

Beginning-of-Year

Item Analysis		
Item #	Standards	DOK
1	MS-LS4-2, DCI.MS-LS4.A.2	1
2	MS-LS2-3, DCI.MS-LS2.B.1, SEP.MS.B.3	2
3	MS-LS3-1, DCI.MS-LS3.A.1	1
4	MS-LS1-6, DCI.MS-LS1.C.1	1
5	MS-LS1-3, DCI.MS-LS1.A.3	1
6	MS-LS4-4, DCI.MS-LS4.B.1	1
7	MS-LS3-1, DCI.MS-LS3.B.1, CCC.MS.B.3	1
8	MS-LS4-6	1
9	MS-LS2-5, DCI.MS-LS4.D.1, CCC.MS.B.2	1
10	MS-LS4-5, DCI.MS-LS4.B.2	1
11	MS-LS1-7, DCI.MS-LS1.C.2, CCC.MS.E.3	1
12	MS-LS1-2, DCI.MS-LS1.A.2	1
13	MS-LS1-5, DCI.MS-LS1.B.3, SEP.MS.F.3	2
14	MS-LS2-3, DCI.MS-LS2.B.1	1
15	MS-LS2-2, DCI.MS-LS2.A.4, SEP.MS.G.1, CCC.MS.A.3	1
16	MS-LS2-2, DCI.MS-LS2.A.4	1
17	MS-LS2-1, DCI.MS-LS2.A.3, SEP.MS.B.1, CCC.MS.B.2	2
18	MS-LS1-5, DCI.MS-LS1.B.3	1
19	MS-LS2-4, DCI.MS-LS2.C.1, CCC.MS.G.2	1
20	MS-LS1-6, DCI.MS-PS3.D.1	1
21	MS-LS4-1, DCI.MS-LS4.A.1, SEP.MS.D.1	1
22	MS-LS1-2, DCI.MS-LS1.A.2, CCC.MS.C.3	2
23	MS-LS3-2, DCI.MS-LS1.B.4	1
24	MS-LS2-4, DCI.MS-LS2.C.1	1
25	MS-LS4-1, DCI.MS-LS4.A.1, CCC.MS.A.4	1
26	MS-LS2-1	1
27	MS-LS1-8, DCI.MS-LS1.D.1, SEP.MS.B.3	2
28	MS-LS1-3, DCI.MS-LS1.A.3, SEP.MS.G.1	1
29	MS-LS1-4, DCI.MS-LS1.B.1	2
30	MS-LS3-2, DCI.MS-LS1.B.4	1

1.
 - A. This is incorrect because having a similar diet is not an indication of evolutionary relatedness.
 - B. This is incorrect because organisms that share a habitat are not necessarily related.
 - C. This is incorrect because extinction patterns are not relevant for determining relatedness among extant organisms.
 - D. This is correct because anatomical similarities together with similarities in DNA can provide clues about evolutionary relationships.

2.
 - A. *Red-tailed hawk* is correct for the top right box, above the grasshopper mouse, because it is a tertiary consumer that would eat the rattlesnake as well as the wood rat, grasshopper mouse, and antelope squirrel.
 - B. *Rattlesnake* is correct for the top left box, above the gila woodpecker, because it is a secondary consumer that would eat wood rats and antelope squirrels, and would be eaten by the red-tailed hawk.
 - C. *Antelope squirrel* is correct for the middle left box, between the wood rat and the gila woodpecker, because it is a primary consumer that would eat cactus, and would be eaten by both a rattlesnake and a red-tailed hawk.
 - D. *Pallid-wing grasshopper* is correct for the middle right box, to the right of the brittlebrush, because it is a primary consumer that would eat brittlebrush leaves and would be eaten by the grasshopper mouse.
 - E. *Prickly pear cactus* is correct for the bottom center box, between the saguaro cactus and the brittlebrush, because it is a producer at the base of the food web.

3.
 - A. *Changes to proteins* is correct for *mutations to genes can result in* because mutations that change genes can also change the proteins that are produced by those genes.
 - B. *An organism's traits* is correct for *proteins determine* because the type of protein a gene codes for controls the traits of the individual.
 - C. *The production of proteins* is correct for *genes contain the code for* because the sequence of DNA base pairs within a gene code for specific amino acids that make up a protein.
 - D. *DNA within a chromosome* is correct for *genes are specific sections of* because genes are the parts of a chromosome that control inherited traits.

4.
 - A. This answer is incorrect because a food web is a complex model of energy flow through an ecosystem that begins when primary consumers eat producers to sustain consumers' own needs for food and energy.
 - B. This answer is incorrect because a food chain is a model that shows the flow of energy from producers, which synthesize sugars, through primary, secondary, and tertiary consumers in an ecosystem.
 - C. This answer is correct because it identifies the inputs and outputs of photosynthesis.
 - D. This answer is incorrect because cellular respiration is a process by which cells release energy from the chemical bonds of food molecules.

5.
 - A. *Circulatory* system is correct. This system transports waste products from cells to organs where the wastes can be removed from the body.
 - B. *Digestive* system is incorrect. This system breaks down food and eliminates food waste from the body but does not excrete cellular waste.
 - C. *Excretory* system is correct. This system releases waste products, including cellular wastes, from the body.
 - D. *Muscular* system is incorrect. This system helps the body move and does not excrete cellular waste.
 - E. *Nervous* system is incorrect. This system is responsible for passing messages throughout the body but does not rid the body of cellular waste.
 - F. *Respiratory* system is correct. This system delivers oxygen to the cells and eliminates carbon dioxide waste from the body's cells.
 - G. *Urinary* system is correct. This system eliminates cell wastes by filtering them out of the blood in the kidneys.

6.
 - A. This is true because geographic barriers can prevent populations from interbreeding, and can allow populations to develop into separate species over time.
 - B. This is false because variation exists in populations, so members of the same species generally have differences.
 - C. This is true because a species is defined as organisms that can reproduce successfully in nature.
 - D. This is true because it is difficult to determine among organisms that reproduce asexually whether similar or identical organisms belong to the same or different species.
 - E. This is false because having a different appearance is not necessarily an indication of being a different species.

7.
 - 1F. *Amino acids* is correct because genes code for amino acids.
 - 2B. *Protein* is correct because amino acids combine and fold to create proteins.
 - 3A. *Gene* is correct because the DNA sequence of a gene determines protein structure.
 - 4E. *Beneficial* is correct because mutations that help an organism are beneficial.
 - 5D. *Harmful* is correct because mutations that make an organism's life more difficult are harmful.
 - 6C. *Neutral* is correct because mutations that neither help nor harm are neutral.

8.
 - A. This is incorrect because the Permian period is part of the Paleozoic era, not the Cenozoic era.
 - B. This is incorrect because the Permian period is part of the Paleozoic era, not the Mesozoic era.
 - C. This is correct. The Permian extinction took place during the Paleozoic era.
 - D. This is incorrect because the current fossil record indicates that only very primitive bacteria were present during the Precambrian era.

9.
 - A. This is true because flowering plants are harvested, processed, and sold around the world for food, clothing, and medicine.
 - B. This is true because many medicines come from flowering plants, and their destruction causes the loss of the medicines.
 - C. This is false because flowering plants are not present in the ocean.
 - D. This is true because flowering plants are a major food source worldwide. Most fruits and vegetables come from flowering plants.
 - E. This is false because, if there is less biodiversity in the flowers, there will not likely be an increase in diversity of pollinators.

10.
 - 1C. *Most desirable traits* is correct because in selective breeding, the most desired traits are chosen to be passed on to the next generation. These traits may be dominant or recessive.
 - 2F. *Display* is correct because parent organisms would need to display the desired traits in order for humans to be able to identify and select them.
 - 3I. *Displaying* is correct because offspring would also need to display the desired trait in order for humans to select them. Selective breeding continues for multiple generations in order to produce a population of organisms that all have the desired trait.

11.
 - A. This is incorrect because sugar molecules are where the light energy from the sun is stored, so forming them does not release energy, it stores energy.
 - B. This is incorrect because although breaking bonds releases energy, the bonds in water molecules are broken during photosynthesis, not during respiration.
 - C. This is correct because sugar molecules are storing the energy from the sun captured during photosynthesis, and that energy is released when the bonds are broken.
 - D. This is incorrect because although the bonds of oxygen molecules are broken during respiration, the sugar molecules are those storing the energy from photosynthesis.

12. A. *Nucleus* is incorrect because prokaryotic cells do not have a nucleus, which is a membrane-bound organelle.
 B. *Cytoplasm* is correct because both prokaryotic and eukaryotic cells contain cytoplasm.
 C. *Chloroplast* is incorrect because only cells that can make their own food contain chloroplasts. Not all prokaryotes and not all eukaryotes contain chloroplasts.
 D. *Cell membrane* is correct because prokaryotic cells and eukaryotic cells both have a cell membrane that surrounds and protects them.
 E. *Genetic material* is correct because both prokaryotic and eukaryotic cells contain genetic material.
 F. *Membrane-bound organelles* is incorrect because prokaryotic cells do not contain membrane-bound organelles.
13. A. *BB* does not belong in any of the boxes. The blue flower on the left must be heterozygous because the parent flowers are *BB* and *bb*. The blue flower on the right must be heterozygous to produce offspring that is homozygous recessive.
 B. *Bb* is correct for both the blue flower on the left and the blue flower on the right. The blue flower on the left must be heterozygous because the parent flowers are homozygous *BB* and *bb*. This cross only results in heterozygous offspring. The blue flower on the right must be heterozygous in order to produce offspring that is homozygous recessive.
 C. *bb* is correct for the bottom white flower because, according to the pedigree, the white color is the recessive phenotype, which is only present in flowers that are homozygous for the recessive allele, *bb*.
14. A. This is incorrect because plants are classified as producers in an ecosystem, not decomposers.
 B. This is incorrect because insects are classified as consumers in an ecosystem, not decomposers.
 C. This is incorrect because turtles are classified as consumers in an ecosystem, not decomposers.
 D. This is correct because fungi break down dead wood and other organic matter, so they can be classified as decomposers.
15. A. Decrease is correct because the populations of shark will decrease with fewer fish in the ecosystem available for food.
 B. Decrease is correct because the populations of seagull will decrease with fewer fish in the ecosystem available for food.
 C. Increase is correct because zooplankton will increase when there are fewer fish in the ecosystem to eat the zooplankton.
 D. Increase is correct because phytoplankton will increase when there are fewer fish in the ecosystem to eat the phytoplankton.
16. A. *Mutualism* is correct because a mutualistic relationship is one in which both species benefit from the interaction.
 B. *Commensalism* is correct because a commensalistic relationship is one in which one species benefits and the other is not affected.
 C. *Parasitism* is correct because a parasitic relationship is one in which one species benefits and the other species is harmed.
17. A. *The amount of rainfall* belongs under *Cause* because this factor will influence the growth of ferns.
 B. *The quality of the soil* belongs under *Both* because poor soil could be a limiting factor for plant growth, but too few ferns could allow soil erosion.
 C. *The temperature of the forest* belongs under *Cause* because this factor will influence the growth of ferns.
 D. *The population of rodents that shelter under ferns* belongs under *Effect* because the rodent population could decrease if there are not enough ferns to shelter them from predators.

- E. *The population of caterpillars that eat ferns* belongs under *Both* because too few ferns for food could mean fewer caterpillars, and too many caterpillars eating ferns could reduce fern population.
18. A. This is correct because a zygote that forms by fertilization will have half of its chromosomes from one parent and half from the other parent.
 B. This is incorrect because, during fertilization, chromosomes from both parents join to form a full set of chromosomes in the zygote.
 C. This is incorrect because gametes have half of a full set of chromosomes, not a full set.
 D. This is incorrect because gametes have half of a full set of chromosomes, not one-fourth.
19. The graph should show 1 female mouse at Month 0, 4 female mice at Month 1, 16 at Month 2, and 64 at Month 3. During Month 1, the first mouse produces 3 mice, so the total female mouse population at the end of Month 1 would be $3 + 1 = 4$. During Month 2, each of the four mice produces 3 newborn female mice. The new population at the end of Month 2 would be 12 new mice plus the 4 parents = 16. During Month 3, the 16 female mice each produce 3 more female mice. So the new population would be $16 \times 3 = 48$ plus the original 16 female parents = 64 at the end of Month 3.
20. A. This is correct because trees use carbon dioxide and water during photosynthesis to produce sugars, which are used to make up the tissues of the tree as it grows.
 B. This is incorrect because, although some minerals do come from the soil, the majority of the matter in a tree is carbon, which comes from carbon dioxide in the air.
 C. This is incorrect because soil contributes a small amount of minerals and sunlight contributes only energy, but not matter, to the growth of a tree.
 D. This is incorrect because, although a significant amount of the matter comes from water, sunlight contributes energy only but not matter.
21. A. The picture of the aquatic organism with complete front and back limbs is correct for the second rock layer from the bottom. This organism begins to show adaptations for aquatic life while retaining all four limbs.
 B. The picture of the modern whale is correct for the top rock layer because this shows a currently living and most modern example of the evolutionary progression from land animal to fully aquatic animal.
 C. The picture of the land animal with four legs is correct for the bottom rock layer. This is the oldest fossil, showing the ancestral land mammal that eventually evolved to become an aquatic mammal.
 D. The picture of the aquatic animal with small, vestigial back legs is correct for the second rock layer from the top because this fossil most closely resembles modern whales. It represents the transitional animals between those that are semi-aquatic and those that are fully aquatic, such as modern whales.
22. 1B. Ribosomes are structures that make proteins.
 2A. A cell wall is a rigid structure that surrounds the cell membrane of plant cells, protecting the plant cell.
 3D. The nuclear membrane surrounds the nucleus, protecting the DNA located within the nucleus.
 4C. The cell membrane surrounds the cell, allowing some things to enter and leave.
23. A. This is incorrect because, although this describes a type of asexual reproduction, binary fission is not a type of vegetative reproduction.
 B. This is incorrect because, although spore production is a type of asexual reproduction, it is not a type of vegetative reproduction.
 C. This is correct because vegetative reproduction describes the process of developing a new plant from part of the body of a parent plant.
 D. This is incorrect because this describes sexual reproduction in plants, not vegetative reproduction.
24. A. *Change to physical environment* is correct for *ocean temperature in a coral reef ecosystem rose by 0.74 °C over the past century, causing corals to become unhealthy or die* and *severe drought caused a water reservoir in California to decrease, threatening the habitats of wetland wildlife*. A rise in ocean

temperature is a physical, not a biological, change to the ecosystem. A drought is also a physical, not a biological, change to an ecosystem.

- B.** *Change to biological component* is correct for *apple growers in the mid-Atlantic region of the United States lost apple crops due to the invasion of the brown marmorated stink bug and nearly 6 million North American bats have been killed by a fungal infection called white nose syndrome*. The proliferation of an invasive species is a biological, not a physical, change to an ecosystem. The spread of fungal disease through a population is also a biological, not a physical, change to an ecosystem.
- 25. A.** This picture belongs in the *Will Form a Fossil* column. Carbonized fossils are formed by the weight of sedimentary rock.
- B.** This picture belongs in the *Will Form a Fossil* column. Frozen remains are formed when organisms are buried in ice.
- C.** This picture belongs in the *Will Not Form a Fossil* column. Fossils are not formed when organisms decay on the floor of the ocean.
- D.** This picture belongs in the *Will Not Form a Fossil* column. Fossils are not formed when organisms decay in soil.
- 26. A.** This is incorrect because an oyster is an example of an individual, not an ecosystem.
- B.** This is incorrect because a school of fish is an example of a population, not an ecosystem.
- C.** This is incorrect because fish and sharks are an example of a predator and prey relationship, not of an ecosystem.
- D.** This is correct because the open ocean is an area that contains multiple populations of organisms interacting, as well as non-living resources.
- 27.** First should be the image of the person touching an ice cube, to represent an initial stimulus. Next should be the receptor cell, showing the cell that senses the stimulus. Third should be the picture of the sensory neuron that conveys the stimulus to the brain and relays the response. The final part of the model is the sensation of cold felt in the finger and the pulling away from the ice cube.
- 28. A.** Selecting *circulatory system* is correct because carbon dioxide is transported and its concentration is monitored in the bloodstream. The circulatory system transports nutrients, wastes, hormones, and gases in the blood.
- B.** Selecting *digestive system* is incorrect because nutrient absorption is not identified as being part of the process of carbon dioxide regulation. The digestive system breaks down food and allows nutrients to be absorbed through the intestines.
- C.** Selecting *excretory system* is incorrect because, although carbon dioxide is a waste product, it is a gas that is expelled through the respiratory system. The excretory system removes excess liquid and solid wastes from the body.
- D.** Selecting *nervous system* is incorrect because, although the brain does communicate with the circulatory and nervous systems, the circulatory (blood) and respiratory (lungs) systems are the two systems being described. The nervous system sends messages to and from the brain to communicate with other body systems.
- E.** Selecting *respiratory system* is correct because the lungs are responsible for removing carbon dioxide from the bloodstream. The respiratory system moves air into and out of the lungs and controls gas exchange between the blood and the lungs.
- 29. 1B.** *Decrease* is correct because females of species A prefer their own dialect and may not recognize the mating calls of the new males as belonging to their species.
- 2E.** *Negative effect* is correct because the ability to reproduce depends on the ability to find a mate and if there are not enough males for females to mate with, the population will suffer.
- 3A.** *Increase* is correct because females of species B prefer new dialects and would be more likely to choose mates that exhibit an unfamiliar mating call.

4D. *Positive effect* is correct because the ability to reproduce depends on the ability to find a mate. Additionally, increasing genetic diversity in a population increases a population's resiliency to disease.

- 30. A.** This is correct because a hydra is able to reproduce by budding.
B. This is incorrect because dolphins are mammals and can only reproduce by sexual reproduction.
C. This is incorrect because manta rays are fish and can only reproduce by sexual reproduction.
D. This is incorrect because, although salamanders can regrow missing limbs, they can only reproduce by sexual reproduction.

Unit 1 Living Systems

Unit 1 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	C	HS-LS1-2	1
2	B	HS-LS1-1, DCI.HS-LS1.A.3, SEP.NOS.HS.A.2	2
3	B	HS-LS1-1, DCI.HS-LS1.A.1	1
4	D	HS-LS2-7, DCI.HS-LS4.D.1	1
5	C	HS-LS1-2, DCI.HS-LS1.A.3	2
6	D	HS-LS1-2, DCI.HS-LS1.A.3	1
7	B	HS-LS1-2, DCI.HS-LS1.A.1	1
8	B	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	1
9	C	HS-LS2-2, DCI.HS-LS2.A.1	1
10	C	HS-LS1-3, DCI.HS-LS1.A.4	1
11	A	HS-LS1-2, DCI.HS-ESS2.C.1	1
12	D	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.B.2	1
13	A	HS-LS1-2, DCI.HS-ESS2.A.1	1
14	A	HS-LS2-5, DCI.HS-LS2.B.3	1
15	B	HS-LS2-2, DCI.HS-LS2.C.1	1

Unit 1 Lesson 1 Quiz – Life in the Earth System

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-ESS2-7, DCI.HS-ESS2.E.1	10	2
2	B	HS-LS1-2, DCI.HS-LS1.A.3	4-5	2
3	B	HS-LS1-2, DCI.HS-LS1.A.3	5	1
4	C	HS-ESS2-7, DCI.HS-ESS2.E.1	11	1
5	B	HS-LS1-2, DCI.HS-ESS2.E.1	7	2
6	C	HS-ESS2-7, DCI.HS-ESS2.E.1	11	2
7	D	HS-LS1-2, DCI.HS-ESS2.A.1	10	1
8	B	HS-LS1-3, DCI.HS-LS1.A.4	10	2
9	D	HS-LS1-2, DCI.HS-LS1.A.3	12	3

10	B	HS-ETS1-2, DCI.HS-ETS1.C.1, CCC.HS.D.1	14	2
11	Rubric	HS-LS1-2, DCI.HS-ESS2.C.1, CCC.HS.E.4	7	3
12	Rubric	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.B.1, CCC.HS.E.2	10	2
13	Rubric	HS-ETS1-4, DCI.HS-ETS1.B.2, CCC.HS.B.3	8	3
14	Rubric	HS-LS2-2, DCI.HS-LS2.C.1	11	2
15	Rubric	HS-LS1-3, DCI.HS-LS1.A.4	12	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Complex systems will usually have more levels of organization than simple systems.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Water in the soil could enter the roots of a plant.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Models can allow the engineers to test the various components of the ship without spending the time and money it would take to build a full-size ship first.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	1 point for any three of the following abiotic factors: water, light, radiation, temperature, humidity, atmosphere, soil, and others 1 point for any three of the following biotic factors: producers, consumers, decomposers, or specific examples of these organisms

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	abiotic factors: water, light, radiation, temperature, humidity, atmosphere, soil, and others biotic factors: producers, consumers, decomposers, or specific examples of these organisms

Unit 1 Lesson 2 Quiz – Organisms: Cells to the Body Systems

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS1-2, DCI.HS-LS1.A.1	17	1
2	B	HS-LS1-1, DCI.HS-LS1.A.1, CCC.HS.F.2	21	2
3	C	HS-LS1-2, DCI.HS-LS1.A.3	20	2

4	C	HS-LS1-1, DCI.HS-LS1.A.1	27	2
5	B	HS-LS1-2, DCI.HS-LS1.A.3	26	1
6	B	HS-LS1-1, DCI.HS-LS1.A.1	12	1
7	D	HS-LS1-1, DCI.HS-LS1.A.3	24-25	1
8	B	HS-LS1-2, DCI.HS-LS1.A.3	26	1
9	D	HS-LS1-6, DCI.HS-LS1.C.3	25	1
10	B	HS-LS1-1, DCI.HS-LS1.A.1, CCC.HS.F.2	21	1
11	Rubric	HS-LS1-6, DCI.HS-LS1.C.4	19	3
12	Rubric	HS-LS1-2, DCI.HS-LS1.A.3	25-26	2
13	Rubric	HS-LS1-2, DCI.HS-LS1.A.3	17	2
14	Rubric	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1, CCC.HS.F.2	26	3
15	Rubric	HS-LS1-4, DCI.HS-LS1.B.1	21	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	from the food that you eat

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The cell would lose the ability to generate enough energy.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Cells that are similar form tissues to perform specific functions. Different tissue types combine to form organs.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Endoplasmic reticulum (ER), ribosomes, and the Golgi apparatus. These three organelles work together to produce, process, sort, and deliver proteins.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The process is differentiation, and it is important because it creates cells that are specialized for performing specific functions.

Unit 1 Lesson 3 Quiz – Mechanisms of Homeostasis

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	33	3
2	A	HS-LS1-3, DCI.HS-LS1.A.4	33	2
3	D	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	34	1
4	A	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	37	1
5	B	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	35	1
6	A	HS-LS1-3, DCI.HS-LS1.A.1, CCC.HS.G.3	38	2
7	C	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	33	2
8	C	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	35	1
9	C	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.1	34	1
10	A	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	40	3
11	Rubric	HS-LS1-5, DCI.HS-LS1.C.1	44	3
12	Rubric	HS-LS1-2, DCI.HS-LS1.A.3, CCC.HS.B.2	39-41	3
13	Rubric	HS-LS1-3, DCI.HS-LS3.B.2	39	2
14	Rubric	HS-LS1-3, DCI.HS-LS1.A.4, SEP.HS.B.1, CCC.HS.G.3	40	3
15	Rubric	HS-LS1-3, DCI.HS-LS1.A.4, SEP.HS.B.1, CCC.HS.D.2	33-40	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	In saltwater fishes, osmoregulation is used to remove salt from their bodies, while in freshwater fishes it is used to keep as much salt in the body as possible.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	When there is a problem with one body system, two things can happen. The first is that other body systems can make up for the one having the problem. For example, if the bone marrow can no longer make blood, other organs such as the spleen can actually do this. Also, if there is a problem with one body system, other body systems may begin to develop problems as well. For example, if you do not eat, not only will the digestive system experience problems, but so will the excretory system, the nervous system, and the muscular system.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	An animal that is too cold may move to a warmer area.

14. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: The ship will be driven off course and damaged by the storm at first. The crew would have to make adjustments to keep the ship on course and repair it. A virus can multiply so quickly that the body cannot maintain homeostasis at first, but then the control systems will trigger an immune response that will kill the virus.

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: The body's internal control systems work together to maintain homeostasis despite changes in internal or external conditions.

Unit 1 Lesson 4 Quiz – Bioengineering

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-ETS1-4, DCI.HS-ETS1.B.2, SEP.NOS.HS.A.2	59	1
2	D	HS-ETS1-3, DCI.HS-ETS1.B.1	52	2
3	C	HS-ETS1-3, DCI.HS-ETS1.B.1	57	2
4	B	HS-ETS1-2, DCI.HS-ETS1.C.1	52-53	1
5	D	HS-ETS1-4, DCI.HS-ETS1.B.2, SEP.NOS.HS.D.3, CCC.HS.D.2	54	2
6	A	HS-ETS1-3, DCI.HS-ETS1.A.1	54	2
7	B	HS-ETS1-3, DCI.HS-ETS1.B.1	56	2
8	B	HS-ETS1-1, DCI.HS-ETS1.A.2, CCC.NOS.HS.B.3	49	1
9	A	HS-ETS1-1, DCI.HS-ETS1.A.2	56-59	1
10	C	HS-ETS1-2, DCI.HS-ETS1.C.1	54-56	2
11	Rubric	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.NOS.HS.B.3	48-60	2
12	Rubric	HS-ETS1-4, DCI.HS-ETS1.B.2, CCC.STSE.HS.B.2	48-60	2
13	Rubric	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.NOS.HS.B.3	59	2
14	Rubric	HS-ETS1-3, DCI.HS-ETS1.A.1	56	2
15	Rubric	HS-LS4-5, DCI.HS-LS4.C.5, CCC.NOS.HS.B.3	48-60	3

11. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answers may vary. Possible answers: bionic limbs, computer interfaces that help a person speak or see, computers that can help a disabled person coordinate his or her movements, hearing aids, motorized wheelchairs

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answers will vary. Possible answers: nanotechnology (tiny robots, controlled-release drugs, biodegradable templates for tissue repair), biomolecular materials (artificial spider silk for strong fabrics, ceramics based on clamshell formation, strong glues based on stream bacteria), biomimetics (hook-and-loop fasteners that work like prickly burrs, lobster-eye telescopes), use of DNA technology in crime investigation, computer modeling

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answers may vary but could include the production of insulin or cellular engineers using stem cells to study new treatments.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answers may vary. Possible answers: Because it will let scientists determine if issues with a design are serious enough to require that the design be changed or replaced by a newer design.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: An understanding of biology helps people choose which foods dietary supplements to eat and which environmental factors may harm or enhance their physical well-being. Understanding science can help people assess claims by pharmaceutical manufacturers and to identify medical reports based on flawed studies or contradicted by known scientific facts.

Unit 1 Unit Test A – Living Systems

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-2, DCI.HS-LS1.A.3, SEP.NOS.HS.B.1, CCC.HS.D.2	2
2	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.NOS.HS.A.3	2
3	HS-LS1-2, DCI.HS-LS1.A.3	1
4	HS-ETS1-2, DCI.HS-ETS1.C.1	1
5	HS-LS1-2, DCI.HS-LS1.A.3	1
6	HS-ETS1-3, DCI.HS-ETS1.B.1	2
7	HS-LS1-3, DCI.HS-LS1.A.4, SEP.NOS.HS.A.3	2
8	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1, CCC.HS.D.2	2
9	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	1
10	HS-LS1-2, DCI.HS-LS1.A.3	1
11	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.HS.D.2	2
12	HS-LS1-3, DCI.HS-LS1.A.4	2
13	HS-ETS1-2, DCI.HS-ETS1.C.1, CCC.HS.D.2	2
14	HS-LS1-2, DCI.HS-LS1.A.3	1

15	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.D.2	2
16	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.F.3, CCC.HS.G.3	3
17	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1, CCC.HS.D.2	2
18	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4, CCC.STSE.HS.B.3	2
19	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.G.1	3
20	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1, CCC.HS.D.2	3
21	HS-ETS1-2, DCI.HS-ETS1.C.1, SEP.HS.F.4	3
22	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.B.2	2
23	HS-LS1-3, DCI.HS-LS1.A.4, SEP.HS.C.1, CCC.HS.D.2	2
24	HS-LS1-3, DCI.HS-LS1.A.4	2
25	HS-LS1-3, DCI.HS-LS1.A.4, SEP.HS.C.1, CCC.HS.G.3	3

- This is incorrect because containing protein is not a factor that explains the next level of organization.
 - This is incorrect because the structure which produces energy would not determine the next level of organization in the model.
 - This is correct because cells' role as the smallest living unit would make them the next level of organization in the model.
 - This is incorrect, because mitochondria would be the level after cells in the model.
- This answer is incorrect, as a single study would not provide enough evidence to start shipping large quantities of the vaccine.
 - This answer is correct, as replication is an essential step of scientific inquiry and the design process. Scientists will want to replicate the results to ensure effectiveness before proceeding to other more costly steps.
 - This is incorrect. Data collection and research are important but likely occurred at an earlier step in the design process.
 - This is incorrect. Scientists need to replicate results before proceeding to a costly step such as mass production.
- This is correct because this example shows different cell types that are working together to help the body maintain a stable internal environment.
 - This is incorrect because this example shows different cell types, not different organs.
 - This is incorrect because the cells are not acting to produce energy, but rather to maintain internal conditions.
 - This is incorrect because it does not show organs; it show cells, and the cells are not producing energy.
- This answer is incorrect because reduction of pain is a benefit of the knee.
 - This is incorrect because this is the purpose of the artificial knee.
 - This is correct because the added weight is not desirable, so it would be a tradeoff in building a knee with a longer lifespan.
 - This is incorrect because resistance to wear and tear would be an advantage of the artificial knee.
- This answer is incorrect because cells are microscopic entities that work together to form tissues. Since the question is describing the workings of the digestive system in a starfish, the parts of that system would be classified as organs.
 - This is correct because the cardiac stomach is a component of this digestive system, so it would be classified as an organ. Organs work together to form systems.

- C. This is incorrect because a system is a set of organs working together with a common purpose. Since the digestive system is described, a component of this system would be classified as an organ.
- D. This answer is incorrect because a tissue is a group of cells that work together with a common purpose. Since the digestive system of the starfish is described in the question, the cardiac stomach would be a component of that system, which would be classified as an organ.
6. A. This is incorrect because constraints of the project cannot be changed by the engineer.
- B. This is incorrect because per the textbook the design process cannot proceed if constraints are not met.
- C. This is incorrect because although tradeoffs will need to be made, safety and reliability are not acceptable tradeoffs for cost in a medical device.
- D. This is correct. The engineer should reconsider the materials, location of manufacture, and any elements of the design that can be simplified to reduce cost.
7. A. This is correct because measuring the diameter of a stoma is a good measurement of stoma size.
- B. This is incorrect because measuring glucose is not a good proxy for stoma size.
- C. This is incorrect because measuring oxygen is not a good proxy for stoma size.
- D. This is incorrect because the time it takes to dry leaves is not a good measurement of stoma size.
8. A. This is incorrect because the atmosphere actually contains approximately 20% oxygen and less than 1% carbon dioxide.
- B. This is incorrect because the respiratory system brings in a mixture of gases from the atmosphere to provide oxygen for cellular respiration throughout the body and exhales excess carbon dioxide. The arrow sizes indicate that more oxygen is used by the body and more carbon dioxide is produced.
- C. This is correct because the arrow sizes indicate that more oxygen is used by the body and more carbon dioxide is produced. The carbon dioxide output arrow from the respiratory system to the atmosphere is larger than the carbon dioxide input arrow. The oxygen output arrow from the respiratory system to the atmosphere is smaller than the oxygen input arrow.
- D. This is incorrect because it does not explain why the arrows between the atmosphere and respiratory system are different sizes.
9. A. This model belongs in *mathematical model* because an equation is a form of mathematical representation.
- B. This model belongs in *conceptual model* because the flow chart is illustrating a process.
- C. This model belongs in *simulation*, because the computer is being used to simulate a natural process.
- D. This model belongs in *physical model* because a three-dimensional model showing structures is a physical representation.
10. A. *Produces cellular proteins* matches ribosomes, because they create proteins during translation.
- B. *Produces energy for cellular functions* goes with mitochondria, because they produce ATP for the cell.
- C. *Stores genetic information for the cell* goes with nucleus, which stores the cell's DNA.
- D. *Controls movement into and out of the cell* goes with cell membrane, because it is a semipermeable membrane that surrounds the cell and maintains the internal environment of the cell.
11. A. *Viral outbreaks* belongs in the third or fourth blanks, because solar disinfection works best for preventing viruses.
- B. *Highly turbid water* belongs in the first or second blanks, because ceramic filtration works best for filtering turbid water.
- C. *Issues with bacteria* belongs in the first or second blanks, because ceramic filtration works best for dealing with bacterial issues.
- D. *Few financial issues* belongs in the third or fourth blanks, because solar disinfection is the cheapest option.

12. A. This action would increase gas exchange because when carbon dioxide in the blood increases, it causes an increase in acidity, which causes the body to increase respiration rate to rid the body of excess carbon dioxide.
- B. This action would increase gas exchange because an increase in leaf opening size would allow more gas to be exchanged.
- C. This action would decrease gas exchange because plants respond to light by increasing the size of the stomata, which increases gas exchange. The opposite of this, or moving the plant into a dark room, would cause the stomata to close, thus decreasing gas exchange.
- D. This action would decrease gas exchange because the rate of respiration would decrease if the diaphragm contracted less frequently.
13. A. *Signaling from the device can cause dizziness* is correct, because dizziness would be an undesired result.
- B. *Implantation of the device can cause infections* is correct, because infections are an undesired result.
- C. *Patients can hear other people speaking more accurately* is incorrect, because improved hearing is a desired outcome of the implant.
- D. *Patients can better determine the direction that sound comes from* is incorrect, because improved discernment of sound location would be an advantage of implants.
- E. *Cochlear implants have become more affordable in the last few years* is incorrect, because this is simply a statement of cost, not a risk.
14. A. Choice A is from the biosphere because the worm is a living organism.
- B. Choice B is from the geosphere because minerals are components of rocks.
- C. Choice C is from the hydrosphere because moisture is water.
- D. Choice D is from the atmosphere because air pockets contain gas that originated in the atmosphere.
- E. Choice E is from the biosphere because the wood was part of a living organism, and the decay is caused by other living organisms.
15. A. This is correct because this would reduce the amount of carbon dioxide that the plant would intake.
- B. This is incorrect because oxygen is an output, not an input, of photosynthesis.
- C. This is incorrect because this increases, not decreases, an input to photosynthesis.
- D. This is incorrect because sugar is an output, not an input of photosynthesis.
- E. This is correct because sunlight is an input to photosynthesis.
16. A. *An individual eating a candy bar* would raise blood glucose as shown on the diagram.
- B. If *some of the body's cells would lose the ability to take up glucose*, the overall blood glucose level would rise. This is because there would be more glucose in the bloodstream that was not able to be taken up by the body cells.
- C. If *the pancreas is unable to make glucagon*, the blood glucose level would continue to decline. This is because glucagon stimulates the liver to make more glucose from glycogen.
- D. If an *individual would lose 5% of his liver function*, the blood glucose level would stay the same. This is because the liver is responsible for taking up excess glucose from the blood and also releasing glucose from glycogen. The loss of a small amount of liver function would not cause the net change to be zero.
17. The correct order should be 4, 3, 1, 2, 5. The smallest level is the organism, an individual animal, plant, or single-celled life form; groups of organisms of the same species live in a population, which is part of a community, the collection of populations living in a certain area. Biomes, global distributions of organisms adapted to living in a particular environment, contain many communities, and the biosphere is the sum of all biomes on Earth, and contains the regions of Earth populated by organisms.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 4]

DCI, SEP, CCC - 4 points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. describe an advantage to a design that would benefit a particular group of people (DCI); and 2. compare different designs and describe a quality that was not considered by others (SEP); and 3. describe an improvement to a design (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing advantages to each type of limbs Part 1: One point is earned for describing a benefit of each type of prosthetic limb, including that Type A provides the greatest functionality, Type B uses recycled materials and costs the least, Type C lasts the longest and is less expensive than Type A. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • Type A provides the greatest functionality, Type B is the cheapest, and Type C would be expected to last the longest.
Evidence of Mastery of Science and Engineering Practices	1 point for describing a consideration not presented in the table Part 3: One point is earned for correctly describing a quality that could be a consideration and why. Explanations can include: realistic appearance, because people using prosthetic limbs might feel more confident with a natural-looking prosthetic; comfort for the wearer, because prosthetics often have to be worn for extended periods of time and must be comfortable. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • How similar to a real limb they look. This should be considered because people will prefer to have a prosthetic limb that looks like a real limb.
Evidence of Mastery of Crosscutting Concepts	2 points for correctly describing a potential improvement of a type Part 2: Two points are earned for describing a quality that could be improved, such as that Type A could be improved if the costs were reduced or the lifespan were increased. Types B and C could be improved if the functionality were increased. Type B could be improved if the lifespan were increased. Type C could be improved if the cost were reduced. Any one of the following responses, or an equivalent, are acceptable. <ul style="list-style-type: none"> • Type C could be improved if they were able to increase its functionality so that it was equal to that of Type A. • Type A could be improved if the cost could be reduced.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. explain the hierarchical organization of interacting systems that provide specific functions within multicellular organisms (DCI); and 2. generate an argument against or in support of whether a virus is alive or not (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the interactions between the Ebola virus and human Part 1: One point is earned for explaining that the virus uses the cell's machinery to replicate. Thus, the interaction is negative for the human but positive for the virus. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • The Ebola virus is not able to make copies of itself on its own but needs a human's cell to reproduce. This interaction is positive for the virus but negative for the human since it kills human cells in the process.

Evidence of Mastery of Science and Engineering Practices	<p>2 points for generating an argument</p> <p>Part 2: Two points are earned for generating a living/nonliving argument and providing one piece of supporting data. An additional point is earned for providing a second piece of evidence to support the claim. The argument could be for either living or nonliving, but the points should be determined by the strength of the two supporting pieces of data. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> I think that viruses should be considered living for two reasons. First, the virus is able to respond to environment by injecting its instructions into human cells. Second, the virus requires an energy source in the form of the human being in which it lives.
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20. Use the rubric below to evaluate total points earned for this item.

[max point: 4]

DCI, SEP, CCC - 4 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> identify levels of organization within a multicellular organism (DCI); and explain the relationships between systems (SEP); and describe a model to simulate systems and interactions within and between systems at different scales (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying levels of organization in the respiratory system</p> <p>Part 1: One point is earned for identifying levels of organization in the respiratory system one level above and below alveoli, and for describing the organization of the human body. Alveoli are tissues, so a level below would be a cell and a level above would be the organ, which in this case would be the lung. The levels of organization in humans is cells, tissues, organs, organ systems and the entire organism. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> One level below the alveoli would be a cell in the alveoli. One level above the alveoli would be the lung. In humans, body systems are organized, from smallest to largest, as follows: cell → tissue → organ → organ system → human
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining effect on circulatory system</p> <p>Part 2: One point is earned for explaining that nonfunctional alveoli would cause a decrease in the amount of oxygen that could be absorbed into the blood, and describing issues that this could lead to in the circulatory system. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If the alveoli in the lungs are not able to transport oxygen into the blood, then the blood that is delivered to the heart will not have enough oxygen in it. When this happens, the heart cells will not work properly, which means that the heart will not function correctly either.
Evidence of Mastery of Crosscutting Concepts	<p>2 points for correctly describing a model that could be developed</p> <p>Part 3: Two points are earned for describing a model that the researcher could use, and explaining how the model could represent both healthy and infected alveoli. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The researcher could use a plastic bag with many small holes in it, and a tube going into the bag, which would represent air going into the lungs from breathing. A bag with dry cotton in it could represent healthy alveoli, while a bag with moist cotton could represent infected alveoli, as the wet cotton would clog some of the holes and prevent easy gas exchange.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. identify criteria for a solution to a complex real-world problem (DCI); and 2. explain why criteria are necessary for solving problems (DCI); and 3. describe a solution to a complex real-world problem based on scientific knowledge, prioritized criteria, and tradeoff considerations (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying a relevant criterion</p> <p>Part 1: One point is earned for identifying a relevant criterion. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • One way that a scientist could evaluate this technology is to determine the side effects of the treatment. <p>1 points for correctly explaining why the criterion is important</p> <p>Part 2: One point is earned for explaining why the criterion is important. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • In order for the treatment to be worthwhile, the benefits of the treatment should be greater than any of the side effects of the treatment. For example, if the treatment causes heart attacks that will kill the patient, then the treatment may not be worthwhile.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for describing an experiment to test the technology</p> <p>Part 3: One point is earned for describing an experiment that could be used to test whether the technology meets the criterion. Answers will vary depending on the criterion chosen, but the experiment should directly relate to whether the technology meets that criterion. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Scientists could give the drug to another organism (like rats) to see what types of side effects it produces. The drug could be given to different groups in different concentrations to see how the dosage of the treatment changed the side effects.

