1.7 [See SP 2.1] LO 1.8 [See SP 6.4] 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 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Morphogenesis of fingers and toes 229, 523, 668, 724, 725, 732, 1057 • Immune function 948–955 • *C. elegans* development 228, 442, 1052, 1053 • Flower development 640, 641, 642, 643, 644, 773, 774, 775, 817, 819, 820, 821, 827, 829, 853, 854
UNIT 4 Mechanisms of Evolution, p. 461						
22 Descent with Modification: A Darwinian View of Life	462–479	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.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.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Sickle-cell disease 82, 284, 355, 496, 497 • Peppered moth 14 • DDT resistance in insects 1271 • Artificial selection 469, 470, 830, 832 • Loss of genetic diversity within a crop species 1255, 1256, 1257, 1258, 1259, 1260, 1261, 1262, 1263, 1264 • Overuse of antibiotics 472 • Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
22 Descent with Modification: A Darwinian View of Life (*continued*)	462–479		1.D: The origin of living systems is explained by natural processes.	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 1.17 [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]	• Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 473, 476 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057
23 The Evolution of Populations	480–499	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.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.	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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Peppered moth 14 • Sickle-cell disease 82, 284, 355, 496, 497 • DDT resistance in insects 1271 • Artificial selection 469, 470, 830, 832 • Loss of genetic diversity within a crop species 1255, 1256, 1257, 1258, 1259, 1260, 1261, 1262, 1263, 1264 • Overuse of antibiotics 472

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
23 The Evolution of Populations (*continued*)	480–499		3.C: The processing of genetic information is imperfect and is a source of genetic variation.	1.C.3: Populations of organisms continue to evolve. 3.C.2: Biological systems have multiple processes that increase genetic variation.	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] LO 1.26 [See SP 5.3] LO 3.27 [See SP 7.2] LO 3.28 [See SP 6.2]	• Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057
24 The Origin of Species	500–518	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.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.	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]	• Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Number of heart chambers in animals 917, 919, 921, 922

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
24 The Origin of Species (*continued*)	500–518		1.C: Life continues to evolve within a changing environment.	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 1.20 [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]	• Opposable thumbs 740, 741 • Absence of legs in some sea mammals 473, 476 • Five major extinctions 534, 535, 536 • Human impact on ecosystems and species extinction rates 53, 696, 1167–1173, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1275 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057
25 The History of Life on Earth	519–545	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. 1.D: The origin of living systems is explained by natural processes. 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 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.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.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. 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 1.9 [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 1.20 [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] 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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
25 The History of Life on Earth (*continued*)	519–545			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.C.1: Changes in genotype can result in changes in phenotype.	LO 1.32 [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 3.24 [See SP 6.4, 7.2] LO 3.25 [See SP 1.1] LO 3.26 [See SP 7.2]	• Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 476 • Five major extinctions 534, 535, 536 • Human impact on ecosystems and species extinction rates 53, 696, 1167–1173, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1275 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Cell density 246 • Biofilms 212, 576 • Temperature 1165, 1166, 1167, 1170, 1172, 1177, 1178, 1180 • Water availability 1226, 1227 • Sunlight 7, 8, 56, 162, 163, 185, 186, 189, 190, 191, 192, 193, 194, 195, 204, 205, 799, 1160, 1161, 1162, 1163, 1167–1170, 1171, 1173, 1174, 1180, 1233, 1235, 1236 • Symbiosis (mutualism, commensalism, parasitism) 582, 583, 608, 648, 649, 661, 662, 663, 808, 809, 812, 815, 821, 836, 907, 908, 1214 • Predator–prey relationships 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Water and nutrient availability, temperature, salinity, pH 132, 567, 580, 857, 1226, 1227 • Water and nutrient availability 1226, 1227 • Availability of nesting materials and sites 1264 • Food chains and food webs 609, 1159, 1218, 1219, 1242–1243 • Species diversity 1216, 1222, 1223, 1225, 1226, 1227, 1254, 1255 • Population density 1159, 1184, 1186–1188, 1191–1194, 1199, 1200–1204, 1242 • Algal blooms 1221, 1270 • Antibiotic resistance mutations 953, 955, 957 • Pesticide resistance mutations 832 • Sickle cell disorder and heterozygote advantage 82, 284, 355, 496

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UNIT 5 The Evolutionary History of Biological Diversity, p. 546						
26 Phylogeny and the Tree of Life	547–566	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.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.	LO 1.4 [See SP 5.3] LO 1.5 [See SP 7.1] 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]	• Peppered moth 14 • Sickle-cell disease 82, 284, 355, 496, 497 • DDT resistance in insects 1271 • Artificial selection 469, 470, 830, 832 • Loss of genetic diversity within a crop species 1255, 1256, 1257, 1258, 1259, 1260, 1261, 1262, 1263, 1264 • Overuse of antibiotics 472 • Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 476 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057

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27 Bacteria and Archaea	567–586	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.D: The origin of living systems is explained by natural 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. 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.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.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.C.3: Viral replication results in genetic variation and viral infection can introduce genetic variation into the hosts. 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 1.14 [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 1.27 [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 2.35 [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 3.29 [See SP 6.2] LO 3.30 [See SP 1.4] 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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 476 • 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 367, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419

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27 Bacteria and Archaea (*continued*)	567–586					• Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Transduction in bacteria 211, 213, 395, 396, 397, 573, 574 • Transposons present in incoming DNA 375, 413, 415, 416, 418, 419, 445, 447, 449, 450, 451, 454, 457 • G-protein linked receptors 214, 215, 222, 998 • Ligand-gated ion channels 217, 1072, 1073, 1074 • Receptor tyrosine kinases 216–217, 218, 219 • Second messengers, such as cyclic GMP, cyclic AMP calcium ions (Ca^{2+}), and inositol triphosphate (IP_3). 220, 221, 364, 838, 997, 1072, 1074 • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera 412, 422, 578, 910, 911, 965, 988, 989 • Effects of neurotoxins, poisons, pesticides 156, 1271 • Drugs (Hypertensives, Anesthetics, Antihistamines and Birth Control Drugs) 931, 965, 1032
28 Protists	587–611	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. 1.C: Life continues to evolve within a changing environment. 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.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.	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. 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.1: All living systems require constant input of free energy. 2.C.2: Organisms respond to changes in their external environments.	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 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 2.1 [See SP 6.2] LO 2.2 [See SP 6.1] LO 2.3 [See SP 6.4] 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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 476 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
28 Protists (*continued*)	587–611		2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. 3.A: Heritable information provides for continuity of life. 4.A: Interactions within biological systems lead to complex properties.	2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	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 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Krebs cycle 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Glycolysis 167, 168, 169, 170, 171, 172, 173, 174, 175, 179, 180, 181 • Calvin cycle 189, 194, 195, 196, 197, 198, 200, 202, 204, 205, 206–207 • Fermentation 178 • Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures) 143, 146, 147, 148, 149, 150, 151, 152, 153, 158, 159, 875, 876, 879, 880, 882, 883, 885, 887, 889, 994 • Ectothermy (the use of external thermal energy to help regulate and maintain body temperature) 874, 877, 878, 879, 881, 994 • Elevated floral temperatures in some plant species 204 • Seasonal reproduction in animals and plants 502, 1015, 1016, 1017 • Life-history strategy (biennial plants, reproductive diapause) 1195, 1196, 1197, 1198, 1242, 1243 • Change in the producer level can affect the number and size of other trophic levels. 1186, 1187, 1188, 1189, 1191, 1192, 1193, 1197, 1198, 1210, 1211, 1213 • Change in energy resources levels such as sunlight can affect the number and size of the trophic levels. 1234, 1236, 1237 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Cell density 246

