CollegeBoard

Name of textbook: *Biology* **Edition:** 9th Edition
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Big Idea 1: The process of evolution drives the diversity and unity of life.

Essential knowledge	Chapters/sections	Illustrative examples covered
1.a.1 Natural selection is a major mechanism of evolution	Chapt 18 Sec 18.1, p. 392 Sec 18.3, p. 393–397 Sec 18.4, p. 408 Chapt 19 All sections, p. 411–425	•**Graphical analysis of allele frequencies in a population** Chapt 18 Sec 18.4, p. 408 Fig 18.21 Chapt 19 Sec 19.3, p. 418 Fig 19.4 •**Application of Hardy-Weinberg Equation** Chapt 19 Sec 19.2, p. 412–414
1.a.2 Natural selection acts on phenotypic variations in populations	Chapt 18 Sec 18.3, p. 395–396 Sec 18.4, p. 394 Chapt 19 Sec 19.0–19.1, p. 411–412 Sec 19.3–19.4, p. 416, 418–423 Chapt 25 Sec 25.6, p. 534	•**Sickle cell anemia** Chapt 16 Sec 16.3, p. 359 Chapt 19 Sec 19.4, p. 421 •**Artificial Selection** Chapt 18 Sec 18.4, p. 394 Fig 18.3 •**Overuse of antibiotics** Chapt 25 Sec 25.6, p. 534 Fig 25.14
Sec 1.A.3 Evolutionary change is also driven by random processes	Chapt 18 Sec 18.3, p. 396–397 Chapt 19 Sec 19.3, p. 416–417	No recommended illustrative examples supplied in Curriculum Framework.
1.a.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics.	Chapt 18 Sec 18.4, p. 397–408 Chapt 19 Sec 19.3, p. 418 Chapt 23 Sec 23.3–23.4, p. 488–497	• **Graphical analysis of allele frequencies in a population** Chapt 18 Sec 18.4, p. 408 Fig 18.21 Chapt 19 Sec 19.3, p. 418 Fig 19.4

Essential knowledge	Chapters/sections	Illustrative examples covered
		•Analysis of sequence data sets, phylogenetic trees, and construction of phylogenetic trees based on sequence data Chapt 18 Sec 18.4, p. 405–406 Fig 18.18, 18.19 Chapt 23 Sec 23.3, p. 488–492 Fig 23.6, 23.7 Sec 23.4, p. 493–497 Fig 23.8–23.11
1.b.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.	Chapt 4 Sec 4.4–4.6, p. 86–101 Chapt 7 Sec 7.3–7.6, p. 156–169 Chapt 8 Sec 8.1, p. 173 Chapt 10 Sec 10.1, p. 214–216 Chapt 12 Sec 12.1, p. 264–265 Chapt 13 Sec 13.2, p. 285–288	**•Cytoskeleton** Chapt 4 Sec 4.6, p. 97–101 Fig 4.23–4.29 Table 4.1 **•Membrane-bound organelles** Chapt 4 Sec 4.5, p. 90, 94–97 Fig 4.20–4.22 Table 4.1 **•Linear chromosomes** Chapt 10 Sec 10.1, p. 214–216 Fig 10.1, 10.3, 10.4 **•Endomembrane systems, including the nuclear envelope** Chapt 4 Sec 4.4, p. 86–88 Fig 4.13 Sec 4.5, p. 89–94 Fig 4.14–4.19 Table 4.1
1.b.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	Chapt 23 All sections, p. 481–500	**•Opposable thumbs** Chapt 23 Sec 23.4, p. 496 Fig 23.10
1.c.1 Speciation and extinction have occurred throughout the Earth's history.	Chapt 20 Sec 20.3, p. 433 Sec 20.5, p. 441–443 Chapt 21 Sec 21.3, p. 455–462 Chapt 23 Sec 23.0, p. 482 Chapt 57	**•Five major extinctions** Chapt 20 Sec 20.5, p. 441–442 Chapt 21 Sec 21.3, p. 456, 458, 460–461, 462 Table 21.1

Essential knowledge	Chapters/sections	Illustrative examples covered
	Sec 57.1, p. 1243–1248	**•Human impact on ecosystems and species extinction rates** Chapt 20 Sec 20.5, p. 442 Chapt 23 Sec 23.0, p. 482 Chapt 57 Sec 57.1, p. 1243–1248 Fig 57.1
1.c.2 Speciation may occur when two populations become reproductively isolated from each other.	Chapt 20 Sec 20.2, p. 428–430 Sec 20.3, p. 430–433	No recommended illustrative examples supplied in Curriculum Framework.
1.c.3 Populations of organisms continue to evolve.	Chapt 18 Sec 18.2, p. 392 Sec 18.4, p. 403, 407–408 Chapt 19 Sec 19.3, p. 419–420 Sec 19.4, p. 422 Chapt 20 Sec 20.3, p. 432–433, 437–438 Chapt 24 Sec 24.4, p. 507–512 Chapt 25 Sec 25.6, p. 534 Chapt 32 Sec 32.7, p. 690–692 Chapt 42 Sec 42.3, p. 886–888 Chapt 44 Sec 44.4, p. 946–947 Chapt 45 Sec 45.1, p. 964–966 Sec 45.6, p. 984–986	**•Chemical resistance and emergent diseases** Chapt 18 Sec 18.2, p. 392 Fig 18.1 Sec 18.4, p. 407–408 Fig 18.21 Chapt 24 Sec 24.4, p. 507–512 Fig 24.7 Table 24.1 Chapt 25 Sec 25.6, p. 534 Fig 25.14 Chapt 45 Sec 45.6, p. 984–986 Fig 45.14, 45.15 **•Observed directional phenotypic change in a population** Chapt 19 Sec 19.3, p. 419–420 Table 19.1 Sec 19.4, p. 422 Fig 19.8 Chapt 20 Sec 20.3, p. 433 **•A eukaryotic example describing the evolution of a structure or process such as heart chambers, limbs, brain, and immune system** Chapt 18 Sec 18.4, p. 403 Fig 18.13

Essential knowledge	Chapters/sections	Illustrative examples covered
		Chapt 32 Sec 32.7, p. 690–692 Chapt 42 Sec 42.3, p. 886–888 Fig 42.5, 42.6 Chapt 44 Sec 44.4, p. 946–947 Fig 44.8 Chapt 45 Sec 45.1, p. 964–966
1.d.1 There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.	Chapt 21 Sec 21.0–21.2, p. 446–454	No recommended illustrative examples supplied in Curriculum Framework.
1.d.2 Scientific evidence from many different disciplines supports models of the origin of life.	Chapt 21 Sec 21.1–21.3, p. 447–455	No recommended illustrative examples supplied in Curriculum Framework.

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

Essential knowledge	Chapters/sections	Illustrative examples covered
2.a.1 All living systems require constant input of free energy.	Chapt 1 Sec 1.1, p. 2 Sec 1.5, p. 8–10 Chapt 7 Sec 7.0–7.5, p. 154–162 Chapt 8 All sections, p. 172–192 Chapt 9 Sec 9.3, p. 199 Sec 9.5, p. 204–206 Chapt 32 Sec 32.8, p. 694–695, 698, 700–701 Chapt 33 Sec 33.0, p. 708–709 Chapt 39	•**Krebs Cycle** Chapt 8 Sec 8.2, p. 174–175, 177, 180–181, 184, 186 Fig 8.2, 8.5, 8.6, 8.12 Table 8.1 •**Glycolysis** Chapt 8 Sec 8.2, p. 174–176, 178–179, 184, 186, 188 Fig 8.2–8.4, 8.12, 8.14 Table 8.1 •**Calvin Cycle** Chapt 9 Sec 9.3, p. 199 Fig 9.8 Sec 9.5, p. 204–206 Fig 9.14 Table 9.3