22. A. This is incorrect, because a fish in salt water would try to conserve water and expel salts, and thus would produce small amounts of concentrated urine.
- B. This is incorrect, because a fish in salt water would try to conserve expel salts, and thus would produce concentrated urine.
- C. This is incorrect, because a fish in salt water would try to conserve water, and thus would produce small amounts of urine.
- D. This is correct, because a fish in salt water would try to conserve water and expel salts, and thus would produce small amounts of concentrated urine.
23. A. This disruption would be more likely to happen in freshwater fish, because they have a need to retain, not excrete, salt.
- B. This disruption would be more likely to happen in saltwater fish, because they have a need to retain, not excrete, water.
- C. This disruption would be more likely to happen in saltwater fish, because they have a need to excrete, not retain, salt.
- D. This disruption would be more likely to happen in freshwater fish, because they have a need to excrete, not retain, water.
24. A. This is incorrect, because a fish in salt water would not need to actively uptake salt in order to maintain proper salt levels.
- B. This is incorrect, as a fish in salt water would not need to prevent low levels of salt.
- C. This is incorrect, as a fish in fresh water would not have excess salt entering its cells.

D. This is correct, as this ability would help to allow a freshwater fish to maintain salt levels.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	The student is able to: 1. explain how not being able to maintain homeostasis would be harmful to the jellyfish (DCI); and 2. describe an experiment that could be used to measure osmoregulation in jellyfish (SEP); and 3. explain how to identify if homeostasis is maintained by the jellyfish (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the effects of not maintaining homeostasis Part 3: One point is earned for explaining how failure to maintain homeostasis would lead to damage to the jellyfish. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The jellyfish would gain too much water if they were placed in fresh water, which could damage the function of their cells.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly describing the experiment Part 1: One point is earned for describing a valid experiment that could be used to determine whether the jellyfish could maintain homeostasis under changing conditions. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Measure the internal and external salt levels of the jellyfish in normal salt water. Then place the jellyfish in different containers of water with lower levels of salt, and measure the internal salt level of the jellyfish each time.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly explaining how to interpret data Part 2: One point is earned for explaining that the salt levels inside the jellyfish should remain constant if it is able to maintain homeostasis under these conditions. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> If the jellyfish has the same level of internal salt for each measurement, then it can maintain homeostasis. If the salt level drops, then it cannot maintain homeostasis.

Unit 1 Unit Test B – Living Systems

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-2, DCI.HS-LS1.A.3, SEP.NOS.HS.B.1, CCC.HS.D.2	2
2	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.NOS.HS.A.3	2
3	HS-LS1-2, DCI.HS-LS1.A.3	1
4	HS-ETS1-2, DCI.HS-ETS1.C.1	1
5	HS-LS1-2, DCI.HS-LS1.A.3	1
6	HS-ETS1-3, DCI.HS-ETS1.B.1	2
7	HS-LS1-3, DCI.HS-LS1.A.4, SEP.NOS.HS.A.3	2
8	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1, CCC.HS.D.2	2
9	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	1
10	HS-LS1-2, DCI.HS-LS1.A.3	1
11	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.HS.D.2	2
12	HS-LS1-3, DCI.HS-LS1.A.4	2
13	HS-ETS1-2, DCI.HS-ETS1.C.1, CCC.HS.D.2	2

14	HS-LS1-2, DCI.HS-LS1.A.3	1
15	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.D.2	2
16	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.F.3, CCC.HS.G.3	3
17	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1, CCC.HS.D.2	2
18	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4, CCC.STSE.HS.B.3	2
19	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.G.1	3
20	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1, CCC.HS.D.2	3
21	HS-ETS1-2, DCI.HS-ETS1.C.1, SEP.HS.F.4	3
22	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.B.2	2
23	HS-LS1-3, DCI.HS-LS1.A.4, SEP.HS.C.1, CCC.HS.D.2	2
24	HS-LS1-3, DCI.HS-LS1.A.4	2
25	HS-LS1-3, DCI.HS-LS1.A.4, SEP.HS.C.1, CCC.HS.G.3	3

1.
 - A. This is incorrect because containing protein is not a factor that explains the next level of organization.
 - B. This is incorrect because the structure which produces energy would not determine the next level of organization in the model.
 - C. This is correct because cells' role as the smallest living unit would make them the next level of organization in the model.
2.
 - A. This answer is incorrect, as a single study would not provide enough evidence to start shipping large quantities of the vaccine.
 - B. This answer is correct, as replication is an essential step of scientific inquiry and the design process. Scientists will want to replicate the results to ensure effectiveness before proceeding to other more costly steps.
 - C. This is incorrect. Scientists need to replicate results before proceeding to a costly step such as mass production.
3.
 - A. This is correct because this example shows different cell types that are working together to help the body maintain a stable internal environment.
 - B. This is incorrect because this example shows different cell types, not different organs.
 - C. This is incorrect because the cells are not acting to produce energy, but rather to maintain internal conditions.
4.
 - A. This answer is incorrect because reduction of pain is a benefit of the knee.
 - B. This is correct because the added weight is not desirable, so it would be a tradeoff in building a knee with a longer lifespan.
 - C. This is incorrect because resistance to wear and tear would be an advantage of the artificial knee.
5.
 - A. This answer is incorrect because cells are microscopic entities that work together to form tissues. Since the question is describing the workings of the digestive system in a starfish, the parts of that system would be classified as organs.
 - B. This is correct because the cardiac stomach is a component of this digestive system, so it would be classified as an organ. Organs work together to form systems.
 - C. This is incorrect because a system is a set of organs working together with a common purpose. Since the digestive system is described, a component of this system would be classified as an organ.

6. A. This is incorrect because the design process cannot proceed if constraints are not met.
 B. This is incorrect because although tradeoffs will need to be made, safety and reliability are not acceptable tradeoffs for cost in a medical device.
 C. This is correct. The engineer should reconsider the materials, location of manufacture, and any elements of the design that can be simplified to reduce cost.
7. A. This is correct because measuring the diameter of a stoma is a good measurement of stoma size.
 B. This is incorrect because measuring oxygen is not a good proxy for stoma size.
 C. This is incorrect because the time it takes to dry leaves is not a good measurement of stoma size.
8. A. This is incorrect because the atmosphere actually contains approximately 20% oxygen and less than 1% carbon dioxide.
 B. This is incorrect because the respiratory system brings in a mixture of gases from the atmosphere to provide oxygen for cellular respiration throughout the body and exhales excess carbon dioxide. The arrow sizes indicate that more oxygen is used by the body and more carbon dioxide is produced.
 C. This is correct because the arrow sizes indicate that more oxygen is used by the body and more carbon dioxide is produced. The carbon dioxide output arrow from the respiratory system to the atmosphere is larger than the carbon dioxide input arrow. The oxygen output arrow from the respiratory system to the atmosphere is smaller than the oxygen input arrow.
9. A. This model belongs in *conceptual model* because the flow chart is illustrating a process.
 B. This model belongs in *simulation*, because the computer is being used to simulate a natural process.
 C. This model belongs in *physical model* because a three-dimensional model showing structures is a physical representation.
10. A. *Produces cellular proteins* matches ribosomes, because they create proteins during translation.
 B. *Produces energy for cellular functions* goes with mitochondria, because they produce ATP for the cell.
 C. *Stores genetic information for the cell* goes with nucleus, which stores the cell's DNA.
11. A. *Viral outbreaks* belongs in the third blank, because solar disinfection works best for preventing viruses.
 B. *Highly turbid water* belongs in the first or second blank, because ceramic filtration works best for filtering turbid water.
 C. *Issues with bacteria* belongs in the first or second blank, because ceramic filtration works best for dealing with bacterial issues.
12. A. This action would increase gas exchange because when carbon dioxide in the blood increases, it causes an increase in acidity, which causes the body to increase respiration rate to rid the body of excess carbon dioxide.
 B. This action would increase gas exchange because an increase in leaf opening size would allow more gas to be exchanged.
 C. This action would decrease gas exchange because plants respond to light by increasing the size of the stomata, which increases gas exchange. The opposite of this, or moving the plant into a dark room, would cause the stomata to close, thus decreasing gas exchange.
13. A. *Signaling from the device can cause dizziness* is correct, because dizziness would be an undesired result.
 B. *Implantation of the device can cause infections* is correct, because infections are an undesired result.
 C. *Patients can hear other people speaking more accurately* is incorrect, because improved hearing is a desired outcome of the implant.
 D. *Patients can better determine the direction that sound comes from* is incorrect, because improved discernment of sound location would be an advantage of implants.

14. A. Choice A is from the biosphere because the worm is a living organism.
 B. Choice B is from the geosphere because minerals are components of rocks.
 C. Choice C is from the hydrosphere because moisture is water.
 D. Choice D is from the atmosphere because air pockets contain gas that originated in the atmosphere.
15. A. This is correct because this would reduce the amount of carbon dioxide that the plant would intake.
 B. This is incorrect because oxygen is an output, not an input, of photosynthesis.
 C. This is incorrect because this increases, not decreases, an input to photosynthesis.
 D. This is correct because sunlight is an input to photosynthesis.
16. A. *An individual eating a candy bar* would raise blood glucose as shown on the diagram.
 B. If *the pancreas is unable to make glucagon*, the blood glucose level would continue to decline. This is because glucagon stimulates the liver to make more glucose from glycogen.
 C. If an *individual would lose 5% of his liver function*, the blood glucose level would stay the same. This is because the liver is responsible for taking up excess glucose from the blood and also releasing glucose from glycogen. The loss of a small amount of liver function would not cause the net change to be zero.
17. The correct order should be 4, 3, 1, 2. The smallest level is the organism, an individual animal, plant, or single-celled life form; groups of organisms of the same species live in a population, which is part of a community, the collection of populations living in a certain area. Largest is the biosphere, which contains the regions of Earth populated by living organisms.
18. Use the rubric below to evaluate total points earned for this item. [max point: 4]

DCI, SEP, CCC - 4 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. describe solutions, taking into account a range of constraints including cost, safety, reliability, and aesthetics (DCI); and 2. describe a solution to a complex real-world problem, based on scientific knowledge, prioritized criteria, and tradeoff considerations (SEP); and 3. identify how new technologies can have big impacts on society and the environment, including some that were not anticipated (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the benefits of the types of limbs</p> <p>Part 1: One point is earned for correctly describing a benefit of each type of prosthetic limb, including that Type A provides the greatest functionality, Type B uses recycled materials and costs the least; Type C lasts the longest and is less expensive than Type A. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Type A provides the greatest functionality, Type B is the cheapest, and Type C would be expected to last the longest.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for describing a consideration not presented in the table</p> <p>Part 3: One point is earned for correctly describing a quality that could be a consideration and explaining why. Examples can include: realistic appearance, because people using prosthetic limbs might feel more confident with a natural-looking prosthetic; comfort for the wearer, because prosthetics often have to be worn for extended periods of time and must be comfortable. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • How similar to a real limb they look. This should be considered because people will prefer to have a prosthetic limb that looks like a real limb.

Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly describing a potential improvement of a type of prosthetic limb</p> <p>Part 2: One point is earned for correctly describing a quality that could be improved, such as that Type A could be improved if the cost were reduced or the lifespan were increased. Types B and C could be improved if the functionality were increased. Type B could be improved if the lifespan were increased. Type C could be improved if the cost were reduced. Any one of the following responses, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Type C could be improved if they were able to increase its functionality so that it was equal to that of type A. Type A could be improved if the cost could be reduced.
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19. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> develop and use a model to explain the hierarchical organization of interacting systems that provide specific functions within multicellular organisms (DCI); and evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the interactions between the Ebola virus and human</p> <p>Part 1: One point is earned for explaining that the virus uses the cell's machinery to replicate. Thus, the interaction is negative for the human but positive for the virus. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The Ebola virus is not able to make copies of itself on its own but needs a human's cell to reproduce. This interaction is positive for the virus but negative for the human since it kills human cells in the process.
Evidence of Mastery of Science and Engineering Practices	<p>2 points for generating an argument</p> <p>Part 2: One point is earned for generating a living/nonliving argument and providing one piece of supporting data. An additional point is earned for providing a second piece of evidence to support the claim. The argument could be for either living or nonliving, but the points should be determined by the strength of the two supporting pieces of data. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> I think that viruses should be considered living for two reasons. First, the virus is able to respond to the environment by injecting its instructions into human cells. Second, the virus requires an energy source in the form of the human being in which it lives.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 4]

DCI, SEP, CCC - 4 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> identify levels of organization within a multicellular organism (DCI); and explain the relationships between systems (SEP); and describe a model to simulate systems and interactions within and between systems at different scales (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying levels of organization in the respiratory system</p> <p>Part 1: One point is earned for identifying levels of organization in the respiratory system one level above and below alveoli, and for describing the organization of the human body. Alveoli are tissues, so a level below would be a cell and a level above would be the organ, which in this case would be the lung. The levels of organization in humans is cells, tissues, organs, organ systems and the entire organism. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> One level below the alveoli would be a cell in the alveoli. One level above the alveoli would be the lung. In humans, body systems are organized, from smallest to largest, as follows: cell → tissue → organ → organ system → human
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining effects on circulatory system</p> <p>Part 2: One point is earned for explaining that nonfunctional alveoli would cause a decrease in the amount of oxygen that could be absorbed into the blood, and describing issues that this could lead to in the circulatory system. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If the alveoli in the lungs are not able to transport oxygen into the blood, then the blood that is delivered to the heart will not have enough oxygen in it. When this happens, the heart cells will not work properly, which means that the heart will not function correctly either.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly describing a model that could be developed</p> <p>Part 3: One point is earned for describing a model that the researcher could use, and explaining how the model could represent both healthy and infected alveoli. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The researcher could use a plastic bag with many small holes in it, and a tube going into the bag, which would represent air going into the lungs from breathing. A bag with dry cotton in it could represent healthy alveoli, while a bag with moist cotton could represent infected alveoli, as the wet cotton would clog some of the holes and prevent easy gas exchange.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> identify criteria for a solution to a complex real-world problem (DCI); and describe a solution to a complex real-world problem based on scientific knowledge, prioritized criteria, and tradeoff considerations (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for identifying a relevant criterion</p> <p>Part 1: One point is earned for identifying a relevant criterion. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> One way that a scientist could evaluate this technology is to determine the side effects of the treatment.
Evidence of Mastery of Science and Engineering Practices	<p>2 points for describing an experiment to test the technology</p> <p>Part 2: Two points are earned for describing an experiment that could be used to test whether the technology meets the criterion. Answers will vary depending on the criterion chosen, but the experiment should directly relate to whether the technology meets that criterion. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Scientists could give the drug to another organism (like rats) to see what types of side effects it produces. The drug could be given to different groups in different concentrations to see how the dosage of the treatment changed the side effects.

22. A. This is incorrect, because a fish in salt water would try to conserve water and expel salts, and thus would produce small amounts of concentrated urine.

B. This is incorrect, because a fish in salt water would try to conserve water, and thus would produce smaller amounts of urine.

- C. This is correct, because a fish in salt water would try to conserve water and expel salts, and thus would produce small amounts of concentrated urine.
23. A. This disruption would be more likely to happen in freshwater fish, because they have a need to retain, not excrete, salt.
 B. This disruption would be more likely to happen in saltwater fish, because they have a need to retain, not excrete, water.
 C. This disruption would be more likely to happen in saltwater fish, because they have a need to excrete, not retain, salt.
24. A. This is incorrect, because a fish in salt water would not need to actively uptake salt in order to maintain proper salt levels.
 B. This is incorrect, as a fish in salt water would not need to prevent low levels of salt.
 C. This is correct, as this ability would help to allow a freshwater fish to maintain salt levels.
25. Use the rubric below to evaluate total points earned for this item. *[max point: 3]*

DCI, SEP, CCC - 3 points	
Claims	The student is able to: 1. describe an experiment that could be used to measure osmoregulation in jellyfish (SEP); 2. explain how to identify if homeostasis is maintained by the jellyfish (CCC); and 3. explain how not being able to maintain homeostasis would be harmful to the jellyfish (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the effects of not maintaining homeostasis Part 3: One point is earned for explaining how failure to maintain homeostasis would lead to damage to the jellyfish. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The jellyfish would gain too much water if they were placed in fresh water, which could damage the function of their cells.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly describing the experiment Part 1: One point is earned for describing a valid experiment that could be used to determine whether the jellyfish could maintain homeostasis under changing conditions. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Measure the internal and external salt levels of the jellyfish in normal salt water. Then place the jellyfish in different containers of water with lower levels of salt, and measure the internal salt level of the jellyfish each time.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly explaining how to interpret data Part 2: One point is earned for explaining that the salt levels inside the jellyfish should remain constant if it is able to maintain homeostasis under these conditions. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> If the jellyfish has the same level of internal salt for each measurement, then it can maintain homeostasis. If the salt level drops, then it cannot maintain homeostasis.

Unit 2 Chemistry in Living Systems

Unit 2 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	A	HS-LS1-6, DCI.HS-LS1.C.2	1
2	D	HS-PS1-1, DCI.HS-PS1.A.1	1
3	B	HS-LS1-6, DCI.HS-LS1.C.2	1

4	D	HS-LS1-5, DCI.HS-LS1.C.1	1
5	A	HS-PS1-1, DCI.HS-PS1.A.1	1
6	B	HS-LS1-6, DCI.HS-PS1.A.3	1
7	A	HS-PS1-1, DCI.HS-PS1.A.1	1
8	D	HS-LS1-6, DCI.HS-PS1.A.1	1
9	A	HS-LS1-2, DCI.HS-LS1.A.3	1
10	D	HS-PS1-1, DCI.HS-PS1.A.1	1
11	D	HS-PS1-3, DCI.HS-PS1.A.3	1
12	B	HS-PS1-3, DCI.HS-PS1.A.3, CCC.HS.F.2	1
13	C	HS-LS1-6, DCI.HS-PS1.A.1	1
14	D	HS-PS3-1, DCI.HS-PS3.B.2, CCC.HS.E.1	1
15	A	HS-LS1-6, DCI.HS-PS1.A.4	1

Unit 2 Lesson 1 Quiz – Chemical Bonds and Reactions

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-PS1-3, DCI.HS-PS2.B.3	74	1
2	D	HS-PS1-1, DCI.HS-PS1.A.1, SEP.HS.B.1	73	1
3	A	HS-PS1-1, DCI.HS-PS1.A.2	73	2
4	C	HS-PS1-2, DCI.HS-PS1.B.3	76	1
5	C	HS-PS1-2, DCI.HS-PS1.B.3	73-74	2
6	D	HS-PS1-7, DCI.HS-PS1.B.1, SEP.HS.B.2, CCC.HS.D.2	82-85	2
7	D	HS-PS2-6, DCI.HS-PS2.B.3	77	2
8	C	HS-PS1-3, DCI.HS-PS1.A.3	76	2
9	D	HS-PS1-4, DCI.HS-PS1.A.4, SEP.HS.D.1	80-82	3
10	C	HS-PS1-4, DCI.HS-PS1.A.4, SEP.HS.D.1	80-85	3
11	Rubric	HS-PS1-4, DCI.HS-PS1.A.4, SEP.HS.F.2	82-85	2
12	Rubric	HS-PS2-6, DCI.HS-PS2.B.3	77	2
13	Rubric	HS-PS1-1, DCI.HS-PS1.A.1	74	2
14	Rubric	HS-PS1-1, DCI.HS-PS1.A.1	74	1
15	Rubric	HS-PS2-6, DCI.HS-PS2.B.3, CCC.HS.D.2	74	2

11. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Enzymes are biological catalysts. They are usually proteins with specific three-dimensional shapes that allow them to bind to particular substrate molecules. Once attached to the enzyme's active site, the substrates are in a correct orientation. This orientation lowers the activation energy that would otherwise be required for the reaction to occur.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	It has partial charges on opposite ends.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	It gains or loses one or more electrons.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	the pair in Part B

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The outer circle representing the outer energy level of one atom would intersect the outer circle of the other atom. Two atoms connected by a covalent bond share one or more pairs of electrons rather than transferring electrons, as in an ionic bond.

Unit 2 Lesson 2 Quiz – Carbon-Based Molecules

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-PS1-2, DCI.HS-PS1.A.3	100-101	1
2	D	HS-LS1-7, DCI.HS-LS1.C.4	101	1
3	A	HS-LS1-6, DCI.HS-PS1.A.1	90	1
4	B	HS-LS1-6, DCI.HS-LS1.C.3	95	1
5	C	HS-PS2-6, DCI.HS-PS1.A.3	95	2
6	C	HS-LS1-6, DCI.HS-LS1.C.2	91-92	2
7	A	HS-LS1-6, DCI.HS-LS1.C.3	92-93	2
8	D	HS-LS1-6, DCI.HS-PS1.A.4	99	2
9	B	HS-LS1-1, DCI.HS-LS1.C.2	98	2
10	C	HS-LS1-6, DCI.HS-LS1.C.3	102	2
11	Rubric	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.D.2	92-100	2
12	Rubric	HS-LS2-5, DCI.HS-LS1.C.1	92-100	2
13	Rubric	HS-PS1-1, DCI.HS-PS1.A.2, SEP.HS.F.2, CCC.HS.F.2	90-92	2
14	Rubric	HS-PS2-6, DCI.HS-PS2.B.3, SEP.HS.B.1, CCC.HS.D.2	91-92	3
15	Rubric	HS-PS1-1, DCI.HS-PS1.A.2, SEP.HS.B.1	91-92	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Photosynthesis is important because it uses energy from sunlight to make sugars that living things can use for energy..

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	After photosynthesis, carbon is in glucose or other organic molecules. After cellular respiration, carbon is in carbon dioxide molecules.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<ul style="list-style-type: none"> • A covalent bond as a bond that forms when two atoms share at least one pair of electrons. • Carbon can form covalent bonds with up to four other atoms, including other carbon atoms, to form rings and chains of molecules. These rings and chains can bond with each other to form very large molecules. • Carbohydrates, lipids, proteins, and nucleic acids, and describing carbohydrates as molecules that can be broken down to provide a source of usable chemical energy for cells or used to build cell walls in plants; lipids as molecules that may be part of a cell's structure or may be broken down as a source of energy; proteins as parts of cell structure, in transport (hemoglobin), or as enzymes; or nucleic acids as molecules that store genetic information used to make proteins.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: The four lines surrounding the C represent the four bonds that carbon can form. By forming bonds with many other elements, carbon can form large, complex molecules like proteins.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Four is the largest number of covalent bonds carbon can form because it has four unpaired electrons in its outer energy level. Unpaired electrons are required for forming covalent bonds.

Unit 2 Unit Test A – Chemistry in Living Systems

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.D.3	2
2	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.E.1	1
3	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.D.1	2
4	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.2	2
5	HS-LS1-6, DCI.HS-LS1.C.3	1
6	HS-LS1-6, DCI.HS-LS1.C.3	2

7	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.F.2	2
8	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.D.3	3
9	HS-LS1-6, DCI.HS-LS1.C.3	1
10	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.F.1, CCC.HS.E.2	1
11	HS-LS1-6, DCI.HS-LS1.C.2	2
12	HS-LS1-6, DCI.HS-LS1.C.2	2
13	HS-LS1-6, DCI.HS-LS1.C.3, SEP.NOS.HS.D.3	2
14	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.4	2
15	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.2	2
16	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.B.1	3
17	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.E.1	3
18	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.D.1	2
19	HS-LS1-6, DCI.HS-LS1.C.3	2
20	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.F.1	3
21	HS-LS1-6, DCI.HS-LS1.C.3	3
22	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.3	1
23	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.B.1	2
24	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.D.2	2
25	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.B.2	2

1.
 - A. This is incorrect because the hydrogen atoms in water have a slight positive charge, and repel other hydrogen atoms in water molecules.
 - B. This is incorrect because an oxygen atom has a slight negative charge in water molecules, and so it repels other oxygen atoms in water molecules.
 - C. This is correct because oxygen atoms have a slight negative charge in water molecules, while hydrogen atoms have a slight positive charge, so they are attracted to each other.
 - D. This is incorrect because the hydrogen atoms are attracted to oxygen atoms in other water molecules as well as their own.
2.
 - A. This is incorrect because energy cannot be created from nothing.
 - B. This is incorrect because energy cannot be destroyed.
 - C. This is incorrect because it describes photosynthesis, not respiration.
 - D. This is correct because it describes how energy is moved from the bonds in sugar to the bonds in ATP during respiration.
3.
 - A. This is correct because the chemical equation shows that the oxygen in carbon dioxide ends up in glucose. Therefore, if the oxygen in the carbon dioxide molecule were radioactive, then the glucose would be radioactive.
 - B. This is incorrect because based on the equation; radioactive oxygen in water ends up in molecular oxygen.
 - C. This is incorrect because the energy present in the photosynthesis reaction comes from light energy, and it is impossible to add radioactive oxygen to light energy.
 - D. This is incorrect because fertilizers generally do not supply oxygen. Also, fertilizer is not present in the chemical equation shown.

4.
 - A. This is incorrect. Energy is stored in both ATP and ADP. Energy is stored in the bonds between phosphate groups.
 - B. This is correct. ATP includes three phosphate groups. Chemical energy is stored within the bonds between these phosphates.
 - C. This is incorrect. ADP has only two phosphate groups. Energy was released with the third phosphate group when a phosphate-to-phosphate bond was broken. ADP is a lower energy molecule.
 - D. This is incorrect. ATP and ADP cycle constantly. During cellular respiration, energy from the breakdown of biomolecules is used to add a phosphate group to ADP, producing the higher energy molecule, ATP. When energy is needed, a phosphate group is broken off ATP, converting it to ADP and releasing energy.
5.
 - A. This is incorrect because H_2 is an element, not a compound, as it does not contain more than one kind of element.
 - B. This is incorrect because N_2 is an element, not a compound, as it does not contain more than one kind of element.
 - C. This is correct because both carbon dioxide and water contain more than one type of element.
 - D. This is incorrect because O_2 is an element, not a compound, as it does not contain more than one kind of element.
6.
 - A. This is incorrect because osmosis helps water move along a concentration gradient, not upwards through a plant.
 - B. This is correct because the tendency of water to adhere to substances helps it to move upward through a plant.
 - C. This is incorrect because water remains a liquid as it moves through a plant.
 - D. This is incorrect because the ability of water to absorb or release heat with little change in temperature does not help it to move through plants.
7.
 - A. This is correct. Carbon's ability to form up to four bonds allows it to form strong chains and rings as seen in the images. If carbon could form only three or fewer bonds, all of the shapes shown would be impossible.
 - B. This is incorrect because carbon can form shapes beyond rings, including chains.
 - C. This is incorrect because although carbon can form double bonds, it is not a requirement of a molecule containing carbon.
 - D. This is incorrect because carbon can and often does bond with other carbons, as evidenced by the images.
8.
 - 1B. *Decrease* is correct because a catalyst reduces the activation energy required to initiate a reaction.
 - 2C. *Do not affect* is correct because catalysts do not change the energy difference of a reaction, which is a function of the bonds formed and broken during the reaction.
 - 3A. *Increase* is correct because the reduced activation energy caused by the catalyst allows the reaction to occur at a faster rate.
 - 4E. *Are not* is correct because catalysts do not change during the reaction.
9.
 - A. Diffusion is the correct answer for the box in lower left of diagram, as this is a type of transport that occurs freely across the cell membrane.
 - B. Passive transport is the correct answer for the box in the upper center of the diagram. Passive transport requires no energy input from the cell but requires a protein intermediate.
 - C. Active transport is correct for the box in the lower right of the diagram, as this is a process that requires the input of energy.

10. A. *In fructose* is correct because carbon forms the backbone of sugar molecules.
 B. *In fructose* is correct because hydrogen bonds to both carbon and oxygen atoms in a sugar molecule.
 C. *In fructose* is correct because oxygen binds to both carbon and hydrogen in sugar.
 D. *Not in fructose* is correct because nitrogen is not a component of sugars. It would be expected to be found in amino acids.
 E. *Not in fructose* is correct because phosphorous is not a component of common sugars. Phosphorous would be expected to be found in ATP molecules.
11. A. This label belongs to the right of the model because the two hydrogen atoms generate a slightly positive charge in the area around the hydrogen atoms.
 B. This label belongs to the left of the model because the oxygen atom has a slightly negative charge in the area around it.
 C. This label belongs in the description box. A water molecule is polar because of the slight charges, and as such is able to dissolve other polar molecules.
 D. This label does not belong on the model. A water molecule is polar, not nonpolar.
 E. This label does not belong on the model. A water molecule is polar, but it does not tend to dissolve nonpolar molecules.
 F. This label does not belong on the model. A water molecule is polar, not nonpolar, and it does not tend to dissolve nonpolar molecules.
12. A. *Always contain carbon* is an incorrect selection, because both amino acids and sugars always contain carbon.
 B. *Is an input in glycolysis* is an incorrect selection, because sugars, not amino acids, are inputs in glycolysis.
 C. *Structure is coded for in DNA* is a correct selection, because both amino acids and sugars always contain hydrogen.
 D. *Can be used as an energy source* is an incorrect selection, because both sugars and amino acids may contain ring structures.
 E. *Can bond together to form proteins* is a correct selection, because amino acids, not sugars, bind to form proteins.
 F. *Can bond together to form carbohydrates* is an incorrect selection, because sugars, not amino acids, are carbohydrates.
13. A. This function goes in the fifth box because sugars provide energy for cell processes.
 B. This function goes in the first box because waxes provide waterproof coating of surfaces such as those of leaves.
 C. This function goes in the third box because phospholipids compose the selectively permeable cell membrane.
 D. This structure goes in the fourth box because phospholipids have both polar and nonpolar structures.
 E. This structure goes in the sixth box because sugars are an easily available energy source for cells.
 F. This structure goes in the second box because waxes are composed of long, hydrophobic carbon chains.
14. A. *Carbohydrate containing ring structures* is correctly matched with the second image, which shows the carbohydrate lactose, and the third image, which shows the carbohydrate amylose.
 B. *Lipid containing hydrocarbon chain* is correctly matched with the first image, which is a lipid called stearic acid, and the fourth image, which is a lipid called lauric acid.
15. A. *Output* is correct because ATP is one of the products of cellular respiration, as it is usable energy for the cell.
 B. *Output* is correct because water is one of the products of cellular respiration.

C. *Input* is correct because glucose is one of the inputs of cellular respiration, as it is the source of chemical energy.

D. *Output* is correct because carbon dioxide is one of the products of cellular respiration.

16. 1B. *The same* is correct because atoms are conserved in chemical reactions such as photosynthesis.

2B. *The same* is correct because mass is conserved in chemical reactions such as photosynthesis.

3A. *Different* is correct because the chemical properties of glucose and oxygen are different from the chemical properties of water and carbon dioxide.

4B. *Different* is correct because photosynthesis increases the amount of energy stored in chemical bonds, so the output molecules would have more energy in their bonds than the input molecules.

17. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. explain that the bonds between atoms change during a chemical reaction (DCI); and 2. explain that the mass is conserved during a chemical reaction (CCC); and 3. identify evidence that energy is released during a chemical reaction (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining what happens to atoms and bonds Part 3: One point is earned for explaining that the bonds between atoms in the reactants will differ from those of the product, but not the atoms themselves. The same atoms are present, just rearranged. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • The number and type of atoms is the same in the reactants as in the products, but they will have different bonds between the atoms.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly explaining that the mass is conserved Part 1: One point is earned for explaining that the reason the mass would be the same in the products as in the reactants is due to the conservation of mass. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • The mass of the reactants and the products would be the same because mass is conserved during chemical reaction. 1 point for correctly identifying evidence of energy release Part 2: One point is earned for identifying evidence that energy was released, such as a change in temperature or the emission of light. Any one of the following responses, or an equivalent, is acceptable. <ul style="list-style-type: none"> • Light given off during the reaction would be evidence of energy release. • If the material heated up, it would be evidence that energy had been released.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. name the molecule that powers cell functions and explain a process for which it provides energy (DCI); and 2. describe the path that energy takes from solar energy reaching Earth to energy used to power cell functions in animals (SEP).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly naming the molecule and identifying a process it powers</p> <p>Part 2: One point is earned for naming ATP as the molecule that provides energy for cell processes, and identifying a cell process that uses energy from ATP, such as active transport. The following responses, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> ATP is the molecule that gives cells processes energy, and a process that it provides energy for is protein synthesis.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly describing the path</p> <p>Part 1: One point is earned for describing the path that energy takes from solar energy reaching Earth to the energy used to power cell functions in animals. During photosynthesis, plants convert solar energy to glucose, which is stored in plant tissues. When an animal consumes a plant, some of the glucose is broken down into ATP, which stores energy in the chemical bonds between phosphate groups. When these bonds are broken, energy is released to power cell functions in the animal. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Sun gives energy to plants. Plants change energy to glucose, which is stored in plant tissues. An animal eats the plant and some of the glucose, which changes into ATP and energy, goes into the animal tissues.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> identify the role of amino acid sequence in the primary structure of a protein (DCI), and explain the role of amino acid sequence to the function of a protein (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for identifying the role of amino acid sequence in the primary structure of protein</p> <p>Part 1: One point is earned for identifying that the primary structure of a protein is determined by the order of the amino acids in the protein.</p> <ul style="list-style-type: none"> The primary structure of a protein is determined by what order the amino acids are arranged. <p>1 point for correctly explaining effects of change in primary structure on function</p> <p>Part 2: One point is earned for explaining that a change in the primary structure of a protein can change result in a change in the structure of a protein, and that changes to a structure of a protein can prevent the protein from functioning correctly. The following response, or an equivalent, is acceptable.</p> <p>A change in the order of the amino acids can cause the protein to fold differently, changing its 3-dimension structure. Because the structure of a protein is crucial to its function, a change in its structure is likely to lead to a disruption in its function.</p>

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe how the molecules in the solution would have changed after completion of the experiment (DCI); and explain what the results of the experiment indicate about energy stored in ATP (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing how the molecules in the ATP solution would change</p> <p>Part 2: One point is earned for describing how the molecules in the ATP solution would have changed after completion of the experiment. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> After the experiment was completed, the original ATP solution would contain ADP and phosphate.

Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining the results of this experiment</p> <p>Part 1: One point is earned for explaining what the results of the experiment indicate about energy stored in ATP. Response should include that muscle tissue becomes shorter when it contracts, which requires energy, and that energy from the ATP caused the muscle to contract. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Energy is needed for muscles to contract. Energy from ATP causes muscles to contract. A muscle tissue shortens when contracted. Muscle contraction requires energy.
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21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. describe the role of amino acid assembly in the primary structure of a protein (DCI), and 2. explain the role of amino acid sequence to the function of a protein (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining why nucleic acids cannot form from sugar alone</p> <p>Part 1: One point is earned for explaining that sugars have only carbon, hydrogen, and oxygen. To form a nucleic acid more elements must be present. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Nucleic acids cannot be formed from sugars alone because sugars are composed of only carbon, hydrogen, and oxygen. Since nucleic acids have nitrogen and phosphorus, their biosynthetic pathways require other elements. <p>1 point for explaining why other nutrients are needed</p> <p>Part 2: One point is earned for explaining that amino acids and sugars have the required nitrogen, oxygen, carbon, and hydrogen, but lack the phosphorus needed to form nucleic acids. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Although amino acids and sugars can supply the nitrogen, carbon, hydrogen, and oxygen required to form nucleic acids, the synthesis of nucleic acids still requires phosphorus, which comes from other compounds.

22. A. This is incorrect because according to the law of conservation of mass, the mass remains the same during a chemical reaction.
- B. This is incorrect because the reactants are not forming; only the products are in the process of formation.
- C. This is correct because, according to the graph, the reactants contain more energy than the products and the difference between the two is the amount of heat released in the reaction.
- D. This is incorrect because, according to the graph, the reactants contain more energy than the products, with the difference between the two lost as heat in the reaction.
23. A. This is correct because the energy change would be the opposite in this graph, so the products would contain more energy than the reactants.
- B. This is incorrect because the energy change would be reversed in the new graph.
- C. This is incorrect because enzymes always lower the activation energy in a reaction, regardless of the type of reaction.
- D. This is incorrect because energy would be absorbed, not released, in this reaction, so it would not be an exergonic reaction.
24. A. This is incorrect because the reactants contained more energy than the products; thus, energy was released.
- B. This is correct because the reactants contained more energy than the products; thus energy was released (an exothermic reaction).
- C. This is incorrect because the peak of the line for the enzyme-enabled reaction is much lower than the peak for the reaction with no enzyme presence. Hence, the activation energy was lowered with the enzyme.

- D. This is correct because the amount of energy shown in the graph is larger at the beginning of the reaction and lower at the end.
- E. This is incorrect because the beginning energy in the graph is higher than the resulting energy.
25. A. This is incorrect because, while that may be the case for a small increase in temperature, a large increase in temperature is more likely to disrupt the enzyme's structure.
- B. This is incorrect because enzymes do not provide energy for a reaction.
- C. This is correct because the enzyme would function less well if its shape changed, which it would be likely to do if the temperature increased greatly.
- D. This is incorrect because the enzyme does not provide energy for a reaction, it just reduces the activation energy needed to initiate the reaction.

Unit 2 Unit Test B – Chemistry in Living Systems

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.D.3	2
2	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.E.1	1
3	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.D.1	2
4	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.2	2
5	HS-LS1-6, DCI.HS-LS1.C.3	1
6	HS-LS1-6, DCI.HS-LS1.C.3	2
7	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.F.2	2
8	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.D.3	3
9	HS-LS1-6, DCI.HS-LS1.C.3	1
10	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.F.1, CCC.HS.E.2	1
11	HS-LS1-6, DCI.HS-LS1.C.2	2
12	HS-LS1-6, DCI.HS-LS1.C.2	2
13	HS-LS1-6, DCI.HS-LS1.C.3, SEP.NOS.HS.D.3	2
14	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.4	2
15	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.2	2
16	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.B.1	3
17	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.E.1	3
18	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.D.1	2
19	HS-LS1-6, DCI.HS-LS1.C.3	2
20	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.F.1	3
21	HS-LS1-6, DCI.HS-LS1.C.3	3
22	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.E.3	1
23	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.B.1	2
24	HS-LS1-6, DCI.HS-LS1.C.3, CCC.HS.D.2	2
25	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.B.2	2

1.
 - A. This is incorrect because the hydrogen atoms in water have a slight positive charge, and repel other hydrogen atoms in water molecules.
 - B. This is incorrect because an oxygen atom has a slight negative charge in water molecules, and so it repels other oxygen atoms in water molecules.
 - C. This is correct because oxygen atoms have a slight negative charge in water molecules, while hydrogen atoms have a slight positive charge, so they are attracted to each other.
2.
 - A. This is incorrect because energy cannot be destroyed.
 - B. This is incorrect because it describes photosynthesis, not respiration.
 - C. This is correct because it describes how energy is moved from the bonds in sugar to the bonds in ATP during respiration.
3.
 - A. This is correct because the chemical equation shows that the oxygen in carbon dioxide ends up in glucose. Therefore, if the oxygen in the carbon dioxide molecule were radioactive, then the glucose would be radioactive.
 - B. This is incorrect because based on the equation; radioactive oxygen in water ends up in molecular oxygen.
 - C. This is incorrect because the energy present in the photosynthesis reaction comes from light energy, and it is impossible to add radioactive oxygen to light energy.
4.
 - A. Correct. ATP includes three phosphate groups. Chemical energy is stored within the bonds between these phosphates.
 - B. This answer is incorrect. ADP has only two phosphate groups. Energy was released with the third phosphate group when a phosphate-to-phosphate bond was broken. ADP is a lower energy molecule.
 - C. This answer is incorrect. ATP and ADP cycle constantly. During cellular respiration, energy from the breakdown of biomolecules is used to add a phosphate group to ADP, producing the higher energy molecule, ATP. When energy is needed, a phosphate group is broken off ATP, converting it to ADP and releasing energy.
5.
 - A. This is incorrect because H_2 is an element, not a compound, as it does not contain more than one kind of element.
 - B. This is incorrect because N_2 is an element, not a compound, as it does not contain more than one kind of element.
 - C. This is correct because both carbon dioxide and water contain more than one type of element.
6.
 - A. This is incorrect because osmosis helps water move along a concentration gradient, not upwards through a plant.
 - B. This is correct because the tendency of water to adhere to substances helps it to move upward through a plant.
 - C. This is incorrect because the ability of water to absorb or release heat with little change in temperature does not help it to move through plants.
7.
 - A. This is correct. Carbon's ability to form up to four bonds allows it to form strong chains and rings as seen in the images. If carbon could form only three or fewer bonds, all of the shapes shown would be impossible.
 - B. This is incorrect because carbon can form shapes beyond rings, including chains.
 - C. This is incorrect because although carbon can form double bonds, it is not a requirement of a molecule containing carbon.
8.
 - 1B. *Decrease* is correct because a catalyst reduces the activation energy required to initiate a reaction.
 - 2C. *Do not affect* is correct because catalysts do not change the energy difference of a reaction, which is a function of the bonds formed and broken during the reaction.