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28 Protists (*continued*)	587–611					• Biofilms 212, 576 • Temperature 1165, 1166, 1167, 1170, 1172, 1177, 1178, 1180 • Water availability 1226, 1227 • Sunlight 7, 8, 56, 162, 163, 185, 186, 189, 190, 191, 192, 193, 194, 195, 204, 205, 799, 1160, 1161, 1162, 1163, 1167–1170, 1171, 1173, 1174, 1180, 1233, 1235, 1236 • Symbiosis (mutualism, commensalism, parasitism) 582, 583, 608, 648, 649, 661, 662, 663, 808, 809, 812, 815, 821, 836, 907, 908, 1214 • Predator–prey relationships 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Water and nutrient availability, temperature, salinity, pH 132, 567, 580, 857, 1226, 1227 • Water and nutrient availability 1226, 1227 • Availability of nesting materials and sites 1264 • Food chains and food webs 609, 1159, 1218, 1219, 1242–1243 • Species diversity 1216, 1222, 1223, 1225, 1226, 1227, 1254, 1255 • Population density 1159, 1884, 1886, 1887, 1888, 1191, 1192, 1193, 1194 • Algal blooms 1221, 1270 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 344, 367, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430, 832 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272

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29 Plant Diversity I: How Plants Colonized Land	612–629	Big Idea 1: The process of evolution drives the diversity and unity of life.	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.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.	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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 476 • Five major extinctions 534, 535, 536 • Human impact on ecosystems and species extinction rates 53, 696, 1167–1173, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1275
30 Plant Diversity II: The Evolution of Seed Plants	630–647	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.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.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.C.3: Populations of organisms continue to evolve. 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 1.14 [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 1.25 [See SP 1.2] LO 1.26 [See SP 5.3] 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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 476

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
30 Plant Diversity II: The Evolution of Seed Plants (*continued*)	630–647	Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.	4.A: Interactions within biological systems lead to complex properties.	4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	LO 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Five major extinctions 534, 535, 536 • Human impact on ecosystems and species extinction rates 53, 696, 1167–1173, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1275 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Operons in gene regulation 361, 362, 363, 364, 365, 366 • Temperature regulation in animals 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Graves' disease (hyperthyroidism) 996, 1004, 1005 • Blood clotting 9, 297, 697, 930, 931, 998 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882

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31 Fungi	648–666	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.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.D: Cells communicate by generating, transmitting and receiving chemical signals.	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.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. 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.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	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 1.17 [See SP 3.1] LO 1.18 [See SP 5.3] LO 1.19 [See SP 1.1] 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 3.34 [See SP 6.2] LO 3.35 [See SP 1.1]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 473, 476 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells. [See also 2.D.4] 220, 221, 953–955, 957–962 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 100, 118, 119, 120, 212, 796

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31 Fungi (*continued*)	648–666					• Neurotransmitters 994, 996, 997, 1062–1074, 1102, 1103, 1104 • Plant immune response 861, 862, 863 • Quorum sensing in bacteria 211, 212 • Morphogens in embryonic development 376, 377, 379, 380, 381, 382, 668, 1037–1042, 1044–1050 • Insulin 9, 78, 105, 138, 213, 224, 909, 910, 911, 996, 998, 999 • Human growth hormone 999, 1002, 1003, 1004, 1005 • Thyroid hormones 218, 999, 1005 • Testosterone 62, 63, 218, 1009, 1025 • Estrogen 62, 63, 218, 1009
32 An Overview of Animal Diversity	667–679	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.D: Cells communicate by generating, transmitting and receiving chemical signals.	1.A.1. Natural selection is a major mechanism of evolution. 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 1.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. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	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 1.9 [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 3.34 [See SP 6.2] LO 3.35 [See SP 1.1]	• Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 473, 476 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
32 An Overview of Animal Diversity (*continued*)	667–679					• Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells. [See also 2.D.4] 220, 221, 953–955, 957–962 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 100, 118, 119, 120, 212, 796 • Neurotransmitters 994, 996, 997, 1062–1074 • Plant immune response 861, 862, 863 • Quorum sensing in bacteria 211, 212 • Morphogens in embryonic development 376, 377, 379, 380, 381, 382, 668, 1037–1042, 1044–1050 • Insulin 9, 78, 105, 138, 213, 224, 909, 910, 911, 996, 998, 999 • Human growth hormone 999, 1002, 1003, 1004, 1005 • Thyroid hormones 218, 999, 1005 • Testosterone 62, 63, 218, 1009, 1025 • Estrogen 62, 63, 218, 1009
33 An Introduction to Invertebrates	680–711	Big Idea 1: The process of evolution drives the diversity and unity of life.	1.B: Organisms are linked by lines of descent from common ancestry. 1.C: Life continues to evolve within a changing environment.	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 1.17 [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]	• Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 473, 476 • Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or chemotherapy drugs occur in the absence of the chemical) 472, 861 • Emergent diseases 395, 396, 397, 399, 401, 403, 404, 405 • Observed directional phenotypic change in a population (Grants' observations of Darwin's finches in the Galāpagos) 467, 468, 480, 481, 482, 500 • A eukaryotic example that describes evolution of a structure or process such as heart chambers, limbs, the brain and the immune system 229, 473, 474, 475, 476, 667–670, 673–675, 677, 681–684, 686, 687, 690–695, 700–706, 708, 709, 713–735, 1057

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34 The Origin and Evolution of Vertebrates	712–750	Big Idea 1: The process of evolution drives the diversity and unity of life.	1.B: Organisms are linked by lines of descent from common ancestry.	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.	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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Number of heart chambers in animals 917, 919, 920, 921, 922 • Opposable thumbs 740, 741 • Absence of legs in some sea mammals 473, 476
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35 Plant Structure, Growth, and Development	752–777	Big Idea 1: The process of evolution drives the diversity and unity of life. 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. 4.A: Interactions within biological systems lead to complex properties.	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] LO 4.7 [See SP 1.3]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126
36 Resource Acquisition and Transport in Vascular Plants	778–798	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.	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.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.C.2: Organisms respond to changes in their external environments.	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 2.21 [See SP 4.1]	• Operons in gene regulation 361, 362, 363, 364, 365, 366 • Temperature regulation in animals 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
36 Resource Acquisition and Transport in Vascular Plants (*continued*)	778–798		2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.	2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	LO 2.28 [See SP 1.4] LO 2.29 [See SP 1.1, 1.2] LO 2.30 [See SP 1.1, 1.2]	• Graves' disease (hyperthyroidism) 996, 1004, 1005 • Blood clotting 9, 297, 697, 930, 931, 998 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Physiological responses to toxic substances 1271, 1272 • Dehydration 67–74, 202, 999, 1002, 1003 • Immunological responses to pathogens, toxins and allergens 861, 862 • Invasive and/or eruptive species 405, 1221 • Human impact on ecosystems and species extinction rates. 53, 696,1167–1173, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1275 • Hurricanes, floods, earthquakes, volcanoes, fires 520, 1223–1225 • Water limitation 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Salination 567, 580, 1171 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses. 948 • Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects. 861, 862 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens. 121, 946–951, 953–955, 957–963
37 Soil and Plant Nutrition	799–814	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.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. 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. 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 2.31 [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 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Morphogenesis of fingers and toes 229, 523, 668, 724, 725, 732, 1057 • Immune function 948–955 • *C. elegans* development 228, 442, 1052, 1053 • Flower development 640, 641, 642, 643, 644, 773, 774, 775, 817, 819, 820, 821, 827, 829, 853, 854