Essential knowledge	Chapters/sections	Illustrative examples covered
	Sec 39.3, p. 835–838 Chapt 47 Sec 47.4, p. 1029 Chapt 52 Sec 52.3, p. 1135 Chapt 53 Sec 53.4, p. 1161–1162 Chapt 55 Sec 55.1, p. 1200–1201	**•Fermentation** Chapt 8 Sec 8.4, p. 188–189 Fig 8.14 Table 8.2 **•Endothermy and ectothermy** Chapt 32 Sec 32.8, p. 694–695, 698, 700–701 Fig 32.20, 32.25 Chapt 39 Sec 39.3, p. 835–838 Fig 39.8, 39.9 **•Elevated floral temperatures in some plant species** Chapt 8 Sec 8.2, p. 183 **•Seasonal reproduction in animals and plants** Chapt 52 Sec 52.3, p. 1135 **•Life-history strategy (biennial plants, reproductive diapause)** Chapt 33 Sec 33.0, p. 708–709 Chapt 53 Sec 53.4, p. 1161–1162 Fig 53.7 **•Change in the producer level can affect the number and size of other trophic levels** Chapt 54 Sec 54.2, p. 1186–1187 Fig 54.16 Chapt 55 Sec 55.1, p. 1201 **•Change in energy resource levels, such as sunlight, can affect the number and size of the trophic levels** Chapt 54 Sec 54.2, p. 1186–1187 Fig 54.16 Chapt 55 Sec 55.1, p. 1200–1201 Fig 55.5 Table 55.1
2.a.2 Organisms capture and store free energy for use in biological processes.	Chapt 1 Sec 1.5, p. 9–10 Chapt 7	**•$NADP^+$ in photosynthesis** Chapt 9 Sec 9.3, p. 198–199

Essential knowledge	Chapters/sections	Illustrative examples covered
	Sec 7.4, p. 159–160 Sec 7.5, p. 161–162 Chapt 8 All sections, p. 172–192 Chapt 9 All sections, p. 193–212	Fig 9.8 Sec 9.4, p. 200–201, 203 Fig 9.11, 9.13 Table 9.1 Sec 9.5, p. 204–208 Fig 9.14, 9.16 Table 9.3 **•Oxygen in cellular respiration** Chapt 8 Sec 8.1, p. 173 Sec 8.2, p. 174, 177, 180, 182 Fig 8.8 Table 8.1
2.a.3 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.	Chapt 2 Sec 2.1, p. 27 Sec 2.5, p. 37–40 Chapt 3 Sec 3.2–3.5, p. 51–69 Chapt 4 Sec 4.1, p. 76–77 Chapt 33 Sec 33.2, p. 718, 719 Chapt 35 Sec 35.2, p. 754–756 Chapt 36 Sec 36.1, p. 762–763 Chapt 46 Sec 46.3, p. 1000–1003 Chapt 47 Sec 47.2, p. 1020–1023 Chapt 55 Sec 55.2, p. 1203–1208	**Properties of water:** **•Cohesion** Chapt 2 Sec 2.5, p. 38 Fig 2.14, 2.15 Chapt 35 Sec 35.2, p. 754–756 Fig 35.11 **•Adhesion** Chapt 2 Sec 2.5, p. 38 Fig 2.14 Chapt 35 Sec 35.2, p. 754–756 **•High specific heat capacity** Chapt 2 Sec 2.5, p. 40 **•Universal solvent supports reactions** Chapt 2 Sec 2.5, p. 38 **•Heat of vaporization** Chapt 2 Sec 2.5, p. 39–40 **Examples of SA:V relationship** **•Root hairs** Chapt 33 Sec 33.2, p. 718, 719 Fig 33.6 Chapt 36 Sec 36.1, p. 762–763 Fig 36.2b **•Cells of the alveoli** Chapt 46

Essential knowledge	Chapters/sections	Illustrative examples covered
		Sec 46.3, p. 1000–1003 Fig 46.7, 46.9a **•Cells of the villi and microvilli** Chapt 4 Sec 4.1, p. 76 Chapt 47 Sec 47.2, p. 1020–1023 Fig 47.10
2.b.1 Cell membranes are selectively permeable due to their structure.	Chapt 4 Sec 4.3, p. 82–86 Chapt 5 Sec 5.0–5.3, p. 106–116 Chapt 25 Sec 25.1, p. 519–520 Chapt 29 Sec 29.1, p. 603	No recommended illustrative examples supplied in Curriculum Framework.
2.b.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.	Chapt 5 Sec 5.4–5.6, p. 116–127 Chapt 41 Sec 41.3, p. 866–867	**•Glucose transport** Chapt 5 Sec 5.3, p. 115 Sec 5.4, p. 120–121 Fig 5.16 Sec 5.5, p. 123–124 Fig 5.19 **•Na^+/K^+ transport** Chapt 5 Sec 5.5, p. 121–123 Fig 5.17 Chapt 41 Sec 41.3, p. 866–867 Fig 41.4b
2.b.3 Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.	Chapt 4 Sec 4.3–4.5, p. 81–97 Chapt 8 Sec 8.2, p. 174–177, 180–187 Chapt 9 Sec 9.2–9.6, p. 195–209	**•Endoplasmic reticulum** Chapt 4 Sec 4.3, p. 83–85 Fig 4.7–4.10 Sec 4.5, p. 89–91, 92 Fig 4.14, 4.16 Table 4.1 **•Mitochondria** Chapt 4 Sec 4.3, p. 83–85 Fig 4.7–4.10 Sec 4.5, p. 90, 94–96 Fig 4.20, 4.21 Table 4.1

Essential knowledge	Chapters/sections	Illustrative examples covered
		Chapt 8 Sec 8.2, p. 174–177, 180–187 Fig 8.2, 8.3, 8.5, 8.6, 8.8, 8.10, 8.11 **•Chloroplasts** Chapt 4 Sec 4.5, p. 90, 95, 96 Fig 4.20, 4.22 Table 4.1 Chapt 9 Sec 9.2–9.6, p. 195–209 Fig 9.4, 9.8–9.16 **•Golgi** Chapt 4 Sec 4.3, p. 83–85 Fig 4.7–4.10 Sec 4.5, p. 90–92 4.15, 4.16 Table 4.1 **•Nuclear envelope** Chapt 4 Sec 4.4, p. 86, 88 Fig 4.13
2.c.1 Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.	Chapt 14 Sec 14.2, p. 309–314 Chapt 33 Sec 33.1, p. 718 Chapt 34 Sec 34.2, p. 736 Chapt 38 Sec 38.2, p. 810–811 Chapt 39 Sec 39.2, p. 834–835 Sec 39.3, p. 835–836 Chapt 44 Sec 44.2, p. 943 Chapt 48 Sec 48.5, p. 1047 Chapt 49 Sec 49.1, p. 1053–1054 Sec 49.5, p. 1060–1072 Chapt 50 Sec 50.2, p. 1084–1085 Sec 50.3, p. 1089–1093	**•Operons in gene regulation** Chapt 14 Sec 14.2, p. 309–314 Fig 14.2–14.5 Table 14.1 **•Temperature regulation in animals** Chapt 39 Sec 39.3, p. 835–836 Fig 39.8, 39.9 **•Plant responses to water limitations** Chapt 33 Sec 33.1, p. 718 Chapt 34 Sec 34.2, p. 736 **•Lactation in mammals** Chapt 49 Sec 49.5, p. 1062–1063, 1065 Fig 49.9 Chapt 50 Sec 50.3, p. 1089 Fig 50.13 **•Onset of labor in childbirth** Chapt 50 Sec 50.4, p. 1096–1097 Fig 10.18