- 3A. *Increase* is correct because the reduced activation energy caused by the catalyst allows the reaction to occur at a faster rate.
- 4E. *Are not* is correct because catalysts do not change during the reaction.
9. A. *Diffusion* is the correct answer for the box in lower left of diagram, as this is a type of transport that occurs freely across the cell membrane.
- B. *Passive transport* is the correct answer for the box in the upper center of the diagram. Passive transport requires no energy input from the cell but requires a protein intermediate.
- C. *Active transport* is correct for the box in the lower right of the diagram, as this is a process that requires the input of energy.
10. A. *In fructose* is correct because carbon forms the backbone of sugar molecules.
- B. *In fructose* is correct because hydrogen bonds to both carbon and oxygen atoms in a sugar molecule.
- C. *Not in fructose* is correct because nitrogen is not a component of sugars. It would be expected to be found in amino acids.
11. A. This label, *positive*, belongs to the right of the model because the two hydrogen atoms generate a slightly positive charge in the area around the hydrogen atoms.
- B. This label, *negative*, belongs to the left of the model because the oxygen atom has a slightly negative charge in the area around it.
12. A. *Always contain carbon* is incorrect because both amino acids and sugars always contain carbon.
- B. *Is an input in glycolysis* is an incorrect selection, because sugars, not amino acids, are inputs in glycolysis.
- C. *Structure is coded for in DNA* is a correct selection, because both amino acids and sugars always contain hydrogen.
- D. *Can be used as an energy source* is an incorrect selection, because both sugars and amino acids may contain ring structures.
- E. *Can bond together to form proteins* is correct because amino acids, not sugars, bind to form proteins.
13. A. This function goes in the fifth box because sugars provide energy for cell processes.
- B. This function goes in the first box because waxes provide waterproof coating of surfaces such as those of leaves.
- C. This function goes in the third box because phospholipids compose the selectively permeable cell membrane.
- D. This structure goes in the fourth box because phospholipids have both polar and nonpolar structures.
- E. This structure goes in the sixth box because sugars are an easily available energy source for cells.
- F. This structure goes in the second box because waxes are composed of long, hydrophobic carbon chains.
14. A. *Carbohydrate containing ring structures* is correctly matched with the second image, which shows the carbohydrate lactose, and the third image, which shows the carbohydrate amylose.
- B. *Lipid containing hydrocarbon chain* is correctly matched with the first image, which is a lipid called stearic acid.
15. A. *Output* is correct because ATP is one of the products of cellular respiration, as it is usable energy for the cell.
- B. *Input* is correct because glucose is one of the inputs of cellular respiration, as it is the source of chemical energy.
- C. *Output* is correct because carbon dioxide is one of the products of cellular respiration.

16. **1B.** *The same* is correct because atoms are conserved in chemical reactions such as photosynthesis.
2B. *The same* is correct because mass is conserved in chemical reactions such as photosynthesis.
3A. *Different* is correct because the chemical properties of glucose and oxygen are different from the chemical properties of water and carbon dioxide.

17. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	The student is able to: 1. identify that atoms are not changed during a chemical reaction (DCI); and 2. identify that the mass is conserved during a chemical reaction and identify that bonds between atoms, which contain energy, do change (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying changes of atomic structure Part 2: One point is earned for identifying that the atomic structure of the reactants will differ from that of the product. The same atoms are present, just rearranged. Any one of the following responses, or an equivalent, is acceptable. <ul style="list-style-type: none"> The number of atoms is the same in the reactants as in the products. The kinds of atoms are the same in the reactants as in the products.
Evidence of Mastery of Crosscutting Concepts	2 points for correctly explaining that the mass is conserved Part 1: Two points are earned for explaining that the reason the mass would be the same in the products as in the reactants due to the conservation of mass. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The mass of the reactants and the products would be the same because mass is conserved during a chemical reaction.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. name the molecule that powers cell functions and explain a process for which it provides energy (DCI); and 2. describe the chemical reaction (reactants and products) that releases energy stored in cells to power cell functions (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly naming molecule and identifying process it powers Part 2: One point is earned for naming ATP as the molecule which provides energy for cell processes, and identifying a cell process that uses energy from ATP, such as active transport. The following responses, or an equivalent, is acceptable. <ul style="list-style-type: none"> ATP is the molecule that gives cells processes energy, and a process that it provides energy for is protein synthesis.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly describing the path Part 1: One point is earned for describing the path that energy takes from solar energy reaching Earth to the energy used to power cell functions in animals. During photosynthesis, plants convert solar energy to glucose, which is stored in plant tissues. When an animal consumes a plant, some of the glucose is broken down into ATP, which stores energy in the chemical bonds between phosphate groups. When these bonds are broken, energy is released to power cell functions in the animal. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Sun gives energy to plants. Plants change energy to glucose, which is stored in plant tissues. An animal eats the plant and some of the glucose, which changes into ATP and energy, goes into the animal tissues.

19. Use the rubric below to evaluate total points earned for this item. *[max point: 2]*

DCI Only - 2 Points	
Claims	The student is able to identify the role of amino acid sequence in the primary structure of a protein (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for identifying the role of amino acid sequence in the primary structure of protein</p> <p>Part 1: Two points are earned for identifying that the primary structure of a protein is determined by the order of the amino acids in the protein. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The primary structure of a protein is determined by what order the amino acids are arranged.

20. Use the rubric below to evaluate total points earned for this item. *[max point: 2]*

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe how the chemistry of the ATP solution would have changed after completion of the experiment (DCI); and explain what the results of the experiment indicate about energy stored in ATP (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing how the molecules in the ATP solution would change</p> <p>Part 2: One point is earned for describing how the molecules in the ATP solution would have changed after completion of the experiment. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> After the experiment was completed, the original ATP solution would contain ADP and phosphate.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining what the results of this experiment indicate about energy stored in ATP</p> <p>Part 1: One point is earned for correctly explaining what the results of the experiment indicate about energy stored in ATP. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Muscle tissue becomes shorter when it contracts. Muscle contraction requires energy. Energy released from the ATP caused the muscle to contract.

21. Use the rubric below to evaluate total points earned for this item. *[max point: 2]*

DCI Only - 2 Points	
Claims	The student is able to explain how molecules may combine with other elements to form nucleic acids (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly explaining why nucleic acids cannot be formed from sugars alone</p> <p>Part 1: Two points are earned for explaining that sugars have only carbon, hydrogen, and oxygen. To form a nucleic acid more elements must be present. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Nucleic acids cannot be formed from sugars alone because sugars are composed of only carbon, hydrogen, and oxygen. Since nucleic acids have nitrogen and phosphorus, their biosynthetic pathways require other elements.

22. A. This is incorrect because according to the law of conservation of mass, the mass will remain constant in a reaction.
- B. This is incorrect because the reactants are not forming; only the products are in the process of formation.
- C. This is correct because, according to the graph, the reactants contain more energy than the products and the difference between the two is the amount of heat released in the reaction.

23. A. This is correct because the energy change would be the opposite in this graph, so the products would contain more energy than the reactants.
 B. This is incorrect because the energy change would be reversed in the new graph.
 C. This is incorrect because enzymes always lower the activation energy in a reaction, regardless of the type of reaction.
24. A. This is incorrect because the reactants contained more energy than the products; thus, energy was released.
 B. This is correct because the reactants contained more energy than the products; thus energy was released (an exothermic reaction).
 C. This is incorrect because the peak of the line for the enzyme-enabled reaction is much lower than the peak for the reaction with no enzyme presence. Hence, the activation energy was lowered with the enzyme.
 D. This is correct because the amount of energy shown in the graph is larger at the beginning of the reaction and lower at the end.
25. A. This is incorrect because, while that may be the case for a small increase in temperature, a large increase in temperature is more likely to disrupt the enzyme's structure.
 B. This is correct because the enzyme would function less well if its shape changed, which it would be likely to do if the temperature increased greatly.
 C. This is incorrect because the enzyme does not provide energy for a reaction, it just reduces the activation energy needed to initiate the reaction.

Unit 3 Matter and Energy in Living Systems

Unit 3 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	C	HS-LS2-4, DCI.HS-LS2.B.2	1
2	A	HS-LS1-7, DCI.HS-LS1.C.4	1
3	B	HS-LS1-5, DCI.HS-LS1.C.1	1
4	D	HS-LS2-4, DCI.HS-LS2.B.2	1
5	C	HS-LS1-7	1
6	D	HS-LS2-4, DCI.HS-LS2.B.2	2
7	C	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.E.2	1
8	A	HS-LS2-4, DCI.HS-LS2.B.2	1
9	A	HS-LS2-3, DCI.HS-LS2.B.1	2
10	C	HS-LS2-3, DCI.HS-LS2.B.1	2
11	B	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.B.1, CCC.HS.E.2	1
12	D	HS-LS2-4	1
13	D	HS-LS1-7, DCI.HS-LS1.C.4	1
14	B	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.B.2, CCC.HS.D.2	1
15	B	HS-LS2-3	1

Unit 3 Lesson 1 Quiz – Photosynthesis

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS1-5, DCI.HS-LS1.C.1	123	1
2	D	HS-LS1-5, DCI.HS-LS1.C.1	122	2
3	C	HS-LS1-5, DCI.HS-LS1.C.1	121	2
4	B	HS-LS1-5, DCI.HS-LS1.C.1	123	2
5	D	HS-LS1-5, DCI.HS-LS1.C.1	121-123	2
6	A	HS-LS1-5, DCI.HS-LS1.C.1	118	2
7	B	HS-LS1-5, DCI.HS-LS1.C.1	120	2
8	C	HS-LS1-5, DCI.HS-LS1.C.1	122	2
9	C	HS-LS1-5, DCI.HS-LS1.C.1	119-121	2
10	B	HS-LS1-5, DCI.HS-LS1.C.1	122-123	2
11	Rubric	HS-LS2-3	116-123	2
12	Rubric	HS-LS1-5, DCI.HS-LS1.C.1	122	2
13	Rubric	HS-LS1-5, DCI.HS-LS1.C.1, SEP.HS.B.1	118	1
14	Rubric	HS-LS1-5, DCI.HS-LS1.C.1	117	3
15	Rubric	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.B.2	121	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Chloroplasts contain chlorophyll, the pigment that absorbs sunlight. Because most roots are underground, they have no need for chloroplasts.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	the water molecules used as a source of electrons

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	reactants: water, carbon dioxide products: glucose (sugars) and oxygen

14. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answers:</p> <ul style="list-style-type: none"> Producers are important to life on Earth because they produce the source of chemical energy for themselves and for other organisms. Animals that eat producers obtain their chemical energy directly from producers. Animals that eat other animals, and bacteria and fungi that decompose other organisms, get their chemical energy indirectly from producers. Photosynthesis is a process that captures energy from sunlight to make sugar molecules that store chemical energy. These sugar molecules are the main sources of chemical energy for most organisms on Earth. Photosynthesis is important to most organisms on Earth, as well as to Earth's environment. Photosynthesis removes carbon dioxide from Earth's atmosphere helping to keep the Earth cool enough to support life.

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>The diagram shows the process of photosynthesis. Sample answer: The stacked structure is a granum, which contains the thylakoids. The light-dependent reactions occur in and across the thylakoid membrane.</p>

Unit 3 Lesson 2 Quiz – Cellular Respiration

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS1-7	133	2
2	C	HS-LS1-7	134	2
3	C	HS-LS1-7		2
4	D	HS-LS1-7	135	2
5	D	HS-LS2-3	136	2
6	C	HS-LS1-6, DCI.HS-LS1.C.3	132	2
7	D	HS-LS1-7	134	1
8	B	HS-LS2-3, DCI.HS-LS2.B.1	129-135	2
9	D	HS-LS1-7, DCI.HS-LS1.C.3	132	3
10	B	HS-LS1-7	133-134	2
11	Rubric	HS-LS2-3	121, 132	3
12	Rubric	HS-LS1-7, DCI.HS-LS1.C.3	131	1
13	Rubric	HS-LS2-3	133	1
14	Rubric	HS-LS2-3, DCI.HS-LS2.B.1	136	3
15	Rubric	HS-LS2-3	132	2

11. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <p>Chloroplasts use light energy, whereas mitochondria use energy from organic compounds. Both organelles produce ATP (or adenosine triphosphate, the form of energy that fuels cell processes).</p>

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Glucose and oxygen are needed for cellular respiration.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Glycolysis takes place in the cytoplasm of a cell.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answer should include: <ul style="list-style-type: none"> An example of fermentation in human cells. Answers should include a discussion of lactic acid fermentation in muscle cells that allows ATP production to continue in the absence of oxygen. An example of fermentation by bacteria occurring in animals. Answers should include a discussion of bacteria in the digestive tract aiding in the process of digestion.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: <ul style="list-style-type: none"> The relationship between photosynthesis and cellular respiration is often described as a cycle because the products of one process are used as the reactants for the other. Photosynthesis produces carbohydrates and oxygen from carbon dioxide and water, incorporating light energy into the bonds of the carbohydrates. Cellular respiration, on the other hand, uses oxygen and releases energy from the bonds of carbohydrates, producing carbon dioxide and water.

Unit 3 Lesson 3 Quiz – Modeling Matter and Energy in Ecosystems

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	A	HS-LS2-4	147	1
2	D	HS-LS2-4	149, 152	1
3	B	HS-LS2-4, DCI.HS-LS2.B.1	151	1
4	A	HS-LS2-4, DCI.HS-LS2.B.1		2
5	C	HS-LS2-4	146-147	2
6	D	HS-LS2-4	153	2
7	A	HS-LS2-4	146	2
8	C	HS-LS2-4	147	3
9	C	HS-LS2-4	152	2
10	C	HS-LS2-5	149	1
11	Rubric	HS-LS2-4, DCI.HS-LS2.B.2	146	2

12	Rubric	HS-LS2-6	146-148	2
13	Rubric	HS-LS2-4	151-153	3
14	Rubric	HS-LS2-4, DCI.HS-LS2.B.2	151-152	2
15	Rubric	HS-LS2-4	146	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Answers may vary, but students should identify two non-photosynthetic organisms that must consumer other organisms for food. Sample answer:</p> <ul style="list-style-type: none"> • A goat and a hawk. They are both heterotrophs because they eat other organisms to get their energy.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> • rosebush-rabbit-hawk

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> • This diagram shows that much energy is lost to the environment, but it does not show how much biomass or energy is available at each trophic level.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> • Energy is lost as you move up the trophic levels, making the energy pyramid larger on the bottom than on the top.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> • Decomposers are necessary because they allow matter to continue to move through the biosphere. Without them, the matter in dead organisms could not be recycled into living organisms.

Unit 3 Lesson 4 Quiz – Cycling of Matter and Energy in Ecosystems

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS2-6	142	1
2	D	HS-LS2-5	162	2
3	A	HS-LS2-5	161-162	2
4	A	HS-LS2-4	162	2

5	C	HS-LS2-4	163	2
6	D	HS-LS2-4	163	2
7	B	HS-LS2-4	160	1
8	A	HS-LS2-5	160	1
9	D	HS-LS2-5		2
10	A	HS-LS2-5	165	2
11	Rubric	HS-LS2-4	160	1
12	Rubric	HS-LS2-4	161-162	2
13	Rubric	HS-LS2-5		3
14	Rubric	HS-LS2-4	163	2
15	Rubric	HS-LS2-4	164-165	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The sun is the source of energy for the water cycle.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Animals take in oxygen and release carbon dioxide in respiration and release carbon dioxide in decomposition.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Plants take in carbon dioxide in the process of photosynthesis.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	It is converted into ammonia by nitrogen-fixing bacteria.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Animals participate in the phosphorus cycle by eating plants that absorb phosphorus.

Unit 3 Unit Test A – Matter and Energy in Living Systems

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-5, DCI.HS-LS1.C.1	1
2	HS-LS2-3, DCI.HS-LS2.B.1, CCC.HS.E.4	2
3	HS-LS1-7, DCI.HS-LS1.C.3, CCC.HS.E.4	2
4	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.D.1	2
5	HS-LS1-5, DCI.HS-LS1.C.1, SEP.HS.F.1	2
6	HS-LS2-5, DCI.HS-LS2.B.3, CCC.HS.D.2	2
7	HS-LS2-4, DCI.HS-LS2.B.2, CCC.HS.E.2	2
8	HS-LS2-3, DCI.HS-LS2.B.1	2
9	HS-LS2-5, DCI.HS-PS3.D.3	2
10	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.B.1	1
11	HS-LS2-5, DCI.HS-LS2.B.3, CCC.STSE.HS.B.3	1
12	HS-LS2-5, DCI.HS-LS2.B.3, CCC.STSE.HS.B.4	2
13	HS-LS2-5, DCI.HS-LS2.B.3	2
14	HS-LS1-7, DCI.HS-LS1.C.3, SEP.HS.B.1, CCC.HS.D.2	2
15	HS-LS2-4, DCI.HS-LS2.B.2, CCC.HS.E.3	3
16	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.E.2	3
17	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.B.1	1
18	HS-LS2-5, DCI.HS-PS3.D.3, CCC.HS.D.2	2
19	HS-LS2-3, DCI.HS-LS2.B.1, SEP.NOS.HS.C.1	2
20	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.E.3, CCC.HS.D.2	3
21	HS-LS2-5, DCI.HS-LS2.B.3, SEP.HS.B.1	3
22	HS-LS1-7, DCI.HS-LS1.C.4, SEP.HS.B.1	1
23	HS-LS1-7, DCI.HS-LS1.C.3	2
24	HS-LS1-7, DCI.HS-LS1.C.4	2
25	HS-LS2-3, DCI.HS-LS2.B.1	3

- A.** This is incorrect because fish do not have the ability to undergo photosynthesis.

B. This is correct because photosynthesis requires carbon dioxide as a carbon source.

C. This is incorrect because carbon dioxide is a product, not a reactant, in respiration.

D. This is incorrect because anaerobic respiration does not use carbon dioxide as a replacement for oxygen.
- A.** This is correct because when muscle cells need energy and lack available oxygen, they will enter fermentation (anaerobic respiration).

B. This is incorrect because a lack of oxygen, not lack of glucose, will not cause cells to enter anaerobic respiration. Breathing heavily is a part of the body's attempt to get more oxygen to cells for aerobic respiration.

C. This is incorrect because glucose is used in both aerobic respiration and fermentation, and aerobic respiration does not explain the burning, as it does not produce lactic acid.

D. This is incorrect because excess carbon dioxide does not cause aerobic respiration to take place.

3. A. This is incorrect because cellular respiration releases energy as heat as the bonds of glucose are broken.
B. This is incorrect because glucose is oxidized and oxygen is reduced in the process of respiration.
C. This is correct because respiration results in a release of energy as heat as glucose molecules are oxidized into carbon dioxide and oxygen is reduced into water.
D. This is incorrect because cellular respiration releases energy as heat as the bonds of glucose are broken and ATP is formed.
4. A. This is incorrect because water is an output of respiration, not an input.
B. This is incorrect because oxygen is an input of respiration, not an output.
C. This is correct because glucose is the primary product of photosynthesis, and is what is broken down during cellular respiration.
D. This is incorrect because carbon dioxide is an output for respiration and an input for photosynthesis.
5. A. This is incorrect because oxygen is not a reactant (requirement) for photosynthesis.
B. This is incorrect because the algae in the subtidal habitat had a higher photosynthetic rate than the algae in the salt marsh. Carbon dioxide is required for photosynthesis, so more carbon dioxide might be expected in the subtidal algae but not in the salt marsh algae.
C. This is correct because the algae in the subtidal habitat had a higher photosynthetic rate than the algae in the salt marsh, which would best be explained by the subtidal algae containing more chlorophyll.
D. This is incorrect because mitochondria are involved in the process of respiration, not photosynthesis.
6. A. This is correct because arrow 2 represents photosynthesis, which moves carbon into the biosphere, and arrow 3 represents respiration, in which carbon dioxide moves from the biosphere into the atmosphere.
B. This is incorrect because arrow 2 moves carbon toward the biosphere. Photosynthesis is a process that removes carbon from the atmosphere, and fixes carbon into food for the plant.
C. This is incorrect because arrow 3 showcases the respiration process, where carbon dioxide is a byproduct released by plants and animals when breaking down sugar (glucose) for energy. The carbon dioxide moves into the atmosphere.
D. This is incorrect because arrow 2 represents photosynthesis, which moves carbon into the biosphere, and arrow 3 represents respiration, in which carbon dioxide moves from the biosphere into the atmosphere, so both arrows move in the opposite direction of that indicated by this answer choice.
7. A. This is correct because the net primary productivity of the tropical rainforest is larger than the NPP of the savanna. Since assimilation is the incorporation of nitrogen into plant biomass, this is occurring more often in the tropical rainforest than in the savanna.
B. This is incorrect because denitrification is the process by which anaerobic bacteria convert nitrogen in the soil to atmospheric nitrogen. The graph is showing information about net primary productivity, which does not relate to denitrification.
C. This is incorrect because the net primary productivity in the savanna is lower than in the temperate deciduous forest. This means that there is actually more assimilation occurring in the temperate deciduous forest than in the savanna since more nitrogen is being incorporated into plant matter in the temperate deciduous forest.
D. This is incorrect because denitrification is the process by which anaerobic bacteria convert nitrogen in the soil to atmospheric nitrogen. The graph is showing information about net primary productivity, which does not relate to denitrification.
8. A. This is incorrect because carbon dioxide and water are reactants of photosynthesis while carbon dioxide and water are the products of cellular respiration.
B. This is incorrect because carbon dioxide is a reactant of the photosynthesis reaction, but not a product.

- C. This is correct because the products of photosynthesis, glucose and oxygen, are the reactants of cellular respiration. Similarly, the products of cellular respiration, water and carbon dioxide, are the reactants of photosynthesis.
- D. This is incorrect because oxygen is a reactant of cellular respiration, and not a product of this reaction.
9. A. This answer is incorrect because it reverses the energy relationship between a lower trophic level and the next level.
- B. This answer is incorrect because it reverses the energy relationship between a lower trophic level and the next level, and it mistakes the percent of the energy which is transferred as 15% instead of 10%.
- C. This answer is correct because 10% of the energy is passed from one trophic level to the next.
- D. This answer is incorrect because it mistakes the percent of the energy which is transferred as 15% instead of 10%.
10. A. *Energy* belongs in the output column because ATP and NADH are produced during the process of glycolysis.
- B. *Oxygen* does not belong in either column because oxygen is not involved in glycolysis, so it is neither an input nor an output.
- C. *3-carbon sugar* belongs in the output column because pyruvate, a 3-carbon sugar, is a product of glycolysis.
- D. *6-carbon sugar* belongs in the input column because glucose, a 6-carbon sugar, is broken down during glycolysis.
11. 1A. *Producers* belongs in the first blank because when phosphorous is added, the result is an increase in the number of producers in the habitat. Phosphorous is the limiting factor for the plants (producers) and when this nutrient is added, the producers, often algae, increase dramatically.
- 2F. *Decomposition* belongs in the second blank because it is the process that happens after the producers die. In order to return the nutrients to the environment, fungi and bacteria break down the algae (producers) into smaller organic components.
- 3I. *Oxygen* belongs in the third blank because the decomposition process removes a large amount of the oxygen in the water. Because decomposition is done by living organisms such as bacteria and fungi, these organisms remove oxygen from the water, thus leaving very little oxygen that other organisms can use to survive.
12. A. *Adding manure to the soil* belongs in the *Increases nitrogen amounts* column because manure is an organic fertilizer that contains nitrogen.
- B. *Planting corn in a nitrogen-rich field* belongs in the *Decreases nitrogen amounts* column because the corn would convert the nitrogen in the soil to biomass. This corn would then be harvested, thus completely removing it from the system.
- C. *Adding nitrogen gas-releasing bacteria to the soil* belongs in the *Decreases nitrogen amounts* column because they convert nitrate back to atmospheric nitrogen, thus removing it from the soil.
- D. *Adding commercial fertilizer* belongs in the *Increases nitrogen amounts* column because it contains nitrogen.
13. A. This activity adds carbon because decomposition releases carbon dioxide as hydrocarbons are broken down.
- B. This activity adds carbon because the burning of fossil fuels results in the production of carbon dioxide.
- C. This activity removes carbon because photosynthesis requires carbon dioxide to be removed from the atmosphere as a source of carbon for sugar.
- D. This activity adds carbon because the products of respiration are water and carbon dioxide.

14. **1B.** *Oxygen* is correct because the inputs of cellular respiration are sugar and oxygen.
2F. *Carbon dioxide* is correct because the final outputs of cellular respiration are carbon dioxide and water.
3A. *ATP* is correct because up to 38 molecules of ATP are produced from one molecule of glucose during cellular respiration.
4I. *Conserved* is correct because energy is neither created nor destroyed. It is transferred and transformed during these reactions.
15. **A.** 10 does not belong in model. None of the trophic levels have 10 kcal/m²/year available to it.
B. 100 belongs in top box. Tertiary consumers would have 10% of 10% of 10,000 kcal/m²/year available to them, or 10² kcal/m²/year.
C. 1,000 belongs in the second box from the top. Secondary consumers would have 10% of 10,000 kcal/m²/year available to them, or 10³ kcal/m²/year.
D. 10,000 belongs in the third box from the top. Primary consumers have 10,000 kcal/m²/year available to them, or 10⁴ kcal/m²/year.
E. 100,000 belongs in the bottom box. Producers would have 10 times 10,000 kcal/m²/year available to them, or 10⁵ kcal/m²/year.
F. 1,000,000 does not belong in the model. None of the trophic levels have s 10⁶ kcal/m²/year available to it.
16. **A.** *Oxygen* belongs in position 2, because oxygen is an output of the light-dependent reactions.
B. *Carbon dioxide* belongs in position 4, because carbon dioxide is an input in the light-independent reactions.
C. *Water* belongs in position 1, because water is an input in the light-dependent reactions.
D. *Sugar* belongs in position 3, because sugar is the main product of the light-independent reactions.
17. **A.** This statement matches the model in the third row. It shows the standard trophic energy efficiency of 10 percent that is transferred from one level to the next. Energy lost as heat is also shown.
B. This statement matches the model in the second row. It shows the total dry mass per unit area making up organisms at the four different trophic levels.
C. This statement matches the model in the first row. It shows the number of individual organisms at the four different trophic levels.
18. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. describe the role of producers in the carbon cycle (DCI); and 2. explain why understanding the model of the carbon cycle contributes to predicting climate changes (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the role of producers</p> <p>Part 1: One point is earned for describing the vital role of producers in the carbon cycle. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Plants and other producers (photosynthetic bacteria and algae) carry out photosynthesis, in which atmospheric carbon in the form of carbon dioxide is converted into chemical energy in the form of organic compounds called sugars. All organisms are made of carbon compounds. Without photosynthesis, organic matter could not be continuously created to be used as food by all other consumers in the ecosystem.

Evidence of Mastery of Crosscutting Concepts	<p>1 point for explaining importance of understanding carbon cycle</p> <p>Part 2: One point is earned for explaining that understanding the carbon cycle allows better understanding of climate change because carbon dioxide is one of the chief drivers of climate change, and understanding inputs and outputs of atmospheric carbon dioxide can help one better model climate change. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> To accurately predict climate forecasts, we need a better understanding of the global and regional variation in the sources and sinks of carbon. Understanding the variation in the inputs and outputs of carbon can help improve the accuracy of climate prediction models.
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19. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> justify a given conclusion using data about cellular respiration (DCI), and identifies a biochemical process that explains given results (DCI), and describe the current understanding of the Krebs cycle (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly justifying a conclusion</p> <p>Part 1: One point is earned for justifying the conclusion that substances increased respiration. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Oxygen being consumed is the measure that respiration is taking place. Fumarate, succinate and malate all caused more oxygen to be consumed than the control, meaning they increased respiration. <p>1 point for correctly identifying a process that explains results</p> <p>Part 2: One point is earned for identifying a biochemical process that would explain the results. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> A cycle (or the Krebs Cycle) would explain why not all of the substances would have been used up in the experiment, because, in a cycle, substances are being renewed over and over again.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly describing the current understanding of the Krebs cycle</p> <p>Part 3: One point is earned for describing our most current understanding of respiration, including the role of oxygen. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> After the Krebs cycle, ATP is produced in the electron transport chain. Oxygen is the final electron acceptor as it becomes a part of water molecules.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain the transfer of matter and flow of energy between organisms and their environment (DCI); and predict the effects of changes in the flow of energy in the ecosystem (SEP); and calculate the efficiency in the transfer of energy and matter (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining the transfer of energy</p> <p>Part 1: One point is earned for describing the flow of energy and matter between the trophic levels. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> There are four trophic levels with the greatest energy and mass found within the first trophic level or photosynthetic producers (algae/phytoplankton). The producers are fed upon by the primary consumers, or zooplankton, in the second trophic level. Insects make up the third trophic level, which are secondary consumers that are fed upon by the top carnivore, fish. At each trophic level, only a portion of the energy and matter is transferred upward to the next level. Some of that energy is lost as heat or metabolism within the organisms, although energy and matter are conserved. Given this energy and matter inefficiency, there are generally fewer organisms and less energy at higher trophic levels.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly predicting the effects of reducing primary production in the ecosystem</p> <p>Part 3: One point is earned for predicting that fewer trophic levels can be sustained with less primary production in the aquatic ecosystem. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> With a significant reduction in primary production, each trophic level will have a greatly reduced energy supply, and the amount of energy available would likely be insufficient to support the top fish carnivores.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for explaining how to calculate efficiency in the transfer of matter and energy</p> <p>Part 2: One point is earned for using the provided data to correctly calculate the energy transfer efficiency from one trophic level to the next level. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data suggest that the energy transfer efficiency is 15 percent because 150,000 kcal is transferred to the second level from the first level containing 1,000,000 kcal of energy. Thus, 85 percent is lost. This transfer efficiency is maintained throughout the energy pyramid. Thus, 22,500 kcal is found at the third level and 3,375 kcal is found at the fourth level.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 4]

DCI, SEP - 4 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe how carbon enters and exits the biosphere and atmosphere in a given food chain (DCI); and predict the effect of altering a given food chain relationships between components of a system (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly describing how carbon enters and exits this specific food chain</p> <p>Part 1: Two points are earned for describing that carbon enters the system as a plant takes in carbon dioxide and utilizes it in photosynthesis to make glucose, which is then assimilated into the plant, and that carbon is released into the atmosphere as all three organisms undergo cellular respiration and release carbon dioxide into the air. Conversely, students could also describe the movement of carbon back into the environment as the organisms die.</p> <ul style="list-style-type: none"> Carbon enters the food chain as the green algae takes in carbon dioxide gas and uses it to create glucose through photosynthesis. Carbon exits the food chain as the animals take in food and perform cellular respiration for energy. This process releases carbon dioxide gas back into the atmosphere.

Evidence of Mastery of Science and Engineering Practices	<p>2 points for correctly predicting the outcome of mayfly removal from the food chain</p> <p>Part 2: Two points are earned for correctly identifying that the green algae will no longer be eaten by the mayfly nymphs, thus the green algae will accumulate, and for predicting that the white perch will die, thus recycling carbon instead of it being released into the atmosphere as carbon dioxide gas.</p> <ul style="list-style-type: none"> When the mayfly nymphs are removed from the food chain, the green algae will no longer have anything that eats them. Because of this, the amount of green algae (carbon) will grow in the ecosystem. Also, because the white perch will no longer have food, they will die, thus returning the carbon located within their bodies to the lake bottom.
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22. A. This is incorrect because the precursor to ATP is ADP.
 B. This is correct because each oxygen picks up a pair of hydrogen ions to form water.
 C. This is incorrect because carbon dioxide is given off from the breakdown of organic compounds.
 D. This is incorrect because organic compounds combine with oxygen to release carbon dioxide and water.
23. The numbers in order should be 5, 2, 4, 3, and 1. First, glucose is absorbed by the muscle cell, and then broken down during glycolysis. During glycolysis and Krebs cycle, the energy in glucose is transferred to NADH and FADH₂. These molecules are used by the electron transport chain to produce ATP, which provides energy for the contraction of muscles.
24. A. The word *water* belongs in the *Increase* column because water is released during respiration.
 B. The word *oxygen* belongs in the *Decrease* column because oxygen is consumed during respiration.
 C. The words *nitrogen gas* belong in the *Remain the same* column because nitrogen gas is not involved in respiration.
 D. The words *carbon dioxide* belong in the *Increase* column because carbon dioxide is released during respiration.
25. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	The student is able to explain how the cycling of matter and transfer of energy account for the shape of an ecological pyramid (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for explaining the apparent loss of matter and energy</p> <p>Part 2: Two points are earned for explaining that matter and energy are lost to their environment as they move through organisms in an ecosystem. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Matter and energy are lost to their environment as they move from photosynthesizing producers to consumers in an ecosystem as shown in the pyramid with amount of energy and numbers of organisms. Energy is lost as heat, and matter is lost as waste. At the low levels, there is more matter and energy at the producer level due to photosynthesis making matter than at the higher consumer levels due to cellular respiration releasing that energy.

Unit 3 Unit Test B – Matter and Energy in Living Systems

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-5, DCI.HS-LS1.C.1	1
2	HS-LS2-3, DCI.HS-LS2.B.1, CCC.HS.E.4	2
3	HS-LS1-7, DCI.HS-LS1.C.3, CCC.HS.E.4	2
4	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.D.1	2

5	HS-LS1-5, DCI.HS-LS1.C.1, SEP.HS.F.1	2
6	HS-LS2-5, DCI.HS-LS2.B.3, CCC.HS.D.2	2
7	HS-LS2-4, DCI.HS-LS2.B.2, CCC.HS.E.2	2
8	HS-LS2-3, DCI.HS-LS2.B.1	2
9	HS-LS2-5, DCI.HS-PS3.D.3	2
10	HS-LS1-6, DCI.HS-LS1.C.3, SEP.HS.B.1	1
11	HS-LS2-5, DCI.HS-LS2.B.3, CCC.STSE.HS.B.3	1
12	HS-LS2-5, DCI.HS-LS2.B.3, CCC.STSE.HS.B.4	2
13	HS-LS2-5, DCI.HS-LS2.B.3	2
14	HS-LS1-7, DCI.HS-LS1.C.3, SEP.HS.B.1, CCC.HS.D.2	2
15	HS-LS2-4, DCI.HS-LS2.B.2, CCC.HS.E.3	3
16	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.E.2	3
17	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.B.1	1
18	HS-LS2-5, DCI.HS-PS3.D.3, CCC.HS.D.2	2
19	HS-LS2-3, DCI.HS-LS2.B.1, SEP.NOS.HS.C.1	2
20	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.E.3, CCC.HS.D.2	3
21	HS-LS2-5, DCI.HS-LS2.B.3, SEP.HS.B.1	3
22	HS-LS1-7, DCI.HS-LS1.C.4, SEP.HS.B.1	1
23	HS-LS1-7, DCI.HS-LS1.C.3	2
24	HS-LS1-7, DCI.HS-LS1.C.4	2
25	HS-LS2-3, DCI.HS-LS2.B.1	3

- This is incorrect because fish do not have the ability to undergo photosynthesis.
 - This is correct because photosynthesis requires carbon dioxide as a carbon source.
 - This is incorrect because carbon dioxide is a product, not a reactant, in respiration.
- This is correct because when muscle cells need energy and lack available oxygen, they will enter fermentation (anaerobic respiration).
 - This is incorrect because a lack of oxygen, not lack of glucose, will not cause cells to enter anaerobic respiration. Breathing heavily is a part of the body's attempt to get more oxygen to cells for aerobic respiration.
 - This is incorrect because excess carbon dioxide does not cause aerobic respiration to take place.
- This is incorrect because cellular respiration releases heat as the bonds of glucose are broken.
 - This is incorrect because glucose is oxidized and oxygen is reduced in the process of respiration.
 - This is correct because respiration results in a release of heat energy as glucose molecules are oxidized into carbon dioxide and oxygen is reduced into water.
- This is incorrect because oxygen is an input of respiration, not an output.
 - This is correct because glucose is the primary product of photosynthesis and is what is broken down during cellular respiration.
 - This is incorrect because carbon dioxide is an output for respiration and an input for photosynthesis.

5.
 - A. This is incorrect because available oxygen would be the same.
 - B. This is incorrect because, although carbon dioxide content would be the same, more carbon dioxide would increase photosynthesis.
 - C. This is correct because the plants in fresh water had a higher photosynthetic rate than the plants in salt water, which would best be explained by the more chlorophyll.
6.
 - A. This is incorrect because arrow 3 showcases the respiration process, where carbon dioxide is a byproduct released by plants and animals when breaking down sugar (glucose) for energy. The carbon dioxide moves into the atmosphere.
 - B. This is correct because arrow 2 represents photosynthesis, which moves carbon into the biosphere, and arrow 3 represents respiration, in which carbon dioxide moves from the biosphere into the atmosphere.
 - C. This is incorrect because arrow 2 moves carbon toward the biosphere. Photosynthesis is a process that removes carbon from the atmosphere, and fixes carbon into food for the plant.
7.
 - A. This is correct because the net primary productivity of the tropical rainforest is larger than the NPP of the savanna. Since assimilation is the incorporation of nitrogen into plant biomass, this is occurring more often in the tropical rainforest than in the savanna.
 - B. This is incorrect because denitrification is the process by which anaerobic bacteria convert nitrogen in the soil to atmospheric nitrogen. The graph is showing information about net primary productivity, which does not relate to denitrification.
 - C. This is incorrect because the net primary productivity in the savanna is lower than in the temperate deciduous forest. This means that there is actually more assimilation occurring in the temperate deciduous forest than in the savanna since more nitrogen is being incorporated into plant matter in the temperate deciduous forest.
8.
 - A. This is incorrect because carbon dioxide and water are reactants of photosynthesis while carbon dioxide and water are the products of cellular respiration.
 - B. This is incorrect because carbon dioxide is a reactant of the photosynthesis reaction, but not a product.
 - C. This is correct because the products of photosynthesis, glucose and oxygen, are the reactants of cellular respiration. Similarly, the products of cellular respiration, water and carbon dioxide, are the reactants of photosynthesis.
9.
 - A. This answer is incorrect because it reverses the energy relationship between a lower trophic level and the next level.
 - B. This answer is incorrect because it reverses the energy relationship between a lower trophic level and the next level, and it mistakes the percent of the energy which is transferred as 15% instead of 10%.
 - C. This answer is correct because 10% of the energy is passed from one trophic level to the next.
10.
 - A. *Energy* belongs in the output column because ATP and NADH are produced during the process of glycolysis.
 - B. *Oxygen* does not belong in either column, because oxygen is not involved in glycolysis, so it is neither an input nor an output.
 - C. *6-carbon sugar* belongs in the input column because glucose, a 6-carbon sugar, is broken down during glycolysis.
11.
 - 1A. *Producers* belongs in the first blank because when phosphorous is added, the result is an increase in the number of producers in the habitat. Phosphorous is the limiting factor for the plants (producers) and when this nutrient is added, the producers, often algae, increase dramatically.
 - 2D. *Decomposition* belongs in the second blank because it is the process that happens after the producers die. In order to return the nutrients to the environment, fungi and bacteria break down the algae (producers) into smaller organic components.