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38 Angiosperm Reproduction and Biotechnology	815–835	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.	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.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.	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 6.4] LO 3.8 [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 3.15 [See SP 6.5] LO 3.16 [See SP 6.3] LO 3.17 [See SP 1.2]	• Morphogenesis of fingers and toes 229, 523, 668, 724, 725, 732, 1057 • Immune function 948–955 • *C. elegans* development 228, 442, 1052, 1053 • Flower development 640, 641, 642, 643, 644, 773, 774, 775, 817, 819, 820, 821, 827, 829, 853, 854 • Addition of a poly-A tail 343, 354, 367, 955 • Addition of a GTP cap 215, 221, 222, 226, 343, 348, 350, 351 • Excision of introns 343, 344, 345, 955 • Enzymatic reactions 76, 152, 153, 154, 156, 158, 159, 347 • Transport by proteins 76, 124, 125, 126, 127, 128, 129, 133, 135, 136, 138 • Synthesis 84, 85, 223, 224, 321, 322, 323, 324, 325, 326, 327, 334, 337, 338, 345–348, 396 • Degradation 348 • Electrophoresis 409, 410, 411, 414 • Plasmid-based transformation 313, 314, 412, 413, 414 • Restriction enzyme analysis of DNA 412, 413, 414, 418, 419 • Polymerase Chain Reaction (PCR) 414, 415, 416, 418, 580 • Genetically modified foods 412, 423, 430 • Transgenic animals 423, 424, 430, 770, 805, 830, 832, 833 • Cloned animals 412, 413, 415, 416, 424, 425, 426, 427, 437 • Pharmaceuticals, such as human insulin or factor X 308, 429, 430, 910, 911, 1257, 1272 • Mitosis-promoting factor (MPF) 235, 236, 237, 238, 239, 240, 244, 245 • Action of platelet-derived growth factor (PDGF) 245, 246 • Cancer results from disruptions in cell cycle control 247, 383, 385, 386, 387 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Sex-linked genes reside on sex chromosomes (X in humans) 296 • In mammals and flies, the Y chromosome is very small and carries few genes 296 • In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males. 295, 296, 298 • 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. 282, 283

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39 Plant Responses to Internal and External Signals	836–865	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.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. 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.	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. 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.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. 3.D.3: Signal transduction pathways link signal reception with cellular response. 3.D.4: Changes in signal transduction pathways can alter cellular response.	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] 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] LO 3.34 [See SP 6.2] LO 3.35 [See SP 1.1] 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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • $NADP^+$ in photosynthesis 189, 195, 196, 198, 200, 209 • Oxygen in cellular respiration 41, 141, 147, 148, 152, 163, 164, 165, 166, 167, 168, 169, 172, 187, 189, 192, 195, 198, 205, 206–207 • Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Operons in gene regulation 361, 362, 363, 364, 365, 366 • Temperature regulation in animals 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Graves' disease (hyperthyroidism) 996, 1004, 1005 • Blood clotting 9, 297, 697, 930, 931, 998 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses. 948 • Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects. 861, 862

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
39 Plant Responses to Internal and External Signals (*continued*)	836–865					• Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens. 121, 946–951, 953–955, 957–963 • 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells. [See also 2.D.4] 220, 221, 953–955, 957–962 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 100, 118, 119, 120, 212, 796 • Neurotransmitters 994, 996, 997, 1062–1074 • Plant immune response 861, 862, 863 • Morphogens in embryonic development 376, 377, 379, 380, 381, 382, 668, 1037–1042, 1044–1050 • Insulin 9, 78, 105, 138, 213, 224, 909, 910, 911, 996, 998, 999 • Human growth hormone 999, 1002, 1003, 1004, 1005 • Thyroid hormones 218, 999, 1005 • Testosterone 62, 63, 218, 1009, 1025 • Estrogen 62, 63, 218, 1009 • G-protein linked receptors 214, 215, 222, 998 • Ligand-gated ion channels 217, 1072, 1073, 1074 • Receptor tyrosine kinases 216–217, 218, 219 • Second messengers, such as cyclic GMP, cyclic AMP calcium ions (Ca^{2+}), and inositol triphosphate (IP_3) 220, 221, 364, 838, 997, 1072, 1074 • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera 412, 422, 578, 910, 911, 965, 988, 989 • Effects of neurotoxins, poisons, pesticides 156, 1271 • Drugs (Hypertensives, Anesthetics, Antihistamines and Birth Control Drugs) 931, 965, 1032

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UNIT 7 Animal Form and Function, p. 866						
40 Basic Principles of Animal Form and Function	867–891	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.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. 4.A: Interactions within biological systems lead to complex properties.	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.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.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 2.E.1: Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms. 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	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 2.12 [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 2.25 [See SP 6.2] LO 2.26 [See SP 5.1] LO 2.27 [See SP 7.1] 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 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 4.7 [See SP 1.3]	• $NADP^+$ in photosynthesis 189, 195, 196, 198, 200, 209 • Oxygen in cellular respiration 41, 141, 147, 148, 152, 163, 164, 165, 166, 167, 168, 169, 172, 187, 189, 192, 195, 198, 205, 206–207 • Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Glucose transport 9, 198, 200, 909, 910 • Na^+/K^+ transport 135, 136 • Operons in gene regulation 361, 362, 363, 364, 365, 366 • Temperature regulation in animals 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Graves' disease (hyperthyroidism) 996, 1004, 1005 • Blood clotting 9, 297, 697, 930, 931, 998 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Gas exchange in aquatic and terrestrial plants 187, 765, 791, 889, 934–937, 939–943, 1243 • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems 892–895, 897–911

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
40 Basic Principles of Animal Form and Function (*continued*)	867–891					• Respiratory systems of aquatic and terrestrial animals 915–917, 934–937, 939–942 • Nitrogenous waste production and elimination in aquatic and terrestrial animals 977, 980, 984, 1243 • Excretory systems in flatworms, earthworms and vertebrates 916, 917, 971–974, 978–981, 983–990 • Osmoregulation in bacteria, fish and protists 935, 971–974, 976–981, 983–992 • Osmoregulation in aquatic and terrestrial plants 783–785, 789, 791, 987 • Circulatory systems in fish, amphibians and mammals 915–917, 919–931 • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms) 778–781, 783, 784, 785 • Morphogenesis of fingers and toes 229, 523, 668, 724, 725, 732, 1057 • Immune function 948–955 • *C. elegans* development 228, 442, 1052, 1053 • Flower development 640, 641, 642, 643, 644, 773, 774, 775, 817, 819, 820, 821, 827, 829, 853, 854 • 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Hibernation 887 • Estivation 887 • Migration 1135, 1266 • Courtship 493, 502, 503, 1015, 1136, 1145, 1146, 1147, 1148, 1149 • Availability of resources leading to fruiting body formation in fungi and certain types of bacteria 211, 606, 607, 653, 655–659 • Niche and resource partitioning 1209, 1210, 1211 • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae) 531, 650, 659, 662, 663, 754, 810, 907, 908, 1214 • Biology of pollination 268–275, 277, 508, 516, 632, 638, 640, 643, 644, 815, 816, 817, 819–822, 829, 1256