Essential knowledge	Chapters/sections	Illustrative examples covered
	Sec 50.4, p. 1096–1097 Chapt 53 Sec 53.3, p. 1158–1160	**•Ripening of fruit** Chapt 38 Sec 38.2, p. 810–811 Fig 38.12 **•Diabetes mellitus in response to decreased insulin** Chapt 49 Sec 49.5, p. 1069–1071 **•Dehydration in response to decreased anti-diuretic hormone (ADH)** Chapt 48 Sec 48.5, p. 1047 **•Graves' disease (hyperthyroidism)** Chapt 49 Sec 49.5, p. 1067 **•Blood clotting** Chapt 44 Sec 44.2, p. 943 Fig 44.5
2.c.2 Organisms respond to changes in their external environments.	Chapt 1 Sec 1.2, p. 4 Chapt 6 Sec 6.0, p. 134–135 Chapt 25 Sec 25.1, p. 521 Chapt 29 Sec 29.2, p. 605 Chapt 38 Sec 8.0–8.1, p. 803–805 Sec 8.2, p. 810–812 Sec 8.3–8.4, p. 813–818 Chapt 39 Sec 39.2–39.3, p. 834–838 Sec 39.3, p. 836–838 Chapt 42 Sec 42.4, p. 894–896 Chapt 52 Sec 52.3, p. 1134–1136	**•Photoperiodism and phototropism in plants** Chapt 38 Sec 38.1, p. 804 Fig 38.1 Sec 38.3, p. 813–815 Fig 38.16–38.18 **•Hibernation and migration in animals** Chapt 39 Sec 39.3, p. 836, 838 Chapt 52 Sec 52.3, p. 1135–1136 Fig 52.10 **•Other organisms (chemotaxis in bacteria, sexual reproduction in fungi)** Chapt 6 Sec 6.0, p. 134–135 Chapt 25 Sec 25.1, p. 521 Chapt 29 Sec 29.2, p. 605 **•Nocturnal and diurnal activity: circadian rhythms** Chapt 42 Sec 42.4, p. 894–896 Chapt 52 Sec 52.3, p. 1134–1135

Essential knowledge	Chapters/sections	Illustrative examples covered
		•Shivering and sweating in humans Chapt 39 Sec 39.3, p. 837
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	Chapt 2 Sec 2.5, p. 37 Chapt 3 Sec 3.2, p. 54–55 Chapt 4 Sec 4.1, p. 75 Sec 4.6, p. 100 Chapt 6 Sec 6.0, p. 134–135 Chapt 9 Sec 9.5, p. 206 Chapt 21 Sec 21.2, p. 452 Chapt 25 Sec 25.2, p. 520 Sec 25.5, p. 530–531 Sec 25.6, p. 534 Chapt 26 Sec 26.1, p. 538 Sec 26.3, p. 543 Sec 26.4, p. 545, 548 Sec 26.7, p. 555–557 Chapt 29 Sec 29.0, p. 602 Sec 29.4, p. 615, 617–619 Chapt 31 Sec 31.2, p. 650–651 Chapt 34 Sec 34.4, p. 738 Chapt 33 Sec 33.1, p. 718 Chapt 36 Sec 36.2, p. 771–772 Chapt 39 Sec 39.3, p. 835–838 Chapt 52 Sec 52.4, p. 1136–1137 Sec 52.5, p. 1137, 1138 Chapt 53 Sec 53.1, p. 1155 Sec 53.2, p. 1157–	**At the cellular level** **•Biofilms** Chapt 6 Sec 6.0, p. 134–135 Chapt 21 Sec 21.2, p. 452 Fig 21.6 Chapt 25 Sec 25.5, p. 530 Fig 25.11 Sec 25.6, p. 534 **•Temperature/sunlight/water availability** Chapt 4 Sec 4.1, p. 75 Chapt 25 Sec 25.2, p. 520 Fig 25.4 Chapt 26 Sec 26.4, p. 548 Chapt 31 Sec 31.2, p. 650 **Organisms:** **•Symbiosis** Chapt 3 Sec 3.2, p. 54–55 Chapt 25 Sec 25.5, p. 530–531 Chapt 26 Sec 26.1, p. 538 Sec 26.3, p. 543 Fig 26.4b Chapt 29 Sec 29.0, p. 602 Sec 29.4, p. 615, 617–619 Fig 29.19, 29.20 Chapt 31 Sec 31.2, p. 650–651 Fig 31.9–31.11 Chapt 36 Sec 36.2, p. 770–772 Fig 36.11, 36.12 Chapt 54 Sec 54.1, p. 1182–1185

Essential knowledge	Chapters/sections	Illustrative examples covered
	1158 Sec 53.3, p. 1158–1161 Chapt 54 Sec 54.1, p. 1177, 1180–1185 Sec 54.2–54.3, p. 1186–1190 Chapt 55 Sec 55.1, p. 1197–1199 Sec 55.2, p. 1204 Chapt 56 Sec 56.2, p. 1228–1231, 1234	Fig 54.12–54.14 **•Predator-prey relationships** Chapt 52 Sec 52.4, p. 1136–1137 Fig 52.11 Sec 52.5, p. 1137, 1138 Fig 52.12 Chapt 54 Sec 54.1, p. 1180–1183 Fig 54.8–54.11 **•Water and nutrient availability, temperature, salinity, pH** Chapt 2 Sec 2.5, p. 37 Fig 2.12 Chapt 9 Sec 9.5, p. 206 Chapt 33 Sec 33.1, p. 718 Chapt 34 Sec 34.4, p. 738 Chapt 39 Sec 39.3, p. 835–838 Fig 39.8, 39.9 Chapt 52 Sec 52.4, p. 1136–1137 Fig 52.11 Chapt 55 Sec 55.2, p. 1204 **Populations, communities, ecosystems:** **•Water and nutrient availability** Chapt 53 Sec 53.1, p. 1155 Sec 53.2, p. 1157–1158 Fig 53.3 Chapt 54 Sec 54.1, p. 1177 Sec 54.2, p. 1186–1187 Fig 54.16 Chapt 56 Sec 56.2, p. 1228–1231, 1234 Fig 56.13 **•Availability of nesting materials and sites** Chapt 53 Sec 53.1, p. 1155 Fig 53.1c

Essential knowledge	Chapters/sections	Illustrative examples covered
		•Food chains and food webs Chapt 55 Sec 55.1, p. 1197–1199 Fig 55.1, 55.2 **•Species diversity** Chapt 54 Sec 54.3, p. 1187–1190 Fig 54.18–54.20 **•Population density** Sec 53.3, p. 1158–1161 Fig 53.4, 53.6 **•Algal blooms** Chapt 26 Sec 26.4, p. 545 Fig 26.6b Chapt 56 Sec 56.2, p. 1230–1231
2.d.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	Chapt 4 Sec 4.5, p. 93 Chapt 6 Sec 6.0, p. 134–135 Chapt 25 Sec 25.1, p. 519 Chapt 34 Sec 34.1, p. 733–735 Chapt 39 Sec 39.2–39.3 p. 834–838 Chapt 44 Sec 44.4, p. 946–947 Chapt 46 Sec 46.0–46.2, p. 993–998, 999 Chapt 47 Sec 47.0–47.2, p. 1012–1017 Chapt 48 Sec 48.3–48.4, p.1036–1040 Chapt 49 Sec 49.4–49.5, p.1060–1061	**•Gas exchange in aquatic and terrestrial plants** Chapt 34 Sec 34.1, p. 733–735 Fig 34.9 **•Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems** Chapt 47 Sec 47.0, p. 1012–1013 Sec 47.1, p. 1013–1016 Fig 47.1–47.3 Sec 47.2, p. 1016–1017 Fig 47.4–47.6 **•Respiratory systems of aquatic and terrestrial animals** Chapt 46 Sec 46.0, p. 993–994 Sec 46.1, p. 994 Sec 46.2, p. 994–998, 999 Fig 46.1–46.5 **•Nitrogenous waste production and elimination in aquatic and terrestrial animals** Chapt 48 Sec 48.3, p.1036–1038 Fig 48.2–48.4 Sec 48.4, p. 1038–1040 Fig 48.5, 48.6