- 3F. *Oxygen* belongs in the third blank because the decomposition process removes a large amount of the oxygen in the water. Because decomposition is done by living organisms such as bacteria and fungi, these organisms remove oxygen from the water, thus leaving very little oxygen that other organisms can use to survive.
12. A. *Adding manure to the soil* belongs in the *Increases nitrogen amounts* column because manure is an organic fertilizer that contains nitrogen.
- B. *Planting corn in a nitrogen-rich field* belongs in the *Decreases nitrogen amounts* column because the corn would convert the nitrogen in the soil to biomass. This corn would then be harvested, thus completely removing it from the system.
- C. *Adding commercial fertilizer* belongs in the *Increases nitrogen amounts* column because it contains nitrogen.
13. A. This activity adds carbon because the burning of fossil fuels results in the production of carbon dioxide.
- B. This activity removes carbon because photosynthesis requires carbon dioxide to be removed from the atmosphere as a source of carbon for sugar.
- C. This activity removes carbon because the products of respiration are water and carbon dioxide.
14. 1B. *Oxygen* is correct because the inputs of cellular respiration are sugar and oxygen.
- 2f. *Carbon dioxide* is correct because the final outputs of cellular respiration are carbon dioxide and water.
- 3A. *ATP* is correct because up to 38 molecules of ATP are produced from one molecule of glucose during cellular respiration.
15. A. *100* belongs in top box. Tertiary consumers would have 10% of 10% of 10,000 kcal/m²/year available to them, or 10² kcal/m²/year.
- B. *1,000* belongs in the second box from the top. Secondary consumers would have 10% of 10,000 kcal/m²/year available to them, or 10³ kcal/m²/year.
- C. *10,000* belongs in the third box from the top. Primary consumers have 10,000 kcal/m²/year available to them, or 10⁴ kcal/m²/year.
- D. *100,000* belongs in the bottom box. Producers would have 10 times 10,000 kcal/m²/year available to them, or 10⁵ kcal/m²/year.
16. A. *Oxygen* belongs in position 2 because oxygen is an output of the light-dependent reactions.
- B. *Carbon dioxide* belongs in position 4 because carbon dioxide is an input in the light-independent reactions.
- C. *Water* belongs in position 1 because water is an input in the light-dependent reactions.
- D. *Sugar* belongs in position 3 because sugar is the main product of the light-independent reactions.
17. A. This statement matches the model in the third row. It shows the standard trophic energy efficiency of 10 percent that is transferred from one level to the next. Energy lost as heat is also shown.
- B. This statement matches the model in the second row. It shows the total dry mass per unit area making up organisms at the four different trophic levels.
- C. This statement matches the model in the first row. It shows the number of individual organisms at the four different trophic levels.
18. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. describe the role of producers in the carbon cycle (DCI); and 2. explain why understanding the model of the carbon cycle contributes to predicting climate changes (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the role of producers</p> <p>Part 1: One point is earned for describing the vital role of producers in the carbon cycle. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Plants and other producers (photosynthetic bacteria and algae) carry out photosynthesis, in which atmospheric carbon in the form of carbon dioxide is converted into chemical energy in the form of organic compounds called sugars. All organisms are made of carbon compounds. Without photosynthesis, organic matter could not be continuously created to be used as food by all other consumers in the ecosystem.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for explaining the importance of understanding carbon cycle</p> <p>Part 2: One point is earned for explaining that understanding the carbon cycle allows better understanding of climate change because carbon dioxide is one of the chief drivers of climate change, and understanding inputs and outputs of atmospheric carbon dioxide can help one better model climate change. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> To accurately predict climate forecasts, we need a better understanding of the global and regional variation in the sources and sinks of carbon. Understanding the variation in the inputs and outputs of carbon can help improve the accuracy of climate prediction models.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> justify a given conclusion using data about cellular respiration (DCI); and describe the current understanding of the Krebs cycle (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly justifying a conclusion</p> <p>Part 1: One point is earned for justifying the conclusion that substances increased respiration. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Oxygen being consumed is the measure that respiration is taking place. Fumarate, succinate and malate all caused more oxygen to be consumed than the control, meaning they increased respiration.
Evidence of Mastery of Science and Engineering Practices	<p>2 points for correctly describing the current understanding of the Krebs cycle</p> <p>Part 2: Two points are earned for describing our most current understanding of respiration. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> After the Krebs cycle, ATP is produced in the electron transport chain. Oxygen is the final electron acceptor as it becomes a part of water molecules.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain the transfer of matter and flow of energy between organisms and their environment (DCI); and calculate the efficiency in the transfer of energy and matter (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining how the model illustrates the cycling of matter and flow of energy among organisms in an ecosystem</p> <p>Part 1: One point is earned for explaining the flow of energy and matter between the trophic levels. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> There are four trophic levels with the greatest energy and mass found within the first trophic level or photosynthetic producers (algae/phytoplankton). The producers are fed upon by the primary consumers, or zooplankton, in the second trophic level. Insects make up the third trophic level, which are secondary consumers that are fed upon by the top carnivore, fish. At each trophic level, only a portion of the energy and matter is transferred upward to the next level. Some of that energy is lost as heat or metabolism within the organisms, although energy and matter are conserved. Given this energy and matter inefficiency, there are generally fewer organisms and less energy at higher trophic levels.
Evidence of Mastery of Crosscutting Concepts	<p>2 points for calculating the efficiency in the transfer of matter and energy</p> <p>Part 2: Two points are earned for calculating the energy transfer efficiency from one trophic level to the next level. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data suggest that the energy transfer efficiency is 15 percent because 150,000 kcal is transferred to the second level from the first level containing 1,000,000 kcal of energy. Thus, 85 percent is lost. This transfer efficiency is maintained throughout the energy pyramid. Thus, 22,500 kcal is found at the third level and 3,375 kcal is found at the fourth level.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 4]

DCI, SEP - 4 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe the contribution of photosynthesis and cellular respiration to the exchange of carbon within and among the biosphere and atmosphere (DCI); and develop a new model based on a change in relationships between components of a system (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly describing how carbon enters and exits this specific food chain</p> <p>Part 1: Two points are earned for describing that carbon enters the system as a plant takes in carbon dioxide and utilizes it in photosynthesis to make glucose, which is then assimilated into the plant, and that carbon is released into the atmosphere as all three organisms undergo cellular respiration and release carbon dioxide into the air. Conversely, students could also describe the movement of carbon back into the environment as the organisms die.</p> <ul style="list-style-type: none"> Carbon enters the food chain as the green algae takes in carbon dioxide gas and uses it to create glucose through photosynthesis. Carbon exits the food chain as the animals take in food and perform cellular respiration for energy. This process releases carbon dioxide gas back into the atmosphere.
Evidence of Mastery of Science and Engineering Practices	<p>2 points for correctly predicting the outcome of mayfly removal from the food chain</p> <p>Part 2: Two points are earned for correctly identifying that the green algae will no longer be eaten by the mayfly nymphs, thus the green algae will accumulate, and for predicting that the white perch will die, thus recycling carbon instead of it being released into the atmosphere as carbon dioxide gas.</p> <ul style="list-style-type: none"> When the mayfly nymphs are removed from the food chain, the green algae will no longer have anything that eats them. Because of this, the amount of green algae (carbon) will grow in the ecosystem. Also, because the white perch will no longer have food, they will die, thus returning the carbon located within their bodies to the lake bottom.

22. A. This is incorrect because the precursor to ATP is ADP.

B. This is correct because each oxygen picks up a pair of hydrogen ions to form water.

C. This is incorrect because carbon dioxide is given off from the breakdown of organic compounds.

23. The numbers in order should be 5, 2, 4, 3, and 1. First, glucose is absorbed by the muscle cell, and then broken down during glycolysis. During glycolysis and Krebs cycle, the energy in glucose is transferred to NADH and FADH₂. These molecules are used by the electron transport chain to produce ATP, which provides energy for the contraction of muscles.
24. A. *Water* belongs in the *Increase* column because water is released during respiration.
 B. *Oxygen* belongs in the *Decrease* column because oxygen is consumed during respiration.
 C. *Nitrogen gas* belongs in the *Remain the same* column because nitrogen gas is not involved in respiration.
 D. *Carbon dioxide* belongs in the *Increase* column because carbon dioxide is released during respiration.
25. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	The student is able to explain how the cycling of matter and transfer of energy account for the shape of an ecological pyramid (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for explaining the apparent loss of matter and energy</p> <p>Part 2: Two points are earned for explaining that matter and energy are lost to their environment as they move through organisms in an ecosystem. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Matter and energy are lost to their environment as they move from photosynthesizing producers to consumers in an ecosystem as shown in the pyramid with amount of energy and numbers of organisms. Energy is lost as heat, and matter is lost as waste. At the low levels, there is more matter and energy at the producer level due to photosynthesis making matter than at the higher consumer levels due to cellular respiration releasing that energy.

Unit 4 Ecosystems: Stability and Change

Unit 4 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	C	HS-LS2-1	1
2	D	HS-LS2-2, DCI.HS-LS2.C.1, CCC.HS.G.1	1
3	B	HS-LS2-1, DCI.HS-LS2.A.1	1
4	A	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.G.2	1
5	D	HS-ESS2-7, DCI.HS-ESS2.E.1, CCC.HS.G.1	2
6	B	HS-LS2-1	1
7	C	HS-LS2-1	1
8	C	HS-LS2-2, DCI.HS-LS2.C.1	1
9	A	HS-LS2-1	2
10	A	HS-LS2-2, DCI.HS-LS2.C.1	1
11	C	HS-LS2-1, CCC.HS.G.2	2
12	B	HS-LS2-1, SEP.HS.B.2, CCC.HS.G.2	1
13	D	HS-LS2-1, CCC.HS.G.2	1
14	D	HS-LS2-1, DCI.HS-LS2.A.1	2
15	A	HS-LS2-1, SEP.HS.E.2	2

Unit 4 Lesson 1 Quiz – Population Dynamics

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	A	HS-LS2-1, SEP.HS.E.2		1
2	D	HS-LS2-1, DCI.HS-LS2.A.1	189-190	2
3	C	HS-LS2-1	191	2
4	C	HS-LS2-1, SEP.HS.B.2, CCC.HS.D.2	187	2
5	A	HS-LS2-1, SEP.HS.E.1, CCC.HS.G.2	186	2
6	C	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.B.2, CCC.HS.D.3	187-188	2
7	B	HS-LS2-1	184	2
8	B	HS-LS2-1, DCI.HS-LS2.A.1	189-190	2
9	A	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.G.1	186	2
10	C	HS-LS2-1, SEP.HS.D.1, CCC.HS.G.2	186	2
11	Rubric	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.D.1, CCC.HS.C.3	186	2
12	Rubric	HS-LS2-1, DCI.HS-LS2.A.1, CCC.STSE.HS.B.1	188	3
13	Rubric	HS-LS2-1, SEP.HS.B.2, CCC.HS.C.3	187	3
14	Rubric	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.D.1	189	2
15	Rubric	HS-LS2-1, SEP.HS.D.1, CCC.HS.G.2	188	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The moose population is low, so the wolves have less food to eat. As a result, their population decreases.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	When population growth is slow, there is a better chance that the carrying capacity of the land will not be exceeded and that environmental degradation can be avoided. In contrast, when a population is growing very quickly, it is difficult for governments to provide services such as a clean water supply, adequate sewage disposal, health care, and education for its citizens.

13. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Students should explain that the survivorship curve shows the number of surviving members of a species over time from a measured set of births. From this information, one can observe whether death rates are higher early in life or later in life. This information can help to explain the number of offspring a species produces.</p> <p>Students should define and provide an example of any two out of the following three types of survivorship curves:</p> <ul style="list-style-type: none"> • A type I curve shows that most individuals survive into old age; humans or other large predators are examples. The level of parental care is high. • A type II curve shows that individuals that are susceptible to predation at any age—small mammals and birds, for example—die at the same rate throughout their lives. The level of parental care is intermediate. • A type III curve—which is followed by fish, amphibians, and plants—shows a high infant mortality rate, shows when the species is most susceptible to predation, and fits with the species' strategy of producing many young so that some survive. The level of parental care is low.

14. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	6.0 mg/cc

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> • Logistic growth. The curve has a period of exponential growth but then levels off at a stable size.

Unit 4 Lesson 2 Quiz – Ecosystem Dynamics

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS2-2, DCI.HS-LS2.C.1, CCC.HS.G.1	206-207	2
2	D	HS-LS2-2, DCI.HS-LS2.C.1	207	2
3	C	HS-LS2-6	206	2
4	C	HS-LS4-5, DCI.HS-LS4.C.4	205	2
5	D	HS-LS2-6	206	2
6	A	HS-LS2-2, DCI.HS-LS2.C.1	204	2
7	D	HS-LS2-6, DCI.HS-LS2.C.1	203-204	2
8	C	HS-LS2-6, DCI.HS-LS2.C.1, CCC.HS.B.2	197	2
9	A	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.B.1	188, 204	2
10	B	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.D.2	199	2
11	Rubric	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.D.2		2
12	Rubric	HS-LS2-2, DCI.HS-LS2.C.1	204	2

13	Rubric	HS-LS2-6, DCI.HS-LS2.C.1	204	2
14	Rubric	HS-LS2-2, DCI.HS-LS2.C.1, SEP.HS.B.2, CCC.HS.D.2	206	3
15	Rubric	HS-LS2-2, DCI.HS-LS2.C.1, SEP.HS.F.2, CCC.HS.G.3	203	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>To receive full credit, students should give an example of a keystone species and explain that whatever happens to this species affects all the other species in the ecosystem. Common examples of a keystone species are beavers and wolves.</p> <p>Sample answer:</p> <ul style="list-style-type: none"> An example of a keystone species is wolves in Yellowstone National Park. Keystone species are important because what affects them affects the whole ecosystem because they influence all other members of the ecosystem.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	biodiversity

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	To receive full credit, students should explain that an ecosystem with greater biodiversity has more organisms that perform similar functions, so it can recover faster from disturbances than an ecosystem with fewer organisms that perform similar functions.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> Bare rock is left as a glacier retreats. The first step in succession is the formation of soil. Pioneer species, which are small, fast-growing plants like grasses and weeds, can help break down rock to form new soil over time. Then, other new species can grow in the soil. The grasses and weeds are replaced by shrubs and small trees. Later, the area becomes a forest, possibly of spruce and hemlock.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	A disturbance in the habitat might change the interactions of plants and animals in the ecosystem. A drastic change in the factors of a habitat that affects one species can have an effect on the whole ecosystem because it affects the natural cycling of nutrients. This disruption could result in endangerment or extinction of species in the ecosystem.

Unit 4 Unit Test A – Ecosystems: Stability and Change

Item Analysis		
Item #	Standards	DOK
1	HS-LS2-1, DCI.HS-LS2.A.1	1
2	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.C.2	1
3	HS-LS2-6, DCI.HS-LS2.C.1, SEP.HS.C.1	2
4	HS-LS2-6, DCI.HS-LS2.C.1	2
5	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.C.1	2
6	HS-LS2-2, DCI.HS-LS2.A.1	2
7	HS-LS2-2, DCI.HS-LS2.A.1	2
8	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.B.1	2
9	HS-LS2-2, DCI.HS-LS2.C.1, SEP.HS.C.1	2
10	HS-LS2-1, DCI.HS-LS2.A.1	1
11	HS-LS2-2, DCI.HS-LS2.C.1	1
12	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.G.1	2
13	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.G.3	2
14	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.C.3	2
15	HS-LS2-2, DCI.HS-LS2.A.1	3
16	HS-LS2-6, DCI.HS-LS2.C.1, SEP.HS.G.1, CCC.HS.G.1	3
17	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.E.2	2
18	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.D.2	2
19	HS-LS2-6, DCI.HS-LS2.C.1, SEP.HS.G.1	2
20	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.D.1	3
21	HS-LS2-6, DCI.HS-LS2.C.1, SEP.NOS.HS.C.2	3
22	HS-LS2-2, DCI.HS-LS2.C.1, CCC.HS.C.2	2
23	HS-LS2-6, DCI.HS-LS2.C.1, CCC.HS.G.1	1
24	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.D.1	2
25	HS-LS2-2, DCI.HS-LS2.A.1, SEP.HS.E.2	3

- This is incorrect because the rabbits would have less food available to them because the area of the ecosystem is staying the same, but the number of rabbits is increasing.
 - This is incorrect because the rabbits would not begin to die off immediately. Over time the population of the rabbits would decrease due to lack of resources needed for survival.
 - This is correct because there would be a higher population of rabbits in the same amount of area. As the population of rabbits increased, the competition for food and other resources would also increase.
 - This is incorrect because this could cause an increase in rabbit population but would not be the result of an increase in the rabbit population.
 - This is incorrect because this is an example of secondary succession, as the forest floor that is exposed was part of an existing ecosystem.
- This is incorrect, because Species A has a survivorship curve that is associated with having the largest number of offspring reach old age.

- B. This is correct, because Species C has a survivorship curve that is associated with having the least number of offspring reach old age.
- C. This is incorrect, because Species C has a survivorship curve that is associated with having the least number of offspring reach old age, while Species A has the greatest number.
- D. This is incorrect, because Species C has a survivorship curve that is associated with having the least number of offspring reach old age, while Species B has a survivorship between Species A and Species C.
3. A. This is incorrect because it describes succession, but not the climax community of that succession.
- B. This is correct because it describes the balanced ecosystem needed for a climax community.
- C. This is incorrect because the plankton is not a climax community, as they are not in a steady state.
- D. This is incorrect because it describes changes in a community that is being disturbed, not a climax community.
4. A. This is correct because the carrying capacity of the population would be reduced by 80%, or to 20% of its original value.
- B. This is incorrect because the carrying capacity of the population would be reduced by 80%, not to 80%.
- C. This is incorrect because the carrying capacity of the population would be reduced to 20%, not 200%, of its original value.
- D. This is incorrect because the carrying capacity of the population would be reduced by 80%, not increased to 800% of its original value.
5. A. This is incorrect because a fire in an established forest is an example of secondary succession.
- B. This is incorrect because it is an example of secondary succession, as the coral reef was an already established ecosystem.
- C. This is correct because this is an example of primary succession, as there was not an existing ecosystem on the rock.
6. A. This is incorrect because the deer population is growing during this time frame with no predators and few other populations of animals to compete with for the limited resources.
- B. This is incorrect because the deer population is growing during this time frame after removal of predators.
- C. This is correct because the population reached maximum levels in approximately 1925 and then the deer had to compete within their own population for the limited food resources of the plateau.
- D. This is incorrect because during this time frame, competition for resources was a factor in the decrease of the population.
7. A. This is incorrect because an increase in the number of carnivores would cause more herbivores to be eaten; thus, fewer would be supported in the ecosystem.
- B. This is incorrect because a decrease in the amount of precipitation would cause the plants to be less effective; thus, there would be less food for the herbivores.
- C. This is correct because an increase in the number of plants would provide more food for the herbivores, thus increasing their carrying capacity.
- D. This is incorrect because a decrease in the amount of sunlight would cause the plants to be less productive; thus the amount of food available to the herbivores would decrease.
8. A. This is correct because the survival rate of crocodiles immediately after birth declines dramatically. This is often due to predators eating the crocodile eggs.
- B. This is incorrect because the survival rate of the elephants declines dramatically during old age and not immediately after birth.
- C. This is incorrect because the survival rate of the falcon is consistent throughout its life, and does not decline dramatically after birth.

- D. This is incorrect because humans receive lots of care after birth so their survival rate is very high.
9. A. This is incorrect because although the quadrat sampling technique is effective for sampling a population, to determine the impact she will need to gather information on populations of native species in addition to the invasive crabs.
- B. This is incorrect because although the quadrat sampling technique is effective for sampling a population, to determine the impact she will need to gather information on populations of native species in addition to the invasive crabs, and also gather information from more than one location.
- C. This is correct because sampling quadrats in a variety of areas and measuring all species present in those quadrats will give the most robust data for evidence.
- D. This is incorrect because measuring the species at an entire salt marsh is not a logistically reasonable way to gather evidence, and even if feasible would not tell the biologist what is happening at all salt marshes and estuaries.
10. A. *The birth rate and death rate in the population are roughly equal* belongs with *stabilize population*, because this scenario would tend to cause the population to remain constant.
- B. *A deadly disease is spreading among predators of the population* belongs with *increase population*, because reduced predation will decrease the death rate of the population.
- C. *A natural disaster occurs and destroys valuable resources the population needs for survival* belongs with *decrease population*, because losing resources reduces the carrying capacity of the ecosystem for the population.
11. Reef B showed the most resilience, maintaining 50% of its previous cover. Reef C maintained a little more than 1/3 of its cover while reef A maintained less than 1/3 of its cover.
12. A. This is incorrect because if the population of otters decreases, there will be greater competition for food with the herring gulls. Since there is less competition for resources, the population density of the herring gull will increase.
- B. This is incorrect because if the population of blue crab increases, that means the herring gull has more food to eat and can support a greater population of herring gulls.
- C. This is correct because if the shrimp population drops, so will the pupfish population, and there will be less food available for the herring gull. Since there is less food available, competition will increase and the population density will decrease.
- D. This is correct because if the otters begin to eat the herring gull eggs, the fewer herring gulls will be born, causing the population density to decrease in that area.
- E. This is correct because a competitor for resources would lower the carrying capacity for gulls in the marsh.
13. A. This is secondary succession because it is an event occurring in an already established ecosystem.
- B. This is secondary succession because it is an event occurring in an already established ecosystem.
- C. This is secondary succession because it is an event occurring in an already established ecosystem.
- D. This is primary succession because there is no established community present and no soil.
- E. This is primary succession because there is no established community present and no soil.
14. A. *Linear* does not belong in any blank, because linear growth would not be shown.
- B. *Increase* belongs in the second blank, because exponential growth means that as the population increases, so does the growth rate.
- C. *Decrease* belongs in the third blank, because the rate of growth would drop as a population reached carrying capacity due to limiting factors.
- D. *Exponential* belongs in the first blank because the fish would initially show exponential growth until limiting factors slowed the rate.

E. *Remains the same* does not belong in any blank, because in neither situation would the growth rate remain constant.

15. A. The *rare bacterial infection in moose* would be an example of a *density-dependent* limiting factor. This is because diseases are more likely to spread as the population increases.
- B. *Climate change* and *polar bears* would be an example of a *density-independent* limiting factor. Climate change is a weather-related event that would impact all in the population, regardless of population size.
- C. *A volcanic eruption covers a lake that frogs lay their eggs in with ash* would be an example of a *density-independent* limiting factor, because it would affect the eggs of all of the frogs in the lake.
- D. *Nitrogen and plant decrease* would be an example of a *density-dependent* limiting factor.
16. There are three stages of succession after a whale fall. First soft tissue is eaten, then bones are decomposed, and then bacteria support a climax community.
17. The carrying capacity was reduced by 90 individuals per square kilometer, which is 37.5% of the carrying capacity of 240.
18. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. explain factors that could lead to the deer population increasing far beyond the carrying capacity (DCI); and 2. explain conditions that could lead to the carrying capacity of the region to decrease (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the event that caused the population change Part 1: One point is earned for explaining that the absence of predators is a factor that would allow the deer population to increase far beyond carrying capacity. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • The deer population would increase dramatically if the predators that feed on the deer are removed from the ecosystem. Since there are no predators to keep the deer population in check, the population will increase exponentially.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly explaining conditions that could lead to a decrease in the carrying capacity Part 2: One point is earned for explaining that lack of food, increased number of predators, and habitat loss could cause the carrying capacity to decrease. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • The carrying capacity will decrease when there is a loss of habitat, there are lots of predators, and there is a lack of available food for the population of deer. The lack of resources creates competition, and fewer deer will be able to survive.

19. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. describe the process of succession that could occur with these species (DCI); and 2. identify whether or not these plant species are dependent on succession events (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing the process of succession Part 1: One point is earned for explaining that a wildfire would cause the seeds to germinate. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • A wildfire is a destructive event that damages an already established ecosystem. The heat of the fire would cause these plants' seeds to germinate in existing soil, starting the process of secondary succession.

Evidence of Mastery of Science and Engineering Practices	<p>1 point for identifying whether or not these plant species are dependent on succession events</p> <p>Part 2: One point is earned for identifying that germination could take place only after exposure to heat, making the plants dependent on wildfire events. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The seeds are able to germinate only after being exposed to heat, like that of a wildfire. Therefore, the plants' biological success is dependent on being in a fire-prone environment.
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20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain predator/prey relationship (DCI); and explain how the number or absence of animals in predator and prey populations affects each population (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining how fox population affects rabbit population</p> <p>Part 1: One point is earned for explaining that the fox population is dependent upon the rabbit population, and that it starts to rise after the rabbit population does and falls once the rabbit population declines. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If the rabbit population goes up, so does the fox population. When the rabbit population goes down, the fox population does also. <p>1 point for explaining how absence of fox population would affect rabbit population</p> <p>Part 2: One point is earned for explaining that initially the rabbit population would rise in the absence of foxes, but that over time the rabbits would consume too many resources and the population would drop again. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The population of the rabbits would go up at first. After a while, the rabbits would eat too many plants, and then their population would drop again because they wouldn't have enough food.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to</p> <ol style="list-style-type: none"> explain and apply the difference between primary and secondary succession (DCI); and describe the factors that would identify a climax community (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining that the cornfield is an example of secondary succession</p> <p>Part 1: One point is earned for explaining that the cornfield is secondary succession because soil is present, and living organisms recently existed there. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> This is an example of secondary succession, because there is already soil present and there were recently other types of plants in the cornfield.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for identifying whether or not these plant species are dependent on succession events</p> <p>Part 2: One point is earned for identifying that germination could take place only after exposure to heat, making the plants dependent on wildfire events. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The seeds are able to germinate only after being exposed to heat, like that of a wildfire. Therefore, The plants' biological success is dependent on being in a fire-phone environment.

22. A. This is incorrect because knowing the carrying capacity of populations in a single year does not allow you to compare trends, which require data taken at different times.
- B. This is incorrect because knowing the total population at one time does not allow you to compare trends in populations.
- C. This is incorrect because knowing the average over time does not provide information on the direction that the population has changed during that time.
- D. This is correct because this was a time period in which the population of the voles dropped significantly, so in comparing population trends, this time period should be looked at to see if other populations also experienced this.
23. 1A. *Increasing* belongs in the first blank because the graph shows more lemmings in 1985 than in 1980.
- 2E. *70* belongs in the second blank because there are about 70 more lemmings shown in the graph in 1985 than in 1980.
- 3I. *Food available to* belongs in the third blank because additional food would lead to an increase in population.
24. A. This is correct because this would cause a decrease in the number of voles, which is what was observed during this time.
- B. This is incorrect because that would cause the population of the lemmings to go down, which is not what is shown on the graph.
- C. This is incorrect because the population of voles was lower in 1992 than it was in 1985.
- D. This is correct because the population of lemmings was lower in 1991 than it was in 1984.
25. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. describe one living and one nonliving factor that could reduce the carrying capacity for the lemmings (DCI); and 2. identify the carrying capacity of the lemmings in the area and the year in which it was reached (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>One point for correctly describing one living and one nonliving factor</p> <p>Part 2: One point is earned for describing a living and a nonliving factor that can affect the carrying capacity of the gray-sided vole. The living factors may include increase in predation, decrease in vegetation/food, increase in competition, or an increase in disease. Nonliving factors could include natural disasters, a decrease in water or space availability, pollution, and climate disruption. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • One example of a living factor would be the number of predators for the gray-sided vole. If the number of predators increases in the environment, then the carrying capacity of the vole would decrease. • One example of a nonliving factor would be a flood that destroyed much of the area where the lemmings lived.
Evidence of Mastery of Science and Engineering Practices	<p>One point for correctly identifying the carrying capacity</p> <p>Part 1: One point is earned for identifying the carrying capacity of the lemming in the area as about 170 and the year it was reached as being 1984. Accept any carrying capacity between 155 and 185, and any year from 1983 through 1985. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The capacity of the lemming is about 170, and it was reached in 1984.

Unit 4 Unit Test B – Ecosystems: Stability and Change

Item Analysis		
Item #	Standards	DOK
1	HS-LS2-1, DCI.HS-LS2.A.1	1
2	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.C.2	1
3	HS-LS2-6, DCI.HS-LS2.C.1, SEP.HS.C.1	2
4	HS-LS2-6, DCI.HS-LS2.C.1	2
5	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.C.1	2
6	HS-LS2-2, DCI.HS-LS2.A.1	2
7	HS-LS2-2, DCI.HS-LS2.A.1	2
8	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.B.1	2
9	HS-LS2-2, DCI.HS-LS2.C.1, SEP.HS.C.1	2
10	HS-LS2-1, DCI.HS-LS2.A.1	1
11	HS-LS2-2, DCI.HS-LS2.C.1	1
12	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.G.1	2
13	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.G.3	2
14	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.C.3	2
15	HS-LS2-2, DCI.HS-LS2.A.1	3
16	HS-LS2-6, DCI.HS-LS2.C.1, SEP.HS.G.1, CCC.HS.G.1	3
17	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.E.2	2
18	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.D.2	2
19	HS-LS2-6, DCI.HS-LS2.C.1, SEP.HS.G.1	2
20	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.D.1	3
21	HS-LS2-6, DCI.HS-LS2.C.1, SEP.NOS.HS.C.2	3
22	HS-LS2-2, DCI.HS-LS2.C.1, CCC.HS.C.2	2
23	HS-LS2-6, DCI.HS-LS2.C.1, CCC.HS.G.1	1
24	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.D.1	2
25	HS-LS2-2, DCI.HS-LS2.A.1, SEP.HS.E.2	3

- This is incorrect because the rabbits would have less food available to them because the area of the ecosystem is staying the same, but the number of rabbits is increasing.
 - This is incorrect because the rabbits would not begin to die off immediately. Over time, the population of the rabbits would decrease due to lack of resources needed for survival.
 - This is correct because there would be a higher population of rabbits in the same amount of area. As the population of rabbits increased, the competition for food and other resources would also increase.
- This is incorrect, because Species A has a survivorship curve that is associated with having the largest number of offspring reach old age.
 - This is correct, because Species C has a survivorship curve that is associated with having the least number of offspring reach old age.
 - This is incorrect, because Species C has a survivorship curve that is associated with having the least number of offspring reach old age, while Species A has the greatest number.

3. A. This is incorrect because it describes succession, but not the climax community of that succession.
 B. This is correct because it describes the balanced ecosystem needed for a climax community.
 C. This is incorrect because the plankton is not a climax community, as they are not in a steady state.
4. A. This is correct because the carrying capacity of the population would be reduced by 80%, or to 20% of its original value.
 B. This is incorrect because the carrying capacity of the population would be reduced by 80%, not to 80%.
 C. This is incorrect because the carrying capacity of the population would be reduced to 20%, not 200%, of its original value.
5. A. This is incorrect because a fire in an established forest is an example of secondary succession.
 B. This is incorrect because it is an example of secondary succession, as the coral reef was an already established ecosystem.
 C. This is correct because this is an example of primary succession, as there was not an existing ecosystem on the rock.
6. A. This is incorrect because the deer population is growing during this time frame with no predators and few other populations of animals to compete with for the limited resources.
 B. This is incorrect because the deer population is growing during this time frame after removal of predators.
 C. This is correct because the population reached maximum levels in approximately 1925 and then the deer had to compete within their own population for the limited food resources of the plateau.
7. A. This is incorrect because an increase in the number of carnivores would cause more herbivores to be eaten; thus, fewer would be supported in the ecosystem.
 B. This is incorrect because a decrease in the amount of precipitation would cause the plants to be less effective; thus, there would be less food for the herbivores.
 C. This is correct because an increase in the number of plants would provide more food for the herbivores, thus increasing their carrying capacity.
8. A. This is correct because the survival rate of crocodiles immediately after birth declines dramatically. This is often due to predators eating the crocodile eggs.
 B. This is incorrect because the survival rate of the elephants declines dramatically during old age and not immediately after birth.
 C. This is incorrect because the survival rate of the falcon is consistent throughout its life, and does not decline dramatically after birth.
9. A. This is incorrect because although the quadrat sampling technique is effective for sampling a population, to determine the impact she will need to gather information on populations of native species in addition to the invasive crabs, and also gather information from more than one location.
 B. This is correct because sampling quadrats in a variety of areas and measuring all species present in those quadrats will give the most robust data for evidence.
 C. This is incorrect because measuring the species at an entire salt marsh is not a logistically reasonable way to gather evidence, and even if feasible would not tell the biologist what is happening at all salt marshes and estuaries.
10. A. *The birth rate and death rate in the population are roughly equal* belongs with *stabilize population*, because this scenario would tend to cause the population to remain constant.
 B. *A deadly disease is spreading among predators of the population* belongs with *increase population*, because reduced predation will decrease the death rate of the population.
 C. *A natural disaster destroys resources the population needs for survival* belongs with *decrease population*, because losing resources reduces the carrying capacity of the ecosystem for the population.

11. Reef B showed the most resilience, maintaining 50% of its previous cover. Reef C maintained a little more than 1/3 of its cover while reef A maintained less than 1/3 of its cover.
12. A. This is incorrect because if the population of otters decreases, there will be greater competition for food with the herring gulls. Since there is less competition for resources, the population density of the herring gull will increase.
 B. This is correct because if the shrimp population drops, so will the pupfish population, and there will be less food available for the herring gull. Since there is less food available, competition will increase and the population density will decrease.
 C. This is correct because if the otters begin to eat the herring gull eggs, the fewer herring gulls will be born, causing the population density to decrease in that area.
 D. This is correct because a competitor for resources would lower the carrying capacity for gulls in the marsh.
13. A. This is secondary succession because it is an event occurring in an already established ecosystem.
 B. This is secondary succession because it is an event occurring in an already established ecosystem.
 C. This is primary succession because there is no established community present and no soil.
 D. This is primary succession because there is no established community present and no soil.
14. A. *Linear* does not belong in any blank, because linear growth would not be shown.
 B. *Increase* belongs in the second blank, because exponential growth means that as the population increases, so does the growth rate.
 C. *Decrease* belongs in the third blank, because the rate of growth would drop as a population reached carrying capacity due to limiting factors.
 D. *Exponential* belongs in the first blank because the fish would initially show exponential growth until limiting factors slowed the rate.
15. A. The *rare bacterial infection in moose* would be an example of a *density-dependent* limiting factor. This is because diseases are more likely to spread as the population increases.
 B. *Climate change* and *polar bears* would be an example of a *density-independent* limiting factor. Climate change is a weather-related event that would impact all in the population, regardless of population size.
 C. Nitrogen and plant decrease would be an example of a *density-dependent* limiting factor.
16. There are three stages of succession after a whale fall. First soft tissue is eaten, then bones are decomposed, and then bacteria support a climax community.
17. The carrying capacity was reduced by 90 individuals per square kilometer, which is 38% of the carrying capacity of 240.
18. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: 1. identify factors that could lead to the deer population increasing far beyond the carrying capacity (DCI); and 2. identify conditions that could lead to the carrying capacity of the region to decrease (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying an event</p> <p>Part 1: One point is earned for identifying that the absence of predators is a factor that would allow the deer population to increase far beyond carrying capacity. The deer population would increase dramatically if the predators that feed on the deer are removed from the ecosystem. Since there are no predators to keep the deer population in check, the population will increase exponentially. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The deer population would increase if its predators were removed.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly identifying one factor</p> <p>Part 2: One point is earned for identifying that one of these factors contributed to the change in carrying capacity. The carrying capacity will decrease when there is a loss of habitat, there are lots of predators, and there is a lack of available food for the population of deer. The lack of resources creates competition, and fewer deer will be able to survive. Any one of the following responses, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • loss of habitat • lots of predators • lack of available food • competition

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. describe the process of succession that could occur with these species (DCI); and 2. identify whether a plant species is dependent on succession events (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the process of succession</p> <p>Part 1: One point is earned for describing that a wildfire would cause the seeds to germinate. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • A wildfire is a destructive event that damages an already established ecosystem. The heat of the fire would cause these plants' seeds to germinate in existing soil, starting the process of secondary succession.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for identifying a plant species dependency on succession events</p> <p>Part 2: One point is earned for identifying that since germination could take place only after exposure to heat, the plants are dependent on wildfire events. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Yes, because their seeds need fire to germinate into new plants.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI - 2 Points	
Claims	<p>The student is able to explain how the number or absence of animals in predator and prey populations affects each population. (DCI)</p>
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for explaining how fox population was affected</p> <p>Part 1: Two points are earned for explaining that the fox population is dependent upon the rabbit population, and that it starts to rise after the rabbit population does and falls once the rabbit population declines. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • If the rabbit population goes up, so does the fox population. When the rabbit population goes down, the fox population does also.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to 1. distinguish between primary and secondary succession (DCI); and 2. describe the factors that would identify a climax community (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying the example Part 1: One point is earned for identifying that the cornfield is secondary succession because soil is present, and living organisms recently existed there. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> secondary succession
Evidence of Mastery of Science and Engineering Practices	1 point for correctly describing how to identify a climax community Part 2: One point is earned for describing that relatively stable populations of animals and plants would identify that the abandoned cornfield has become a climax community. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The researcher should study the plants and animals in the cornfield. In a climax community, the types of plants and animals in the cornfield would remain steady, and not change greatly from year to year.

22. A. This is incorrect because knowing the carrying capacity of populations in a single year does not allow you to compare trends, which require data taken at different times.
- B. This is incorrect because knowing the average over time does not provide information on the direction that the population has changed during that time.
- C. This is correct because this was a time period in which the population of the voles dropped significantly, so in comparing population trends this time period should be looked at to see if other populations also experienced this.
23. 1A. *Increased* belongs in the first blank because the graph shows more lemmings in 1985 than in 1980.
- 2E. 70 belongs in the second blank because there are about 70 more lemmings shown in the graph in 1985 than in 1980.
- 3H. *Food available to* belongs in the third blank because additional food would lead to an increase in population.
24. A. This is correct because this would cause a decrease in the number of voles, which is what was observed during this time.
- B. This is incorrect because that would cause the population of the lemmings to go down, which is not what is shown on the graph.
- C. This is correct because the population of lemmings was lower in 1991 than it was in 1984.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. describe one living and one nonliving factor that could reduce the carrying capacity for the lemmings (DCI); and 2. identify the carrying capacity of the lemmings in the area and the year in which it was reached (SEP).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing one living or one nonliving factor that would reduce carrying capacity</p> <p>Part 2: One point is earned for describing a living and a nonliving factor that can affect the carrying capacity of the gray-sided vole. The living factors may include increase in predation, decrease in vegetation/food, increase in competition, or an increase in disease. Nonliving factors could include natural disasters, a decrease in water or space availability, pollution, and climate disruption. Any one of the following responses, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> One example of a living factor would be the number of predators for the gray-sided vole. If the number of predators increases in the environment, then the carrying capacity of the vole would decrease. One example of a nonliving factor would be a flood that destroyed much of the area where the lemmings lived.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly identifying the carrying capacity</p> <p>Part 1: One point is earned for identifying the carrying capacity of the lemming in the area as about 170 and the year it was reached as being 1984. Accept any carrying capacity between 155 and 185, and any year from 1983 through 1985. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The capacity of the lemming is about 170, and it was reached in 1984.

Unit 5 Cells: Stability and Change

Unit 5 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	D	HS-LS1-4, DCI.HS-LS1.B.1	1
2	D	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.G.1	2
3	B	HS-LS1-4, DCI.HS-LS1.B.1	3
4	A	HS-LS1-4, DCI.HS-LS1.B.1	1
5	C	HS-LS1-4, DCI.HS-LS1.B.1	2
6	C	HS-LS1-4, DCI.HS-LS1.B.1	2
7	B	HS-LS1-4, DCI.HS-LS1.B.1	2
8	C	HS-LS1-4, DCI.HS-LS1.B.1	2
9	C	HS-LS1-4, DCI.HS-LS1.B.1	2
10	D	HS-LS1-4, DCI.HS-LS1.B.1, CCC.NOS.HS.B.2	2
11	A	HS-LS1-4, DCI.HS-LS1.B.1	1
12	A	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.A.1	1
13	D	HS-LS1-4, DCI.HS-LS1.B.1	2
14	D	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.F.2	1
15	D	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.F.2	1

Unit 5 Lesson 1 Quiz – The Cell Cycle

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS1-1, DCI.HS-LS1.A.1	229	1
2	A	HS-LS1-4, DCI.HS-LS1.B.1	223-224	1
3	D	HS-LS1-4, DCI.HS-LS1.B.1	223	1
4	D	HS-LS1-4, DCI.HS-LS1.B.1	227	2
5	B	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	223	1
6	C	HS-LS1-4, DCI.HS-LS1.B.1	225	2
7	A	HS-LS1-1, DCI.HS-LS1.A.1, CCC.HS.F.2	229	1
8	C	HS-LS1-4, DCI.HS-LS1.B.1	223	2
9	A	HS-LS3-2, DCI.HS-LS3.B.1	222	2
10	A	HS-LS1-4	226	2
11	Rubric	HS-LS1-4, DCI.HS-LS1.B.1	224	2
12	Rubric	HS-LS1-4, DCI.HS-LS1.B.1	223	3
13	Rubric	HS-LS1-4, DCI.HS-LS1.B.1	227	3
14	Rubric	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1, CCC.HS.D.2	224-227	2
15	Rubric	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1, CCC.HS.D.2	227	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answers may vary. Some examples of rapidly dividing cells would be cells of the digestive tract, embryonic cells, hair cells, skin cells, etc. Examples of slowly dividing cells would be neurons, adult cells, most internal organs, etc. Students should also provide reasoning as to why their chosen cells divide rapidly and slowly. Often rapidly dividing cells do so because of wear and tear.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> The G1 phase of the cell cycle is the phase of cell growth, during which the cell builds more organelles. This is followed by the S stage, during which DNA is copied. In the G2 phase, the cell grows and prepares for cell division by making microtubules that will be used in the spindle.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> The main cause of Sally's cancer is mutations in sections of DNA that code for regulatory factors.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> Sally's cancer cells have found a way to bypass the checkpoints and continue through the cell cycle unchecked.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> In a normal cell, apoptosis occurs when a genetic mutation occurs. In a cancerous cell, apoptosis does not occur so the cell continues to be functional.

Unit 5 Lesson 2 Quiz – Mitosis and Differentiation

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	B	HS-LS1-4, DCI.HS-LS1.B.1	238	1
2	D	HS-LS1-4, DCI.HS-LS1.B.1	242-243	2
3	D	HS-LS1-4, DCI.HS-LS1.B.1	241	2
4	D	HS-LS1-4, DCI.HS-LS1.B.1	237	1
5	D	HS-LS1-4, DCI.HS-LS1.B.1	241-243	1
6	A	HS-LS1-4, DCI.HS-LS1.B.1	242	1
7	C	HS-LS1-4, DCI.HS-LS1.B.1	237	1
8	D	HS-LS1-4, DCI.HS-LS1.B.1, CCC.NOS.HS.B.2	242	2
9	D	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1, CCC.HS.F.2	239-240	2
10	C	HS-LS1-4, DCI.HS-LS1.B.1	237	1
11	Rubric	HS-LS1-4, DCI.HS-LS1.B.1	243	1
12	Rubric	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1, CCC.HS.D.2	242-243	2
13	Rubric	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.2, CCC.HS.D.2	237-238	2
14	Rubric	HS-LS1-4, DCI.HS-LS1.B.1	235	2
15	Rubric	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.F.2	238	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>They're important because they are capable of differentiating into any type of cell, and so they could be used to help heal any type of tissue.</p>

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <ul style="list-style-type: none"> • A totipotent stem cell can differentiate into any type of cell. A multipotent stem cell could only differentiate into certain types of cells, such as nerve cells.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	mitosis

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Histones come together to form a core. DNA is wrapped around a series of cores to form a chromatin.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Student responses should contain the following:</p> <ul style="list-style-type: none"> • Prophase: Chromosomes condense. • Metaphase: Chromosomes line up in the center of the cell. • Anaphase: Chromatids separate and are pulled toward opposite ends of the cell. • Telophase: Chromosomes arrive at opposite poles and begin to uncoil.