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
41 Animal Nutrition	892–914	Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.	4.B: Competition and cooperation are important aspects of biological systems.	4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	LO 4.18 [See SP 1.4]	• Exchange of gases 187, 765, 791, 889, 934–937, 939–942 • Circulation of fluids 1, 915–917, 919–927, 931 • Digestion of food 892–895, 897–911 • Excretion of wastes 869, 870, 971–974, 978–981, 983–990 • Bacterial community in the rumen of animals 908 • Bacterial community in and around deep sea vents 520, 521
42 Circulation and Gas Exchange	915–945	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.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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing) 211, 212 • Use of pheromones to trigger reproduction and developmental pathways 644, 995, 1008, 1017 • Response to external signals by bacteria that influences cell movement 987 • Epinephrine stimulation of glycogen breakdown in mammals 210, 220–224, 997–999, 1006–1007, 1075 • Temperature determination of sex in some vertebrate organisms 1015 • DNA repair mechanisms 325, 326, 327 • Exchange of gases 187, 765, 791, 889, 934–937, 939–942 • Circulation of fluids 1, 915–917, 919–927, 931 • Digestion of food 892–895, 897–911 • Excretion of wastes 869, 870, 971–974, 978–981, 983–990 • Bacterial community in the rumen of animals 908 • Bacterial community in and around deep sea vents 520, 521

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
43 The Immune System	946–970	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.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.	1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. 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. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	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 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] LO 3.34 [See SP 6.2] LO 3.35 [See SP 1.1]	• Graphical analyses of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Analysis of sequence data sets 349, 557, 558, 590, 592, 593, 595, 602, 604, 605 • Analysis of phylogenetic trees 15, 468, 474, 525, 527, 531, 532, 537, 543, 548, 549, 550, 554, 555, 556, 557, 558, 564, 590, 592, 593, 595, 602, 604, 605, 617, 670, 677, 713, 714, 728 • Construction of phylogenetic trees based on sequence data 15, 468, 474, 548, 549, 550, 554, 555, 556, 557, 558, 564, 728 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses. 948 • Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects. 861, 862 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens. 121, 946–951, 953–955, 957–963 • Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing) 211, 212 • Use of pheromones to trigger reproduction and developmental pathways 644, 995, 1008, 1017 • Response to external signals by bacteria that influences cell movement 987 • Epinephrine stimulation of glycogen breakdown in mammals 210, 220–224, 997–999, 1006–1007, 1075 • Temperature determination of sex in some vertebrate organisms 1015 • DNA repair mechanisms 325, 326, 327 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells. [See also 2.D.4] 220, 221, 953–955, 957–962 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 100, 118, 119, 120, 212, 796 • Neurotransmitters 994, 996, 997, 1062–1074 • Plant immune response 861, 862, 863 • Quorum sensing in bacteria 211, 212 • Morphogens in embryonic development 376, 377, 379, 380, 381, 382, 668, 1037–1042, 1044–1050 • Insulin 9, 76, 78, 105, 129, 138, 213, 224, 909, 910, 911, 996, 998, 999 • Human growth hormone 999, 1002, 1003, 1004, 1005 • Thyroid hormones 218, 999, 1005 • Testosterone 62, 63, 218, 1009, 1025 • Estrogen 62, 63, 218, 1009

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44 Osmoregulation and Excretion	971–992	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.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.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.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.	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 2.25 [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]	• Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689 • Glucose transport 9, 198, 200, 909, 910 • Na^+/K^+ transport 135, 136 • Operons in gene regulation 361, 362, 363, 364, 365, 366 • Temperature regulation in animals 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Graves' disease (hyperthyroidism) 996, 1004, 1005 • Blood clotting 9, 297, 697, 930, 931, 998 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Gas exchange in aquatic and terrestrial plants 187, 765, 791, 889, 934–937, 939–943, 1243 • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems 892–895, 897–911 • Respiratory systems of aquatic and terrestrial animals 915–917, 934–937, 939–942 • Nitrogenous waste production and elimination in aquatic and terrestrial animals 977, 980, 984, 1243 • Excretory systems in flatworms, earthworms and vertebrates 916, 917, 971–974, 978–981, 983–990 • Osmoregulation in bacteria, fish and protists 935, 971–974, 976–981, 983–992

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
44 Osmoregulation and Excretion (*continued*)	971–992					• Osmoregulation in aquatic and terrestrial plants 783–785, 789, 791, 987 • Circulatory systems in fish, amphibians and mammals 915–917, 919–931 • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms) 778–781, 783, 784, 785 • Physiological responses to toxic substances 1271, 1272 • Dehydration 67–74, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Immunological responses to pathogens, toxins and allergens 861, 862 • Invasive and/or eruptive species 405, 1221 • Human impact on ecosystems and species extinction rates. 53, 696, 802, 803, 1167–1173, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268–1275 • Hurricanes, floods, earthquakes, volcanoes, fires 520, 1223–1225 • Water limitation 779–785, 787, 788, 789, 791, 793, 794, 795 • Salination 567, 580, 1171
45 Hormones and the Endocrine System	993–1012	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. 3.E: Transmission of information results in changes within and between biological systems.	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. 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history. 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. 3.D.3: Signal transduction pathways link signal reception with cellular response. 3.D.4: Changes in signal transduction pathways can alter cellular response. 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	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 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 3.36 [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] 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]	• Cell density 246 • Biofilms 212, 576 • Temperature 1164, 1165, 1166, 1167–1170, 1172, 1177, 1178, 1180, 1226 • Water availability 1226, 1227 • Sunlight 7, 8, 56, 162, 163, 185, 186, 189, 190, 191, 192, 193, 194, 195, 204, 205, 799, 1160, 1161, 1162, 1163, 1167–1170, 1171, 1173, 1174, 1180, 1233, 1235, 1236 • Symbiosis (mutualism, commensalism, parasitism) 582, 583, 608, 648, 649, 661, 662, 663, 808, 809, 812, 815, 821, 836, 907, 908, 1214 • Predator–prey relationships 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Water and nutrient availability, temperature, salinity, pH 132, 567, 580, 857, 1226, 1227 • Water and nutrient availability 1167–1170, 1226, 1227 • Availability of nesting materials and sites 1264 • Food chains and food webs 608, 609, 1159, 1218, 1219, 1242–1243 • Species diversity 1216, 1222, 1223, 1225, 1226, 1227, 1254, 1255 • Population density 1159, 1184, 1186–1188, 1191–1194, 1199, 1200–1204, 1242 • Algal blooms 1221, 1270 • Gas exchange in aquatic and terrestrial plants 187, 765, 791, 889, 934–937, 939–943 • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems 892–895, 897–911 • Respiratory systems of aquatic and terrestrial animals 915–917, 934–937, 939–942