Essential knowledge	Chapters/sections	Illustrative examples covered
		Common ancestry: **•Excretory systems in flatworms, earthworms, and vertebrates** Chapt 48 Sec 48.3, p.1036–1038 Fig 48.2–48.4 Sec 48.4, p. 1038–1040 Fig 48.5, 48.6 **•Osmoregulation in bacteria, fish, and protists** Chapt 25 Sec 25.1, p. 519 Chapt 48 Sec 48.4, p. 1038–1039 Fig 48.5 **•Circulatory systems in fish, amphibians, and mammals** Chapt 44 Sec 44.4, p. 946–947 Fig 44.8 **•Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms)** Chapt 39 Sec 39.3, p. 835–838 Fig 39.9
2.d.3 Biological systems are affected by disruptions to their dynamic homeostatis.	Chapt 1 Sec 1.1, p. 1-2 Chapt 21 Sec 21.3, p. 462 Chapt 24 Sec 24.4, p. 507–512 Chapt 25 Sec 25.6, p. 532–534 Chapt 29 Sec 29.5, p. 620–622 Chapt 32 Sec 32.8, p. 697 Chapt 38 Sec 38.4, p. 817–818 Chapt 41 Sec 41.3, p. 867, 869 Chapt 45 Sec 45.0, p 963–964 Sec 45.6, p. 982–989 Chapt 54 Sec 54.4, p. 1190–1191	**•Physiological responses to toxic substances** Chapt 25 Sec 25.6, p. 533–534 Chapt 32 Sec 32.8, p. 697 Chapt 38 Sec 38.4, p. 817–818 Fig 38.21 Chapt 41 Sec 41.3, p. 867, 869 Fig 41.6 Chapt 55 Sec 55.1, p. 1202 Chapt 57 Sec 57.1, p. 1245 **•Immunological responses to pathogens, toxins and allergens** Chapt 25 Sec 25.6, p. 532–534 Fig 25.13 Table 25.5

Essential knowledge	Chapters/sections	Illustrative examples covered
	Chapt 55 Sec 55.1, p. 1202 Sec 55.3, p. 1213 Chapt 56 Sec 56.1, p. 1223–1224 Chapt 57 Sec 57.1, p. 1243–1248 Sec 57.3–57.5, p. 1253–1261	Chapt 29 Sec 29.5, p. 620–622 Fig 29.22 Chapt 45 Sec 45.0, p 963–964 Sec 45.6, p. 982–989 **•Invasive and/or eruptive species** Chapt 1 Sec 1.1, p. 1-2 Chapt 24 Sec 24.4, p. 507–512 Fig 24.7 Table 24.1 Chapt 25 Sec 25.6, p. 534 Chapt 45 Sec 45.6, p. 984–986 Chapt 57 Sec 57.1, p. 1246–1248 Fig 57.7 **•Human impact** Chapt 21 Sec 21.3, p. 462 Chapt 57 Sec 57.1, p. 1243–1244, 1246–1248 Fig 57.1, 57.3–57.8 Sec 57.3, p. 1253–1257 Fig 57.13, 57.14 Sec 57.4, p. 1255–1259 Fig 57.15–57.18 Table 57.2 Sec 57.5, p. 1259–1261 Fig 57.19, 57.20 **•Hurricanes, floods, earthquakes, volcanoes, fires** Chapt 54 Sec 54.4, p. 1190–1191 Chapt 55 Sec 55.3, p. 1213 Fig 55.18 Chapt 56 Sec 56.1, p. 1223–1224 **•Water limitation** Chapt 57 Sec 57.3, p. 1253 **•Salination** Chapt 56 Sec 56.1, p. 1224

Essential knowledge	Chapters/sections	Illustrative examples covered
2.d.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	Chapt 38 Sec 38.4, p. 817–818 Chapt 45 All sections, p. 963–992	**•Invertebrate immune systems have non-specific response mechanisms but lack pathogen-specific defense responses** Chapt 45 Sec 45.1, p. 964 **•Plant defenses against pathogens** Chapt 38 Sec 38.4, p. 817–818 **•Vertebrate immune systems—non-specific and non-heritable defense mechanisms** Chapt 45 Sec 45.0–45.5, p. 963–982 Fig 45.1–45.12 Table 45.1
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.	Chapt 4 Sec 4.5, p. 94–95 Chapt 17 All sections, p. 370–390 Chapt 33 Sec 33.3, p. 720–724 Chapt 34 Sec 34.1, p. 731 Chapt 37 Sec 37.1, p. 782 Chapt 45 Sec 45.2, p. 967 Chapt 51 All sections, p. 1106–1126	**Programmed cell death:** **•Immune function** Chapt 45 Sec 45.2, p. 967 **•*C. elegans* development** Chapt 17 Sec 17.2, p. 381–384 Fig 17.14–17.16
2.e.2 Timing and coordination of physiological events are regulated by multiple mechanisms.	Chapt 1 Sec 1.4, p. 8 Chapt 6 Sec 6.0–6.1, p. 134–135 Chapt 20 Sec 20.2, p. 429 Chapt 25 Sec 25.4, p. 528 Chapt 26 Sec 26.7, p 555–557 Chapt 29 Sec 29.2, p. 605 Sec 29.3, p. 612, 614–616 Chapt 38	**•Circadian rhythms** Chapt 42 Sec 42.4, p. 894–896 Chapt 52 Sec 52.3, p. 1134–1135 **•Seasonal responses such as hibernation, estivation and migration** Chapt 39 Sec 39.3, p. 837–838 Chapt 43 Sec 43.3, p. 916 Chapt 52 Sec 52.3, p. 1135–1136 Fig 52.10 Chapt 56 Sec 56.1, p. 1225

Essential knowledge	Chapters/sections	Illustrative examples covered
	All sections, p. 803–820 Chapt 39 Sec 39.3, p. 837–838 Chapt 42 Sec 42.4, p. 894–896 Chapt 43 Sec 43.3, p. 916 Sec 43.6, p. 926 Chapt 52 Sec 52.3, p. 1134–1136 Sec 52.5, p. 1139 Sec 52.6, p. 1143 Chapt 56 Sec 56.1, p. 1225	**•Release and reaction to pheromones** Chapt 43 Sec 43.6, p. 926 Chapt 52 Sec 52.5, p. 1139 **•Visual displays in reproductive cycle** Chapt 1 Sec 1.4, p. 8 Chapt 20 Sec 20.2, p. 429 Fig 20.3 Chapt 52 Sec 52.6, p. 1143 Fig 52.18 **•Fruiting body formation in fungi, slime molds, and certain types of bacteria** Chapt 25 Sec 25.4, p. 528 Table 25.4 Chapt 26 Sec 26.7, p 555–557 Fig 26.19, 26.20 Chapt 29 Sec 29.2, p. 605 Sec 29.3, p. 612, 614–616 Fig 29.15, 29.17 **•Quorum sensing in bacteria** Chapt 6 Sec 6.0, p. 134–135
2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.	Chapt 1 Sec 1.4, p. 8 Chapt 3 Sec 3.2, p. 54–55 Chapt 20 Sec 20.2, p. 429 Chapt 25 Sec 25.4, p. 528 Sec 25.5, p. 530–531 Chapt 26 Sec 26.6–26.7, p. 554–557 Chapt 29 Sec 29.3–29.4, p. 609, 611, 612, 614–619 Chapt 36 Sec 36.2, p. 770–772 Chapt 37	**•Hibernation and estivation** Chapt 39 Sec 39.3, p. 837–838 Chapt 56 Sec 56.1, p. 1225 **•Migration** Chapt 43 Sec 43.3, p. 916 Chapt 52 Sec 52.3, p. 1135–1136 Fig 52.10 **•Courtship** Chapt 1 Sec 1.4, p. 8 Chapt 20 Sec 20.2, p. 429 Fig 20.3 Chapt 52

Essential knowledge	Chapters/sections	Illustrative examples covered
	Sec 37.2, p. 784–789 Sec 37.3, p. 794–796 Chapt 39 Sec 39.3, p. 837–838 Chapt 43 Sec 43.3, p. 916 Chapt 47 Sec 47.1, p. 1013 Chapt 52 All sections, p. 1129–1152 Chapt 54 Sec 54.1, p. 1175–1180 Chapt 55 Sec 55.2, p. 1204–1205 Chapt 56 Sec 56.1, p. 1225	Sec 52.6, p. 1143 Fig 52.18 **•Availability of resources leading to fruiting body formation in fungi and certain types of bacteria** Chapt 25 Sec 25.4, p. 528 Table 25.4 Chapt 26 Sec 26.7, p 555–557 Fig 26.19, 26.20 Chapt 29 Sec 29.3, p. 612, 614–616 Fig 29.15, 29.17 **•Niche and resource partitioning** Chapt 54 Sec 54.1, p. 1175–1180 Fig 54.3–54.7 **•Mutualistic relationships (lichens; bacteria in digestive tracts of animals; mycorrhizae)** Chapt 3 Sec 3.2, p. 54–55 Chapt 25 Sec 25.5, p. 530–531 Chapt 29 Sec 29.3, p. 609, 611 Fig 29.11 Sec 29.4, p. 617–619 Fig 29.19, 29.20 Chapt 36 Sec 36.2, p. 770–772 Fig 36.11, 36.12 Chapt 47 Sec 47.1, p. 1013 Chapt 55 Sec 55.2, p. 1204–1205 Fig 55.9 **•Biology of pollination** Chapt 37 Sec 37.2, p. 784–789 Fig 37.4, 37.5 Table 37.1