Unit 5 Unit Test A – Cells: Stability and Change

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-4, DCI.HS-LS1.B.1	1
2	HS-LS1-4, DCI.HS-LS1.B.1, CCC.NOS.HS.C.2	1
3	HS-LS1-4, DCI.HS-LS1.B.1, SEP.NOS.HS.A.2	2
4	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.2	2
5	HS-LS1-4, DCI.HS-LS1.B.1	2
6	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.E.2	2
7	HS-LS1-4, DCI.HS-LS1.B.1	2
8	HS-LS1-4, DCI.HS-LS1.B.1	2
9	HS-LS1-4, DCI.HS-LS1.B.1	2
10	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1	2
11	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.E.2	2
12	HS-LS1-4, DCI.HS-LS1.B.1	1
13	HS-LS1-4, DCI.HS-LS1.B.1, CCC.NOS.HS.A.1	2

14	HS-LS1-4, DCI.HS-LS1.B.1	2
15	HS-LS1-4, DCI.HS-LS1.B.1	2
16	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.B.2	2
17	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.G.3	3
18	HS-LS1-4, DCI.HS-LS1.B.1	2
19	HS-LS1-4, DCI.HS-LS1.B.1	2
20	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1, CCC.HS.D.2	3
21	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.1	3
22	HS-LS1-4, DCI.HS-LS1.B.1	1
23	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.1	1
24	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.G.1	3
25	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.2	3

- This is incorrect because, in some cases, one cell will differentiate while the other cell will remain a stem cell.
 - This is correct because during mitosis two daughter cells are produced that are identical to each other.
 - This is incorrect because, in some cases, they will specialize and will have very different shapes than the parent cell.
 - This is incorrect because the number of chromosomes is preserved in a mitotic division.
- This is incorrect because this statement is a true statement and is a major principle of the cell theory.
 - This is incorrect because this statement is a proven principle of the cell theory.
 - This is correct because cells are made by other cells, not by spontaneous generation.
 - This is incorrect because animal and plant cells share many characteristics, such as a nucleus and mitochondria.
- This is incorrect because light microscopes need light in order to show an image.
 - This is incorrect because light microscopes do not show images at very high magnifications because they are limited by wavelengths of light.
 - This is correct because more powerful microscopes allowed for the visualization of internal cell structures and functions.
 - This is incorrect because scientists needed to share their information about cells in order for the theory to be formulated.
- This is incorrect because the two chromatids contain the same genetic information.
 - This is correct because the two sister chromatids can split into different daughter cells.
 - This is incorrect because only one chromatid is needed for protein synthesis.
 - This is incorrect because this occurs in meiosis, not mitosis.
- This is incorrect because mitosis is not involved with the clotting of blood.
 - This is incorrect because mitosis does not allow air to enter the skin.
 - This is incorrect because mitosis does not prevent bacteria from entering the site of injury.
 - This is correct because mitosis is the process that forms new cells at the site of injury.

6. A. This is incorrect because nerve cells in the brain would have very low rates of mitosis.
 B. This is incorrect because muscle cells in the heart would have relatively low rates of mitosis.
 C. This is incorrect because cells in the lens of the eye would have low rates of mitosis.
 D. This is correct because cells in the lining of the intestine are replaced often and have high rates of mitosis.
7. A. This is correct because cells need to differentiate in order to form specific tissues and organs.
 B. This is incorrect because the cells do not die off naturally at first to form tissues and organs.
 C. This is incorrect because cells from other fertilized embryos do not join to form tissues and organs.
 D. This is incorrect because viruses are not involved with the changing of DNA to form tissues and organs.
8. A. This is correct because it is the expression of genes that causes differentiation in organisms.
 B. This is incorrect because the temperature does not play a role in cell differentiation.
 C. This is incorrect because the frequency of female egg laying is not related to cell differentiation.
 D. This is incorrect because the location of where the eggs are deposited does not play a role in cell differentiation.
9. A. This is incorrect because the increased cell length does not cause the organelles to replicate at a slower rate.
 B. This is incorrect because the distance from the nucleus to the cell membrane does not affect the frequency of genetic abnormalities.
 C. This is correct because cell volume increases faster than surface area resulting in a loss of adequate ability to pass wastes and intake nutrients.
 D. This is incorrect because the increased distance does not cause an overload of protein synthesis, causing the cell to become toxic.
10. A. This is correct because identical daughter cells are produced after the last step of the cellular process shown, which is mitosis.
 B. This is incorrect because crossing over does not produce identical daughter cells.
 C. This is incorrect because chromatids moving toward opposite poles happen much earlier in the mitotic process.
 D. This is incorrect because mitosis results in two smaller cells, not one larger one.
11. A. *Lower* belongs in the second and third box, because cancer cells will not respond as well to inhibiting factors as noncancerous cells, and a lower percent would be in interphase, because more of them would be undergoing mitosis.
 B. *Higher* belongs in the first box, because cancerous cells divide more often than noncancerous cells.
12. A. This image matches *chromosomes begin to uncoil* because it shows the chromosomes reaching the two poles of the cell, and this is when they will begin to uncoil.
 B. This image matches *chromatids separate* because it shows the sister chromatids being separated, which occurs during anaphase.
 C. This image matches *spindle fibers attach to centromere* because it shows the sister chromatids lining up in the middle of the cell, which is when the spindle fibers attach to their centromere.
13. A. This is correct because only a living organism can produce living cells.
 B. This is correct because cells are the smallest level of a living organism.
 C. This is incorrect because some cells, such as red blood cells, do not contain DNA as mature cells.
 D. This is correct because cells are the basic unit of life.
 E. This is incorrect because some cells, such as certain nerve cells, cannot reproduce.

- F. This is incorrect because the number of cells in an organism may change many times as the organism grows.
14. A. This is incorrect because the separation of chromosomes does not result in the formation of new cells.
 B. This is correct because the formation of new cells allows for the replacement of those that have been damaged.
 C. This is incorrect because the separation of sister chromatids does not allow for cells to heal themselves.
 D. This is correct because as cells divide, new cells are added to the overall number in the organism.
 E. This is incorrect because the alignment of chromosomes along the cell equator does not fix genetic abnormalities.
15. 1B. *Stem cells* is correct because they are the cells that are able to divide into different types of specialized cells.
 2G. *Specialized cells* is correct because these are the types of cells that perform specialized functions within the organism.
 3H. *Expressing different genes* is correct because specialized cells do not differ in the DNA they have but rather in which genes they express.
16. A. 1 goes into the first blank, because if the cell did not undergo cytokinesis, it would remain a single cell.
 B. 2 goes in the second blank, because the cell has undergone mitosis, so 2 nuclei were formed.
 C. 4 goes in the third blank, because each nucleus would have the same number of chromosomes as the cell did before mitosis.
 D. 8 does not go in any blank, because it does not correctly complete any sentence.
17. A. This event is internal because cyclins are an internal influence on the cell cycle.
 B. This event is external because physical contact is an external influence on the cell cycle.
 C. This event is internal because kinases are an internal influence on the cell cycle.
 D. This event is external because ultraviolet radiation is an external influence on the cell cycle.
18. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. describe a factor that controls cell division (DCI); and 2. describe how damage to these factors can cause abnormal cell division (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing a factor that controls cell division Part 1: One point is earned for describing a one of the internal factors that control cell division, such as genetic signals, proteins in the cytoplasm, hormones released by other cells, or physical contact with other cells. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> hormones that are released by other cells 1 point for correctly describing the effects of damage to these factors Part 2: One point is earned for describing how damage to one factor that controls cell division can result in abnormal occurrences, such as uncontrolled division, cessation of cell division, or even cell death. The following answer, or an equivalent, is acceptable. <ul style="list-style-type: none"> When damage occurs to the mechanisms that control cell division, cells can reproduce out of control. This causes tumors to form.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student should be able to: <ol style="list-style-type: none"> 1. explain the main differences between these two processes (DCI); and 2. identify a type of mitotic reproduction found in multicellular organisms (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining the main differences between mitosis and binary fission</p> <p>Part 1: One point is earned for correctly explaining the main differences between mitosis and binary fission. The following response, or equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Mitosis is the process of cell division in eukaryotic cells. It involves a multistep process that duplicates the genetic material of the cell and then separates it into two identical daughter cells. Binary fission occurs in prokaryotic cells. It involves the duplication of a circular piece of DNA and does not involve the separation of chromosomes. <p>1 point for identifying a type of mitotic reproduction</p> <p>Part 2: One point is earned for the identifying one type of mitotic reproduction found in multicellular organisms, such as budding, fragmentation, or vegetative reproduction. The following answer or an equivalent is acceptable.</p> <ul style="list-style-type: none"> • Vegetative reproduction is a form of mitotic reproduction found in plants.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. explain the importance of stem cells to multicellular organism (DCI); and 2. explain differences between cells that are components of body systems (SEP); and 3. explain how a model of stem cells could be useful for studying diseases to the body system (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining why stem cells are important</p> <p>Part 2: One point is earned for explaining that stems cells allow for the development of many different types of cells from a single cell, thus allowing a multicellular organism to produce cells that are specialized for many functions. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Stem cells can give rise to many different types of cells, which make different tissues that perform different functions in a multicellular organism.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining differences between cell types</p> <p>Part 1: One point is earned for explaining that specialized cells like a neuron or an epithelial cell can only divide to form cells that are similar to themselves, while a stem cell can divide to form cells of many different types. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Neurons and epithelial cells can only make other neurons and epithelial cells, but stems cells can make many different kinds of cells.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining why stem cells would be modeled by people studying disease</p> <p>Part 3: One point is earned for explaining why modeling stem cells would be useful for studying diseases, such as the fact that they have the potential to be used to repair damaged tissues and organs. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Modeling stem cells would help researchers find ways to replace tissues that have been damaged with new cells.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. explain why cells function more efficiently as smaller units (DCI); and 2. describe how the surface-area-to-volume ratio affects the health of a cell (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining why cells function more efficiently as smaller units Part 2: One point earned for explaining that cell size can directly impact how it functions and that if it gets too large the organelles are too far away from the membrane to work properly. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> If cells get too large, the organelles are too far away from the cell membrane, so passage across the membrane is affected. Cells are healthy when nutrients easily pass into the cell, and waste can easily escape.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly describing how the surface-area-to-volume ratio affects the health of a cell Part 1: One point earned for describing that as the cell increases the surface-area-to-volume ratio gets smaller. Cells need a high surface-area-to-volume ratio to remain healthy. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> As cells get larger, the surface-area-to-volume ratio gets smaller. To remain healthy, cells need a high ratio of surface area to volume. A high surface area means that the cell can take in more nutrients faster and get rid of wastes faster.

22. A. *Different* belongs in the second and third boxes, as the cells would have different functions, and thus would also have different structures and express different proteins.
B. *The same* belongs in the first and forth boxes because the cells would have the same genes and would both divide by mitosis.
23. A. This is incorrect because chromosomes are double stranded.
B. This is correct because centromeres do connect sister chromatids in a chromosome.
C. This is correct because histones are proteins around which the DNA in a chromosome wraps.
D. This is incorrect because telomeres are noncoding regions of DNA.
24. A. This statement belongs in the *Binary fission* column because only prokaryotic cells undergo binary fission.
B. This statement belongs in the *Binary fission* column because bacteria, which undergo binary fission, have circular chromosomes.
C. This statement belongs in both columns because both mitosis and binary fission involve cytokinesis.
D. This statement belongs in the *Mitosis* column because eukaryotic cells, which undergo mitosis, have their DNA in a nucleus.
E. This statement belongs in the *Mitosis* column because only eukaryotic cells differentiate to become specialized cells.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student will be able to: 1. compare the structures of the chromosomes before and after interphase and explain the cause (DCI); and 2. predict what would happen if an error occurred during interphase and the cell entered mitosis (SEP).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly comparing the differences between the chromosomes and identifying the cause</p> <p>Part 1: One point is earned for comparing the differences between the chromosome structures before and after interphase. Student's comparison should indicate that the cell before interphase has only one copy of each chromosome/chromatid in the nucleus, but that due to DNA replication, the cell contains two copies of each chromatid after interphase. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Before interphase, there is only one copy of each chromosome in the nucleus. During the synthesis phase of interphase, each chromosome is replicated by DNA replication, so that when interphase is over, there are two copies of each chromosome.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly predicting what would happen if an error occurred during interphase and the cell was able to enter mitosis</p> <p>Part 2: One point is earned for predicting that an error during DNA replication would cause the two daughter cells produced by mitosis to contain different genetic information. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If an error occurred during DNA replication, the duplication of the genetic material would not be identical. One chromosome would have a different sequence than the other. If this chromosome was allowed to enter into mitosis, then all daughter cells would have this abnormality.

Unit 5 Unit Test B – Cells: Stability and Change

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-4, DCI.HS-LS1.B.1	1
2	HS-LS1-4, DCI.HS-LS1.B.1, CCC.NOS.HS.C.2	1
3	HS-LS1-4, DCI.HS-LS1.B.1, SEP.NOS.HS.A.2	2
4	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.2	2
5	HS-LS1-4, DCI.HS-LS1.B.1	2
6	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.E.2	2
7	HS-LS1-4, DCI.HS-LS1.B.1	2
8	HS-LS1-4, DCI.HS-LS1.B.1	2
9	HS-LS1-4, DCI.HS-LS1.B.1	2
10	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1	2
11	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.E.2	2
12	HS-LS1-4, DCI.HS-LS1.B.1	1
13	HS-LS1-4, DCI.HS-LS1.B.1, CCC.NOS.HS.A.1	2
14	HS-LS1-4, DCI.HS-LS1.B.1	2
15	HS-LS1-4, DCI.HS-LS1.B.1	2
16	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.B.2	2
17	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.G.3	3
18	HS-LS1-4, DCI.HS-LS1.B.1	2
19	HS-LS1-4, DCI.HS-LS1.B.1	2
20	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.1, CCC.HS.D.2	3
21	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.1	3
22	HS-LS1-4, DCI.HS-LS1.B.1	1

23	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.1	1
24	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.G.1	3
25	HS-LS1-4, DCI.HS-LS1.B.1, SEP.HS.B.2	3

1. A. This is incorrect because, in some cases, one cell will differentiate while the other cell will remain a stem cell.
B. This is correct because during mitosis two daughter cells are produced that are identical to each other.
C. This is incorrect because, in some cases, they will specialize and will have very different shapes than the parent cell.
2. A. This is incorrect because this statement is a true statement and is a major principle of the cell theory.
B. This is incorrect because this statement is a proven principle of the cell theory.
C. This is correct because cells are made by other cells, not by spontaneous generation.
3. A. This is incorrect because light microscopes need light in order to show an image.
B. This is incorrect because light microscopes do not show images at very high magnifications because they are limited by wavelengths of light.
C. This is correct because more powerful microscopes allowed for the visualization of internal cell structures and functions.
4. A. This is incorrect because the two chromatids contain the same genetic information.
B. This is correct because the two sister chromatids can split into different daughter cells.
C. This is incorrect because only one chromatid is needed for protein synthesis.
5. A. This is incorrect because mitosis is not involved with the clotting of blood.
B. This is incorrect because mitosis does not allow air to enter the skin.
C. This is correct because mitosis is the process that forms new cells at the site of injury.
6. A. This is incorrect because nerve cells in the brain would have very low rates of mitosis.
B. This is incorrect because muscle cells in the heart would have relatively low rates of mitosis.
C. This is correct because cells in the lining of the intestine are replaced often and have high rates of mitosis.
7. A. This is correct because cells need to differentiate in order to form specific tissues and organs.
B. This is incorrect because the cells do not die off naturally at first to form tissues and organs.
C. This is incorrect because cells from other fertilized embryos do not join to form tissues and organs.
8. A. This is correct because it is the expression of genes that causes differentiation in organisms.
B. This is incorrect because the temperature does not play a role in cell differentiation.
C. This is incorrect because the frequency of female egg laying is not related to cell differentiation.
9. A. This is incorrect because the increased cell length does not cause the organelles to replicate at a slower rate.
B. This is incorrect because the distance from the nucleus to the cell membrane does not affect the frequency of genetic abnormalities.
C. This is correct because the increased distance reduces the functionality of the organelles.

10. A. This is correct because identical daughter cells are produced after the last step of the cellular process shown, which is mitosis.
B. This is incorrect because crossing over does not produce identical daughter cells.
C. This is incorrect because chromatids moving toward opposite poles happen much earlier in the mitotic process.
11. A. *Lower* belongs in the second and third box, because cancer cells will not respond as well to inhibiting factors as noncancerous cells, and a lower percent would be in interphase, because more of them would be undergoing mitosis.
B. *Higher* belongs in the first box, because cancerous cells divide more often than noncancerous cells.
12. A. This image matches *chromosomes begin to uncoil* because it shows the chromosomes reaching the two poles of the cell, and this is when they will begin to uncoil.
B. This image matches *chromatids separate* because it shows the sister chromatids being separated, which occurs during anaphase.
C. This image matches *spindle fibers attach to centromere* because it shows the sister chromatids lining up in the middle of the cell, which is when the spindle fibers attach to their centromere.
13. A. This is correct because only a living organism can produce living cells.
B. This is correct because cells are the smallest level of a living organism.
C. This is incorrect because some cells, such as red blood cells, do not contain DNA as mature cells.
D. This is correct because cells are the basic unit of life.
E. This is incorrect because some cells, such as certain nerve cells, cannot reproduce.
14. A. This is correct because the formation of new cells allows for the replacement of those that have been damaged.
B. This is incorrect because the separation of chromosomes does not result in the formation of new cells.
C. This is incorrect because the separation of sister chromatids does not allow for cells to heal themselves.
D. This is correct because as cells divide, new cells are added to the overall number in the organism.
15. 1B. *Stem cells* is correct because they are the cells that are able to divide into different types of specialized cells.
2F. *Specialized cells* is correct because these are the types of cells that perform specialized functions within the organism.
3G. *Expressing different genes* is correct because specialized cells do not differ in the DNA they have but rather in which genes they express.
16. A. 1 goes into the first blank, because if the cell did not undergo cytokinesis, it would remain a single cell.
B. 2 goes in the second blank, because the cell has undergone mitosis, so 2 nuclei were formed.
C. 4 goes in the third blank, because each nucleus would have the same number of chromosomes as the cell did before mitosis.
D. 8 does not go in any blank, because it does not correctly complete any sentence.
17. A. This event is internal because cyclins are an internal influence on the cell cycle.
B. This event is external because physical contact is an external influence on the cell cycle.
C. This event is internal because kinases are an internal influence on the cell cycle.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. describe a factor that controls cell division (DCI); and 2. describe how damage to these factors can cause abnormal cell division (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing a factor that controls cell division Part 1: One point is earned for describing one of the internal factors that control cell division, such as genetic signals, proteins in the cytoplasm, hormones released by other cells, or physical contact with other cells. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> hormones that are released by other cells 1 point for correctly describing the effects of damage to these factors Part 2: One point is earned for describing how damage to one factor that controls cell division can result in abnormal occurrences, such as uncontrolled division, cessation of cell division, or even cell death. The following answer, or an equivalent, is acceptable. <ul style="list-style-type: none"> When damage occurs to the mechanisms that control cell division, cells can reproduce out of control. This causes tumors to form.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student should be able to: 1. explain the main differences between these two processes (DCI); and 2. identify a type of mitotic reproduction found in multicellular organisms (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for explaining the main differences between mitosis and binary fission Part 1: One point is earned for correctly explaining the main differences between mitosis and binary fission. The following response, or equivalent, is acceptable. <ul style="list-style-type: none"> Mitosis is the process of cell division in eukaryotic cells. It involves a multistep process that duplicates the genetic material of the cell and then separates it into two identical daughter cells. Binary fission occurs in prokaryotic cells. It involves the duplication of a circular piece of DNA and does not involve the separation of chromosomes. 1 point for identifying a type of mitotic reproduction Part 2: One point is earned for identifying one type of mitotic reproduction found in multicellular organisms, such as budding, fragmentation, or vegetative reproduction. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Vegetative reproduction is a form of mitotic reproduction found in plants.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	The student is able to: 1. explain the importance of stem cells to multicellular organism (DCI); and 2. explain differences between cells that are components of body systems (SEP); and 3. explain how a model of stem cells could be useful for studying diseases to the body system (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining why stem cells are important</p> <p>Part 2: One point is earned for explaining that stems cells allow for the development of many different types of cells from a single cell, thus allowing a multicellular organism to produce cells that are specialized for many functions. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Stem cells can give rise to many different types of cells, which make different tissues that perform different functions in a multicellular organism.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining differences between cell types</p> <p>Part 1: One point is earned for explaining that specialized cells like a neuron or an epithelial cell can only divide to form cells that are similar to themselves, while a stem cell can divide to form cells of many different types. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Neurons and epithelial cells can only make other neurons and epithelial cells, but stems cells can make many different kinds of cells.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining why stem cells would be modeled by people studying disease</p> <p>Part 3: One point is earned for explaining why modeling stem cells would be useful for studying diseases, such as the fact that they have the potential to be used to repair damaged tissues and organs. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Modeling stem cells would help researchers find ways to replace tissues that have been damaged with new cells.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain why cells function more efficiently as smaller units (DCI); and describe how the surface-area-to-volume ratio affects the health of a cell (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly why cells function more efficiently as smaller units</p> <p>Part 2: One point earned for showing that cell size can directly impact how it functions and that if it gets too large the organelles are too far away from the membrane to work properly. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If cells get too large, the organelles are too far away from the cell membrane, so passage across the membrane is affected. Cells are healthy when nutrients easily pass into the cell, and waste can easily escape.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly describing how the surface-area-to-volume ratio affects the health of a cell</p> <p>Part 1: One point earned for describing that as the cell increases the surface-area-to-volume ratio gets smaller. Cells need a high surface-area-to-volume ratio to remain healthy. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> As cells get larger, the surface-area-to-volume ratio gets smaller. To remain healthy, cells need a high ratio of surface area to volume. A high surface area means that the cell can take in more nutrients faster and get rid of wastes faster.

22. A. *Different* belongs in the second and third boxes, as the cells would have different functions, and thus would also have different structures and express different proteins.
- B. *The same* belongs in the first and forth boxes because the cells would have the same genes and would both divide by mitosis.
23. A. This is incorrect because chromosomes are double stranded.
- B. This is correct because centromeres do connect sister chromatids in a chromosome.
- C. This is correct because histones are proteins around which the DNA in a chromosome wraps.
24. A. This statement belongs in the *Binary fission* column because only prokaryotic cells undergo binary fission.

- B. This statement belongs in the *Binary fission* column because bacteria, which undergo binary fission, have circular chromosomes.
- C. This statement belongs in both columns because both mitosis and binary fission involve cytokinesis.
- D. This statement belongs in the *Mitosis* column because eukaryotic cells, which undergo mitosis, have their DNA in a nucleus.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student will be able to: <ol style="list-style-type: none"> compare the structures of the chromosomes before and after interphase and explain the cause (DCI); and predict what would happen if an error occurred during interphase and the cell entered mitosis (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for comparing the structures of the chromosomes and identifying DNA replication as the cause</p> <p>Part 1: One point is earned for describing that the cell before interphase has only one copy of each chromosome/chromatid in the nucleus, but that due to DNA replication, the cell contains two copies of each chromatid after interphase. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Before interphase, there is only one copy of each chromosome in the nucleus. During the synthesis phase of interphase, each chromosome is replicated by DNA replication, so that when interphase is over, there are two copies of each chromosome.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly predicting what would happen if an error occurred during interphase and the cell was able to enter mitosis</p> <p>Part 2: One point is earned for explaining that an error during DNA replication would cause the two daughter cells produced by mitosis to contain different genetic information. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If an error occurred during DNA replication, the duplication of the genetic material would not be identical. One chromosome would have a different sequence than the other. If this chromosome was allowed to enter into mitosis, then all daughter cells would have this abnormality.

Unit 6 The Structure and Function of DNA

Unit 6 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	C	HS-LS1-1, DCI.HS-LS1.A.2	1
2	C	HS-LS1-6, DCI.HS-LS1.C.2	1
3	B	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.2	2
4	B	HS-LS1-6, DCI.HS-LS1.C.2	2
5	D	HS-LS1-1, DCI.HS-LS1.A.2	1
6	D	HS-LS1-1, DCI.HS-LS1.A.1	1
7	C	HS-LS1-1, DCI.HS-LS1.A.2	1
8	C	HS-LS3-1, DCI.HS-LS3.A.1	1
9	D	HS-LS1-4, DCI.HS-LS1.A.2	1
10	B	HS-LS3-1, DCI.HS-LS1.A.2	1
11	A	HS-LS1-1, DCI.HS-LS1.A.2	1

12	A	HS-LS1-1, DCI.HS-LS1.A.2	1
13	B	HS-LS1-1, DCI.HS-LS1.A.2	1
14	B	HS-LS1-2, CCC.HS.F.2	1
15	A	HS-LS1-1, DCI.HS-LS4.A.1	2

Unit 6 Lesson 1 Quiz – DNA Structure and Replication

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS3-1, DCI.HS-LS3.A.1	259	1
2	C	HS-LS1-1, SEP.NOS.HS.B.3, CCC.HS.F.2	264-265	1
3	B	HS-PS2-6, DCI.HS-PS2.B.3	265	1
4	B	HS-LS1-1, DCI.HS-LS1.A.2, SEP.NOS.HS.B.3, CCC.HS.F.2	260-261	2
5	D	HS-LS1-1, DCI.HS-LS3.A.1	263	2
6	B	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.2	266-267	2
7	C	HS-LS1-1, DCI.HS-LS1.C.2	266-267	2
8	D	HS-LS1-1	262	2
9	A	HS-LS1-1, SEP.NOS.HS.B.1, CCC.HS.F.2	262	2
10	D	HS-LS1-1	263	2
11	Rubric	HS-LS1-1, DCI.HS-LS1.A.2	267	2
12	Rubric	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.2	266-267	2
13	Rubric	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.2, CCC.HS.F.2	260	3
14	Rubric	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.2, CCC.HS.F.2	262	3
15	Rubric	HS-LS1-1, DCI.HS-LS3.A.1	265	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <p>DNA replication is said to be semiconservative because each new molecule of DNA keeps one unchanged strand of DNA from the original molecule.</p>

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>DNA replication is initiated when initiator proteins locate the origin, and other proteins unzip the double strand. Each strand acts as a template for a new, complementary strand. New DNA is made by enzymes called DNA polymerases.</p>

13. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Allow a maximum of 2 credits:</p> <ul style="list-style-type: none"> 1 credit for describing the four experiments as follows: 1) mouse + live S = dead mouse; 2) mouse + live R = live mouse; 3) mouse + heat-killed S = live mouse; 4) mouse + heat-killed S + live R = dead mouse 1 credit for providing a connection between Griffith's results and the term <i>transforming principle</i>. <p>Sample answer: When the fourth mouse died, Griffith reasoned that the R bacteria had taken up some material from the dead S bacteria and incorporated it. He reasoned that the incorporation somehow transformed the R bacteria into the deadly S strain.</p>

14. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Allow a maximum of 3 credits:</p> <ul style="list-style-type: none"> 1 credit for defining a bacteriophage as a virus that infects bacteria and for identifying it as a good choice for the experiment because it contains little more than DNA and protein 1 credit for describing the procedure as follows: 1) Phages with radioactive sulfur atoms in their protein molecules were used to infect bacteria. No radioactivity was found inside the bacteria. 2) Phages with radioactive phosphorus atoms in their DNA molecules were used to infect bacteria. Radioactivity was found inside the bacteria. 1 credit for concluding that, because phosphorus entered the bacteria, but sulfur did not, the bacteriophages' DNA entered the bacteria and the protein did not. So, the scientists reasoned that the transforming principle was DNA.

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>DNA molecules are composed of two complementary strands of nucleotides arranged in a pattern resembling a spiral staircase. Each nucleotide consists of a sugar molecule, a phosphate group, and one of four possible bases. The double helix arrangement is maintained by the formation of hydrogen bonds between complementary bases on the two strands. The bases adenine and thymine pair with each other, and the bases cytosine and guanine pair. Thus, equal amounts of A and T, as well as equal amounts of C and G, are present.</p>

Unit 6 Lesson 2 Quiz – Protein Synthesis

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS1-6, DCI.HS-LS1.C.2	280	1
2	B	HS-LS1-1, DCI.HS-LS1.C.2	277-278	1
3	D	HS-LS1-1, DCI.HS-LS1.C.2	281	1
4	B	HS-LS1-1, DCI.HS-LS3.A.1, CCC.HS.F.2	280	1
5	D	HS-LS1-4, DCI.HS-LS1.B.1	278	1
6	A	HS-LS3-1, DCI.HS-LS3.A.1	273	1
7	C	HS-LS1-1, DCI.HS-LS1.A.2	280	1
8	B	HS-LS1-1, DCI.HS-LS1.C.2, CCC.HS.F.2	276	2
9	D	HS-LS1-1, DCI.HS-LS1.C.2, CCC.HS.F.2	276	2

10	A	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.2	279	2
11	Rubric	HS-LS1-1, DCI.HS-LS3.A.1, CCC.HS.F.2	282	1
12	Rubric	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.F.2	281	2
13	Rubric	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.F.2	266-267	2
14	Rubric	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.F.2	276	2
15	Rubric	HS-LS1-1, DCI.HS-LS1.C.2, CCC.HS.F.2	282	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: When a DNA base is either added or removed, this would cause a frameshift mutation.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample Answer: <ul style="list-style-type: none"> Ribosomes are the site of translation, which is the second stage in protein production. Specifically, ribosomes link amino acids together and also pull the mRNA along to “read” the code.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	They are identical to each other and to the original DNA molecule.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	RNA

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The protein’s structure could change, which would affect the protein’s ability to function.

Unit 6 Lesson 3 Quiz – Gene Expression and Regulation

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS3-1, DCI.HS-LS3.A.1	290	1
2	A	HS-LS3-1, DCI.HS-LS3.A.1	287	1

3	C	HS-LS3-1, DCI.HS-LS3.A.1	288	1
4	C	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.F.2	289	2
5	C	HS-LS3-1, DCI.HS-LS3.A.1	288-289	1
6	B	HS-LS1-1, DCI.HS-LS1.B.1	287	2
7	A	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.F.2	288	2
8	D	HS-LS3-1, DCI.HS-LS3.A.1	290-294	2
9	D	HS-LS3-1, DCI.HS-LS3.A.1	286-294	2
10	D	HS-LS3-1, DCI.HS-LS3.A.1	288	1
11	Rubric	HS-LS3-1, DCI.HS-LS3.A.1	294	1
12	Rubric	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.F.2	288-289	1
13	Rubric	HS-LS3-1, DCI.HS-LS3.A.1	292	2
14	Rubric	HS-LS3-1, DCI.HS-LS3.A.1	288-289	3
15	Rubric	HS-LS1-1, DCI.HS-LS1.A.2	292	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Example answers could include factors such as light (the Arctic fox), temperature (plants), or various drugs and chemicals (developing fetus).

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The lac operon, which initiates lactose metabolism in bacteria, is turned on and off by two operons that are triggered by glucose and lactose levels. Three enzymes take up and metabolize lactose. The promoter is located between a site that promotes transcription (CAP site) and a site that represses transcription (the operator).

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <p>An exon is a segment of coding DNA that leaves the nucleus after transcription to complete the process of protein formation. An intron stays in the nucleus and is composed of noncoding DNA; thus it does not produce proteins.</p>

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Bacteria must get food directly from their environment. Operons respond to environmental factors such as the presence or absence of food molecules.

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <p>Eukaryotic organisms regulate translation by changing the structure of the proteins that start the process of translation. These proteins often either encourage or discourage the ribosomes from attaching to the mRNA, thus changing the rate of translation.</p>

Unit 6 Unit Test A – The Structure and Function of DNA

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-1, DCI.HS-LS1.A.2	1
2	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.B.1	1
3	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.1	2
4	HS-LS1-1, DCI.HS-LS1.A.2	2
5	HS-LS1-1, DCI.HS-LS1.A.2	2
6	HS-LS1-1, DCI.HS-LS1.A.2	2
7	HS-LS1-1, DCI.HS-LS1.A.2	2
8	HS-LS1-1, DCI.HS-LS1.A.2	1
9	HS-LS1-1, DCI.HS-LS1.A.2	1
10	HS-LS1-1, DCI.HS-LS1.A.2	2
11	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.B.1	2
12	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.1	2
13	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.A.2	2
14	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.G.1	2
15	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.1, CCC.HS.F.1	3
16	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.D.1	3
17	HS-LS1-1, DCI.HS-LS1.A.2	2
18	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.B.2	3
19	HS-LS1-1, DCI.HS-LS1.A.2, SEP.NOS.HS.A.2,	3
20	HS-LS1-1, DCI.HS-LS1.A.1	3
21	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.B.1	3
22	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.G.1	2
23	HS-LS1-1, DCI.HS-LS1.A.2	2
24	HS-LS1-1, DCI.HS-LS1.A.2	1
25	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.1	2

1. A. This is incorrect because enzymes determine the structure of lipids and have nothing to do with hair genotypes.
- B. This is correct because DNA contains the genetic codes for proteins.
- C. This is incorrect because all phosphate molecules in DNA are the same, thus they cannot determine hair color.

- D. This is incorrect because proteins determine the structure of carbohydrates, and carbohydrates have nothing to do with genotypes.
2. A. This is incorrect because adenine does not pair with guanine. When adenine is on one strand, thymine must be on the other strand.
 B. This is incorrect because the adenine does not pair with cytosine. When adenine is on one strand, then thymine must be on the other strand.
 C. This is correct because the double helix requires base pairing, and adenine pairs with thymine.
 D. This is incorrect because thymine can not pair with cytosine. When adenine is on one strand, thymine must be on the other strand.
3. A. This is incorrect because RNA does not form from the rearrangement of DNA.
 B. This is incorrect because RNA does not break off from DNA but instead is a copy of the information found in the DNA
 C. This is correct because DNA gets transcribed into RNA and the thymine bases are replaced with uracil.
 D. This is incorrect because RNA is not translated from DNA but is instead RNA transcribed from DNA.
4. A. This is incorrect because bases are not replaced by other bases in the process. Additionally, this would be showing only a part of the process and not provide evidence of an entire RNA molecule being formed from a DNA molecule.
 B. This is incorrect because DNA is converted into RNA during transcription, not translation. Evidence for what is happening in translation would not provide evidence for RNA being formed from DNA.
 C. This is incorrect because the double-stranded DNA does not split apart into two RNA molecules. Additionally, this would not provide evidence that RNA is formed from DNA.
 D. This is correct because DNA is transcribed into RNA and would provide proof that RNA is formed from DNA.
5. A. This is incorrect because codons do not regulate how often RNA is translated but instead direct the cellular machinery as to which amino acid to insert.
 B. This is incorrect because codons do not regulate when DNA is transcribed in the nucleus but instead direct the cellular machinery as to which amino acid to insert in the protein chain.
 C. This is correct because codons are responsible for the amino acids that produce proteins.
 D. This is incorrect because codons do not alert the cell when it is time to make more ribosomes but instead direct the cellular machinery as to which amino acid to insert in the protein chain.
6. A. This is incorrect because DNA is an input for transcription but is not involved in translation.
 B. This is incorrect because DNA is an input for transcription and is not involved in translation.
 C. This is correct because transcription produces mRNA molecule, which is translated at the ribosome into a polypeptide chain.
 D. This is incorrect because mRNA is involved in both processes, where it is an output for transcription.
7. A. This is incorrect because the enzyme helicase applies to both the leading and lagging strands, as it separates the two from one another.
 B. This is incorrect because the enzyme DNA polymerase adds nucleotides to both the leading and lagging strands.
 C. This is correct because the lagging strand is discontinuous and needs to be bound together by the enzyme ligase.
 D. This is incorrect because new complementary strands are formed on both the leading and lagging strands.
8. The correct mRNA sequence would be UAGGCU.

9. A. *Predation* is incorrect because, although it can influence which genes are selected for, it cannot influence gene expression.
 B. This is correct because *temperature* can influence which proteins are produced.
 C. This is correct because *amount of light* can influence which proteins are produced.
 D. This is correct because *drugs and chemicals* can influence which proteins are able to be made.
 E. This is incorrect, because the *genetic makeup of an organism* is an internal, not an external, factor.
10. First, DNA is matched to nucleotides. Errors are then detected and replication stops. The incorrect nucleotide is removed and replaced with the correct nucleotide. This process continues until the entire strand of DNA has been copied.
11. A. This is incorrect because the base uracil is found in RNA, not DNA.
 B. This is correct because DNA is a double helix, while RNA is single stranded.
 C. This is correct because the sugar in DNA is deoxyribose, and the sugar in RNA is ribose.
 D. This is incorrect because both deoxyribose and ribose are 5-carbon sugars.
 E. This is incorrect because DNA strands are held together by hydrogen bonds, and RNA is single stranded.
12. A. This description belongs in the *rRNA* column, because rRNA makes up ribosomes.
 B. This description belongs in the *tRNA* column, because tRNA transfers amino acids to ribosomes.
 C. This description belongs in the *mRNA* column, because mRNA makes up the messages that code for proteins.
13. A. DNA is shaped like a helix matches Rosalind Franklin took x-ray photographs of DNA that showed an X surrounded by a circle because this discovery showed the most likely shape of DNA is helical.
 B. *DNA is the hereditary material* matches Oswald Avery observed that when DNA is destroyed, bacteria transformation did not occur and Alfred Hershey and Martha Chase found that when bacteria are infected by bacteria, phosphorous from viral DNA remains in the bacteria because both suggested that the material in the cell that is responsible for expressed traits is DNA.
 C. *DNA bases pair according to rules* matches Erwin Chargaff found that different species have similar ratios of purines to pyrimidines in their DNA because this discovery helped support Chargaff's rules of base pairing.
14. A. *Deletion* does not belong in any blank because it does not correctly complete any of the sentences.
 B. *Frameshift* belongs in the third blank because a frameshift mutation happens when there is a change in the reading frame.
 C. *Insertion* belongs in the second blank because insertion mutations happen when a nucleotide is inserted into the DNA sequence.
 D. *Point* belongs in the first blank because a point mutation is a mutation in which a single nucleotide is replaced by a different one.
15. First, mRNA leaves the nucleus, binds to the ribosome, and initiates synthesis with the start codon. Then, the polypeptide chain is formed through the tRNA complexes binding at the ribosome until the stop codon is reached and the chain is released.
16. 1B. *AUC* is the correct answer for Response 1 because this codon contains the complementary bases to the DNA sequence TAG.
 2E. *Isoleucine* is the correct answer for Response 2 because this amino acid corresponds to the mRNA codon AUC per the codon wheel.
 3G. *ATC* is the correct answer for Response 3 because ATC in DNA corresponds with UAG in mRNA, one of the "stop" codons.

4L. *Arginine* is the correct answer for Response 4 because GCC in DNA corresponds to the codon CGG in mRNA, which codes for the amino acid arginine.

17. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. determine the phenotype of a <i>lacI</i> mutation that prevents binding to the operator (DCI); and 2. explain how a mutation on the <i>lac</i> operon that causes irreversible binding with the repressor protein affects a bacterium (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly determining the phenotype of a <i>lacI</i> mutation Part 1: One point is earned for determining that the <i>lacI</i> mutation that does not produce a repressor protein would express <i>lacZ</i> continuously, even when no lactose is present. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The bacterium with a <i>lacI</i> mutation would always express <i>lacZ</i>, regardless of the amount of galactose in the environment. 1 point for correctly explaining the results of a mutation that causes the irreversible binding of the repressor protein to the <i>lac</i> operator Part 2: One point is earned for explaining that a mutation in the operator that causes the repressor to bind irreversibly will lead to a bacterium being unable to produce the gene products that allow metabolism of lactose and will thus cause the cell to be unable to metabolize lactose. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> This mutation would cause the <i>lac</i> gene to be shut off all of the time, so none of the proteins needed to metabolize lactose would be available. The bacterium then would not be able to process lactose.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: 1. explain how a mutation to a gene can affect the gene product (DCI); and 2. predict the effect of different causes of change in nucleotide order (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining how a mutation to a gene can affect a protein Part 1: One point is earned for explaining that a mutated gene will result in incorrect instructions for the production of a protein, so the resulting protein will not have the correct structure and function. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> DNA contains the coding region for proteins. If the DNA sequence is mutated, mRNA transcribed from the DNA will code for a mutant protein with a structure different from wild-type protein.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly predicting which mutation would be more likely to interfere with protein function Part 2: One point is earned for predicting that the insertion deletion would be more likely to interfere with protein function, and explaining the reason is that it would change the reading frame of the DNA. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The mutation in which a nucleic acid is inserted would be more likely to disrupt the function of the protein, because it will change the reading frame, and can cause many amino acids to be incorrect in the protein.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 points	
Claims	The student is able to: 1. explain the significance of the Avery experiments (DCI); and 2. explain why scientists were reluctant to accept that the results also applied to animals (SEP); and
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the significance of the Avery experiments Part 1: One point is earned for explaining that the Avery experiments suggested that DNA, and not protein, was the chemical that is responsible for transferring traits. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Because only DNA could transform bacteria, it meant that DNA was probably responsible for heredity.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly explaining why scientists were reluctant to accept that Avery's results also applied to animals Part 2: One point is earned for explaining that scientists thought all animals had identical DNA, that scientists thought a code with only four bases was too simple to be the genetic code for animals. Or, scientists thought animals and bacteria used different molecules for inheritance. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Scientists thought that different animals had exactly the same DNA, so it could not be the genetic information for different animals.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. explain the differences and similarities between DNA replication and transcription (DCI); and 2. explaining a similarity between the processes of DNA replication and transcription (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining differences between replication and transcription Part 1: One point is earned for explaining that in replication both strands are copied, not just one; DNA, not RNA, is the product of replication; different enzymes are involved. Also, replication occurs only once during a single cell cycle but transcription happens many times. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> DNA replication produces DNA, but transcription produces RNA. Also, DNA replication copies all of the chromosome, but transcription copies only the part of the chromosome that has genes. 1 point for correctly explaining similarity between replication and transcription Part 2: One point is earned for explaining that both processes involve the copying of DNA, both processes follow similar base-pairing rules, both processes occur in the nucleus, and both processes involve a polymerase. The following answer, or an equivalent, is acceptable. <ul style="list-style-type: none"> Both DNA replication and transcription require that an enzyme help to unwind the chromosome.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. use the model to describe the structure of DNA (DCI); and 2. explain how elements of the model of DNA contribute to its function (SEP).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the structure of the DNA molecule</p> <p>Part 1: One point is earned for describing the structure of the DNA molecule as a double helix, with nucleotides joined together by covalent bonds that connect sugars and phosphates, forming the backbone and hydrogen bonds holding the bases together in the middle. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The current model represents DNA nucleotides of a single strand joined together by covalent bonds that connect the sugar of one nucleotide to the phosphate of the next nucleotide. The alternating sugars and phosphates form the sides of a double helix, or the sugar-phosphate backbone of the molecule. The DNA double helix is held together by hydrogen bonds between the bases in the middle.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining the role of hydrogen bonds in DNA</p> <p>Part 2: One point is earned for explaining the role of hydrogen bonds to the function of DNA, such as, they hold the double helix together and maintain the structure of DNA, or that their weakness allows them to be easily broken for replication and protein synthesis. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The hydrogen bonds hold the bases of DNA together and maintain the shape of the DNA molecule.