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
45 Hormones and the Endocrine System (*continued*)	993–1012					• Nitrogenous waste production and elimination in aquatic and terrestrial animals 977, 980, 984, 1243 • Excretory systems in flatworms, earthworms and vertebrates 916, 917, 971–974, 978–981, 983–990 • Osmoregulation in bacteria, fish and protists 935, 971–974, 976–981, 983–992 • Osmoregulation in aquatic and terrestrial plants 783–785, 789, 791, 987 • Circulatory systems in fish, amphibians and mammals 915–917, 919–931 • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms) 778–781, 783, 784, 785 • Physiological responses to toxic substances 1271, 1272 • Dehydration 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Immunological responses to pathogens, toxins and allergens 861, 862 • Invasive and/or eruptive species 405, 1221 • Hurricanes, floods, earthquakes, volcanoes, fires 520, 1223–1225 • Water limitation 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Salination 567, 580, 1171 • Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing) 211, 212 • Use of pheromones to trigger reproduction and developmental pathways 644, 995, 1008, 1017 • Response to external signals by bacteria that influences cell movement 987 • Epinephrine stimulation of glycogen breakdown in mammals 210, 220–224, 997–999, 1006–1007, 1075 • Temperature determination of sex in some vertebrate organisms 1015 • DNA repair mechanisms 325, 326, 327 • Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells. [See also 2.D.4] 220, 221, 953–955, 957–962 • Plasmodesmata between plant cells that allow material to be transported from cell to cell. 100, 118, 119, 120, 212, 796 • Human impact on ecosystems and species extinction rates. 53, 696, 802, 803, 802, 803, 1167–1170, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1275 • Neurotransmitters 994, 996, 997, 1062–1074 • Plant immune response 861, 862, 863 • Quorum sensing in bacteria 211, 212 • Morphogens in embryonic development 376, 377, 379, 380, 381, 382, 668, 1037–1042, 1044–1050

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
45 Hormones and the Endocrine System (*continued*)	993–1012					• Insulin 9, 76, 78, 105, 129, 138, 213, 224, 909, 910, 911, 996, 998, 999 • Human growth hormone 999, 1002, 1003, 1004, 1005 • Thyroid hormones 218, 999, 1005 • Testosterone 62, 63, 218, 1009, 1025 • Estrogen 62, 63, 218, 1009 • G-protein linked receptors 214, 215, 222, 998 • Ligand-gated ion channels 217, 1072, 1073, 1074 • Receptor tyrosine kinases 216–217, 218, 219 • Second messengers, such as cyclic GMP, cyclic AMP calcium ions (Ca^{2+}), and inositol triphosphate (IP_3) 220, 221, 364, 838, 997, 1072, 1074 • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera 412, 422, 578, 910, 911, 965, 988, 989 • Effects of neurotoxins, poisons, pesticides 156, 1271 • Drugs (Hypertensives, Anesthetics, Antihistamines and Birth Control Drugs) 931, 965, 1032 • Acetylcholine 1054, 1074, 1122–1124 • Epinephrine 210, 220–224, 997–999, 1006–1007, 1075 • Norepinephrine 1074, 1075 • Dopamine 1074, 1075 • Serotonin 1074, 1075 • GABA 1074, 1075 • Vision 6, 541, 542, 1111–1117 • Hearing 1106–1110 • Muscle movement 76, 1120–1129 • Abstract thought and emotions 1089, 1090, 1092, 1094, 1095 • Neuro-hormone production 1002–1004 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 1086–1089, 1091, 1093 • Right and left cerebral hemispheres in humans 1087, 1091
46 Animal Reproduction	1013–1036	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.	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.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring.	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 3.12 [See SP 1.1, 7.2] LO 3.13 [See SP 3.1] LO 3.14 [See SP 2.2]	• Operons in gene regulation 361, 362, 363, 364, 365, 366 • Temperature regulation in animals 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 76, 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Graves' disease (hyperthyroidism) 996, 1004, 1005

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
46 Animal Reproduction (*continued*)	1013–1036		3.B: Expression of genetic information involves cellular and molecular mechanisms.	3.B.1: Gene regulation results in differential gene expression, leading to cell specialization.	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]	• Blood clotting 9, 297, 697, 930, 931, 998 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Hibernation 887 • Estivation 887 • Migration 1135, 1151, 1266 • Courtship 493, 502, 503, 1015, 1136, 1145, 1146, 1147, 1148, 1149 • Availability of resources leading to fruiting body formation in fungi and certain types of bacteria 211, 606, 607, 653, 655–659 • Niche and resource partitioning 1209, 1210, 1211 • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae) 531, 650, 659, 662, 663, 754, 810, 907, 908, 1214 • Biology of pollination 268–275, 277, 508, 516, 632, 638, 640, 643, 644, 815, 816, 817, 819–822, 829, 1256 • Sickle-cell disease 82, 284, 355, 496, 497 • Tay-Sachs disease 107, 286 • Huntington's disease 426 • X-linked color blindness 297, 298 • Trisomy 21/Down syndrome 254, 305, 306, 307 • Klinefelter's syndrome 305, 306, 307 • Reproduction issues 502, 503, 508–516, 597, 598, 599, 600, 604, 606, 607, 1018, 1019, 1021 • Civic issues such as ownership of genetic information, privacy, historical contexts, etc. 26 • Promoters 340, 341, 342, 343, 346, 369, 371, 806 • Terminators 340, 367 • Enhancers 367, 368, 371
47 Animal Development	1037–1060	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.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.	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. 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.	LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1] 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]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 187, 205, 206, 207, 529 • Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
47 Animal Development (*continued*)	1037–1060	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes.	3.D: Cells communicate by generating, transmitting and receiving chemical signals.	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 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]	• Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • Morphogenesis of fingers and toes 229, 523, 668, 724, 725, 732, 1057 • Immune function 948–955 • *C. elegans* development 228, 442, 1052, 1053 • Flower development 640, 641, 642, 643, 644, 773, 774, 775, 817, 819, 820, 821, 827, 829, 853, 854 • G-protein linked receptors 214, 215, 222, 998 • Ligand-gated ion channels 217, 1072, 1073, 1074 • Receptor tyrosine kinases 216–217, 218, 219 • Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera 412, 422, 578, 910, 911, 965, 988, 989 • Effects of neurotoxins, poisons, pesticides 156, 1271 • Drugs (Hypertensives, Anesthetics, Antihistamines and Birth Control Drugs) 931, 965, 1032
48 Neurons, Synapses, and Signaling	1061–1078	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.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 3.43 [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]	• Peppered moth 14 • Sickle-cell disease 82, 284, 355, 496, 497 • DDT resistance in insects 1271 • Artificial selection 469, 470, 830, 832 • Loss of genetic diversity within a crop species 1255, 1256, 1257, 1258, 1259, 1260, 1261, 1262, 1263, 1264 • Overuse of antibiotics 472 • 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing) 211, 212 • Use of pheromones to trigger reproduction and developmental pathways 644, 995, 1008, 1017 • Response to external signals by bacteria that influences cell movement 987 • Epinephrine stimulation of glycogen breakdown in mammals 210, 220–224, 997–999, 1006–1007, 1075