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

Essential knowledge	Chapters/sections	Illustrative examples covered
3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.	Chapt 1 Sec 1.4, p. 6, 8 Chapt 11 Sec 11.4, p. 258–259 Chapt 12 All sections, p. 263–281 Chapt 13 Sec 13.0–13.5, p. 282–300 Chapt 14 Sec 14.3, p. 316, 319–320 Chapt 15 All sections, p. 232–346 Chapt 17 Sec 17.1, p. 373, 374	**mRNA transcription in eukaryotic cells:** **•Addition of a poly-A tail** Chapt 13 Sec 13.3, p. 291, 292 Fig 13.12 Chapt 14 Sec 14.3, p. 319 **•Addition of a GTP cap** Chapt 13 Sec 13.3, p. 291, 292 Fig 13.12 **•Excision of introns** Chapt 13 Sec 13.3, p. 292–293 Fig 13.12 Chapt 14 Sec 14.3, p. 319 Fig 14.14 **Expression of phenotypes:** **•Enzymatic reactions** Chapt 11 Sec 11.4, p. 258–259 Fig 11.22 Chapt 12 Sec 12.3, p. 276–278 Fig 12.17 Chapt 13 Sec 13.3, p. 289 Fig 12.8 Chapt 14 Sec 14.3, p. 316 Fig 14.9 **•Synthesis** Chapt 13 Sec 13.4, p. 293–297 Fig 13.13, 13.16, 13.17 **•Degradation** Chapt 14 Sec 14.3, p. 320 Fig 14.15 **Examples of genetic engineering:** **•Electrophoresis** Chapt 15 Sec 15.2, p. 331, 332

Essential knowledge	Chapters/sections	Illustrative examples covered
		Fig 15.8 **•Plasmid-based transformation** Chapt 15 Sec 15.1, p. 324–326 Fig 15.2, 15.3 **•Restriction enzyme analysis of DNA** Chapt 15 Sec 15.1, p. 324, 325 Fig 15.1 **•Polymerase Chain Reaction (PCR)** Chapt 15 Sec 15.1, p. 329–331 Fig 15.7 **Products of genetic engineering:** **•Genetically-modified foods** Chapt 15 Sec 15.4, p. 342–343 Fig 15.16 **•Transgenic animals** Chapt 15 Sec 15.4, p. 340–342 Fig 15.14, 15.15 **•Cloned animals** Chapt 17 Sec 17.1, p. 373, 374 Fig 17.4 **•Pharmaceuticals, such as human insulin or factor X** Chapt 15 Sec 15.4, p. 339
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.	Chapt 6 Sec 6.5, p. 148 Chapt 10 All sections, p. 213–236 Chapt 17 Sec 17.3, p. 387–388 Chapt 39 Sec 39.2, p. 831	**•Cancer results from disruptions in cell cycle control** Chapt 6 Sec 6.5, p. 148 Chapt 10 Sec 10.0, p. 213–214 Chapt 17 Sec 17.3, p. 387–388 Fig 17.20 Chapt 39 Sec 39.2, p. 831
3.A.3 The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from	Chapt 11 Sec 11.0–11.3, p. 237–255 Chapt 16 Sec 16.1, p. 349	**•Sickle cell anemia** Chapt 16 Sec 16.3, p. 358–359 Fig 16.8 **•Huntington's disease**

Essential knowledge	Chapters/sections	Illustrative examples covered
parent to offspring	Sec 16.2–16.3, p. 351–361 Sec 16.5–16.6, p. 362–366	Chapt 16 Sec 16.3, p. 358–360 Fig 16.10 **•X-linked color blindness** Chapt 11 Sec 11.3, p. 253–254 Fig 11.15 **•Trisomy 21/Down Syndrome** Chapt 16 Sec 16.2, p. 352–354 Fig 16.4 **•Klinefelter syndrome** Chapt 16 Sec 16.2, p. 354 **•Reproduction issues** Chapt 16 Sec 16.5, p. 362–365 Fig 16.12, 16.13 **•Civic issues** Chapt 16 Sec 16.6, p. 365–366
3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.	Chapt 11 Sec 11.3–11.4, p. 249–260	**•Sex-linked genes reside on sex chromosomes (X in humans)** Chapt 11 Sec 11.3, p. 253–255 Fig 11.15, 11.16 **•In mammals and flies, the Y chromosome is very small and carries few genes** Chapt 11 Sec 11.3, p. 251–252 Fig 11.14 **•In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males** Chapt 11 Sec 11.3, p. 251–254 Fig 11.15 Table 11.4
3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.	Chapt 13 Sec 13.3, p. 288–283 Chapt 14 All sections, p. 307–322	**•Promoters** Chapt 13 Sec 13.3, p. 289–290, 291 Fig 13.9–13.11 Chapt 14 Sec 14.2, p. 309–313 Fig 14.2, 14.4, p14.5 Sec 14.3, p. 317–318

Essential knowledge	Chapters/sections	Illustrative examples covered
		Fig 14.11 **•Enhancers** Chapt 14 Sec 14.3, p. 317–318 Fig 14.11
3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression.	Chapt 6 Sec 6.4, p. 147 Chapt 11 Sec 11.3, p. 252 Chapt 14 All sections, p. 307–322 Chapt 38 Sec 38.2, p. 805–813 Chapt 17 Sec 17.2–17.3, p. 375–388 Chapt 30 Sec 30.3, p. 630 Chapt 32 Sec 32.5, p. 683 Chapt 33 Sec 33.3, p. 723–725	**•Levels of cAMP regulate metabolic gene expression in bacteria** Chapt 14 Sec 14.2, p. 312–313 Fig 14.5, 14.6 **•Expression of the SRY gene triggers the male sexual development pathway in animals** Chapt 11 Sec 11.3, p. 252 **•Ethylene levels cause changes in the production of different enzymes, allowing fruit ripening** Chapt 38 Sec 38.2, p. 811 Fig 38.12 **•Gibberelin promotes seed germination in plants** Chapt 38 Sec 38.2, p. 809–810 **•Morphogens stimulate cell differentiation and development** Chapt 17 Sec 17.2, p. 379–380 **•Changes in p53 activity can result in cancer** Chapt 17 Sec 17.3, p. 388 **•HOX genes play a role in development** Chapt 17 Sec 17.2, p. 380–381 Fig 17.13 Chapt 30 Sec 30.3, p. 630 Chapt 32 Sec 32.5, p. 683
3.C.1 Changes in genotype can result in changes in phenotype.	Chapt 1 Sec 1.6, p. 14–15 Chapt 7 Sec 7.6, p. 169	**•Antibiotic resistance mutations** Chapt 7 Sec 7.6, p. 169 Chapt 25

Essential knowledge	Chapters/sections	Illustrative examples covered
	Chapt 12 Sec 12.3, p. 276–277 Chapt 13 Sec 13.6, p. 300–304 Chapt 16 Sec 16.2–16.3, p. 351–361 Chapt 17 Sec 17.2, p. 375–387 Chapt 18 Sec 18.3, p. 394–396 Chapt 19 Sec 19.1, p. 412 Sec 19.3–19.4, p. 416–423 Chapt 24 Sec 24.4, p. 512 Chapt 25 Sec 25.6, p. 534 Chapt 26 Sec 26.4, p. 546	Sec 25.6, p. 534 Fig 25.14 **•Pesticide resistance mutations** Chapt 26 Sec 26.4, p. 546 **•Sickle cell disorder and heterozygote advantage** Chapt 16 Sec 16.3, p. 359 Chapt 19 Sec 19.4, p. 420–421 Fig 19.7
3.C.2 Biological systems have multiple processes that increase genetic variation.	Chapt 1 Sec 1.2, p. 5 Chapt 10 Sec 10.4, p. 225–233 Chapt 11 Sec 11.1, p. 241–242, 245–246 Sec 11.3–11.4, p. 249–260 Chapt 12 Sec 12.3, p. 276–277 Chapt 25 Sec 25.2, p. 522–523	No recommended illustrative examples supplied in Curriculum Framework.
3.C.3 Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.	Chapt 24 Sec 24.3–24.4, p. 504–512 Chapt 25 Sec 25.2, p. 522–523	**•Transduction in bacteria** Chapt 25 Sec 25.2, p. 522–523 Fig 25.7 **•Transposons present in incoming DNA** Chapt 13 Sec 13.6, p. 303
3.D.1 Cell communication processes share common features that reflect a shared	Chapt 5 Sec 5.2, p. 114–115 Chapt 6	**•Quorum sensing in microbes** Chapt 6 Sec 6.0, p. 134–135