22. A. This is incorrect because promoters are found in both groups of organisms and are DNA sequences, not proteins.
 B. This is incorrect because promoters are found in both groups of organisms.
 C. This is correct because promoters are DNA sequences that aid RNA polymerase in transcription.
 D. This is incorrect because promoters are DNA sequences, not proteins, and are involved in transcription, not translation.
23. A. This is incorrect because DNA is used by both groups of organisms to code for proteins.
 B. This is incorrect because ribosomes are used by both groups of organisms to produce proteins.
 C. This is correct because cyanobacteria lack a nucleus, so transcription must occur in the cytoplasm.
 D. This is incorrect because both groups of organisms use the process of translation to produce proteins.
24. A. This is correct because prokaryotic cells regulate gene expression by regulating the amount of transcription.
 B. This is incorrect because prokaryotic cells do not prevent gene expression by preventing cell division.
 C. This is incorrect because this would not allow prokaryotes to regulate individual genes.
 D. This is incorrect because prokaryotic cells do not, in general, regulate gene expression by post-translation mechanisms.
25. A. This explanation is true because it is the activation of certain genes at certain times that causes cells to differentiate.
 B. This explanation is true because cells turn off particular genes when they are no longer needed.
 C. This explanation is false because prokaryotic organisms do not have differentiated cells.
 D. This explanation is false because genes do not get removed from an organism for its cells to differentiate.

Unit 6 Unit Test B – The Structure and Function of DNA

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-1, DCI.HS-LS1.A.2	1
2	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.B.1	1

3	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.1	2
4	HS-LS1-1, DCI.HS-LS1.A.2	2
5	HS-LS1-1, DCI.HS-LS1.A.2	2
6	HS-LS1-1, DCI.HS-LS1.A.2	2
7	HS-LS1-1, DCI.HS-LS1.A.2	2
8	HS-LS1-1, DCI.HS-LS1.A.2	1
9	HS-LS1-1, DCI.HS-LS1.A.2	1
10	HS-LS1-1, DCI.HS-LS1.A.2	2
11	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.B.1	2
12	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.1	2
13	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.A.2	2
14	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.G.1	2
15	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.1, CCC.HS.F.1	3
16	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.D.1	3
17	HS-LS1-1, DCI.HS-LS1.A.2	2
18	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.B.2	3
19	HS-LS1-1, DCI.HS-LS1.A.2, SEP.NOS.HS.A.2,	3
20	HS-LS1-1, DCI.HS-LS1.A.1	3
21	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.B.1	3
22	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.G.1	2
23	HS-LS1-1, DCI.HS-LS1.A.2	2
24	HS-LS1-1, DCI.HS-LS1.A.2	1
25	HS-LS1-1, DCI.HS-LS1.A.2, SEP.HS.F.1	2

- This is correct because DNA contains the genetic codes for proteins.
 - This is incorrect because all phosphate molecules in DNA are the same, thus they cannot determine hair color.
 - This is incorrect because proteins determine the structure of carbohydrates, and carbohydrates have nothing to do with genotypes.
- This is incorrect because adenine does not pair with guanine. When adenine is on one strand, thymine must be on the other strand.
 - This is incorrect because the adenine does not pair with cytosine. When adenine is on one strand, then thymine must be on the other strand.
 - This is correct because the double helix requires base pairing, and adenine pairs with thymine.
- This is incorrect because RNA does not break off from DNA but instead is a copy of the information found in the DNA.
 - This is correct because DNA is transcribed into RNA and the thymine bases are replaced with uracil.
 - This is incorrect because RNA is not translated from DNA but is instead RNA transcribed from DNA.
- This is incorrect because bases are not replaced by other bases in the process. Additionally, this would be showing only a part of the process and not provide evidence of an entire RNA molecule being formed from a DNA molecule.

- B. This is incorrect because DNA is converted into RNA during transcription, not translation. Evidence for what is happening in translation would not provide evidence for RNA being formed from DNA.
- C. This is correct because DNA is transcribed into RNA and would provide proof that RNA is formed from DNA.
5. A. This is incorrect because codons do not regulate how often RNA is translated but instead direct the cellular machinery as to which amino acid to insert.
- B. This is correct because codons are responsible for the amino acids that produce proteins.
- C. This is incorrect because codons do not alert the cell when it is time to make more ribosomes but instead direct the cellular machinery as to which amino acid to insert in the protein chain.
6. A. This is incorrect because DNA is an input for transcription and is not involved in translation.
- B. This is correct because transcription produces mRNA molecule, which is translated at the ribosome into a polypeptide chain.
- C. This is incorrect because mRNA is involved in both processes, where it is an output for transcription.
7. A. This is incorrect because the enzyme helicase applies to both the leading and lagging strands, as it separates the two from one another.
- B. This is incorrect because the enzyme DNA polymerase adds nucleotides to both the leading and lagging strands.
- C. This is correct because the lagging strand is discontinuous and needs to be bound together by the enzyme ligase.
8. The correct mRNA sequence would be UAGGC.
9. A. *Predation* is incorrect because, although it can influence which genes are selected for, it cannot influence gene expression.
- B. This is correct because *temperature* can influence which proteins are produced.
- C. This is correct because *drugs and chemicals* can influence which proteins are able to be made.
- D. This is incorrect because the *genetic makeup of an organism* is an internal, not an external, factor.
10. First, DNA is matched to nucleotides. Errors are then detected and replication stops. The incorrect nucleotide is removed and replaced with the correct nucleotide. This process continues until the entire strand of DNA has been copied.
11. A. This is incorrect because the base uracil is found in RNA, not DNA.
- B. This is correct because DNA is a double helix, while RNA is single stranded.
- C. This is correct because the sugar in DNA is deoxyribose, and the sugar in RNA is ribose.
- D. This is incorrect because DNA strands are held together by hydrogen bonds, and RNA is single stranded.
12. A. This description belongs in the *rRNA* column, because rRNA makes up ribosomes.
- B. This description belongs in the *tRNA* column, because tRNA transfers amino acids to ribosomes.
- C. This description belongs in the *mRNA* column, because mRNA makes up the messages that code for proteins.
13. A. DNA is shaped like a helix matches Rosalind Franklin took x-ray photographs of DNA that showed an X surrounded by a circle because this discovery showed the most likely shape of DNA is helical.
- B. *DNA is the hereditary material* matches *Oswald Avery observed that when DNA is destroyed, bacteria transformation did not occur* because it suggested that the material in the cell that is responsible for expressed traits is DNA.

- C. *DNA bases pair according to rules matches Erwin Chargaff found that different species have similar ratios of purines to pyrimidines in their DNA* because this discovery helped support Chargaff's rules of base pairing.
14. A. *Frameshift* belongs in the third blank because a frameshift mutation happens when there is a change in the reading frame.
- B. *Insertion* belongs in the second blank because insertion mutations happen when a nucleotide is inserted into the DNA sequence.
- C. *Point* belongs in the first blank because a point mutation is a mutation in which a single nucleotide is replaced by a different one.
15. This is correct because the mRNA leaves the nucleus, binds to the ribosome, and initiates synthesis with the start codon. Subsequently the polypeptide chain is formed through the tRNA complexes binding at the ribosome until the stop codon is reached and the chain is released.
16. 1B. *AUC* is the correct answer for Response 1 because this codon contains the complementary bases to the DNA sequence TAG.
- 2E. *Isoleucine* is the correct answer for Response 2 because this amino acid corresponds to the mRNA codon AUC per the codon wheel.
- 3G. *ATC* is the correct answer for Response 3 because ATC in DNA corresponds with UAG in mRNA, one of the "stop" codons.
- 4L. *Arginine* is the correct answer for Response 4 because GCC in DNA corresponds to the codon CGG in mRNA, which codes for the amino acid arginine.
17. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. determine the phenotype of a <i>lacI</i> mutation that prevents binding to the operator (DCI); and 2. explain how a mutation on the <i>lac</i> operon that causes irreversible binding with the repressor protein affects a bacterium (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly determining the phenotype of a <i>lacI</i> mutation</p> <p>Part 1: One point is earned for determining that the <i>lacI</i> mutation that does not produce a repressor protein would express <i>lacZ</i> continuously, even when no lactose is present. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The bacterium with a <i>lacI</i> mutation would always express <i>lacZ</i>, regardless of the amount of galactose in the environment. <p>1 point for correctly explaining the results of a mutation that causes the irreversible binding of the repressor protein to the <i>lac</i> operator</p> <p>Part 2: One point is earned for explaining that a mutation in the operator that causes the repressor to bind irreversibly will lead to the bacterium being unable to produce the gene products that allow metabolism of lactose and will thus cause the cell to be unable to metabolize lactose. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • This mutation would cause the <i>lac</i> gene to be shut off all of the time, so none of the proteins needed to metabolize lactose would be available. The bacterium then would not be able to process lactose.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: 1. explain how a mutation to a gene can affect the gene product (DCI); and 2. predict the effect of different causes of change in nucleotide order (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining how a mutation to a gene can affect a protein Part 1: One point is earned for explaining that a mutated gene will result in incorrect instructions for the production of a protein, so the resulting protein will not have the correct structure and function. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> DNA contains the coding region for proteins. If the DNA sequence is mutated, mRNA transcribed from the DNA will code for a mutant protein with a structure different from wild-type protein.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly predicting which mutation would be more likely to interfere with protein function Part 2: One point is earned for predicting that the insertion deletion would be more likely to interfere with protein function, and explaining the reason is that it would change the reading frame of the DNA. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The mutation in which a nucleic acid is inserted would be more likely to disrupt the function of the protein, because it will change the reading frame, and can cause many amino acids to be incorrect in the protein.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 points	
Claims	The student is able to: 1. explain the significance of the Avery experiments (DCI); and 2. explain why scientists were reluctant to accept that the results also applied to animals (SEP); and
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the significance of the Avery experiments Part 1: One point is earned for explaining that the Avery experiments suggested that DNA, and not protein, was the chemical that is responsible for transferring traits. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Because only DNA could transform bacteria, it meant that DNA was probably responsible for heredity.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly explaining why scientists were reluctant to accept that the results also applied to animals Part 2: One point is earned for explaining a reason that scientists of Avery's time were reluctant to accept that the finding would also apply to animals. Reasons can include that scientists thought all animals had identical DNA, which scientists thought a code with only four bases was too simple to be the genetic code for animals, or that scientists thought animals and bacteria used different molecules for inheritance. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Scientists thought that different animals had exactly the same DNA, so it could not be the genetic information for different animals.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. explain the differences and similarities between DNA replication and transcription (DCI); and 2. explaining a similarity between the processes of DNA replication and transcription (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly explaining a difference and a similarity between replication and transcription</p> <p>Part 1: One point is earned for explaining a difference between the processes of DNA replication and transcription. Differences include that in replication both strands are copied, not just one; DNA, not RNA, is the product of replication; different enzymes are involved; and replication occurs only once during a single cell cycle but transcription happens many times. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> DNA replication produces DNA, but transcription produces RNA. <p>Part 2: One point is earned for explaining a similarity between the processes of DNA replication and transcription. Similarities include that both processes involve the copying of DNA, both processes follow similar base-pairing rules, both processes occur in the nucleus, and both processes involve a polymerase. The following answer, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Both DNA replication and transcription require that an enzyme help unwind the chromosome.
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21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> use the model to describe the structure of DNA (DCI); and explain how elements of the model of DNA contribute to its function (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the structure of the DNA molecule</p> <p>Part 1: One point is earned for describing the structure of the DNA molecule as a double helix, with nucleotides joined together by covalent bonds that connect sugars and phosphates, forming the backbone and hydrogen bonds holding the bases together in the middle. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The current model represents DNA nucleotides of a single strand joined together by covalent bonds that connect the sugar of one nucleotide to the phosphate of the next nucleotide. The alternating sugars and phosphates form the sides of a double helix, or the sugar-phosphate backbone of the molecule. The DNA double helix is held together by hydrogen bonds between the bases in the middle.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining the role of hydrogen bonds in DNA</p> <p>Part 2: One point is earned for explaining the role of hydrogen bonds to the function of DNA, such as, they hold the double helix together and maintain the structure of DNA, or that their weakness allows them to be easily broken for replication and protein synthesis. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The hydrogen bonds hold the bases of DNA together and maintain the shape of the DNA molecule.

22. A. This is incorrect because promoters are found in both groups of organisms.
 B. This is correct because promoters are DNA sequences that aid RNA polymerase in transcription.
 C. This is incorrect because promoters are DNA sequences, not proteins, and are involved in transcription, not translation.
23. A. This is incorrect because DNA is used by both groups of organisms to code for proteins.
 B. This is incorrect because ribosomes are used by both groups of organisms to produce proteins.
 C. This is correct because cyanobacteria lack a nucleus, so transcription must occur in the cytoplasm.
24. A. This is correct because prokaryotic cells regulate gene expression by regulating the amount of transcription.
 B. This is incorrect because prokaryotic cells do not prevent gene expression by preventing cell division.
 C. This is incorrect because this would not allow prokaryotes to regulate individual genes.

25. A. This explanation is true because it is the activation of certain genes at certain times that causes cells to differentiate.
- B. This explanation is true because cells turn off particular genes when they are no longer needed.
- C. This explanation is false because prokaryotic organisms do not have differentiated cells.

Unit 7 Genetics and Heredity

Unit 7 Pretest

Item Analysis				
Item #	Key	Standards	DOK	
1	B	HS-LS3-1, SEP.NOS.HS.A.2, CCC.NOS.HS.B.2	2	
2	C	HS-LS3-1	1	
3	D	HS-LS3-1	1	
4	C	HS-LS3-1	1	
5	B	HS-LS3-1, SEP.NOS.HS.A.2, CCC.NOS.HS.B.2	1	
6	A	HS-LS3-1	2	
7	C	HS-LS3-2, DCI.HS-LS3.B.2	2	
8	D	HS-LS3-2, DCI.HS-LS3.B.2	2	
9	A	HS-LS3-1	2	
10	D	HS-LS3-1, DCI.HS-LS3.A.1	1	
11	B	HS-LS3-1, CCC.HS.A.1	2	
12	A	HS-LS3-2, DCI.HS-LS3.B.1	1	
13	B	HS-LS3-1, DCI.HS-LS3.A.1	1	
14	A	HS-LS3-1, DCI.HS-LS3.A.1	2	
15	C	HS-LS3-1, DCI.HS-LS3.A.1	2	

Unit 7 Lesson 1 Quiz – Meiosis

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	A	HS-LS3-2, DCI.HS-LS3.B.1	312	1
2	B	HS-LS3-2	307	2
3	C	HS-LS3-2, DCI.HS-LS3.B.1	312	2
4	D	HS-LS3-2, DCI.HS-LS3.B.1	312	2
5	A	HS-LS3-1, DCI.HS-LS3.A.1		2
6	B	HS-LS3-2	307	2
7	D	HS-LS3-2, DCI.HS-LS3.B.1	312	2
8	B	HS-LS3-1	307	2
9	B	HS-LS3-2, DCI.HS-LS3.B.1	308-309	2
10	D	HS-LS3-2	308	2
11	Rubric	HS-LS3-2	308-312	2
12	Rubric	HS-LS3-2, DCI.HS-LS3.B.1	311-312	2

13	Rubric	HS-LS3-2, DCI.HS-LS3.B.1	311-312	2
14	Rubric	HS-LS3-2, DCI.HS-LS3.B.1		2
15	Rubric	HS-LS3-2, DCI.HS-LS3.B.1, SEP.HS.B.2, CCC.HS.D.2	311-312	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	In sexual reproduction, two parents each form haploid cells, which join to form offspring.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	at the conclusion of crossing over

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Genetic recombination results when crossing over occurs between homologous chromosomes, when homologous pairs separate independently in meiosis I, when sister chromatids separate independently in meiosis II, and when the zygote that forms a new individual is created by the random joining of two gametes.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Crossing over occurs when two homologous chromosomes exchange reciprocal segments of DNA during prophase I of meiosis. This results in chromosomes in which the two chromatids no longer have identical genetic material. When meiosis is completed, the resulting gametes carry new combinations of genes. New gene combinations may help an organism survive in a changing environment.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Homologous chromosomes line up randomly along the equator of the cell. Two chromosomes, one from the mother and one from the father, go to each new cell. So, each cell has one of four possible chromosome combinations.

Unit 7 Lesson 2 Quiz – Mendel and Heredity

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	B	HS-LS3-1, DCI.HS-LS3.A.1	320	1
2	A	HS-LS3-1	316-324	1
3	D	HS-LS3-1, DCI.HS-LS3.A.1	317	1
4	B	HS-LS3-1	323	1
5	C	HS-LS3-1	320	2

6	A	HS-LS3-1, DCI.HS-LS3.A.1	319	1
7	A	HS-LS3-1	317	2
8	B	HS-LS3-1, DCI.HS-LS3.A.1	318-319	2
9	D	HS-LS3-1	317-319	2
10	C	HS-LS3-1	311	2
11	Rubric	HS-LS3-1	322	1
12	Rubric	HS-LS3-2	311, 319	1
13	Rubric	HS-LS3-1, DCI.HS-LS3.A.1	320	2
14	Rubric	HS-LS3-1	317-319	2
15	Rubric	HS-LS3-1	320-321	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <p>In incomplete dominance, the heterozygous phenotype is a blending of the two homozygous phenotypes. In other words, the phenotype is an intermediate. In codominance, however, the heterozygous phenotype shows characteristics of both homozygous phenotypes. An example of incomplete dominance is red and white flowers producing a pink flower. An example of incomplete dominance is a chicken with both white and black feathers producing a black chicken with white spots.</p>

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer:</p> <p>The law of independent assortment refers to the independent segregation and distribution of homologous chromosomes during meiosis, while the law of segregation deals with the separation of alleles during gamete formation in meiosis.</p>

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>A gene is a segment of DNA that plays an important role in determining how an organism develops and functions.</p>

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>The male and female reproductive parts are enclosed within the same flower.</p>

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>the dominant allele</p>

Unit 7 Lesson 3 Quiz – Traits and Probability

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS3-2, DCI.HS-LS3.B.2	324	2
2	A	HS-LS3-1, SEP.HS.D.2	333	2
3	A	HS-LS3-2, DCI.HS-LS3.B.2	335	1
4	B	HS-LS3-2, DCI.HS-LS3.B.1	335	2
5	B	HS-LS3-1, SEP.HS.D.2	333	3
6	D	HS-LS3-1	332-333	3
7	B	HS-LS3-1, SEP.HS.D.2	332-333	3
8	A	HS-LS3-1	336-337	3
9	D	HS-LS3-1	322,	3
10	C	HS-LS3-1, SEP.HS.D.2	332-333	3
11	Rubric	HS-LS3-1	332-333	3
12	Rubric	HS-LS3-1	322,	3
13	Rubric	HS-LS3-1, SEP.HS.D.2	331	3
14	Rubric	HS-LS3-1, SEP.HS.D.2	336-337	3
15	Rubric	HS-LS3-1	322,	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<i>Ff.</i> Sample answer: The offspring include both heterozygous and homozygous recessive organisms. Since the offspring get one recessive allele from the white-flowered parent, the other parent must be able to donate either a dominant or a recessive allele.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The parents are C_1C_1 and C_2C_2 . The Punnett square should show that all offspring have the genotype C_1C_2 .

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The general formula for probability is $\frac{\text{number of one kind of event}}{\text{number of all events}}$. This may be expressed as a ratio $\frac{500}{2,000}$, as a decimal (0.25), or as a percentage (25 percent).

14. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Since all the female offspring receive the normal allele for vision from the father, all female offspring will have normal color vision, although half of them will receive the recessive allele from the mother and thus be carriers. Since all of the male offspring receive the Y chromosome from the father, it is the X chromosome they receive from the mother that will determine whether or not they are colorblind. Since the mother is heterozygous, male offspring will have a 50 percent chance of being colorblind.

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Incomplete dominance is the phenomenon that occurs when two or more alleles influence a phenotype but neither is dominant to the other. In other words, the offspring displays a trait that is intermediate to a trait exhibited by each parent. In the case of snapdragons, pink is a color that is intermediate between red and white and thus can be assumed to be caused by incomplete dominance.

Unit 7 Lesson 4 Quiz – Mutations and Genetic Diversity

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS3-2, DCI.HS-LS3.B.1	343	1
2	B	HS-LS3-2, DCI.HS-LS3.B.1	345	1
3	D	HS-LS3-2, DCI.HS-LS3.B.1	348	1
4	C	HS-LS3-2, DCI.HS-LS3.B.1	348	1
5	B	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.G.1	347	1
6	A	HS-LS3-2, DCI.HS-LS3.B.1	346	2
7	B	HS-LS3-2, DCI.HS-LS3.B.1	349	2
8	C	HS-LS3-2, DCI.HS-LS3.B.1	343	2
9	D	HS-LS3-2, DCI.HS-LS3.B.1	348	2
10	C	HS-LS3-2, DCI.HS-LS3.B.1	348	2
11	Rubric	HS-LS3-2, DCI.HS-LS3.B.1	346	1
12	Rubric	HS-LS3-2, DCI.HS-LS3.B.2, CCC.HS.B.2	343	2
13	Rubric	HS-LS3-2, DCI.HS-LS3.B.1	344	2
14	Rubric	HS-LS3-2, DCI.HS-LS3.B.1	346	2
15	Rubric	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.G.1	344	2

11. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	A frameshift mutation is the addition or removal of a single nitrogen-containing base, which shifts the reading frame of the DNA sequence.

12. Use the rubric below to evaluate total points earned for this item. [max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	To receive full credit, students should explain that environmental factors, known as mutagens, can create mutations that lead to an increased genetic diversity. Students should also give one example of an environmental factor and explain how it can affect the expression of traits. Sample answer: Environmental factors called mutagens can create mutations that lead to increased genetic diversity. One example of a mutagen is sunlight, or UV light, which can interfere with the replication of cells and lead to cancer.

13. Use the rubric below to evaluate total points earned for this item. [max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	a point mutation

14. Use the rubric below to evaluate total points earned for this item. [max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	frameshift mutation, insertion

15. Use the rubric below to evaluate total points earned for this item. [max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Yes, the human body has DNA repair enzymes that help find and fix mutations.

Unit 7 Lesson 5 Quiz – Genetic Engineering

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS3-1, DCI.HS-LS3.A.1		1
2	C	HS-LS1-1, DCI.HS-LS1.A.2	362	1
3	A	HS-LS3-1, SEP.HS.B.2	364-365	2
4	D	HS-LS3-1	357-359	2
5	D	HS-LS3-1, DCI.HS-LS3.A.1	366	1
6	C	HS-LS3-1, SEP.NOS.HS.A.2, CCC.NOS.HS.B.2	357	2
7	C	HS-LS3-1, DCI.HS-LS3.A.1, CCC.NOS.HS.B.3	357	2
8	B	HS-LS3-1, SEP.HS.D.1	358	2
9	D	HS-LS3-1	360	2
10	A	HS-LS3-1, SEP.NOS.HS.B.1	363	2
11	Rubric	HS-LS3-1, DCI.HS-LS3.A.1, SEP.NOS.HS.C.1, CCC.NOS.HS.B.1	358	2
12	Rubric	HS-LS3-2, CCC.STSE.HS.B.2	362	2
13	Rubric	HS-LS3-1, SEP.HS.B.1	367	3

14	Rubric	HS-LS3-1, SEP.HS.B.2	362-364	2
15				

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> The goal of PCR is to make many more copies of a specific section of DNA. The reason that primers are necessary is that the DNA nucleotides need to have a section of DNA to start with in replicating the DNA.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Crop plants can be genetically engineered to add favorable characteristics, including improved yields and resistance to weed killers and destructive pests. Genetically engineered growth hormone increases milk production in dairy cows and weight gain in cattle and hogs. Transgenic animals can be cloned and used to make human proteins that are useful in medicine.</p>

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> Gene therapy treats or prevents a genetic disorder by replacing a faulty section of DNA with a correctly functioning section. Cystic fibrosis is an example of a disorder that could be treated with this therapy as there is just one abnormal protein that is the cause of the disease.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <p>Insulin is produced by bacteria in this way. A human insulin gene is spliced into bacteria, and the bacteria produce insulin.</p>

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer: A transgenic organism is an organism that has one or more genes from another organism inserted into its genome. Transgenic animals are produced by inserting foreign DNA into the nucleus of a fertilized egg. The fertilized egg is inserted into a female animal, and if the embryo develops normally, the resulting offspring is transgenic.</p>

Unit 7 Unit Test A – Genetics and Heredity

Item Analysis		
Item #	Standards	DOK
1	HS-LS3-2, DCI.HS-LS3.B.1	1
2	HS-LS3-1, DCI.HS-LS3.A.1	1
3	HS-LS3-3, DCI.3.LS3.B.2, SEP.HS.D.2	1
4	HS-LS3-2, DCI.HS-LS3.B.1, SEP.HS.G.3	2
5	HS-LS3-1, DCI.HS-LS3.A.1	2
6	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.B.1	2
7	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4	2
8	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.STSE.HS.B.2	2
9	HS-LS3-2, DCI.3.LS3.B.1, CCC.HS.G.2	1
10	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.B.2	2
11	HS-LS3-3, DCI.3.LS3.B.2, SEP.HS.B.2	1
12	HS-LS3-1, DCI.HS-LS3.A.1	2
13	HS-LS3-1, DCI.HS-LS3.A.1, SEP.HS.G.3	2
14	HS-LS3-1, DCI.HS-LS3.A.1	2
15	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.NOS.HS.B.3	2
16	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.B.1	3
17	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.B.1	3
18	HS-LS3-1, DCI.HS-LS3.A.1, SEP.HS.A.1	2
19	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4, CCC.NOS.HS.B.2	2
20	HS-LS3-1, DCI.HS-LS3.A.1	3
21	HS-LS3-2, DCI.HS-LS3.B.1	3
22	HS-LS3-3, DCI.HS-LS3.B.2, SEP.HS.A.1	2
23	HS-LS3-3, DCI.HS-LS3.B.2, CCC.HS.C.3	2
24	HS-LS3-1, DCI.HS-LS3.A.1	2
25	HS-LS3-3, DCI.HS-LS3.B.2	3

1.
 - A. This is incorrect because exposure to a chemical carcinogen is likely to increase the rate of mutations in a cell.
 - B. This is incorrect because infection with a virus, such as HPV, is likely to increase the rate of mutations in a cell.
 - C. This is incorrect because exposure to UV radiation is likely to increase the rate of mutations in a cell.
 - D. This is correct because the need to adapt cannot cause genetic mutation. Adaptations are often derived from genetic mutations, but individual organisms cannot choose to change their genes to adapt.

2. A. This is incorrect because a point mutation would affect only a single base pair and would not be easily seen on a karyotype.
B. This is incorrect because a frameshift mutation would change the reading frame, but it would not be easily seen on a karyotype.
C. This is correct because a nondisjunction mutation would change the chromosome number and would thus be identifiable using a karyotype.
D. This is incorrect because a gene duplication mutation would make a small change relative to the overall size of a chromosome and would not be easily seen on a karyotype.
3. A. This is correct because if both parents are heterozygous, there is a 25% chance that they will both pass on the recessive allele to their child.
B. This is incorrect because there is no scenario in which a child would have a 50% chance of inheriting this disease from the parents.
C. This is incorrect because there is no scenario in which a child would have a 75% chance of inheriting this disease from the parents.
D. This is incorrect because there would only be a 100% chance if both parents also had the disease.
4. A. This is correct because meiosis occurs in germ cells, which will pass on to offspring and thus the population.
B. This is incorrect because body cells like liver cells are not passed on to offspring and cannot affect the population.
C. This is incorrect because body cells like skin cells are not passed on to offspring and cannot affect the population.
D. This is incorrect because body cells like brain cells are not passed on to offspring and cannot affect the population.
5. A. This is incorrect because sex chromosomes are also inherited during meiosis.
B. This is correct because meiosis separates the homologous pairs of chromosomes.
C. This is incorrect because chromosomes are always contained in the nucleus.
D. This is incorrect because S phase precedes meiosis as well.
6. A. This is incorrect because recombination is not needed for fertilization to occur.
B. This is incorrect because recombination exchanges genetic material between chromosomes, it does not change the number of chromosomes.
C. This is correct because recombination exchanges genetic information between homologous chromosomes.
D. This is incorrect because, while inversion can happen, it is not the usual method for exchanging genetic information through recombination.
7. A. This is incorrect because a PCR will not directly determine the location of a gene on a chromosome.
B. This is incorrect because a PCR helps make copies of DNA, not protein.
C. This is incorrect because a PCR is not used in expressing DNA, only copying it.
D. This is correct because a PCR is used to amplify DNA.
8. A. This is correct because introducing genes into wild salmon populations could have negative consequences.
B. This is incorrect because the fact that they eat more is a desired trait.
C. This is incorrect because while this might be a concern, it is not one that could have lasting consequences for the environment.
D. This is incorrect because, while it may be a concern for those who raise salmon, low reproduction rates would not have any lasting impact on the environment.

9. A. *Deletion* does not belong in any blank because it does not correctly complete any sentence.
 B. *Insertion* belongs in the first blank because the mutation described involves the insertion of DNA bases.
 C. *Amino acids* belongs in the third blank because amino acids compose a protein.
 D. *Nucleic acid* belongs in the second blank because the nucleic acid sequence is directly affected by the mutation.
10. A. *Gene duplication* matches the third description because gene duplication occurs when just a section of a homologous chromosome does not separate during meiosis. It can be either harmful or beneficial.
 B. *Nondisjunction* matches the first and fourth descriptions because each is an example of failure of chromosomes to separate during meiosis. When homologous chromosomes do not separate, it is called nondisjunction.
 C. *Translocation* matches the second description because this is an example of when genes are swapped on nonhomologous chromosomes (such as chromosomes 15 and 2).
11. A. *BB* belongs in the upper left-hand box because both parents donated a dominant allele to the resulting offspring.
 B. *Bb* belongs in both the upper right-hand and lower left-hand boxes because one parent donated a dominant allele and the other donated a recessive allele to the resulting offspring.
 C. *bb* belongs in the bottom right-hand box because both parents donated recessive alleles to the resulting offspring.
12. A. This technique matches *a genetic engineer wants to replace a defective copy of a gene with a functional copy in a chromosome* because this would require a gene editing technique like CRISPR.
 B. This technique matches *a scientist needs many copies of a gene to conduct an experiment* because PCR allows for the rapid reproduction of DNA sequences.
 C. This technique matches *a doctor wants to know if a patient has an inherited disorder* because genetic testing allows for certain genetic conditions to be identified.
 D. This technique matches *a medical researcher needs many copies of a protein to be produced to use in a medical treatment* because plasmids can be used to cause bacteria to express many copies of a protein.
13. 1B. *Two copies* is correct, because a diploid cell will have 2 copies of each chromosome.
 2E. *One copy* is correct, as a haploid cell will have one copy of each chromosome.
 3J. *Chromosome 2* is correct because it is the only chromosome with one copy of the chromosomes. Chromosome 1 and 3 both have two copies.
 4P. *Chromosomes 1 and 3* is correct because they each have two copies of chromosomes. Chromosome 2 is shown with only one copy.
 5R. *Chromosome 2* is correct because it would express proteins from genes at a lower level as there is only 1 copy of the chromosome.
14. A. This is correct because exons are coding portions of the genome.
 B. This is incorrect because introns are noncoding portions of the genome.
 C. This is correct because the mature RNA transcript codes for a protein.
 D. This is incorrect because the promoter region helps initiate transcription but does not code for proteins.
 E. This is correct because RNA polymerase is an enzyme, not noncoding DNA.
15. 1B. *Recessive to* is correct because all of the offspring produced thick skin, so it is dominant to thin skin.
 2G. $3/4$ is correct because all of the plants from the first cross would be heterozygous, so $1/4$ of the resulting cross would be homozygous recessive.

16. A. This evidence belongs in *Supports* because it describes a factor that influences DNA, and a change in DNA can change traits.
- B. This evidence belongs in *Does not support* because it does not describe how traits are influenced, just how they are passed on.
- C. This evidence belongs in *Does not support* because it describes how traits are expressed, but not influenced.
- D. This evidence belongs in *Supports* because it describes how genes can influence each other to determine expression.
- E. This evidence belongs in *Supports* because it describes a specific instance where a mutagen affects DNA, which will in turn influence traits.
17. A. This is correct because a difference in light can lead to a difference in gene expression.
- B. This is correct because environmental factors such as soil composition may influence plant height.
- C. This is incorrect because if each parent were homozygous for all genes regulating height, then their offspring would have similar genetic profiles for height.
- D. This is correct because each parent could have different alleles of genes and these will be further rearranged during meiosis, which would lead to different heights among their offspring.
- E. This is incorrect because a mutation that occurred in the somatic cells of the parents would not be passed on to the offspring.
18. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. describe how mutations in gametes affect the offspring (DCI); and 2. explain how a model can be used to determine the effects of the mutation (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing mutations in offspring Part 1: One point is earned for describing that mutations in gametes cause a different amino acid sequence for the expressed gene. The difference in amino acid sequence has the ability to cause the gene product to be non-functional or not expressed at all. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • If the mutation changes the amino acid sequence, the gene could not be expressed.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly explaining how a model can be used to study mutations Part 2: One point is earned for explaining that the model can be used to show that only one of the two daughter cells will contain the mutation, as only one of the two sister chromatids will have the mutation. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • The model shows that the mutation is on only one sister chromatid. Since the sister chromatids separate into two chromosomes in mitosis, this mutation will be present in only one of the daughter cells.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	The student is able to: 1. explain what genetic testing is (DCI); and 2. propose a strategy to reduce the risk of genetic testing (SEP); and 3. identify a disadvantage of genetic testing (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining what genetic testing is Part 1: One point is earned for explaining that genetic testing involves examining the chromosomes of an individual to look for the presence of disease-related heritable genotypes and mutations. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Genetic testing looks for genetic markers in a patient's genome. From these markers, the likelihood that a patient would suffer certain diseases in the future can be predicted.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly proposing a safeguard to a risk of genetic testing Part 3: One point is earned for proposing a safeguard to mitigate the risks of genetic testing. The proposal should address the risk posed in part 2 by the student in such a way that could reasonably be expected to mitigate that risk. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> To mitigate the harmful psychological effects of misdiagnosis, doctors can share only genetic markers that indicate a high probability of disease validated through many empirical data sets. This would give the patient high confidence that he or she understands the potential for developing the disease.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly identifying a risk of genetic testing Part 2: One point is earned for identifying a risk of genetic testing, such as the psychological pressures that could result, that risky behaviors could be encouraged by negative results, or that others could use the information against the patient in some way. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Genetic testing often predicts only the potential of developing certain diseases. As a result, a healthy patient who has the markers for a particular disease, but who actually would never suffer from that disease, may spend his or her whole life worrying about developing the disease.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. describe the process of cloning in bacteria and plants; and 2. explain why the process of cloning in animals is more difficult (DCI).
Evidence of Mastery of Disciplinary Core Ideas	2 points for correctly describing cloning in bacteria, plants, and animals Part 1: One point is earned for describing the process of cloning bacteria as simply allowing them to reproduce asexually and the process of cloning plants as typically involving cutting a piece of the plant off and allowing the cutting to grow into a full plant. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Cloning of bacteria is done by growing them in a culture. Plants can be cloned by planting cuttings of the parent. Part 2: One point is earned for explaining why the process of cloning animals is more difficult. The explanation can involve the fact that the transfer of a nucleus from one cell to another is difficult or that turning on genes in a somatic cell that have been turned off can be very difficult. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Cloning animals is more difficult because transferring the nucleus of one cell to another is more difficult. It involves carefully removing a healthy nucleus from one cell and inserting it into another cell without damaging the nucleus or the host cell.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. identify how the law of segregation describes meiosis (DCI); and 2. explain the role of meiosis in generating genetic variation (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying how the law of segregation describes meiosis Part 1: One point is earned for identifying that, during meiosis, the two alleles of each gene independently segregate into different cells, resulting in an organism inheriting one copy of each gene from each parent. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> When gametes are forming, the two copies of each gene separate into different daughter cells, so each gamete only has one copy of each gene to give to the zygote. 1 point for correctly explaining the role of meiosis in the law of segregation Part 2: One point is earned for explaining the role of meiosis in generating genetic variation, such as through crossing over of homologous chromosomes. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> During meiosis, chromosomes cross over and trade alleles of a gene, resulting in new allele combinations.

22. A. This is correct because the wild-combed parent will contribute only recessive alleles while the walnut-combed parent will contribute only dominant alleles; thus, the resulting chicks will all be $RrPp$ (walnut-combed). Since only walnut-combed chickens are produced, the probability of a wild-combed is 0%.
- B. This is incorrect because the wild-combed parent will contribute only recessive alleles while the walnut-combed parent will contribute only dominant alleles; thus, the resulting chicks will all be $RrPp$ (walnut-combed).
- C. This is incorrect because the wild-combed parent will contribute only recessive alleles while the walnut-combed parent will contribute only dominant alleles; thus, the resulting chicks will all be $RrPp$ (walnut-combed).
- D. This is incorrect because the wild-combed parent will contribute only recessive alleles while the walnut-combed parent will contribute only dominant alleles; thus, the resulting chicks will all be $RrPp$ (walnut-combed).
23. A. This is correct because both parents are Bb ; thus 25% of the offspring would be BB , so 25 chicks.
- B. This is incorrect because both parents are Bb ; thus 25% of the offspring would be BB , so 25 chicks would be black.
- C. This is incorrect because the trait is incompletely dominant and both parents are Bb ; thus only 25% of the offspring would be BB .
- D. This is incorrect because both parents are Bb ; thus not all of the offspring would be black.
24. A. The correct selection for Individual 1 is Ww , since a cross between individuals 1 and 2 produces some offspring with yellow skin.
- B. The correct selection for Individual 5 is Ww since the individual has white skin, but a cross with individual 6 produces a yellow-skinned chick.
- C. The correct selection for Individual 8 is ww since this chick has yellow skin, which is recessive.
- D. The correct selection for Individual 9 is WW or Ww . Since both parents are white-skinned, there is a chance that individual 9 inherited a dominant allele from both parents. However, it could also have inherited a dominant allele from one parent and a recessive allele from the other.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI Only - 3 Points	
Claims	The student is able to: 1. explain how many chicks will be produced from a given mating; and 2. predict how an environmental factor will affect the results of a given cross (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly predicting the percentages and explaining the answer</p> <p>Part 1: Two points are earned for predicting that 100% of the female chicks from this cross would be nonbarred, while 100% of the male chicks would be barred, and for explaining that the male parent would contribute a nonbarred allele to both male and female offspring, while the female parent would contribute the barred allele to only the male chicks. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Because the male parent is nonbarred (Z^bZ^b) and the female parent is barred (Z^BW), only the male offspring would be barred. All of the female chicks would be nonbarred. This is because the male parent gives the Z^b allele to both the male and female offspring while the female parent gives the Z^B allele to only the male offspring. <p>1 point for correctly predicting how the environmental change would affect this ratio</p> <p>Part 2: One point is earned for predicting that if the environment causes more females to be produced, then the percentage of barred chickens in the flock would decline. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If the environment causes more females to be produced than males, the percentage of barred chicks in the flock would decline. This is because only the males from this cross can be barred, and if there are fewer of these produced, then more nonbarred chicks would be produced.