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
48 Neurons, Synapses, and Signaling (*continued*)	1061–1078					• Temperature determination of sex in some vertebrate organisms 1015 • DNA repair mechanisms 325, 326, 327 • Acetylcholine 1054, 1074, 1122–1124 • Epinephrine 210, 220–224, 997–999, 1006–1007, 1075 • Norepinephrine 1074, 1075 • Dopamine 1074, 1075 • Serotonin 1074, 1075 • GABA 1074, 1075 • Vision 6, 541, 542, 1111–1117 • Hearing 1106–1110 • Muscle movement 76, 1120–1129 • Abstract thought and emotions 1089, 1090, 1092, 1094, 1095 • Neuro-hormone production 1002–1004 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 1086–1089, 1091, 1093 • Right and left cerebral hemispheres in humans 1087, 1091
49 Nervous Systems	1079–1100	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.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.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 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 2.35 [See SP 4.2] LO 2.36 [See SP 6.1] LO 2.37 [See SP 7.2] 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 362, 363 • Temperature regulation in animals 867, 876, 877, 878, 879, 880, 881, 883, 884, 885, 887 • Plant responses to water limitations 779, 780, 781, 782, 783, 784, 785, 787, 788, 789, 791, 793, 794, 795 • Lactation in mammals 1003 • Onset of labor in childbirth 1028, 1029, 1030, 1032 • Ripening of fruit 639 • Diabetes mellitus in response to decreased insulin 76, 910, 911 • Dehydration in response to decreased antidiuretic hormone (ADH) 67–75, 77, 78, 202, 988, 989, 990, 999, 1002, 1003 • Graves' disease (hyperthyroidism) 996, 1004, 1005 • Blood clotting 9, 297, 697, 930, 931, 998 • Photoperiodism and phototropism in plants 841, 842, 853, 854 • Hibernation and migration in animals 887, 1135, 1151, 1266 • Taxis and kinesis in animals 216, 570 • Chemotaxis in bacteria, sexual reproduction in fungi 256, 570, 652 • Nocturnal and diurnal activity: circadian rhythms 851, 852, 853, 854, 855, 876, 887, 1088, 1126 • Shivering and sweating in humans 881, 882 • Gas exchange in aquatic and terrestrial plants 187, 765, 791, 889, 934–937, 939–943 • Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems 892–895, 897–911 • Respiratory systems of aquatic and terrestrial animals 915–917, 934–937, 939–942 • Nitrogenous waste production and elimination in aquatic and terrestrial animals 977, 980, 984, 1243

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
49 Nervous Systems (*continued*)	1079–1100					• Excretory systems in flatworms, earthworms and vertebrates 916, 917, 971–974, 978–981, 983–990 • Osmoregulation in bacteria, fish and protists 935, 971–974, 976–981, 983–992 • Osmoregulation in aquatic and terrestrial plants 783–785, 789, 791, 987 • Circulatory systems in fish, amphibians and mammals 915–917, 919–931, 934–937, 939–943 • Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms) 778–781, 783, 784, 785 • 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Acetylcholine 1054, 1074, 1122–1124 • Epinephrine 210, 220–224, 997–999, 1006–1007, 1075 • Norepinephrine 1074, 1075 • Dopamine 1074, 1075 • Serotonin 1074, 1075 • GABA 1074, 1075 • Vision 6, 541, 542, 1111–1117 • Hearing 1106–1110 • Muscle movement 76, 1120–1129 • Abstract thought and emotions 1089, 1090, 1092, 1094, 1095 • Neuro-hormone production 1002–1004 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 1086–1089, 1091, 1093 • Right and left cerebral hemispheres in humans 1087, 1091
50 Sensory and Motor Mechanisms	1101–1132	Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce 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.	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. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.	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 2.38 [See SP 5.1] LO 2.39 [See SP 6.1] LO 2.40 [See SP 7.2]	• Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses. 948 • Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects. 861, 862 • Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens. 121, 949–951, 953–955, 957–963

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
50 Sensory and Motor Mechanisms (*continued*)	1101–1132	Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes.	3.E: Transmission of information results in changes within and between biological systems.	3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	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]	• 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Quorum sensing in bacteria 211, 212 • Hibernation 887 • Estivation 887 • Migration 1135, 1266 • Courtship 493, 502, 503, 1015, 1136, 1145, 1146, 1147, 1148, 1149 • Availability of resources leading to fruiting body formation in fungi and certain types of bacteria 211, 606, 607, 653, 655–659 • Niche and resource partitioning 1209, 1210, 1211 • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae) 531, 650, 659, 662, 663, 754, 810, 907, 908, 1214 • Biology of pollination 268–275, 277, 508, 516, 632, 638, 640, 643, 644, 815, 816, 817, 819–822, 829, 1256 • Acetylcholine 1054, 1074, 1122–1124 • Epinephrine 210, 220–224, 997–999, 1006–1007, 1075 • Norepinephrine 1074, 1075 • Dopamine 1074, 1075 • Serotonin 1074, 1075 • GABA 1074, 1075 • Vision 6, 541, 542, 1111–1117 • Hearing 1106–1110 • Muscle movement 76, 1120–1129 • Abstract thought and emotions 1089, 1090, 1092, 1094, 1095 • Neuro-hormone production 1002–1004 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 1086–1089, 1091, 1093 • Right and left cerebral hemispheres in humans 1087, 1091
51 Animal Behavior	1133–1156	Big Idea 1: The process of evolution drives the diversity and unity of life.	1.B: Organisms are linked by lines of descent from common ancestry.	1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	LO 1.14 [See SP 3.1] LO 1.15 [See SP 7.2] LO 1.16 [See SP 6.1]	• Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological integrity and organelle transport) 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 128, 150, 1050 • Membrane-bound organelles (mitochondria and/or chloroplasts) 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 122, 167, 187, 205, 206, 207, 529

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
51 Animal Behavior (*continued*)	1133–1156	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.E: Transmission of information results in changes within and between biological systems.	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.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	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 3.43 [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]	• Linear chromosomes 232, 233, 234, 236–242, 254, 255, 257, 258–259, 260, 261, 263, 264, 292, 293, 296, 298, 300, 301, 304, 305, 306, 307, 308, 328, 329, 330 • Endomembrane systems, including the nuclear envelope 3, 4, 5, 95, 97, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 125, 126 • 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 791, 851, 852, 853, 1088 • Diurnal/nocturnal and sleep/awake cycles 791, 851, 852, 853, 1088 • Seasonal responses, such as hibernation, estivation and migration 887, 1135 • Release and reaction to pheromones 652, 995, 1006, 1137 • Visual displays in the reproductive cycle 1015, 1022, 1023, 1025, 1026, 1028, 1032 • Fruiting body formation in fungi, slime molds and certain types of bacteria 606, 607, 655–661 • Quorum sensing in bacteria 211, 212 • Hibernation 887 • Estivation 887 • Migration 1135, 1266 • Courtship 493, 502, 503, 1015, 1136, 1145, 1146, 1147, 1148, 1149 • Availability of resources leading to fruiting body formation in fungi and certain types of bacteria 211, 606, 607, 652, 653, 655–661 • Niche and resource partitioning 1209, 1210, 1211 • Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae) 531, 650, 659, 662, 663, 754, 810, 907, 908, 1214 • Biology of pollination 268–275, 277, 508, 516, 632, 638, 640, 643, 644, 815, 816, 817, 819–822, 829, 1256 • Acetylcholine 1054, 1074, 1122–1124 • Epinephrine 210, 220–224, 997–999, 1006–1007, 1075 • Norepinephrine 1074, 1075 • Dopamine 1074, 1075 • Serotonin 1074, 1075 • GABA 1074, 1075 • Vision 6, 541, 542, 1111–1117 • Hearing 1106–1110 • Muscle movement 76, 1120–1129 • Abstract thought and emotions 1089, 1090, 1092, 1094, 1095 • Neuro-hormone production 1002–1004 • Forebrain (cerebrum), midbrain (brainstem) and hindbrain (cerebellum) 1086–1089, 1091, 1093 • Right and left cerebral hemispheres in humans 1087, 1091