Essential knowledge	Chapters/sections	Illustrative examples covered
evolutionary history.	Sec 6.0, p. 134–135 Sec 6.2, p. 136–137 Sec 6.4–6.6, p. 141–151 Chapt 17 Sec 17.2, p. 385 Chapt 33 Sec 33.1, p. 710 Chapt 38 Sec 38.2, p. 805–812 Sec 38.3, p. 816 Chapt 41 Sec 41.4, p. 872–877 Chapt 49 Sec 49.3, p. 1058–1060 Chapt 51 Sec 51.2, p. 1108 Chapt 52 Sec 52.5, p. 1139	**•Response to external signals by bacteria that influences cell movement** Chapt 25 Sec 25.1, p. 521 Chapt 36 Sec 36.2, p. 771–772 Fig 36.12
3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	Chapt 1 Sec 1.4, p. 8 Chapt 5 Sec 5.7, p. 127–130 Chapt 6 All sections, p. 134–153 Chapt 38 Sec 38.4, p. 817–818 Chapt 17 Sec 17.1, p. 370 Chapt 41 Sec 41.0, p. 860–861 Sec 41.4, p. 872–877 Chapt 45 Sec 45.3–45.5, p. 970–977 Chapt 49 All sections, p. 1052–1076 Chapt 51 Sec 51.1, p. 1107 Sec 51.5, p. 1115–1116	**•Immune cells interact by cell-cell contact, antigen-presenting cells, helper T-cells, killer T-cells** Chapt 45 Sec 45.3, p. 971–973 Fig 45.5 Sec 45.4, p. 973–975 Fig 45.6 Sec 45.5, p. 975–977 Fig 45.7, 45.8 **•Plasmodesmata between plant cells that allow material to be transported from cell to cell** Chapt 5 Sec 5.7, p. 129–130 Fig 5.27 Chapt 6 Sec 6.2, p. 136 **•Neurotransmitters** Chapt 1 Sec 1.4, p. 8 Chapt 41 Sec 41.0, p. 860–861 Sec 41.4, p. 872–877 Fig 41.11 Table 41.2

Essential knowledge	Chapters/sections	Illustrative examples covered
		•Plant immune response Chapt 6 Sec 6.1, p. 135 Chapt 38 Sec 38.4, p. 817–818 Fig 38.21 **•Quorum sensing in bacteria** Chapt 6 Sec 6.0, p. 134–135 **•Morphogenisis in embryonic development** Chapt 17 Sec 17.1, p. 370 Chapt 51 Sec 51.1, p. 1107 Sec 51.5, p. 1115–1116 Fig 51.11 **• Insulin** Chapt 49 Sec 49.5, p. 1068–1070 Fig 49.12, 49.13 **•Human Growth Hormone** Chapt 49 Sec 49.5, p. 1065–1066 Fig 49.9 **•Thyroid hormones** Chapt 49 Sec 49.5, p. 1066–1077 Fig 49.10 **•Testosterone and estrogen** Chapt 49 Sec 49.5, p. 1072–1073
3.D.3. Signal transduction pathways link signal reception with cellular response.	Chapt 3 Sec 3.5, p. 68–69 Chapt 6 All sections, p. 134–153 Chapt 7 Sec 7.6, p. 167–168 Chapt 14 Sec 14.2, p. 312–313 Chapt 26 Sec 26.7, p. 557–558 Chapt 36 Sec 36.3, p. 776 Chapt 41 Sec 41.4, p. 875–876 Chapt 42	**•G-protein linked receptors** Chapt 6 Sec 6.3, p. 139, 140 Fig 6.5b Sec 6.4, p. 142–143 Sec 6.5, p. 148, 151 Fig 6.15 Chapt 41 Sec 41.4, p. 875 Chapt 49 Sec 49.3, p. 1059–1060 Fig 49.5 Chapt 52 Sec 52.5, p. 1139 **•Ligand-gated ion channels** Chapt 6

Essential knowledge	Chapters/sections	Illustrative examples covered
	Sec 42.4, p. 900–901 Chapt 43 Sec 43.7, p. 930–931, 932 Chapt 49 Sec 49.3, p. 1057–1060 Chapt 52 Sec 52.5, p. 1139	Sec 6.3, p. 139, 140 Fig 6.5a Sec 6.4, p. 141–142 Chapt 41 Sec 41.4, p. 875–876 Fig 41.11c **•Receptor tyrosine kinases** Chapt 6 Sec 6.3, p. 138–141 Fig 6.5c Sec 6.4, p. 146–147 Sec 6.5, p. 148 Chapt 49 Sec 49.3, p. 1060 **•Secondary messengers such as: cyclic GMP, cyclic AMP, calcium ions, and inositol triphosphate** Chapt 3 Sec 3.5, p. 68–69 Fig 3.25 Chapt 6 Sec 6.1, p. 135 Fig 6.1 Sec 6.4, p. 143–146 Fig 6.7–6.10 Sec 6.5, p. 148–149 Fig 6.13 Chapt 7 Sec 7.6, p. 167–168 Fig 7.16 Chapt 14 Sec 14.2, p. 312–313 Fig 14.5, 15.6 Chapt 26 Sec 26.7, p. 557–558 Chapt 36 Sec 36.3, p. 776 Chapt 41 Sec 41.4, p. 875–876 Fig 41.11b Chapt 42 Sec 42.4, p. 900–901 Fig 42.16 Chapt 43 Sec 43.7, p. 930–931, 932 Fig 43.22 Chapt 49 Sec 49.3, p. 1059–1060

Essential knowledge	Chapters/sections	Illustrative examples covered
		Fig 49.5
3.D.4. Changes in signal transduction pathways can alter cellular response.	Chapt 4 Sec 4.5, p. 96 Chapt 6 Sec 6.0, p. 135 Sec 6.4, p. 141 Sec 6.5, p. 148, 150 Chapt 17 Sec 17.3, p. 387–388 Chapt 25 Sec 25.6, p. 533–534 Chapt 39 Sec 39.2, p. 831 Chapt 41 Sec 41.3, p. 867, 869 Chapt 42 Sec 42.6, p. 904–907 Chapt 45 Sec 45.6, p. 986, 988 Chapt 49 Sec 49.2, p. 1056 Chapt 50 Sec 50.6, p. 1098 Chapt 59 Sec 59.5, p. 1069–1071	**•Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera** Chapt 4 Sec 4.5, p. 96 Chapt 6 Sec 6.0, p. 135 Sec 6.4, p. 141 Sec 6.5, p. 148, 150 Chapt 17 Sec 17.3, p. 387–388 Fig 17.20 Chapt 39 Sec 39.2, p. 831 Chapt 45 Sec 45.6, p. 986 Chapt 59 Sec 59.5, p. 1069–1071 **•Effects of neurotoxins, poisons, pesticides** Chapt 25 Sec 25.6, p. 533–534 Chapt 41 Sec 41.3, p. 867, 869 Fig 41.6 **•Drugs (Hypertensives, Anesthetics, Antihistamines, and Birth Control drugs** Chapt 41 Sec 41.3, p. 867 Chapt 42 Sec 42.6, p. 904–907 Fig 42.19 Table 42.4 Chapt 45 Sec 45.6, p. 988 Chapt 49 Sec 49.2, p. 1056 Chapt 50 Sec 50.6, p. 1098
3.E.1. Individuals can act on information and communicate it to others.	Chapt 52 All sections, p. 1127–1152	**Organisms exchange information:** **•Predator warning** Chapt 32 Sec 32.7, p. 692 Fig 32.18 Chapt 52 Sec 52.2, p. 1131