Unit 7 Unit Test B – Genetics and Heredity

Item Analysis		
Item #	Standards	DOK
1	HS-LS3-2, DCI.HS-LS3.B.1	1
2	HS-LS3-1, DCI.HS-LS3.A.1	1
3	HS-LS3-3, DCI.3.LS3.B.2, SEP.HS.D.2	1
4	HS-LS3-2, DCI.HS-LS3.B.1, SEP.HS.G.3	2
5	HS-LS3-1, DCI.HS-LS3.A.1	2
6	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.B.1	2
7	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4	2
8	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.STSE.HS.B.2	2
9	HS-LS3-2, DCI.3.LS3.B.1, CCC.HS.G.2	1
10	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.B.2	2
11	HS-LS3-3, DCI.3.LS3.B.2, SEP.HS.B.2	1
12	HS-LS3-1, DCI.HS-LS3.A.1	2
13	HS-LS3-1, DCI.HS-LS3.A.1, SEP.HS.G.3	2
14	HS-LS3-1, DCI.HS-LS3.A.1	2
15	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.NOS.HS.B.3	2
16	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.B.1	3
17	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.B.1	3
18	HS-LS3-1, DCI.HS-LS3.A.1, SEP.HS.A.1	2

19	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4, CCC.NOS.HS.B.2	2
20	HS-LS3-1, DCI.HS-LS3.A.1	3
21	HS-LS3-2, DCI.HS-LS3.B.1	3
22	HS-LS3-3, DCI.HS-LS3.B.2, SEP.HS.A.1	2
23	HS-LS3-3, DCI.HS-LS3.B.2, CCC.HS.C.3	2
24	HS-LS3-1, DCI.HS-LS3.A.1	2
25	HS-LS3-3, DCI.HS-LS3.B.2	3

- This is incorrect because infection with a virus, such as HPV, is likely to increase the rate of mutations in a cell.
 - This is incorrect because exposure to UV radiation is likely to increase the rate of mutations in a cell.
 - This is correct because the need to adapt cannot cause genetic mutation. Adaptations are often derived from genetic mutations, but individual organisms cannot choose to change their genes to adapt.
- This is incorrect because a point mutation would affect only a single base pair and would not be easily seen on a karyotype.
 - This is incorrect because a frameshift mutation would change the reading frame, but it would not be easily seen on a karyotype.
 - This is correct because a nondisjunction mutation would change the chromosome number and would thus be identifiable using a karyotype.
- This is correct because if both parents are heterozygous, there is a 25% chance that they will both pass on the recessive allele to their child.
 - This is incorrect because there is no scenario in which a child would have a 50% chance of inheriting this disease from the parents.
 - This is incorrect because there is no scenario in which a child would have a 75% chance of inheriting this disease from the parents.
- This is correct because meiosis occurs in germ cells, which will pass on to offspring and thus the population.
 - This is incorrect because body cells like skin cells are not passed on to offspring and cannot affect the population.
 - This is incorrect because body cells like brain cells are not passed on to offspring and cannot affect the population.
- This is incorrect because sex chromosomes are also inherited during meiosis.
 - This is correct because meiosis separates the homologous pairs of chromosomes.
 - This is incorrect because S phase precedes meiosis as well.
- This is incorrect because recombination is not needed for fertilization to occur.
 - This is incorrect because recombination exchanges genetic material between chromosomes, it does not change the number of chromosomes.
 - This is correct because recombination exchanges genetic information between homologous chromosomes.
- This is incorrect because a PCR will not directly determine the location of a gene on a chromosome.
 - This is incorrect because a PCR helps make copies of DNA, not protein.
 - This is correct because a PCR is used to amplify DNA.

8. A. This is correct because introducing genes into wild salmon populations could have negative consequences.
 B. This is incorrect because the fact that they eat more is a desired trait.
 C. This is incorrect because while this might be a concern, it is not one that could have lasting consequences for the environment.
9. A. *Insertion* belongs in the first blank because the mutation described involves the insertion of DNA bases.
 B. *Amino acid* belongs in the third blank because amino acids compose a protein.
 C. *Nucleic acid* belongs in the second blank because the nucleic acid sequence is directly affected by the mutation.
10. A. *Gene duplication* matches the second description because gene duplication occurs when just a section of a homologous chromosome does not separate during meiosis. It can be either harmful or beneficial.
 B. *Nondisjunction* matches the third descriptions because it is an example of failure of chromosomes to separate during meiosis. When homologous chromosomes do not separate, it is called nondisjunction.
 C. *Translocation* matches the first description this is an example of when genes are swapped on nonhomologous chromosomes (such as chromosomes 15 and 2).
11. A. *BB* belongs in the upper left-hand box because both parents donated a dominant allele to the resulting offspring.
 B. *Bb* belongs in both the upper right-hand and lower left-hand boxes because one parent donated a dominant allele and the other donated a recessive allele to the resulting offspring.
 C. *bb* belongs in the bottom right-hand box because both parents donated recessive alleles to the resulting offspring.
12. A. This technique matches a *scientist needs many copies of a gene to conduct an experiment* because PCR allows for the rapid reproduction of DNA sequences.
 B. This technique matches a *doctor wants to know if a patient has an inherited disorder* because genetic testing allows for certain genetic conditions to be identified.
 C. This technique matches a *medical researcher needs many copies of a protein to be produced to use in a medical treatment* because plasmids can be used to cause bacteria to express many copies of a protein.
13. 1B. *Two copies* is correct, because a diploid cell will have 2 copies of each chromosome.
 2A. *One copy* is correct, as a haploid cell will have one copy of each chromosome.
 3E. *Chromosome 2* is correct because it is the only chromosome with one copy of the chromosomes. Chromosome 1 and 3 both have two copies.
 4F. *Chromosomes 1 and 3* is correct because they each have two copies of chromosomes. Chromosome 2 is shown with only one copy.
 5H. *Chromosome 2* is correct because it would express proteins from genes at a lower level as there is only 1 copy of the chromosome.
14. A. This is correct because exons are coding portions of the genome.
 B. This is incorrect because introns are noncoding portions of the genome.
 C. This is correct because the mature RNA transcript codes for a protein.
 D. This is incorrect because the promoter region helps initiate transcription but does not code for proteins.
15. 1B. *Recessive to* is correct because all of the offspring produced thick skin, so it is dominant to thin skin.
 2G. *3/4* is correct because all of the plants from the first cross would be heterozygous, so 1/4 of the resulting cross would be homozygous recessive.
16. A. This evidence belongs in *Supports* because it describes a factor that influences DNA, and a change in DNA can change traits.

- B. This evidence belongs in *Does not support* because it does not describe how traits are influenced, just how they are passed on.
- C. This evidence belongs in *Does not support* because it describes how traits are expressed, but not influenced.
- D. This evidence belongs in *Supports* because it describes how genes can influence each other to determine expression.

17. A. This is correct because a difference in light can lead to a difference in gene expression.
- B. This is incorrect because if each parent were homozygous for all genes regulating height, then their offspring would have similar genetic profiles for height.
- C. This is correct because each parent could have different alleles of genes and these will be further rearranged during meiosis, which would lead to different heights among their offspring.
- D. This is incorrect because a mutation that occurred in the somatic cells of the parents would not be passed on to the offspring.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. describe how mutations in gametes affect the offspring (DCI); and 2. explain how a model can be used to determine the effects of the mutation (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing mutations in offspring Part 1: One point is earned for describing that mutations in gametes cause a different amino acid sequence for the expressed gene. The difference in amino acid sequence has the ability to cause the gene product to be non-functional or not expressed at all. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • If the mutation changes the amino acid sequence, the gene could not be expressed.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly explaining how a model can be used to study mutations Part 2: One point is earned for explaining that the model can be used to show that only one of the two daughter cells will contain the mutation, as only one of the two sister chromatids will have the mutation. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • The model shows that the mutation is on only one sister chromatid. Since the sister chromatids separate into two chromosomes in mitosis, this mutation will be present in only one of the daughter cells.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. explain what genetic testing is (DCI); and 2. propose a strategy to reduce the risk of genetic testing (SEP); and 3. identify a disadvantage of genetic testing (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining what genetic testing is Part 1: One point is earned for explaining that genetic testing involves examining the chromosomes of an individual to look for the presence of disease-related heritable genotypes and mutations. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • Genetic testing looks for genetic markers in a patient's genome. From these markers, the likelihood that a patient would suffer certain diseases in the future can be predicted.

Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly proposing a safeguard to a risk of genetic testing</p> <p>Part 3: One point is earned for proposing a safeguard to mitigate the risks of genetic testing. The proposal should address the risk posed in part 2 by the student in such a way that could reasonably be expected to mitigate that risk. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> To mitigate the harmful psychological effects of misdiagnosis, doctors can share only genetic markers that indicate a high probability of disease validated through many empirical data sets. This would give the patient high confidence that he or she understands the potential for developing the disease.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly identifying a risk of genetic testing</p> <p>Part 2: One point is earned for identifying a risk of genetic testing, such as the psychological pressures that could result, that risky behaviors could be encouraged by negative results, or that others could use the information against the patient in some way. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Genetic testing often predicts only the potential of developing certain diseases. As a result, a healthy patient who has the markers for a particular disease, but who actually would never suffer from that disease, may spend his or her whole life worrying about developing the disease.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe the process of cloning in bacteria and plants; and explain why the process of cloning in animals is more difficult (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly describing the process of cloning in bacteria, plants, and animals</p> <p>Part 1: One point is earned for describing the process of cloning bacteria as simply allowing them to reproduce asexually and the process of cloning plants as typically involving cutting a piece of the plant off and allowing the cutting to grow into a full plant. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Cloning of bacteria is done by growing them in a culture. Plants can be cloned by planting cuttings of the parent. <p>Part 2: One point is earned for explaining why the process of cloning animals is more difficult. The explanation can involve the fact that the transfer of a nucleus from one cell to another is difficult or that turning on genes in a somatic cell that have been turned off can be very difficult. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Cloning animals is more difficult because transferring the nucleus of one cell to another is more difficult. It involves carefully removing a healthy nucleus from one cell and inserting it into another cell without damaging the nucleus or the host cell.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> identify how the law of segregation describes meiosis (DCI); and explain the role of meiosis in generating genetic variation (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying how the law of segregation describes meiosis</p> <p>Part 1: One point is earned for identifying that, during meiosis, the two alleles of each gene independently segregate into different cells, resulting in an organism inheriting one copy of each gene from each parent. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> When gametes are forming, the two copies of each gene separate into different daughter cells, so each gamete only has one copy of each gene to give to the zygote. <p>1 point for correctly explaining the role of meiosis in the law of segregation</p> <p>Part 2: One point is earned for explaining the role of meiosis in generating genetic variation, such as through crossing over of homologous chromosomes. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> During meiosis, chromosomes cross over and trade alleles of a gene, resulting in new allele combinations.
The entire rubric is Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining role of meiosis in the law of segregation</p> <p>Part 2: One point is earned for explaining the role of meiosis in generating genetic variation, such as through crossing over of homologous chromosomes. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> During meiosis, chromosomes cross over and trade alleles of a gene, resulting in new allele combinations.

22. A. This is correct because the wild-combed parent will contribute only recessive alleles while the walnut-combed parent will contribute only dominant alleles; thus the resulting chicks will all be $RrPp$ (walnut-combed). Since only walnut-combed chickens are produced, the probability of a wild-combed is 0%.
- B. This is incorrect because the wild-combed parent will contribute only recessive alleles while the walnut-combed parent will contribute only dominant alleles; thus, the resulting chicks will all be $RrPp$ (walnut-combed).
- C. This is incorrect because the wild-combed parent will contribute only recessive alleles while the walnut-combed parent will contribute only dominant alleles; thus, the resulting chicks will all be $RrPp$ (walnut-combed).
23. A. This is correct because both parents are Bb ; thus 25% of the offspring would be BB , so 25 chicks.
- B. This is incorrect because both parents are Bb ; thus 25% of the offspring would be BB , so 25 chicks would be black.
- C. This is incorrect because the trait is incompletely dominant and both parents are Bb ; thus only 25% of the offspring would be BB .
24. A. The correct selection for individual 1 is Ww , since a cross between individuals 1 and 2 produces some offspring with yellow skin.
- B. The correct selection for individual 5 is Ww since the individual has white skin, but a cross with individual 6 produces a yellow-skinned chick.
- C. The correct selection for individual 8 is ww since this chick has yellow skin, which is recessive.
- D. The correct selection for individual 9 is WW or Ww . Since both parents are white-skinned, there is a chance that individual 9 inherited a dominant allele from both parents. However, it could also have inherited a dominant allele from one parent and a recessive allele from the other.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI Only - 3 Points	
Claims	The student is able to: 1. explain how many chicks will be produced from a given mating; and 2. predict how an environmental factor will affect the results of a given cross (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly predicting the percentages and explaining the answer</p> <p>Part 1: Two points are earned for predicting that 100% of the female chicks from this cross would be nonbarred, while 100% of the male chicks would be barred, and for explaining that the male parent would contribute a nonbarred allele to both male and female offspring, while the female parent would contribute the barred allele to only the male chicks. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Because the male parent is nonbarred (Z^bZ^b) and the female parent is barred (Z^BW), only the male offspring would be barred. All of the female chicks would be nonbarred. This is because the male parent gives the Z^b allele to both the male and female offspring while the female parent gives the Z^B allele to only the male offspring. <p>1 point for correctly predicting how the environmental change would affect this ratio</p> <p>Part 2: One point is earned for predicting that if the environment causes more females to be produced, then the percentage of barred chickens in the flock would decline. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If the environment causes more females to be produced than males, the percentage of barred chicks in the flock would decline. This is because only the males from this cross can be barred, and if there are fewer of these produced, then more nonbarred chicks would be produced.

Unit 8 Evidence for Evolution

Unit 8 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	A	HS-LS4-1	1
2	D	HS-LS4-2, DCI.HS-LS4.C.1	1
3	A	HS-LS4-2, DCI.HS-LS4.C.1, CCC.HS.G.1	1
4	C	HS-LS4-1, DCI.HS-LS4.A.1	2
5	D	HS-LS4-1, CCC.NOS.HS.A.1	1
6	B	HS-LS4-5, DCI.HS-LS4.C.4	2
7	A	HS-LS4-3	1
8	D	HS-LS4-4, DCI.HS-LS4.C.2	2
9	A	HS-LS2-7, DCI.HS-LS4.D.1	2
10	B	HS-LS4-1, DCI.HS-LS4.A.1	2
11	B	HS-LS4-1, DCI.HS-LS4.A.1	2
12	C	HS-LS4-1, DCI.HS-LS4.A.1	2
13	C	HS-LS4-1, DCI.HS-LS4.A.1	2
14	B	HS-LS4-2, DCI.HS-LS4.C.1	1
15	C	HS-LS4-3, DCI.HS-LS4.C.2, CCC.HS.G.1	2

Unit 8 Lesson 1 Quiz – Lines of Evidence for Evolution

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS4-2, DCI.HS-LS4.C.1	383	1
2	C	HS-LS4-1	389	1
3	C	HS-LS4-1, DCI.HS-LS4.A.1, SEP.NOS.HS.B.3	386	2
4	D	HS-LS4-1, DCI.HS-LS4.A.1, SEP.NOS.HS.B.1	382-385	2
5	A	HS-LS4-1, DCI.HS-LS4.A.1, SEP.NOS.HS.B.1	385	2
6	A	HS-LS4-1, DCI.HS-LS4.A.1	388	2
7	B	HS-LS4-1, DCI.HS-LS4.A.1, SEP.NOS.HS.B.3	383-384	2
8	B	HS-LS4-1, DCI.HS-LS4.A.1	388	2
9	C	HS-LS4-2, DCI.HS-LS4.C.2, CCC.HS.G.1	382-388	2
10	D	HS-LS4-1, DCI.HS-LS4.A.1	387-388	2
11	Rubric	HS-LS4-1, DCI.HS-LS4.A.1	280,	2
12	Rubric	HS-LS4-1, DCI.HS-LS4.A.1	382-384	2
13	Rubric	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.1	383-384	3
14	Rubric	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.F.2	386-387	3
15	Rubric	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.F.2	280,	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	All organisms use the same genetic code.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answers:</p> <ul style="list-style-type: none"> Scientists can compare the genetic codes of different bird species through DNA sequencing technology. The more related the species are, the more similar the birds' DNA will be. Pseudogenes, which no longer function, show evolutionary relationships because they are still carried along with the birds' functional DNA throughout subsequent generations.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The Rhesus monkey and humans have the most similar amino acids in the hemoglobin protein. This shows that they share a more recent common ancestor than the other organisms do.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	They have similar structural patterns of the bones that make up the forelimb. However, the three forelimbs have different functions in the organisms. Thus, they are homologous structures. This indicates that the organisms share a common ancestor and the structures originate from a common ancestral structure.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The fact that the genetic code is the same in all organisms and is nearly universal suggests that all life-forms have a common evolutionary ancestor with a single genetic code.

Unit 8 Lesson 2 Quiz – Theory of Natural Selection

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	B	HS-LS4-2, DCI.HS-LS4.B.1	404-407	1
2	B	HS-LS4-2, DCI.HS-LS4.C.1		1
3	A	HS-LS4-2, DCI.HS-LS4.C.1, CCC.HS.G.1	399-407	1
4	D	HS-LS4-1, DCI.HS-LS4.A.1	401	2
5	C	HS-ESS1-5, DCI.HS-ESS2.B.2, CCC.HS.C.1	401-402	2
6	A	HS-LS4-2, DCI.HS-LS4.C.1	407	2
7	D	HS-LS4-2, DCI.HS-LS4.B.1	403	2
8	D	HS-LS4-2, DCI.HS-LS4.B.1	407	2
9	A	HS-LS4-3, DCI.HS-LS4.C.2	398, 400	2
10	B	HS-LS4-2, DCI.HS-LS4.B.1	404-407	2
11	Rubric	HS-LS4-3, DCI.HS-LS4.C.2	401, 407	2
12	Rubric	HS-LS4-2, DCI.HS-LS4.C.1, SEP.HS.F.2, CCC.HS.G.1	404-407	2
13	Rubric	HS-LS4-1, DCI.HS-LS4.A.1	401-402	2
14	Rubric	HS-LS4-2, DCI.HS-LS4.C.1, SEP.HS.B.2	404-407	2
15	Rubric	HS-LS4-3, DCI.HS-LS4.B.2, SEP.HS.F.2, CCC.HS.G.1	397-398, 403-407	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answers may vary. Sample answer: They were similar in certain characteristics but different in bill shape and size, which is suited to each food type.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Those inherited traits that allow organisms to survive and reproduce more successfully in a given environment will become more common over time. Thus, species are changing (evolving).

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Answers may vary. Sample answer: Although there were differences among these finch species, all the species also had many traits in common. The main similarities among these species led Darwin to conclude that they had a common ancestor.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	First, populations produce more offspring than can possibly survive in an environment (overproduction). Next, the offspring vary in their characteristics. And much of this variation is genetic (variation). Then, in a certain environment, individuals with certain heritable traits survive and reproduce better than individuals without those traits (competition). Finally, those traits that help individuals reproduce and survive better become more common over time (adaptation).

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answers:</p> <ul style="list-style-type: none"> Natural selection is the mechanism by which individuals who have inherited traits that better suit the environment will survive and produce more offspring. Individual deer that have difficulty eating food other than the shrubs killed by the drought will die out. Larger deer that are able to reach the leaves of taller trees will survive better and produce more offspring.

Unit 8 Unit Test A – Evidence of Evolution

Item Analysis		
Item #	Standards	DOK
1	HS-LS4-1, DCI.HS-LS4.A.1	1
2	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.B.2	2
3	HS-LS4-3, DCI.HS-LS4.B.2, CCC.HS.C.1	2
4	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.1	2
5	HS-LS4-1, DCI.HS-LS4.A.1	2
6	HS-LS4-2, DCI.HS-LS4.B.1	2
7	HS-LS4-2, DCI.HS-LS4.B.1, SEP.HS.G.2	2
8	HS-LS4-3, DCI.HS-LS4.C.2, CCC.HS.G.1	2
9	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.A.1	2
10	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.2	2
11	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.1	2
12	HS-LS4-2, DCI.HS-LS4.B.1, SEP.HS.F.1	2
13	HS-LS4-3, DCI.HS-LS4.C.2	1
14	HS-LS4-1, DCI.HS-LS4.A.1	2
15	HS-LS4-3, DCI.HS-LS4.C.3	1
16	HS-LS4-2, DCI.HS-LS4.C.1, SEP.NOS.HS.D.2	2
17	HS-LS4-3, DCI.HS-LS4.C.3, SEP.HS.F.1	3

18	HS-LS4-1, DCI.HS-LS4.A.1	2
19	HS-LS4-1, DCI.HS-LS4.A.1, CCC.NOS.HS.A.1	3
20	HS-LS4-2, DCI.HS-LS4.B.1, CCC.NOS.HS.C.2	3
21	HS-LS4-2, DCI.HS-LS4.C.1, CCC.HS.B.1	3
22	HS-LS4-1, DCI.HS-LS4.A.1	1
23	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.2	2
24	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.A.1	2
25	HS-LS4-1, DCI.HS-LS4.A.1, SEP.NOS.HS.D.2, CCC.NOS.HS.A.1	3

1.
 - A. This is incorrect because feeding habits are not genetically determined.
 - B. This is incorrect because habitat loss is not genetically determined.
 - C. This is incorrect because insects do not perform the process of photosynthesis.
 - D. This is correct because the presence of identical DNA sequences and genes is evidence of common ancestry in organisms.
2.
 - A. This is incorrect because fossils are usually found in sedimentary rock, not volcanic rock.
 - B. This is correct because sedimentary rock of an age younger than the fossil species would be the most likely place to find a transitional fossil.
 - C. This is incorrect because the fossil of a transitional species would be expected to be found in younger, sedimentary rock, not older, volcanic rock.
 - D. This is incorrect because the fossil of a transitional species would be expected to be found in younger rock.
3.
 - A. This is incorrect because this is an example of artificial selection.
 - B. This is incorrect because the domestication of animals is an example of artificial selection.
 - C. This is correct because one of the tenets of natural selection is that more offspring are produced than can survive.
 - D. This is incorrect because the selection of corn seeds by a farmer is an example of artificial selection.
4.
 - A. This is correct because common developmental traits are one of the pieces of evidence used to determine common ancestry.
 - B. This is incorrect because the adult form of a fish still retains its gills.
 - C. This is incorrect because the illustration does not indicate anything about the genetics of the different organisms.
 - D. This is incorrect because it does not show anything about what the common ancestor of fish and salamanders looked like, rather only that they have one.
5.
 - A. This is correct because although birds and bats share anatomical bone structures in their wings, the wings themselves are quite different in structure. This suggests that they did not evolve together.
 - B. This is incorrect because similar bone structures in the wings do not guarantee that species have a common ancestor.
 - C. This is incorrect because birds and bats are both vertebrates, so they do have a common ancestor even if their wings evolved separately.
 - D. This is incorrect because wings in birds and bats provide significant evidence of common ancestry even if the structures are not considered homologous.
6.
 - A. This is correct because if all offspring have the same rate of survival, then natural selection will not occur.
 - B. This is incorrect because if offspring can inherit beneficial and detrimental traits from their parents, those can be selected against by natural selection.

- C. This is incorrect because if some offspring have an increased rate of survival, natural selection will occur.
- D. This is incorrect because genetic variation is the mechanism by which natural selection occurs.
7. A. This is incorrect because although human impact can influence traits in animal populations over time, these studies focus on changes in animal population numbers, not their traits.
- B. This is correct because the fact that a new vaccine must be developed every year to fight influenza infections indicates that the virus causing these infections is constantly changing via evolutionary processes.
- C. This is incorrect because stem cells are cells in a multicellular organism that undergo differentiation, which is a different type of change than the evolutionary change taking place in a population of organisms.
- D. This is incorrect because although analysis of fossils is useful for determining evolutionary processes that occurred in the past, it cannot be used to study evolution as it occurs in the present.
8. A. This is incorrect because sexual reproduction leads to offspring with differing characteristics.
- B. This is incorrect because having the effect of reducing resources would discourage a behavior, not encourage it.
- C. This is correct because behaviors that increase reproductive success are selected for.
- D. This is incorrect because behavior that harmed female anglerfish would be unlikely to be selected for.
9. A. This is incorrect because being of different sizes does not relate the fossils to modern arthropods.
- B. This is correct because similar physical features are often evidence of common ancestry.
- C. This is incorrect because similar physical features may be found at very different times in evolutionary history.
- D. This is incorrect because the location where the fossils were found is not shown in the diagram and would not support a relationship to modern arthropods.
10. A. This is incorrect because dinosaurs existed long before modern birds evolved.
- B. This is correct because the presence of feathers indicates that birds evolved from dinosaurs.
- C. This is incorrect because birds and dinosaurs are believed to have very similar bone structures.
- D. This is incorrect because dinosaurs were extinct before modern birds evolved.
11. A. *DNA* belongs in the second blank because related species will have similarities in DNA sequences.
- B. *Vestigial* does not belong in any blank because vestigial structures are not described in the paragraph.
- C. *Analogous* does not belong in any blank because analogous structures are structures that lack a common origin.
- D. *Homologous* belongs in the first blank because homologous structures provide evidence of common ancestry.
- E. *Carbohydrate* does not belong in any blank because carbohydrate sequences are rarely used in determining common ancestry.
- F. *Cell membrane* does not belong in any blank because cell membranes are not described in the paragraph.
12. First, the population of rabbits randomly mates, increasing genetic diversity. Second, an individual in the population grows brown fur because of a randomly generated gene. Third, brown fur provides better camouflage in the new environment for the individual. Fourth, the brown individual successfully breeds and passes on the gene for brown fur. Fifth, offspring with the brown fur gene have more success surviving and mating. Sixth, the brown fur gene becomes more prevalent in the population. This shows the trait randomly appearing due to genetic variation, helping the individual compete more successfully, and spreading throughout the population.

13. A. *Adaption* matches the second statement, because adaption refers to traits that help benefit the survival of an organism.
- B. *Competition* matches the fourth statement, because competition means the differential survival of organisms in the same environment.
- C. Overproduction matches the third statement, because overproduction means the capacity to produce more offspring than can survive.
- D. Variation matches the first statement, because variation describes the differences in traits within a population.
14. A. This is an incorrect selection because occupying similar niches does not imply common ancestry.
- B. This is a correct selection because embryonic similarities suggest evolutionary relationships.
- C. This is an incorrect selection because although the wings have similar functions, they do not have anatomical similarity.
- D. This is a correct selection because similar genetic sequences imply common ancestry.
- E. This is a correct selection because anatomical similarities are often evidence of common ancestry.
15. A. This statement belongs in the *Artificial Selection* column, because this is an example of a human controlling the traits of the corn.
- B. This statement belongs in the *Natural Selection* column, because a lion hunting is an example of natural events affecting the reproductive success of gazelles.
- C. This statement belongs in the *Artificial Selection* column, because this is an example of a human controlling the traits of cattle.
- D. This statement belongs in the *Natural Selection* column, because female choice in breeding is an example of natural events affecting the reproductive success of male birds.
16. A. This observation supports *modern animals are related to fossil forms* because an extinct species showed similar characteristics to an extant species.
- B. This observation supports *geologic processes add up to great change over time*, because it shows that rock can be moved from below sea level to great heights over time.
- C. This observation supports *species adapt to their surroundings*, because it provides evidence of speciation.
17. A. This is correct because the data show a slight increase in the percentage of brown-skinned lizards after the drought.
- B. This is incorrect because the data show the percentage of large-bodied lizards decreasing after the drought.
- C. This is incorrect because the data show the percentage of green-skinned lizards decreasing after the drought.
- D. This is correct because the data show a large increase in the percentage of small-bodied lizards after the drought.
- E. This is incorrect because there is a definite change in the percentages seen among the different traits before and after the drought.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain how the fossil of Tiktaalik can be used to show common ancestry between fish and tetrapods (DCI); and 2: explain the significance of Tiktaalik in regard to understanding the evolution of land animals (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining how Tiktaalik shows common ancestry</p> <p>Part 1: One point is earned for explaining how the Tiktaalik fossil demonstrates common ancestry between fishes and tetrapods. Answer should include that the fossil shows structures found in both fishes and tetrapods and appears to be a transitional species. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The fossil shows features of fishes, such as fins, as well as features of tetrapods, such as shoulder bones. This suggests that the animal was a common ancestor of both fishes and tetrapods. <p>1 point for explaining the significance of Tiktaalik in regard to understanding early land animals</p> <p>Part 2: One point for explaining that the <i>Tiktaalik</i> pelvic bone shows that early land animals used rear as well as front limbs for moving around on land. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The pelvic bone shows that Tiktaalik used its back limbs as well as its front limbs to move around, which means early land animals did not just use their front limbs.
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19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student will be able to:</p> <ol style="list-style-type: none"> explain how the discovery of fossils in different layers of Earth can lead to knowledge of species evolution (DCI); and explain whether geologic evidence will still be able to be used in a hundred years (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining how fossils can show species evolution</p> <p>Part 1: One point for correctly explaining that fossils are found in all layers of Earth's crust. The deeper the fossil is found, the older it is. When similar fossils are found in different layers with slight differences it leads to the conclusion that the species evolved. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Fossils of the same species found in different layers of Earth's crust can have slight differences in their appearance. The deeper the fossil is found, the older it is. By comparing fossils from different layers, the evolutionary path can be seen.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for explaining if geologic evidence will still be able to be used in a hundred years</p> <p>Part 2: One point for explaining that a hundred years from now geologic evidence will still be able to be used because fossils will still be found in the layers of rock. Technology will have advanced to better determine the ages of the fossils and to help put them into more inclusive categories that determine evolutionary relationships. Since organisms are continuously fossilized, there will always be new information found to help answer questions about species evolution. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> A hundred years from now geological evidence will still be used to study evolution. Organisms will continue to be fossilized and technological advancements will help scientists gather data that will allow for more accurate evolutionary relationships to be made.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe how genetic mutations enable bacteria to develop resistance to antibiotics over time (DCI); and explain what can happen in natural systems and how human decisions are made based on that knowledge (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the role of natural selection in the loss of effectiveness in antibiotics over time</p> <p>Part 1: One point is earned for describing that bacteria develop resistance to antibiotics over time through natural selection for mutations that make them resistant, and those with the resistant genes will survive to pass them on to the next generation so that over time the majority of the population will be resistant. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> In any bacterial population, there may be a few individuals that have a mutation in a gene that allows them to survive the effects of an antibiotic compound while all others in the population do not survive the compound. Because these individuals survive to reproduce, bacteria in future generations can inherit the mutation that allows them to resist the antibiotic. Over time, nearly the entire population could be resistant to the antibiotic.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining how the data supports the use of restraint</p> <p>Part 2: One point is earned for using the data to explain how medical professionals must deal with the problem of antibiotics losing their effectiveness in treating bacterial infections in humans by approaching the prescription of antibiotics with caution. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data show that antibiotics can quickly lose their effectiveness. Medical professionals trying to treat bacterial infections in humans should use antibiotics sparingly. The more antibiotics are used, the more exposure that bacterial populations will have to antibiotics, which allows for natural selection and the development of antibiotic-resistant populations.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain how the fish populations of lakes B and C would be expected to evolve (DCI); and predict how the survival of the fish would be affected by a move from lake C to lake B.
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the evolution of the males in the populations</p> <p>Part 1: One point is earned for explaining that the males in the population of lake B would become less brightly colored due to predation on the more brightly colored males, while the males in lake C would become more brightly colored due to the greater reproductive success of the brighter males. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The males in lake B would become less bright because the brighter ones would get eaten, and the males in lake C would become more bright because the females would choose the brightest males.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly predicting the effects of moving the population of lake C</p> <p>Part 2: One point is earned for predicting that moving the males from lake C into lake B would result in their survival decreasing, as they are not well adapted to living with a high predator density. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The population would be brighter and more easily seen, so they would get eaten more easily, and thus, the population would go down.

22. **1B.** *Developmental* is correct because the data are not related to the anatomical structure or the physiology of the eye, but rather to the development of the eye.

2D. *Homeobox* is correct, as homeobox genes direct the development of animal body plans.

23. The most closely related is the gene from organism X, followed by the gene from organism Y, followed by the eyeless gene, followed by the gene from organism Z.

24. A. This is incorrect because the protein in the passage had identical amino acid sequence despite mice and flies not being closely related.
- B. This is incorrect because genetic sequences do not have to be identical in order to code for the same proteins in two different cells, so this does not rule out evolutionary relatedness.
- C. This is correct because having the same or similar amino acid sequence makes two proteins have the same or similar structure and function. Having proteins with the same or similar structure and function is evidence that two cells have similar evolutionary histories.
- D. This is incorrect because the amino acid sequence shown in the passage had fewer differences than the nucleic acid sequence.
- E. This is correct because nucleic acid sequences code for amino acid sequences in proteins. When these are similar, they are evidence that the sequences originated from a common ancestor.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. support the argument that vertebrates and insects evolved from a common ancestor (DCI); and 2. explain why the advent of genetic sequencing technologies provided a turning point in evidence gathering (SEP); and 3. predict how the eye structures and genes controlling eye development in animal species in the future will compare to those in the present. (CCC)
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly using evidence to support common ancestry</p> <p>Part 1: One point is earned for using genetic and developmental evidence about eye structures to argue that the similarity in eye genes of animals supports the theory of evolution, including the presence of a common ancestor that likely had a primitive eye from which all eyes evolved. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Since all animals with eye structures have the same basic gene that controls eye development, this suggests that they all have a common ancestor that had one ancestral gene from which all of these genes originated. Then complex changes occurred after groups split from one another so that their eye structures now differ.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly explaining how genetic techniques have been used to gather evidence</p> <p>Part 2: One point is earned for using the evidence to explain that genetic techniques provided a new line of evidence in support of evolution and that genetic evidence showed things about eye evolution that anatomical evidence could not, such as the similarity in sequence of genes controlling development. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Before genetic sequencing, anatomical comparisons were the primary way that people could use to draw conclusions about the idea of evolution. Because eyes were very different across groups, it was easy to conclude that animals did not evolve from a common ancestor. However, once the genes for eye development were compared, it became clear that animal eyes shared enough genetic similarity that they could have evolved from a primitive eye structure that later underwent a great deal of change after groups split off from one another.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for predicting future of eye development in animals</p> <p>Part 3: One point is earned for predicting that the future will result in a similar pattern shown in the past and that the genes for eye development will likely show little change even if eye structures do show differences. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The gene for eye development will likely continue to show little change since it has not undergone much change over time. There must be negative effects on the animal if this gene changes too much, which prevents these changes from being passed on if they occur. However, the many differences in eye structures that developed over time indicate that while genes may stay similar it is possible that they will continue to change in outward appearance a great deal in the future.

Unit 8 Unit Test B – Evidence of Evolution

Item Analysis		
Item #	Standards	DOK
1	HS-LS4-1, DCI.HS-LS4.A.1	1
2	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.B.2	2
3	HS-LS4-3, DCI.HS-LS4.B.2, CCC.HS.C.1	2
4	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.1	2
5	HS-LS4-1, DCI.HS-LS4.A.1	2
6	HS-LS4-2, DCI.HS-LS4.B.1	2
7	HS-LS4-2, DCI.HS-LS4.B.1, SEP.HS.G.2	2
8	HS-LS4-3, DCI.HS-LS4.C.2, CCC.HS.G.1	2
9	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.A.1	2
10	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.2	2
11	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.1	2
12	HS-LS4-2, DCI.HS-LS4.B.1, SEP.HS.F.1	2
13	HS-LS4-3, DCI.HS-LS4.C.2	1
14	HS-LS4-1, DCI.HS-LS4.A.1	2
15	HS-LS4-3, DCI.HS-LS4.C.3	1
16	HS-LS4-2, DCI.HS-LS4.C.1, SEP.NOS.HS.D.2	2
17	HS-LS4-3, DCI.HS-LS4.C.3, SEP.HS.F.1	3
18	HS-LS4-1, DCI.HS-LS4.A.1	2
19	HS-LS4-1, DCI.HS-LS4.A.1, CCC.NOS.HS.A.1	3
20	HS-LS4-2, DCI.HS-LS4.B.1, CCC.NOS.HS.C.2	3
21	HS-LS4-2, DCI.HS-LS4.C.1, CCC.HS.B.1	3
22	HS-LS4-1, DCI.HS-LS4.A.1	1
23	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.D.2	2
24	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.A.1	2
25	HS-LS4-1, DCI.HS-LS4.A.1, SEP.NOS.HS.D.2, CCC.NOS.HS.A.1	3

- This is incorrect because feeding habits are not genetically determined.
 - This is incorrect because insects do not perform the process of photosynthesis.
 - This is correct because the presence of identical DNA sequences and genes is evidence of common ancestry in organisms.
- This is incorrect because fossils are usually found in sedimentary rock, not volcanic rock.
 - This is correct because sedimentary rock of an age younger than the fossil species would be the most likely place to find a transitional fossil.
 - This is incorrect because the fossil of a transitional species would be expected to be found in younger rock.
- This is incorrect because this is an example of artificial selection.
 - This is incorrect because the domestication of animals is an example of artificial selection.
 - This is correct because one of the tenets of natural selection is that more offspring are produced than can survive.

4. A. This is correct because common developmental traits are one of the pieces of evidence used to determine common ancestry.
B. This is incorrect because the adult form of a fish still retains its gills.
C. This is incorrect because it does not show anything about what the common ancestor of fish and salamanders looked like, rather only that they have one.
5. A. This is correct because although birds and bats share anatomical bone structures in their wings, the wings themselves are quite different in structure. This suggests that they did not evolve together.
B. This is incorrect because similar bone structures in the wings do not guarantee that species have a common ancestor.
C. This is incorrect because birds and bats are both vertebrates, so they do have a common ancestor even if their wings evolved separately.
6. A. This is correct because if all offspring have the same rate of survival, then natural selection will not occur.
B. This is incorrect because if offspring can inherit beneficial and detrimental traits from their parents, those can be selected against by natural selection.
C. This is incorrect because genetic variation is the mechanism by which natural selection occurs.
7. A. This is incorrect because although human impact can influence traits in animal populations over time, these studies focus on changes in animal population numbers, not their traits.
B. This is correct because the fact that a new vaccine must be developed every year to fight influenza infections indicates that the virus causing these infections is constantly changing via evolutionary processes.
C. This is incorrect because although analysis of fossils is useful for determining evolutionary processes that occurred in the past, it cannot be used to study evolution as it occurs in the present.
8. A. This is incorrect because having the effect of reducing resources would discourage a behavior, not encourage it.
B. This is correct because behaviors that increase reproductive success are selected for.
C. This is incorrect because behavior that harmed female anglerfish would be unlikely to be selected for.
9. A. This is incorrect because being of different sizes does not relate the fossils to modern arthropods.
B. This is correct because similar physical features are often evidence of common ancestry.
C. This is incorrect because similar physical features may be found at very different times in evolutionary history.
10. A. This is incorrect because dinosaurs existed long before modern birds evolved.
B. This is correct because the presence of feathers indicates that birds evolved from dinosaurs.
C. This is incorrect because dinosaurs were extinct before modern birds evolved.
11. A. *DNA* belongs in the second blank because related species will have similarities in DNA sequences.
B. *Vestigial* does not belong in any blank because vestigial structures are not described in the paragraph.
C. *Analogous* does not belong in any blank because analogous structures are structures that lack a common origin.
D. *Homologous* belongs in the first blank because homologous structures provide evidence of common ancestry.
E. *Carbohydrate* does not belong in any blank because carbohydrate sequences are rarely used in determining common ancestry.

12. First, the population of rabbits randomly mates, increasing genetic diversity. Second, an individual in the population grows brown fur because of a randomly generated gene. Third, brown fur provides better camouflage in the new environment for the individual. Fourth, the brown individual successfully breeds and passes on the gene for brown fur. Fifth, offspring with the brown fur gene have more success surviving and mating. Sixth, the brown fur gene becomes more prevalent in the population. This shows the trait randomly appearing due to genetic variation, helping the individual compete more successfully, and spreading throughout the population.
13. A. *Competition* matches the third statement, because competition means the differential survival of organisms in the same environment.
B. *Overproduction* matches the second statement, because overproduction means the capacity to produce more offspring than can survive.
C. *Adaptation* matches the first statement, because adaptation refers to traits that help benefit the survival of an organism.
14. A. This is an incorrect selection because occupying similar niches does not imply common ancestry.
B. This is a correct selection because embryonic similarities suggest evolutionary relationships.
C. This is an incorrect selection because although the wings have similar functions, they do not have anatomical similarity.
D. This is a correct selection because similar genetic sequences imply common ancestry.
15. A. This statement belongs in the *Artificial Selection* column, because this is an example of a human controlling the traits of the corn.
B. This statement belongs in the *Natural Selection* column, because a lion hunting is an example of natural events affecting the reproductive success of gazelles.
C. This statement belongs in the *Natural Selection* column, because female choice in breeding is an example of natural events affecting the reproductive success of male birds.
16. A. This observation supports *modern animals are related to fossil forms* because an extinct species showed similar characteristics to an extant species.
B. This observation *supports geologic processes add up to great change over time*, because it shows that rock can be moved from below sea level to great heights over time.
C. This observation supports *species adapt to their surroundings*, because it provides evidence of speciation.
17. A. This is incorrect because the data show the percentage of large-bodied lizards decreasing after the drought.
B. This is correct because the data show a slight increase in the percentage of brown-skinned lizards after the drought.
C. This is incorrect because the data show the percentage of green-skinned lizards decreasing after the drought.
D. This is correct because the data show a large increase in the percentage of small-bodied lizards after the drought.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Point	
Claims	The student is able to explain the evolution of tetrapods. (DCI)
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for explaining how <i>Tiktaalik</i> can lead to information about tetrapod evolution</p> <p>Part 1: Two points for explaining that the <i>Tiktaalik</i> pelvic bone shows that early land animals used rear as well as front limbs for moving around on land. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The pelvic bone shows that <i>Tiktaalik</i> used its back limbs as well as its front limbs to move around, which means early land animals did not just use their front limbs.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student will be able to:</p> <ol style="list-style-type: none"> explain how the discovery of fossils in different layers of Earth can lead to knowledge of species evolution (DCI); and explain whether geologic evidence will still be able to be used in a hundred years (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining how fossils can show species evolution</p> <p>Part 1: One point for correctly explaining that fossils are found in all layers of Earth's crust. The deeper the fossil is found, the older it is. When similar fossils are found in different layers with slight differences it leads to the conclusion that the species evolved. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Fossils of the same species found in different layers of Earth's crust can have slight differences in their appearance. The deeper the fossil is found, the older it is. By comparing fossils from different layers the evolutionary path can be seen.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for explaining if geologic evidence will still be able to be used in a hundred years</p> <p>Part 2: One point for explaining that a hundred years from now geologic evidence will still be able to be used because fossils will still be found in the layers of rock. Technology will have advanced to better determine the ages of the fossils and to help put them into more inclusive categories that determine evolutionary relationships. Since organisms are continuously fossilized, there will always be new information found to help answer questions about species evolution. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> A hundred years from now geological evidence will still be used to study evolution. Organisms will continue to be fossilized and technological advancements will help scientists gather data that will allow for more accurate evolutionary relationships to be made.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe how genetic mutations enable bacteria to develop resistance to antibiotics over time (DCI); and explain what can happen in natural systems and how human decisions are made based on that knowledge (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for describing the role of natural selection in the loss of effectiveness in antibiotics over time</p> <p>Part 1: One point is earned for describing that bacteria develop resistance to antibiotics over time through natural selection for mutations that make them resistant, and those with the resistant genes will survive to pass them on to the next generation so that over time the majority of the population will be resistant. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> In any bacterial population, there may be a few individuals that have a mutation in a gene that allows them to survive the effects of an antibiotic compound while all others in the population do not survive the compound. Because these individuals survive to reproduce, bacteria in future generations can inherit the mutation that allows them to resist the antibiotic. Over time, nearly the entire population could be resistant to the antibiotic.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for using the data to explain what can happen in natural systems and how that can affect human decisions</p> <p>Part 2: One point is earned for using the data to explain how medical professionals must deal with the problem of antibiotics losing their effectiveness in treating bacterial infections in humans by approaching the prescription of antibiotics with caution. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data show that antibiotics can quickly lose their effectiveness. Medical professionals trying to treat bacterial infections in humans should use antibiotics sparingly. The more antibiotics are used, the more exposure that bacterial populations will have to antibiotics, which allows for natural selection and the development of antibiotic-resistant populations.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain how the fish populations of lakes B and C would be expected to evolve (DCI); and explain how the survival of the fish would be affected by a move from lake C to lake B.
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the evolution of the males in the two populations</p> <p>Part 1: One point is earned for explaining that the males in the population of lake B would become less brightly colored due to predation on the more brightly colored males, while the males in lake C would become more brightly colored due to the greater reproductive success of the brighter males. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The males in lake B would become less bright because the brighter ones would get eaten, and the males in lake C would become brighter because the females would choose the brightest males.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining the effects of moving the population of lake C</p> <p>Part 2: One point is earned for explaining that moving the males from lake C into lake B would result in their survival decreasing, as they are not well adapted to living with a high predator density. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The population would be brighter and more easily seen, so they would get eaten more easily, and thus, the population would go down.