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
UNIT 8 Ecology, p. 1157						
52 An Introduction to Ecology and the Biosphere	1158–1183	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.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.	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.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 2.22 [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 4.23 [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]	• Cell density 246 • Biofilms 212, 576 • Temperature 1165, 1166, 1167–1170, 1172, 1177, 1178, 1180 • Water availability 1226, 1227 • Sunlight 7, 8, 56, 162, 163, 185, 186, 189, 190, 191, 192, 193, 194, 195, 204, 205, 799, 1160, 1161, 1162, 1163, 1167–1170, 1171, 1173, 1174, 1180, 1233, 1235, 1236 • Symbiosis (mutualism, commensalism, parasitism) 582, 583, 608, 648, 649, 661, 662, 663, 664, 808, 809, 812, 815, 821, 836, 907, 908, 1214, 1215 • Predator–prey relationships 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061,1159, 1198, 1212, 1213 • Water and nutrient availability, temperature, salinity, pH 132, 567, 580, 857, 1167–1170, 1226, 1227 • Water and nutrient availability 1226, 1227 • Availability of nesting materials and sites 1264 • Food chains and food webs 608, 609, 1218, 1219, 1242–1243 • Species diversity 1216, 1222, 1223, 1225, 1226, 1227, 1254, 1255 • Population density 1159, 1184, 1186–1188, 1191–1194, 1199, 1200–1204, 1242 • Algal blooms 1221, 1270 • Predator/prey relationships spreadsheet model 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Symbiotic relationship 582, 583, 608, 648, 649, 661, 662, 663, 664, 808, 809, 812, 815, 821, 907, 908, 1214 • Introduction of species 1259 • Global climate change models 1204, 1267, 1271, 1272, 1273, 1274, 1275 • Loss of keystone species 1220 • Kudzu 1259 • Dutch elm disease 662, 663 • Logging, slash and burn agriculture, urbanization, monocropping, infrastructure development (dams, transmission lines, roads), and global climate change threaten ecosystems and life on Earth. 645, 1254–1256, 1258–1261, 1263, 1264, 1266–1277 • An introduced species can exploit a new niche free of predators or competitors, thus exploiting new resources. 1211, 1232, 1256, 1258 • Small pox [historic example for Native Americans] 402, 957 • Continental drift 533 • Meteor impact on dinosaurs 535 • Height and weight in humans 742, 743, 744, 746, 999, 1002, 1003, 1004, 1005 • Flower color based on soil pH 280

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
52 An Introduction to Ecology and the Biosphere (*continued*)	1158–1183					• Sex determination in reptiles 1015 • Density of plant hairs as a function of herbivory 862, 863 • Effect of adding lactose to a Lac + bacterial culture 363, 364 • Presence of the opposite mating type on pheromones production in yeast and other fungi 649, 652, 653, 655–660 • Prairie chickens 489, 1262 • Potato blight causing the potato famine 861 • Corn rust effects on agricultural crops 445, 663 • Not all animals in a population stampede. 1135, 1139 • Not all individuals in a population in a disease outbreak are equally affected; some may not show symptoms, some may have mild symptoms, or some may be naturally immune and resistant to the disease. 1198
53 Population Ecology	1184–1207	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.A: Change in the genetic makeup of a population over time is evolution. 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.A.1. Natural selection is a major mechanism of evolution. 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.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance. 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 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 2.22 [See SP 1.3, 3.2] LO 2.23 [See SP 4.2, 7.2] LO 2.24 [See SP 5.1] LO 2.29 [See SP 1.1, 1.2] LO 2.30 [See SP 1.1, 1.2] 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 4.23 [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]	• Graphical analysis of allele frequencies in a population 278, 422, 482, 491, 559, 561, 562 • Application of the Hardy-Weinberg equilibrium equation 463, 484, 485, 488, 489, 491, 492, 493, 494 • Cell density 246 • Biofilms 212, 576 • Temperature 1165, 1166, 1167–1170, 1172, 1177, 1178, 1180 • Water availability 1167–1170, 1226, 1227 • Sunlight 7, 8, 56, 162, 163, 185, 186, 189, 190, 191, 192, 193, 194, 195, 204, 205, 799, 1160, 1161, 1162, 1163, 1167–1170, 1171, 1173, 1174, 1180, 1233, 1235, 1236 • Symbiosis (mutualism, commensalism, parasitism) 582, 583, 608, 648, 649, 661, 662, 663, 808, 809, 812, 815, 821, 836, 907, 908, 1214, 1215 • Predator–prey relationships 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Water and nutrient availability, temperature, salinity, pH 132, 567, 580, 857, 1167–1170, 1226, 1227 • Water and nutrient availability 1226, 1227 • Availability of nesting materials and sites 1264 • Food chains and food webs 608, 609, 1159, 1218, 1219, 1242–1243 • Species diversity 1216, 1222, 1223, 1225, 1226, 1227, 1254, 1255 • Population density 1159, 1184, 1186–1188, 1191–1194, 1199, 1200–1204, 1242 • Algal blooms 1221, 1270 • Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses. 948 • Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects. 861, 862

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53 Population Ecology (*continued*)	1184–1207					• Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens. 121, 949–951, 953–955, 957–963 • Predator/prey relationships spreadsheet model 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Symbiotic relationship 582, 583, 608, 648, 649, 661, 662–664, 808, 809, 812, 815, 821, 907, 908, 1214, 1215 • Introduction of species 1259 • Global climate change models 1204, 1267, 1271, 1272, 1273, 1274, 1275 • Loss of keystone species 1220 • Kudzu 1259 • Dutch elm disease 662, 663 • Height and weight in humans 742, 743, 744, 746, 999, 1002, 1003, 1004, 1005 • Flower color based on soil pH 280 • Sex determination in reptiles 1015 • Density of plant hairs as a function of herbivory 862, 863 • Effect of adding lactose to a Lac + bacterial culture 363, 364 • Presence of the opposite mating type on pheromones production in yeast and other fungi 649, 652, 653, 655–660 • Prairie chickens 489, 1262 • Potato blight causing the potato famine 861 • Corn rust effects on agricultural crops 445, 663 • Not all animals in a population stampede. 1135, 1139 • Not all individuals in a population in a disease outbreak are equally affected; some may not show symptoms, some may have mild symptoms, or some may be naturally immune and resistant to the disease. 1198
54 Community Ecology	1208–1231	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.E: Transmission of information results in changes within and between biological systems.	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.	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]	• Cell density 246 • Biofilms 212, 576 • Temperature 1165, 1166, 1167–1170, 1172, 1177, 1178, 1180 • Water availability 1226, 1227 • Sunlight 7, 8, 56, 162, 163, 185, 186, 189, 190, 191, 192, 193, 194, 195, 204, 205, 799, 1160, 1161, 1162, 1163, 1167–1170, 1171, 1173, 1174, 1180, 1233, 1235, 1236 • Symbiosis (mutualism, commensalism, parasitism) 582, 583, 608, 648, 649, 661, 662, 663, 808, 809, 812, 815, 821, 836, 907, 908, 1214, 1215 • Predator–prey relationships 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Water and nutrient availability, temperature, salinity, pH 132, 567, 580, 857, 1167–1170, 1226, 1227 • Water and nutrient availability 1226, 1227