Essential knowledge	Chapters/sections	Illustrative examples covered
		Sec 52.7, p. 1148 Fig 52.22 Chapt 54 Sec 54.1, p. 1181 Fig 54.9 **•Protection of young** Chapt 52 Sec 52.6, p. 1144–1145 Fig 52.19, 52.20 **•Plant-plant interactions due to herbivory** Chapt 6 Sec 6.1, p. 135 Chapt 38 Sec 38.4, p. 818 **•Avoidance responses** Chapt 52 Sec 52.2, p. 1131 Chapt 54 Sec 54.1, p. 1181 **Communication mechanisms:** **•Herbivory responses** Chapt 6 Sec 6.1, p. 135 **•Territorial marking in mammals** Chapt 52 Sec 52.5, p. 1139 **•Coloration in flowers** Chapt 37 Sec 37.2, p. 786–789 Fig 37.4, 37.5 Table 37.1 **Signaling modalities:** **•Bee dances** Chapt 52 Sec 52.5, p. 1142 Fig 52.17 **•Bird song** Chapt 32 Sec 32.8, p. 700 Chapt 52 Sec 52.1, p. 1130 Sec 52.5, p. 1138, 1140–1141 **•Territorial marking in mammals** Chapt 52 Sec 52.5, p. 1139

Essential knowledge	Chapters/sections	Illustrative examples covered
		•Pack, herd, flock, schooling behavior in animals Chapt 52 Sec 52.5, p. 1137, 1138 Fig 52.12 **•Predator warning** Chapt 32 Sec 32.7, p. 692 Fig 32.18 Chapt 52 Sec 52.2, p. 1131 Sec 52.7, p. 1148 Fig 52.22 Chapt 54 Sec 54.1, p. 1181 Fig 54.9 **•Colony and swarming behavior in insects** Chapt 52 Sec 52.5, p. 1141-1142 Fig 52.16, 52.17 **•Coloration** Chapt 32 Sec 32.7, p. 692 Fig 32.18 Sec 32.8, p. 700 Chapt 52 Sec 52.2, p. 1131 Chapt 54 Sec 54.1, p. 1181 Fig 54.9 **Influence of natural selection:** **•Parent and offspring interactions** Chapt 52 Sec 52.2, p. 1133 Fig 52.7 Sec 52.6, p. 1144–1145 Fig 52.19 **•Migration patterns** Chapt 52 Sec 52.3, p. 1135–1136 **•Courtship and mating behaviors** Chapt 52 Sec 52.6, p. 1142–1144 Fig 52.18 **•Foraging in bees and other animals** Chapt 52 Sec 52.4, p. 1136–1137

Essential knowledge	Chapters/sections	Illustrative examples covered
		Fig 52.11 Sec 52.5, p. 1142 Fig 52.17 **•Avoidance behavior to electric fences, poisons or traps** Chapt 52 Sec 52.2, p. 1132 **Cooperative behavior:** **•Pack, herd, flock, and schooling behavior in animals** Chapt 52 Sec 52.5, p. 1137, 1138 Fig 52.12 Sec 52.7, p. 1146 **•Predator warning** Sec 52.7, p. 1147–1148 Fig 52.22 **•Colony and swarming behavior in insects** Chapt 52 Sec 52.5, p. 1141-1142 Fig 52.16, 52.17 Sec 52.7, p. 1146
3.E.2. Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	Chapt 6 Sec 6.3, p. 139 Sec 6.4, p. 141 Sec 6.5, p. 148 Chapt 40 Sec 40.3, p. 852, 854 Chapt 41 All sections, p. 860–881 Chapt 42 All sections, p. 882–910 Chapt 47 Sec 47.4, p. 1030	**Neurotransmitters:** Chapt 41 Sec 41.4, p. 872–877 Fig 41.11 Table 41.2 **•Acetylcholine** Chapt 6 Sec 6.3, p. 139 Sec 6.4, p. 141 Sec 6.5, p. 148 Chapt 40 Sec 40.3, p. 852, 854 Fig 40.11 Chapt 42 Sec 42.5, p. 904 **•Epinephrine** Chapt 6 Sec 6.5, p. 148 **•Norepinephrine** Chapt 42 Sec 42.4, p. 896 Sec 42.5, p. 904 Sec 42.6, p. 904–905

Essential knowledge	Chapters/sections	Illustrative examples covered
		•**Dopamine** Chapt 42 Sec 42.4, p. 893, 899 Sec 42.6, p. 904–905 Fig 42.19 Chapt 47 Sec 47.4, p. 1030 •**Serotonin** Chapt 6 Sec 6.5, p. 148 Chapt 42 Sec 42.4, p. 896 Sec 42.6, p. 904–905 •**GABA** Chapt 6 Sec 6.4, p. 141–142 Chapt 41 Sec 41.4, p. 875 Chapt 42 Sec 42.4, p. 893 •**Functions of brain regions** Chapt 42 Sec 42.3, p. 886–888 Fig 42.5, 42.6 Sec 42.4, p. 891–895 42.10–42.13 Table 42.2

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

Essential knowledge	Chapters/sections	Illustrative examples covered
4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.	Chapt 3 All sections, p. 46–73	No recommended illustrative examples supplied in Curriculum Framework.
4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.	Chapt 4 Sec 4.5, p. 89–97	No recommended illustrative examples supplied in Curriculum Framework.

Essential knowledge	Chapters/sections	Illustrative examples covered
4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	Chapt 11 Sec 11.4, p. 258–260 Chapt 17 All sections, p. 369–390 Chapt 33 Sec 33.3, p. 722–725	No recommended illustrative examples supplied in Curriculum Framework.
4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.	Chapt 34 Sec 34.3, p. 736–737, 738 Chapt 35 Sec 35.2–35.3, p. 753–758 Chapt 40 Sec 40.3, p. 852, 854, 855–856 Chapt 41 Sec 41.1, p. 861–862 Chapt 42 Sec 42.2, p. 884–885 Sec 42.4, p. 889–890 Chapt 44 Sec 44.2, p. 941–942 Sec 44.4, p. 946, 947 Sec 44.7, p. 954–955 Chapt 46 Sec 46.3, p. 1000–1001, 1002–1005 Chapt 47 Sec 47.2, p. 1018–1021 Chapt 48 Sec 48.5, p. 1040	**Interactions between organs:** **•Stomach and small intestines** Chapt 47 Sec 47.2, p. 1018–1021 Fig 47.9, 47.10 **•Kidney and bladder** Chapt 48 Sec 48.5, p. 1040 Fig 48.7 **•Root, stem, and leaf** Chapt 35 Sec 35.2, p. 753–756, 757 Fig 35.10, 35.11 Table 35.2 Sec 35.3, p. 756–758 Fig 35.12 **Interactions between organ systems:** **•Respiratory and circulatory** Chapt 44 Sec 44.2, p. 941–942 Sec 44.4, p. 946, 947 Fig 44.8 Sec 44.7, p. 954–955 Fig 44.16 Chapt 46 Sec 46.3, p. 1000–1001, 1002–1005 Fig 46.7, 46.9–46.11 **•Nervous and muscular** Chapt 40 Sec 40.3, p. 852, 854, 855–856 Fig 40.11, 40.12 Chapt 41 Sec 41.1, p. 861–862 Fig 41.1 Chapt 42 Sec 42.2, p. 884–885 Fig 42.4 Sec 42.4, p. 889–890 Fig 42.8, 42.9 **•Plant vascular and leaf**

Essential knowledge	Chapters/sections	Illustrative examples covered
		Chapt 34 Sec 34.3, p. 736–737, 738 Fig 34.11, 34.12 Chapt 35 Sec 35.2, p. 753–756, 757 Fig 35.10, 35.11 Table 35.2 Sec 35.3, p. 756–758 Fig 35.12
4.A.5: Communities are composed of populations of organisms that interact in complex ways.	Chapt 53 Sec 53.2–53.3, p.1156–1161 Chapt 54 All sections, p. 1173–1195 Chapt 57 Sec 57.1, p. 1247–1248	**•Symbiotic relationships** Chapt 54 Sec 54.1, p. 1182–1185 Fig 54.12–54.14 **•Graphical representation of field data** Chapt 54 Sec 54.1, p. 1174, 1180 Fig 54.1, 54.7 Sec 54.3, p. 1188, 1189 Fig 54.18–54.20 **•Introduction of species** Chapt 57 Sec 57.1, p. 1247–1248 Fig 57.7
4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.	Chapt 53 Sec 53.3, p. 1158–1160 Chapt 54 Sec 54.1, p. 1174–1180 Chapt 55 Sec 55.1–55.2, p.1197–1208 Chapt 57 Sec 57.1, p. 1243–1244, 1246–1248	No recommended illustrative examples supplied in Curriculum Framework.
4.B.1: Interactions between molecules affect their structure and function.	Chapt 7 Sec 7.6, p. 162–168	No recommended illustrative examples supplied in Curriculum Framework.
4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.	Chapt 3 Sec 3.2, p. 54–55 Chapt 4 Sec 4.3–4.7, p. 81–102 Chapt 6 Sec 6.0–6.1, p. 134–135	**•Exchange of gases** Chapt 46 Sec 46.1, p. 996–998, 999 Fig 46.3–46.5 Sec 46.2, p. 998–1003 Fig 46.6–46.8 **•Circulation of fluids**

Essential knowledge	Chapters/sections	Illustrative examples covered
	Chapt 25 Sec 25.5, p. 530–531 Chapt 29 Sec 29.3, p. 609, 611 Sec 29.4, p. 615–619 Chapt 34–36 All sections, p. 728–780 Chapt 37 Sec 37.1, p. 782–784 Chapt 39 Sec 39.1, p. 822–830, 832–833 Chapt 42 Sec 42.3–42.4, p. 886–901 Chapt 44 Sec 44.5, p. 946–951 Chapt 46 Sec 46.1, p. 996–998, 999 Sec 46.2, p. 998–1003 Chapt 47 Sec 47.1, p. 1013 Sec 47.2, p. 1016–1023 Chapt 48 Sec 48.4–48.5, p.1038–1048 Chapt 50 Sec 50.2–50.3, p. 1080–1093 Chapt 55 Sec 55.2, p. 1204–1205 Sec 55.3, p. 1209	Chapt 44 Sec 44.5, p. 946–951 Fig 44.8–44.11 **•Digestion of food** Chapt 47 Sec 47.2, p. 1016–1023 Fig 47.4, 47.8–47.11 **•Excretion of wastes** Chapt 48 Sec 48.4, p. 1038–1040 Fig 48.5, 48.6 Sec 48.5, p. 1040–1048 Fig 48.8–48.14 **•Bacterial community in the rumen of animals** Chapt 25 Sec 25.5, p. 530 Chapt 47 Sec 47.1, p. 1013 **•Bacterial community in and around deep sea vents** Chapt 55 Sec 55.3, p. 1209
4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.	Chapt 53 Sec 53.1–53.3, p. 1154–1161 Chapt 54 All sections, p. 1173–1195 Chapt 57 Sec 57.1, p. 1246–1248 Sec 57.3–57.5, p.1253–1261	**•Loss of keystone species** Chapt 54 Sec 54.2, p. 1185–1186 **•Dutch elm disease** Chapt 26 Sec 26.4, p. 549

Essential knowledge	Chapters/sections	Illustrative examples covered
4.B.4: Distribution of local and global ecosystems changes over time.	Chapt 18 Sec 18.4, p. 410–402 Chapt 20 Sec 20.4, p. 442 Chapt 21 Sec 21.3, p. 460–461 Chapt 26 Sec 26.4, p. 549 Chapt 55 Sec 55.2, p. 1204 Sec 55.3, p. 1211–1212 Chapt 56 Sec 56.2, p. 1229 Chapt 57 Sec 57.1, p. 1246–1248 Sec 57.3–57.5, p.1253–1261	**•Logging, slash and burn agriculture, urbanization, mono-cropping, infrastructure development (dams, transmission lines, roads), and global climate change threaten ecosystems and life on earth** Chapt 55 Sec 55.2, p. 1204 Chapt 56 Sec 56.2, p. 1229 Chapt 57 Sec 57.1, p. 1246–1248 Fig 57.5 Sec 57.3–57.5, p. 1253–1259 Fig 57.13–57.18 Sec 57.5, p. 1259-1261 Fig 57.19, 57.20 **•An introduced species can exploit a new niche free of predators or competitors, thus exploiting new resources** Chapt 57 Sec 57.1, p. 1246–1248 Fig 57.7 **•Dutch elm disease** Chapt 26 Sec 26.4, p. 549 **•Potato blight** Chapt 26 Sec 26.4, p. 549 **•El Niño** Chapt 55 Sec 55.3, p. 1211–1212 **•Continental Drift** Chapt 18 Sec 18.4, p. 410–402 Fig 18.11, 18.12 **•Meteor impact on dinosaurs** Chapt 20 Sec 20.4, p. 442 Chapt 21 Sec 21.3, p. 460–461
4.C.1: Variation in molecular units provides cells with a wider range of functions.	Chapt 6 Sec 6.4, p. 145 Chapt 9 Sec 9.2, p. 195–197	**•Different types of phospholipids in cell membranes** Chapt 6 Sec 6.4, p. 145

Essential knowledge	Chapters/sections	Illustrative examples covered
	Chapt 13 Sec 13.1, p. 284 Chapt 16 Sec 16.3, p. 358 Chapt 22 Sec 22.2, p. 470 Chapt 45 Sec 45.3, p. 973 Sec 45.5, p. 978–980 Chapt 46 Sec 46.3, p. 1003	Fig 6.10 **•Different types of hemoglobin** Chapt 13 Sec 13.1, p. 284 Chapt 16 Sec 16.3, p. 358 Chapt 22 Sec 22.2, p. 470 Chapt 46 Sec 46.3, p. 1003 **•MHC proteins** Chapt 45 Sec 45.3, p. 973 **•Chlorophylls** Chapt 9 Sec 9.2, p. 195–197 Fig 9.6 **•Molecular diversity of antibodies in response to an antigen** Chapt 45 Sec 45.5, p. 978–980 Fig 45.11
4.C.2: Environmental factors influence the expression of the genotype in an organism.	Chapt 11 Sec 11.4, p. 258–259 Chapt 19 Sec 19.3, p. 418 Chapt 14 Sec 14.2, p. 309–310 Chapt 29 Sec 29.2, p. 605 Sec 29.3, p. 607 Chapt 40 Sec 40.1, p. 844	**•Height and weight in humans** Chapt 11 Sec 11.4, p. 259 Chapt 19 Sec 19.3, p. 418 **•Flower color based on soil pH** Chapt 11 Sec 11.4, p. 258–259 Fig 11.21 **•Effect of adding lactose to a Lac+ bacterial culture** Chapt 14 Sec 14.2, p. 309–310 Fig 14.2 **•Effect of increased UV on melanin production in animals** Chapt 40 Sec 40.1, p. 844 **•Presence of the opposite mating type on pheromone production in yeast and other fungi** Chapt 29 Sec 29.2, p. 605 Sec 29.3, p. 607

Essential knowledge	Chapters/sections	Illustrative examples covered
		•Darker fur in cooler regions of the body in certain mammal species Chapt 11 Sec 11.4, p. 259
4.C.3: The level of variation in a population affects population dynamics.	Chapt 37 Sec 37.6, p.799	This book does not cover any of the suggested illustrative examples.
4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.	Chapt 54 Sec 54.2, p. 1185–1187 Sec 54.3, p. 1190	No recommended illustrative examples supplied in Curriculum Framework.

Sections of the text book that do not have to be covered in an AP Biology course:

Part I
The Process of Science: p. 15–22
Atoms and Molecules: p. 26–37, 40–42
Part IV
The Evolution of Primates: p. 465–480
Part V
The Diversity of Life: p. 501–504, 512–707 (note: this section contains many of the illustrative examples listed above, however the main focus of this section, diversity of life, is not required for an AP Biology curriculum.)