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
54 Community Ecology (*continued*)	1208–1231	Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.	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.	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.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 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 4.25 [See SP 6.1] LO 4.26 [See SP 6.4] LO 4.27 [See SP 6.4]	• Availability of nesting materials and sites 1264 • Food chains and food webs 608, 609, 1218, 1219, 1242–1243 • Species diversity 1216, 1222, 1223, 1225, 1226, 1227, 1254, 1255 • Population density 1159, 1184, 1186–1188, 1191–1194, 1199, 1200–1204, 1242 • Algal blooms 1221, 1270 • Fight or flight response 210, 998, 1006 • Predator warnings 1142, 1212 • Protection of young 1146 • Plant-plant interactions due to herbivory 1213 • Avoidance responses 1142, 1212 • Herbivory responses 862, 863, 906 • Territorial marking in mammals 1199 • Coloration in flowers 268, 269, 270, 271, 272, 273, 275, 280 • Bee dances 1136, 1137 • Birds songs 1142 • Territorial marking in mammals 1199 • Pack behavior in animals 1135, 1139 • Herd, flock, and schooling behavior in animals 1135, 1139, 1140, 1141, 1142, 1143, 1153 • Predator warning 1142, 1212 • Coloration 19, 20, 330, 1010, 1212, 1213 • Parent and offspring interactions 1017, 1145, 1146, 1196, 1197 • Migration patterns 1135, 1266 • Courtship and mating behaviors 1136, 1145, 1146, 1147, 1148 • Foraging in bees and other animals 1137, 1140 • Avoidance behavior to electric fences, poisons, or traps 1141 • Pack behavior in animals 1135, 1142, 1145 • Herd, flock and schooling behavior in animals 1135, 1139, 1140, 1141, 1142, 1143, 1153 • Predator warning 1142, 1212 • Stomach and small intestines 689, 901, 906, 907 • Kidney and bladder 973, 974, 980, 981, 983, 984, 985, 987, 988, 990, 999, 1001, 1002, 1003, 1058 • Root, stem and leaf 625, 752–768, 787, 788, 789, 791, 793, 811 • Respiratory and circulatory 163, 175, 181, 917, 918, 919, 920, 923, 924, 925, 926, 927, 934, 935, 936, 937, 939, 940, 941, 942, 943 • Nervous and muscular 874, 994, 1062, 1063, 1064, 1065, 1066, 1067, 1068, 1069, 1071, 1072, 1073, 1074, 1075, 1080, 1081, 1082, 1083, 1084, 1085, 1086, 1087, 1088, 1089, 1090, 1091, 1092, 1093, 1094, 1095, 1096, 1097, 1098, 1102, 1103, 1104, 1106, 1122, 1123, 1124, 1125, 1126, 1127

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Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
54 Community Ecology (*continued*)	1208–1231					• Plant vascular and leaf 612–617, 619, 620, 623–627, 630–632, 635–638 • Predator/prey relationships spreadsheet model 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Symbiotic relationship 582, 583, 608, 648, 649, 661, 662, 663, 664, 808, 809, 812, 815, 821, 907, 908, 1214 • Introduction of species 1259 • Global climate change models 1204, 1267, 1271, 1272, 1273, 1274, 1275 • Loss of keystone species 1220 • Kudzu 1259 • Dutch elm disease 662, 663 • Logging, slash and burn agriculture, urbanization, monocropping, infrastructure development (dams, transmission lines, roads), and global climate change threaten ecosystems and life on Earth. 645, 1254–1256, 1258–1261, 1263, 1264, 1266–1277 • An introduced species can exploit a new niche free of predators or competitors, thus exploiting new resources. 1211, 1232, 1256, 1258 • Small pox [historic example for Native Americans] 402, 957 • Continental drift 533 • Meteor impact on dinosaurs 535 • Prairie chickens 489, 1262 • Potato blight causing the potato famine 861 • Corn rust effects on agricultural crops 445, 663 • Not all animals in a population stampede. 1135, 1139 • Not all individuals in a population in a disease outbreak are equally affected; some may not show symptoms, some may have mild symptoms, or some may be naturally immune and resistant to the disease. 1198
55 Ecosystems and Restoration Ecology	1232–1253	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.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. 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 4.14 [See SP 2.2] LO 4.15 [See SP 1.4] LO 4.16 [See SP 6.4]	• Cohesion 46, 789 • Adhesion 46, 789 • High specific heat capacity 44, 47, 48, 49, 50 • Universal solvent supports reactions 48, 49, 52 • Heat of vaporization 44, 45, 47, 48, 49, 50, 1244 • Heat of fusion 44, 47, 48, 49, 50 • Water's thermal conductivity 47, 48 • Root hairs 753, 754, 755, 761, 762, 763, 787, 789, 801, 809, 811 • Cells of the alveoli 937 • Cells of the villi 204, 904, 905 • Microvilli 100, 116, 689

Chapters	Page Numbers	Big Idea	Enduring Understanding	Essential Knowledge	Learning Objectives	Illustrative examples covered in this textbook—teach at least one
56 Conservation Biology and Global Change	1254–1279	Big Idea 1: The process of evolution drives the diversity and unity of life. 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. 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. 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 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 534, 535, 536 • Human impact on ecosystems and species extinction rates 53, 696, 802, 803, 1167–1173, 1173–1176, 1248–1251, 1255, 1256, 1258, 1259, 1260, 1263, 1264, 1266, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1275 • Predator/prey relationships spreadsheet model 462, 650, 667, 671, 694, 695, 696, 697, 704, 720, 836, 1061, 1159, 1198, 1212, 1213 • Symbiotic relationship 582, 583, 608, 648, 649, 661, 662, 663, 664, 808, 809, 812, 815, 821, 907, 908, 1214, 1215 • Introduction of species 405, 1259 • Global climate change models 1204, 1236, 1237, 1267, 1271, 1272, 1273, 1274, 1275 • Loss of keystone species 1220 • Kudzu 1259 • Dutch elm disease 662, 663 • Prairie chickens 489, 1262 • Potato blight causing the potato famine 861 • Corn rust effects on agricultural crops 445, 663 • Not all animals in a population stampede. 1135, 1139 • Not all individuals in a population in a disease outbreak are equally affected; some may not show symptoms, some may have mild symptoms, or some may be naturally immune and resistant to the disease. 1198