22. **1B.** *Developmental* is correct because the data are not related to the anatomical structure or the physiology of the eye, but rather to the development of the eye.

2C. *Homeobox* is correct, as homeobox genes direct the development of animal body plans.

23. The most closely related is the gene from organism X, followed by the gene from organism Y, followed by the eyeless gene, and then the gene from organism Z.

24. **A.** This is incorrect because genetic sequences do not have to be identical in order to code for the same proteins in two different cells, so this does not rule out evolutionary relatedness.

- B. This is correct because having the same or similar amino acid sequence makes two proteins have the same or similar structure and function. Having proteins with the same or similar structure and function is evidence that two cells have similar evolutionary histories.
- C. This is incorrect because the amino acid sequence shown in the passage had fewer differences than the nucleic acid sequence.
- D. This is correct because nucleic acid sequences code for amino acid sequences in proteins. When these are similar, they are evidence that the sequences originated from a common ancestor.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 points	
Claims	The student is able to: 1. support the argument that vertebrates and insects evolved from a common ancestor (DCI); and 2. explain why the advent of genetic sequencing technologies provided a turning point in evidence gathering (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for using evidence to construct an argument to support common ancestry Part 1: One point is earned for using genetic and developmental evidence about eye structures to argue that the similarity in eye genes of animals supports the theory of evolution, including the presence of a common ancestor that likely had a primitive eye from which all eyes evolved. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Since all animals with eye structures have the same basic gene that controls eye development, this suggests that they all have a common ancestor that had one ancestral gene from which all of these genes originated. Then complex changes occurred after groups split from one another so that their eye structures now differ.
Evidence of Mastery of Science and Engineering Practices	2 points for explaining how genetic techniques have been used to gather new evidence Part 2: Two points are earned for using the evidence to explain that genetic techniques provided a new line of evidence in support of evolution and that genetic evidence showed things about eye evolution that anatomical evidence could not, such as the similarity in sequence of genes controlling development. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Before genetic sequencing, anatomical comparisons were the primary way that people could use to draw conclusions about the idea of evolution. Because eyes were very different across groups, it was easy to conclude that animals did not evolve from a common ancestor. However, once the genes for eye development were compared, it became clear that animal eyes shared enough genetic similarity that they could have evolved from a primitive eye structure that later underwent a great deal of change after groups split off from one another.

Unit 9 Patterns of Evolution

Unit 9 Pretest

Item Analysis			
Item #	Key	Standards	DOK
1	C	HS-LS4-3, DCI.HS-LS4.C.2	1
2	A	HS-LS4-2, DCI.HS-LS4.B.1	1
3	C	HS-LS4-3, DCI.HS-LS4.C.2	2
4	B	HS-LS4-3, DCI.HS-LS4.C.2	2
5	D	HS-LS4-4	1
6	A	HS-LS4-3, DCI.HS-LS4.B.2	1
7	A	HS-LS4-4	1
8	C	HS-LS4-3, DCI.HS-LS4.C.1	2

9	A	HS-LS3-3	2
10	B	HS-LS4-5, DCI.HS-LS4.C.5	1
11	D	HS-LS4-5, DCI.HS-LS4.C.4	2
12	D	HS-LS2-8, DCI.HS-LS2.D.1	1
13	D	HS-LS2-8, DCI.HS-LS2.D.1	1
14	C	HS-LS4-5, DCI.HS-LS4.C.4	1
15	C	HS-LS4-3, DCI.HS-LS4.B.2, CCC.HS.G.1	1

Unit 9 Lesson 1 Quiz – Evolution of Populations

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS4-3, DCI.HS-LS4.C.2	424	1
2	B	HS-LS4-3, DCI.HS-LS4.C.2, SEP.HS.D.1	420-424	3
3	C	HS-LS4-4	428	1
4	A	HS-LS3-3	422	2
5	D	HS-LS4-3, DCI.HS-LS4.C.2, CCC.HS.G.1	419	2
6	B	HS-LS4-3, DCI.HS-LS4.B.2	425	2
7	B	HS-LS4-3, DCI.HS-LS4.C.2	400,	2
8	A	HS-LS3-3	422	1
9	A	HS-LS4-4	426	1
10	C	HS-LS3-2, DCI.HS-LS3.B.1	429	1
11	Rubric	HS-LS4-3, DCI.HS-LS4.B.2, SEP.HS.F.2, CCC.HS.G.1	430	2
12	Rubric	HS-LS4-3, DCI.HS-LS4.B.2, CCC.HS.G.1	424	3
13	Rubric	HS-LS4-3, DCI.HS-LS4.B.2, SEP.HS.D.1	423-425	3
14	Rubric	HS-LS4-2, DCI.HS-LS4.C.1, SEP.HS.F.2, CCC.HS.G.1	407,	2
15	Rubric	HS-LS4-3, DCI.HS-LS4.C.3, SEP.HS.F.2, CCC.HS.G.1	407,	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Portions of DNA in a bacterial cell can move from one cell to another. If one bacterial cell has a mutation or change that allows it to resist antibiotics, it can transfer this genetic resistance to other bacteria. When the antibiotic kills the rest of the bacteria, only the resistant cells remain. These cells reproduce to create whole populations of bacteria that are resistant to the antibiotics.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The wild pigs prefer to eat cactus plants that have fewer spines, so more cacti that are very spiny are surviving to reproduce. Their offspring are also very spiny.

13. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Graph A represents stabilizing selection. Stabilizing selection narrows the range of individuals to those in the middle of the range, where average is selected. An example is body size in lizards where selection is against those of very small or very large size. Graph B represents directional selection. Directional selection tends to eliminate individuals in a population that are at one extreme of the range of phenotypes. An example of directional selection is pesticide resistance in insects. Selection is in favor of the most pesticide-resistant insects.

14. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: If the islands have different ecosystems, birds with a particular shape or size of beak would be more successful depending on the types of foods available in their ecosystem.

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: Population A would decrease because this population eats insects.

Unit 9 Lesson 2 Quiz – Changes in Species

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	B	HS-LS4-3, DCI.HS-LS4.C.2	435	1
2	D	HS-LS4-5, DCI.HS-LS4.C.4	436	2
3	D	HS-LS4-3, DCI.HS-LS4.C.2	435,	2
4	B	HS-LS4-5, DCI.HS-LS4.C.4, CCC.HS.G.1	441-442	2
5	C	HS-LS4-5, DCI.HS-LS4.C.5	442	1
6	A	HS-LS4-5, DCI.HS-LS4.C.5	441	1
7	D	HS-LS4-5, DCI.HS-LS4.C.4	436-437	2
8	C	HS-LS4-5, DCI.HS-LS4.C.4	438	2
9	D	HS-LS4-3, DCI.HS-LS4.C.2	436	1
10	D	HS-LS4-3, DCI.HS-LS4.C.2	435-439	3
11	Rubric	HS-LS4-3, DCI.HS-LS4.C.2, SEP.HS.D.1, CCC.HS.G.1	438	2
12	Rubric	HS-LS4-3, DCI.HS-LS4.B.2, CCC.HS.G.1	435-439	3
13	Rubric	HS-LS4-5, DCI.HS-LS4.C.4, SEP.HS.F.2, CCC.HS.G.1	441-443	2
14	Rubric	HS-LS4-5, DCI.HS-LS4.C.4, SEP.HS.F.2, CCC.HS.G.1	435-438,	2
15	Rubric	HS-LS4-5, DCI.HS-LS4.C.4, CCC.HS.G.1	441-442	2

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Beaks are adapted for food types specific to particular habitats.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Natural selection and geographic isolation would begin to act on each of the two populations according to the environment on each side of the canyon. If the environments are different, the adaptations will be different. Genetic drift may also occur, especially if one of the groups is very small. Differences between the populations will accumulate as the two populations diverge. Speciation will occur when the net effects of evolutionary forces result in a population that has unique features and the two populations can no longer interbreed even if they were to come into contact with one another again.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	If an environment changes faster than new adaptations arise in a species, the species may be driven to extinction because previously well-adapted species may become poorly adapted for the new environmental condition.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample answer: The very tall peaks represent mass extinctions during which many species become extinct at the same time. After a mass extinction, small numbers of well-adapted species can diversify and evolve to live in a wide range of environments that are left empty by the newly extinct species. This is called adaptive radiation.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Sample Answer: The very tall peaks represent mass extinctions. Mass extinctions can be caused by events that cause significant climate change. Examples of these types of events include continental movement and global catastrophes such as major volcanic eruptions or massive meteor strikes.

Unit 9 Lesson 3 Quiz – Adaptive Value of Behavior

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS2-8, DCI.HS-LS2.D.1	452	1
2	B	HS-LS2-8, DCI.HS-LS4.C.2	454	1
3	A	HS-LS2-8, DCI.HS-LS2.D.1	453-454	1
4	B	HS-LS4-3, DCI.HS-LS4.B.2	421	2
5	C	HS-LS2-8, DCI.HS-LS2.D.1	452-454	2
6	B	HS-LS2-8, DCI.HS-LS2.D.1	454, 457	2

7	A	HS-LS2-8, DCI.HS-LS2.D.1	449	2
8	D	HS-LS4-2, DCI.HS-LS4.C.1, CCC.HS.G.1	451	2
9	B	HS-LS2-8	451	2
10	C	HS-LS2-8, DCI.HS-LS2.D.1	451-452	2
11	Rubric	HS-LS2-8, DCI.HS-LS2.D.1	454	2
12	Rubric	HS-LS4-3, DCI.HS-LS4.C.2, SEP.HS.F.2	449-451	2
13	Rubric	HS-LS2-8	452	3
14	Rubric	HS-LS2-8, DCI.HS-LS2.D.1, SEP.HS.F.2	454	2
15	Rubric	HS-LS2-8, SEP.HS.F.2	451	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	A ground squirrel or prairie dog risks its life by serving as a visible lookout for predators. The group benefits by being warned of an oncoming predator.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	An animal that has an inherited behavior that enhances its reproductive success, such as cub-killing behavior in lions, will produce more offspring than animals lacking that behavior. Its offspring will have inherited the same reproduction-enhancing behavior and, in turn, go on to produce more offspring than animals that lack that behavior. Over time, there will be more animals with the reproduction-enhancing behavior and fewer animals that lack that behavior.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> Visual signals such as plumage in birds can communicate mating fitness. Chemical signals can include pheromone trails in insects. Touch signals such as mutual grooming in primates create social bonds. Vocal signals include vocalizations used by chimpanzees to provide information about their location. <p>Answers may vary.</p>

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Group A has the highest percentage of close relatives; Group B has the lowest. Individual animals are better able to enhance their own fitness when they protect close relatives.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<ul style="list-style-type: none"> Names as a cost of territoriality the time lost to other activities, such as foraging or mating. Explains that the animal might abandon its territory when the territory's resources decline or when the energy lost to maintaining the territory is greater than the energy gained.

Unit 9 Unit Test A – Patterns of Evolution

Item Analysis		
Item #	Standards	DOK
1	HS-LS4-4, DCI.HS-LS4.C.3, SEP.HS.A.1	2
2	HS-LS4-4, DCI.HS-LS4.C.2	2
3	HS-LS3-3, DCI.HS-LS3.B.2	1
4	HS-LS2-8, DCI.HS-LS2.D.1, CCC.HS.B.1	2
5	HS-LS4-5, DCI.HS-LS4.C.4	1
6	HS-LS2-8, DCI.HS-LS2.D.1, CCC.NOS.HS.A.1	2
7	HS-LS4-4, DCI.HS-LS4.B.2, SEP.NOS.HS.D.3	2
8	HS-LS2-8, DCI.HS-LS2.D.1	2
9	HS-LS4-3, DCI.HS-LS4.B.2, SEP.HS.D.2	2
10	HS-LS3-3, DCI.HS-LS3.B.2, CCC.HS.C.3	2
11	HS-LS4-5, DCI.HS-LS4.C.4	1
12	HS-LS2-8, DCI.HS-LS2.D.1, CCC.HS.G.1	1
13	HS-LS4-4, DCI.HS-LS4.C.3, CCC.HS.D.2	3
14	HS-LS4-5, DCI.HS-LS4.C.5, SEP.HS.F.1	3
15	HS-LS4-5, DCI.HS-LS4.C.4, SEP.NOS.HS.C.2	2
16	HS-LS2-8, DCI.HS-LS2.D.1	1
17	HS-LS4-4, DCI.HS-LS4.B.1, SEP.HS.F.1	2
18	HS-LS4-5, DCI.HS-LS4.C.5, CCC.HS.A.1	2
19	HS-LS4-4, DCI.HS-LS4.B.2, CCC.HS.B.1	2
20	HS-LS2-8, DCI.HS-LS2.D.1	3
21	HS-LS4-5, DCI.HS-LS4.C.4, SEP.HS.G.1, CCC.HS.B.1	3
22	HS-LS2-8, DCI.HS-LS2.D.1, SEP.HS.F.1	2
23	HS-LS2-8, DCI.HS-LS2.D.1, SEP.HS.G.1	2
24	HS-LS2-8, DCI.HS-LS2.D.1	1
25	HS-LS2-8, DCI.HS-LS2.D.1	3

- This is correct because this would help explain an increase in the percent of the population that is dark blue, not light blue.
 - This is incorrect because a preference for light blue males would help explain an increase in the percent of the population that is light blue.
 - This is incorrect because increased overheating of dark insects would help explain an increase in the percent of the population that is light blue.
 - This is incorrect because increased visibility of dark insects to predators would help explain an increase in the percent of the population that is light blue.
- This is incorrect because traits which are developed during life are not passed onto offspring.
 - This is incorrect because snakes would not make decisions that require the complexity of thought that this scenario suggests.
 - This is incorrect because the newt would not have evolved to have a toxin defense if its predators were already resistant to it.

- D. This is correct because it illustrates how natural selection operated to eliminate snakes without the resistance trait so that only snakes that by chance had the resistance trait were able to survive and reproduce, preferentially passing the resistance trait on to the next generation.
3. A. This is incorrect because that would be the result of directional selection.
B. This is incorrect because that would be the result of directional selection.
C. This is correct because stabilizing selection would cause more of the population to have intermediate characteristics.
D. This is incorrect because this is the opposite of the effect expected from stabilizing selection.
4. A. This is incorrect because, while this study might indicate at what age a wolf stops being able to hunt and therefore becomes dependent on its pack for survival, it would not reveal whether group hunting has a survival advantage over solo hunting.
B. This is incorrect because finding that individual wolves hunt different prey than a group of wolves hunt would not add any more supporting evidence than finding that larger pack sizes bring in more meat per pack member per day.
C. This is incorrect because, while this study might indicate whether wolves develop a division of labor within the pack as pack size increases, it would not reveal whether group hunting has a survival advantage over solo hunting.
D. This is correct because, if the reproductive success of the pack increases with pack size, it provides a second piece of correlational evidence that supports the hypothesis that group hunting has a survival advantage over solo hunting.
5. A. This is incorrect because one species benefits while another species is harmed.
B. This is incorrect because the bird populations decrease while the trees can increase population.
C. This is incorrect because reducing cellular respiration is harmful while increasing metabolism in trees is helpful.
D. This is correct because both the algae and fish benefit in this case.
6. A. This is incorrect because the nocturnal behavior of this species most likely evolved because nighttime activity provided significant survival benefits to the lizard. To shift to daytime activity would threaten survival because the lizards might not be able to cope with the effects of heat, water loss, or lack of food.
B. This is incorrect because individuals do not adapt to environmental change; adaptations occur over generations within a population as a result of natural selection.
C. This is incorrect because animals cannot easily shift their diets. For example, they may not have the appropriate mouthparts or digestive enzymes to handle new and different foods or they may not be equipped to locate unfamiliar sources of food.
D. This is correct because through natural selection of group defensive behavior, the lizard species could develop an adaptation over time to survive as predation by raccoons intensifies.
7. A. This is incorrect because this example does not involve preferential pollination of white flowers over red or pink flowers.
B. This is incorrect because this example does not involve increased survival rates of red and white flowering plants and decreased survival rates of pink flowers.
C. This is incorrect because this example does not involve increased survival rates of pink flowering plants and decreased survival rates of red and white flowers.
D. This is correct because this example involves decreased survival rates of red flowering plants with a shift toward increased survival rates of white flowers.
8. A. This is incorrect because dominant genes are not inherited more easily.
B. This is incorrect because over time, deaths of individuals will change gene frequency.

- C. This is incorrect because altruism genes do not necessarily have to be inherited with other traits.
 - D. This is correct because the guard bee's sacrifice increases the likelihood that the queen of the hive can reproduce.
9. A. This is incorrect because it is not possible to interpret absolute population from these frequency graphs.
- B. This is incorrect because the total number of phenotypes in both populations is the same.
- C. This is correct because the variance in population B is larger.
- D. This is incorrect because population A is longer on average compared with population B.
10. Genotypes SS and Ss will have stripes, so $35\% + 50\% = 85\%$ of the population will have stripes.
11. A. This is correct because extreme flooding can make an area uninhabitable by a species.
- B. This is correct because changes in oxygen can be maladaptive.
- C. This is incorrect because a loss of predators would not decrease a species' population.
- D. This is correct because a change in temperatures can cause a species to die out.
- E. This is correct because insufficient water resources can cause extinction.
- F. This is incorrect because increased resources would most likely cause an increase in a population, not cause extinction.
12. 1C. *Risk* is correct because this behavior involves risk to the life of the individual.
- 2F. *Survivorship* is correct because this behavior prevents other animals in the colony from being killed.
13. A. This selective pressure belongs in the *Diversifying selection* column because a disease that targets one allele leads to diversification away from that allele; it selects for the extreme phenotypes.
- B. This selective pressure belongs in the *Directional selection* column because weather that favors less density would lead to directional selection toward fatter mice.
- C. This selective pressure belongs in the *Directional selection* column because a change in temperature would lead to directional selection, favoring one allele.
- D. This selective pressure belongs in the *Directional selection* column because a change in food supply would lead to directional selection, favoring one allele.
- E. This selective pressure belongs in the *Diversifying selection* column because selection against one fur color leads to diversifying selection because it selects for the extreme phenotypes.
14. A. This is an example of mutation because it involves a direct change in DNA sequence.
- B. This is an example of natural selection because the population is evolving due to outside pressures.
- C. This is an example of sexual selection because it involves a change in allele frequency resulting from mating choice.
15. A. *Directional* does not belong in any box because the mean length of the lizard population remained the same.
- B. *Disruptive* belongs in the second box, because the lizards on the second island have fewer members of the population with intermediate characteristics.
- C. *Stabilizing* belongs in the first box because the first island had more members of its population with intermediate characteristics.
16. A. This is correct, as spiders are not taught to spin webs of the same shape.
- B. This is incorrect, as the bear is displaying learned, not innate, behavior.
- C. This is correct because any behavior performed right after hatching is an innate behavior.
- D. This is incorrect, as the cheetah is displaying a learned behavior.

- E. This is incorrect, as the chimpanzee is displaying a learned behavior.
- F. This is correct, as the penguins are performing a behavior they have never had a chance to learn.

17. In order for a species to evolve there needs to be a variety of traits in a population, and the population with the most advantageous traits survives over time and passes on those traits. The order that explains how the two groups of fruit flies evolved from the same group is: Fruit flies that are members of a population living in a temperate region differ in the range of temperatures that they can tolerate; the fruit flies begin to migrate to new regions where temperatures become very hot in summer. Fruit flies with high heat tolerance survive the high temperatures while flies with moderate or low heat tolerance die; the surviving fruit flies reproduce and pass on their heat tolerance trait to their offspring.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. describe what the bottleneck effect is (DCI); and 2. explain how the bottleneck effect affects populations of different sizes (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing the bottleneck effect</p> <p>Part 1: One point is earned for describing that the bottleneck effect describes genetic drift caused by a decrease in population that reduces genetic diversity. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The bottleneck effect occurs when a population dramatically shrinks. The loss of individuals shrinks the gene pool, and certain alleles may be lost from it.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining that the bottleneck effect would be more detrimental to a small population</p> <p>Part 2: One point is earned for explaining that a small population would be more harmed by the bottleneck effect in this situation, as it is more likely to completely lose alleles from its gene pool. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The bottleneck effect would do more damage to the smaller population than the larger one, because a small population would be more likely to lose its genetic diversity by losing a large portion of its population.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. describe how natural selection leads to adaptation of populations (DCI); and 2. explain why empirical evidence can be used to show correlation but not causation when making a specific claim (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing how an environmental change can lead to changes in genotypes and phenotypes</p> <p>Part 1: One point is earned for describing a mechanism to explain genotype and phenotype changes in a rabbit population as the result of natural selection resulting from climate change. The mechanism should involve a selection pressure that would affect different phenotypes differently. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Climate change resulted in a decrease in snowfall in the region where the rabbits live. The loss of the white background of snow made rabbits with white fur more vulnerable to predation since they could be more easily seen against the gray landscape. Rabbits with gray fur were less vulnerable since they blended in with the gray landscape. This led to more white rabbits being lost to predation and an increase in gray rabbits. Since white rabbits did not survive, their genes were not passed on to later generations. Instead, more gray rabbits passed on their genes, resulting in the observed shifts in both genotypes and phenotypes in the rabbit population.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining why weather data could be used to show correlation</p> <p>Part 2: One point is earned for explaining that weather data provides empirical evidence of correlation between climate change and changes in the rabbit population. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If the weather data shows that snowfall was lower in 2015 than in 2000, then that is evidence that suggests a possible link between the amount of snow and the survivability of white rabbits. It is logical to think that a lack of snow could make white rabbits more vulnerable to predation because the white background that helped white rabbits blend in with their surroundings vanished, leaving the rabbits to stand out against a gray background.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI Only - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> use evidence from laboratory experiments to describe animal behavior (DCI); and evaluate evidence for the role of group behavior on individual and species' chances to survive (DCI); and construct an explanation about how group behavior evolved through natural selection because membership increases the chances of survival for individuals that can go on to reproduce and carry on the group behavior trait (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly using evidence to describe differences in individual versus group behavior</p> <p>Part 1: One point is earned for describing that the observations imply starlings alone are slower to take flight to escape a hawk predator than starlings in groups. This happens even though the single birds spend more time scanning their environment for danger. Flocking behavior therefore is beneficial to starlings by making them more effective in responding to hawk attacks. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • In the wild, it appears that starlings are able to respond to danger in a more productive way. Even though the lone starling looked around more, it took him longer to flee from a predator when he was alone. This means that being in a group is better for the survival of the starling. <p>1 point for correctly explaining how evidence suggests that behavior is an advantage</p> <p>Part 2: One point is earned for explaining that these results suggest that flocking improves starling survival against hawk attacks. A starling in a group will be faster to take flight than a starling by itself. In addition, the starling in a group will spend less energy than a lone starling scanning its environment for danger. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Being in a flock is going to help the starling in a few different ways. First, the starling will spend less of its energy looking around for predators. Therefore, it will have more energy to devote to other activities, such as finding food and reproducing. Second, the starling will flee from danger more quickly, thus increasing its survival. <p>1 point for correctly explaining the evolution of flocking behavior in starlings using the concept of natural selection</p> <p>Part 3: One point is earned for explaining that through natural selection, lone birds would preferentially be taken as prey, allowing birds that formed groups to persist in a population. Because the lone birds were taken, they did not reproduce and did not contribute their genes to later generations. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Speaking in terms of evolution, the starlings that functioned alone would more often be taken by predators for food. Those that lived in groups would not be taken as often, thus would survive long enough to reproduce, producing more starlings that had group behavior. Over time, the number of starlings that lived alone would decrease and the starlings that lived in groups would increase.
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21. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain how changes in the environment can lead to the extinction of a species (DCI); and 2. predict how a population would change according to the given data (SEP); and 3. evaluate data to determine whether they are causal or correlational (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining how changes in the environment can lead to the extinction of a species</p> <p>Part 1: One point is earned for explaining that negative changes in the environment, such as a decline in food or a major change in temperature, can lead to the extinction of a species. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Most organisms have a very limited range of environments in which they can survive. Factors such as available food, temperature, and amount of water in the environment are crucial to the organism's success. If one of these attributes changes drastically, individual organisms in the population will most likely die, which can cause an extinction of the species.

Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly predicting how a population would change</p> <p>Part 3: One point is earned for predicting that the fish population may change if atmospheric carbon dioxide decreased, but that this change is not guaranteed. Accept any well-supported answer. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Because the data are correlational, the fish population might increase when the carbon dioxide levels decrease, but this change is not guaranteed.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining whether data is causal or correlational</p> <p>Part 2: One point is earned for explaining that the data are correlational since there is not a specific interaction given. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data here are correlational because time is the independent variable in these observations.

22. A. This is incorrect because birds are not capable of this type of high-level thought.
- B. This is incorrect because the warning call trait does not change progressively in quality over time as one generation passes the trait to the next.
- C. This is correct because this bird's major predator cannot detect this high-frequency call, so birds that use it are not putting themselves at risk of drawing attention to themselves as they warn others of a predator's presence.
- D. This is incorrect because organisms do not develop traits out of a need for the trait.
23. A. The first claim, "*Having the ability to make a warning call,*" and the third claim, "*Some group defensive behaviors,*" are correctly labeled with *reasonable*. Birds without the warning call trait would be less able to protect others, which would lessen their survival. Birds with the trait would be favored to survive and pass their genes to the next generation. The scolding call would be advantageous to the adult bird using it to defend itself against a predator; the mobbing call would be advantageous to the young that are being protected from predator attack; and the warning call would be advantageous to both young and adult birds to warn them about a potential predator attack.
- B. The second claim, "*Birds with a mobbing call trait,*" and the fourth claim, "*A songbird born with defective hearing,*" are correctly labeled with *not reasonable*. The mobbing call trait will benefit the survival of the population as a whole by increasing the survival of young. This trait should persist since it promotes increased survival of young. A bird born with defective hearing would not be able to take advantage of the warning call that a predator was in the area and would be less likely to survive.
24. A. This phrase matches with *warning call* as only the warning call has a frequency that is outside of the range of detection by the sparrowhawk, which makes it much safer since the songbird can use it without being heard by the sparrowhawk.
- B. This phrase matches with *scolding call* as only the scolding call is used for a situation in which only an adult is in danger.
- C. This phrase matches with *mobbing call* as only the mobbing call is given by birds that are flying and swooping down on a predator that threatens a nest.
25. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> evaluate evidence and construct an explanation for the role of learning in group behavior (DCI); and use the concept of natural selection to explain how this learned behavior evolved (DCI).

Evidence of Mastery of Disciplinary Core Ideas	2 points for explaining the evolution of learned defensive behavior
	<p>Part 1: One point is earned for explaining how learned communication of danger improves the species' survival against predation using the information presented in the stem. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The observations indicate that songbirds are not born with the ability to visually recognize sparrowhawks. However, because they do respond to a warning call, the nestlings can be saved from predation by other birds that have learned to use the warning call when a sparrowhawk approaches. Later, these baby birds will learn to recognize the sparrowhawk by sight and to use the warning call when they see it. In this way, the group benefits from the learned behavior of birds, which is a defensive behavior that helps both young and adult birds survive. <p>Part 2: One point is earned for explaining the mechanism by natural selection that allowed the calling behavior to become established in this species. The explanation should include description of mechanism that lead to increased survival of birds with calling behavior. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Adult songbirds that did not learn to use the warning call would be less able to protect their young, who could not help themselves because they did not recognize the predator. Songbirds with the ability to learn this defensive behavior could help defend their young. As a result, the songbirds with the learned behavior were better able to survive and help their offspring survive and reproduce.

Unit 9 Unit Test B – Patterns of Evolution

Item Analysis		
Item #	Standards	DOK
1	HS-LS4-4, DCI.HS-LS4.C.3, SEP.HS.A.1	2
2	HS-LS4-4, DCI.HS-LS4.C.2	2
3	HS-LS3-3, DCI.HS-LS3.B.2	1
4	HS-LS2-8, DCI.HS-LS2.D.1, CCC.HS.B.1	2
5	HS-LS4-5, DCI.HS-LS4.C.4	1
6	HS-LS2-8, DCI.HS-LS2.D.1, CCC.NOS.HS.A.1	2
7	HS-LS4-4, DCI.HS-LS4.B.2, SEP.NOS.HS.D.3	2
8	HS-LS2-8, DCI.HS-LS2.D.1	2
9	HS-LS4-3, DCI.HS-LS4.B.2, SEP.HS.D.2	2
10	HS-LS3-3, DCI.HS-LS3.B.2, CCC.HS.C.3	2
11	HS-LS4-5, DCI.HS-LS4.C.4	1
12	HS-LS2-8, DCI.HS-LS2.D.1, CCC.HS.G.1	1
13	HS-LS4-4, DCI.HS-LS4.C.3, CCC.HS.D.2	3
14	HS-LS4-5, DCI.HS-LS4.C.5, SEP.HS.F.1	3
15	HS-LS4-5, DCI.HS-LS4.C.4, SEP.NOS.HS.C.2	2
16	HS-LS2-8, DCI.HS-LS2.D.1	1
17	HS-LS4-4, DCI.HS-LS4.B.1, SEP.HS.F.1	2
18	HS-LS4-5, DCI.HS-LS4.C.5, CCC.HS.A.1	2
19	HS-LS4-4, DCI.HS-LS4.B.2, CCC.HS.B.1	2
20	HS-LS2-8, DCI.HS-LS2.D.1	3
21	HS-LS4-5, DCI.HS-LS4.C.4, SEP.HS.G.1, CCC.HS.B.1	3

22	HS-LS2-8, DCI.HS-LS2.D.1, SEP.HS.F.1	2
23	HS-LS2-8, DCI.HS-LS2.D.1, SEP.HS.G.1	2
24	HS-LS2-8, DCI.HS-LS2.D.1	1
25	HS-LS2-8, DCI.HS-LS2.D.1	3

1.
 - A. This is correct because this would help explain an increase in the percent of the population that is dark blue, not light blue.
 - B. This is incorrect because a preference for light blue males would help explain an increase in the percent of the population that is light blue.
 - C. This is incorrect because increased overheating of dark insects would help explain an increase in the percent of the population that is light blue.
2.
 - A. This is incorrect because the toxin resistance acquired during life would not be passed onto offspring.
 - B. This is incorrect because the newt would not have evolved to have a toxin defense if its predators were already resistant to it.
 - C. This is correct because it illustrates how natural selection operated to eliminate snakes without the resistance trait so that only snakes that by chance had the resistance trait were able to survive and reproduce, preferentially passing the resistance trait on to the next generation.
3.
 - A. This is incorrect because that would be the result of directional selection.
 - B. This is correct because stabilizing selection would cause more of the population to have intermediate characteristics.
 - C. This is incorrect because this is the opposite of the effect expected from stabilizing selection.
4.
 - A. This is incorrect because, while this study might indicate at what age a wolf stops being able to hunt and therefore becomes dependent on its pack for survival, it would not reveal whether group hunting has a survival advantage over solo hunting.
 - B. This is incorrect because finding that individual wolves hunt different prey than a group of wolves hunt would not add any more supporting evidence than finding that larger pack sizes bring in more meat per pack member per day.
 - C. This is correct because, if the reproductive success of the pack increases with pack size, it provides a second piece of correlational evidence that supports the hypothesis that group hunting has a survival advantage over solo hunting.
5.
 - A. This is incorrect because one species benefits while another species is harmed.
 - B. This is incorrect because the bird populations decrease while the trees can increase population.
 - C. This is correct because both the algae and fish benefit in this case.
6.
 - A. This is incorrect because the nocturnal behavior of this species most likely evolved because nighttime activity provided significant survival benefits to the lizard. To shift to daytime activity would threaten survival because the lizards might not be able to cope with the effects of heat, water loss, or lack of food.
 - B. This is incorrect because animals cannot easily shift their diets. For example, they may not have the appropriate mouthparts or digestive enzymes to handle new and different foods or they may not be equipped to locate unfamiliar sources of food.
 - C. This is correct because through natural selection of group defensive behavior, the lizard species could develop an adaptation over time to survive as predation by raccoons intensifies.
7.
 - A. This is incorrect because this example does not involve preferential pollination of white flowers over red or pink flowers.
 - B. This is incorrect because this example does not involve increased survival rates of red and white flowering plants and decreased survival rates of pink flowers.

- C. This is correct because this example involves decreased survival rates of red flowering plants with a shift toward increased survival rates of white flowers.
8. A. This is incorrect because dominant genes are not inherited more easily.
 B. This is correct because the guard bee's sacrifice increases the likelihood that the queen of the hive can reproduce.
 C. This is incorrect because over time, deaths of individuals will change gene frequency.
9. A. This is incorrect because it is not possible to interpret absolute population from these frequency graphs.
 B. This is incorrect because the total number of phenotypes in both populations is the same.
 C. This is correct because the variance in population B is larger.
10. Genotypes SS and Ss will have stripes, so $35\% + 50\% = 85\%$ of the population will have stripes.
11. A. This is correct because extreme flooding can make an area uninhabitable by a species.
 B. This is correct because changes in oxygen can be maladaptive.
 C. This is incorrect because a loss of predators would not decrease a species' population.
 D. This is correct because insufficient water resources can cause extinction.
 E. This is incorrect because increased resources would most likely cause an increase in a population, not cause extinction.
12. 1B. *Risk* is correct because this behavior involves risk to the life of the individual.
 2D. *Survivorship* is correct because this behavior prevents other animals in the colony from being killed.
13. A. This selective pressure belongs in the *Diversifying selection* column because a disease that targets one allele leads to diversification away from that allele; it selects for the extreme phenotypes.
 B. This selective pressure belongs in the *Directional selection* column because a change in temperature would lead to directional selection, favoring one allele.
 C. This selective pressure belongs in the *Directional selection* column because a change in food supply would lead to directional selection, favoring one allele.
 D. This selective pressure belongs in the *Diversifying selection* column because selection against one fur color leads to diversifying selection because it selects for the extreme phenotypes.
14. A. This is an example of mutation because it involves a direct change in DNA sequence.
 B. This is an example of natural selection because the population is evolving due to outside pressures.
15. A. *Directional* does not belong in any box because the mean length of the lizard population remained the same.
 B. *Disruptive* belongs in the second box, because the lizards on the second island have fewer members of the population with intermediate characteristics.
 C. *Stabilizing* belongs in the first box because the first island had more members of its population with intermediate characteristics.
16. A. This is correct, as spiders are not taught to spin webs of the same shape.
 B. This is incorrect, as the bear is displaying learned, not innate, behavior.
 C. This is correct because any behavior performed right after hatching is an innate behavior.
 D. This is incorrect, as the cheetah is displaying a learned behavior.
 E. This is incorrect, as the chimpanzee is displaying a learned behavior.

17. In order for a species to evolve there needs to be a variety of traits in a population, and the population with the most advantageous traits survives over time and passes on those traits. The order that explains how the two groups of fruit flies evolved from the same group is: fruit flies begin to migrate to new regions where temperatures become very hot in summer; fruit flies with high heat tolerance survive the high temperatures while flies with moderate or low heat tolerance die; the surviving fruit flies reproduce and pass on their heat tolerance trait to their offspring.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: 1. describe what the bottleneck effect is (DCI); and 2. explain how the bottleneck effect affects populations of different sizes (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing the bottleneck effect Part 1: One point is earned for describing that the bottleneck effect describes genetic drift caused by a reduction in population that results in reduced genetic diversity. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The bottleneck effect occurs when a population dramatically shrinks. The loss of individuals shrinks the gene pool, and certain alleles may be lost from it.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly explaining that the bottleneck effect would be more detrimental to a small population Part 2: One point is earned for explaining that a small population would be more harmed by the bottleneck effect in this situation, as it is more likely to completely lose alleles from its gene pool. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The bottleneck effect would do more damage to the smaller population than the larger one, because a small population would be more likely to lose its genetic diversity by losing a large portion of its population.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: 1. describe how natural selection leads to adaptation of populations (DCI); and 2. explain why empirical evidence can be used to show correlation but not causation when making a specific claim (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for describing a mechanism Part 1: One point is earned for explaining genotype and phenotype changes in a rabbit population as the result of natural selection. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Climate change resulted in a decrease in snowfall in the region where the rabbits live. The loss of the white background of snow made rabbits with white fur more vulnerable to predation since they could be more easily seen against the gray landscape. Rabbits with gray fur were less vulnerable since they blended in with the gray landscape. This led to more white rabbits being lost to predation and an increase in gray rabbits. Since white rabbits did not survive, their genes were not passed on to later generations. Instead, more gray rabbits passed on their genes, resulting in the observed shifts in both genotypes and phenotypes in the rabbit population.

Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining why weather data could be used to show correlation</p> <p>Part 2: One point is earned for explaining why weather data provides evidence of correlation between climate change and changes in the rabbit population. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> If the weather data shows that snowfall was lower in 2015 than in 2000, then that is evidence that suggests a possible link between the amount of snow and the survivability of white rabbits. It is logical to think that a lack of snow could make white rabbits more vulnerable to predation because the white background that helped white rabbits blend in with their surroundings vanished, leaving the rabbits to stand out against a gray background.
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20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI Only - 3 Points	
Claims	The student is able to evaluate evidence for the role of group behavior on individual and species' chances to survive. (DCI)
Evidence of Mastery of Disciplinary Core Ideas	<p>3 points for correctly evaluating evidence to discern a biological advantage of group behavior</p> <p>Part 1: Three points are earned for explaining that these results suggest that flocking improves starling survival against hawk attacks. A starling in a group will be faster to take flight than a starling by itself. In addition, the starling in a group will spend less energy than a lone starling scanning its environment for danger. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Being in a flock is going to help the starling in a few different ways. First, the starling will spend less of its energy looking around for predators. Therefore, it will have more energy to devote to other activities, such as finding food and reproducing. Second, the starling will flee from danger more quickly, thus increasing its survival.

21. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain how changes in the environment can lead to the extinction of a species (DCI); and predict how a population would change according to the given data (SEP); and evaluate data to determine whether they are causal or correlational (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining how changes in the environment can lead to the extinction of a species</p> <p>Part 1: One point is earned for explaining that negative changes in the environment, such as a decline in food or a major change in temperature, can lead to the extinction of a species. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Most organisms have a very limited range of environments in which they can survive. Factors such as available food, temperature, and amount of water in the environment are crucial to the organism's success. If one of these attributes changes drastically, individual organisms in the population will most likely die, which can cause an extinction of the species.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly predicting how a population would change</p> <p>Part 3: One point is earned for predicting that the fish population may change if atmospheric carbon dioxide decreased, but that this change is not guaranteed. Accept any well-supported answer. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Because the data are correlational, the fish population might increase when the carbon dioxide levels decrease, but this change is not guaranteed.

Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly evaluating data to be causal or correlational</p> <p>Part 2: One point is earned for determining that the data are correlational since there is not a specific interaction given. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data here are correlational because time is the independent variable in these observations.
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22. A. This is incorrect because birds are not capable of this type of high-level thought.
- B. This is correct because this bird's major predator cannot detect this high-frequency call, so birds that use it are not putting themselves at risk of drawing attention to themselves as they warn others of a predator's presence.
- C. This is incorrect because organisms do not develop traits out of a need for the trait.
23. A. The first claim, "*Having the ability to make a warning call,*" and the third claim, "*Some group defensive behaviors,*" are correctly labeled with *reasonable*. Birds without the warning call trait would be less able to protect others, which would lessen their survival. Birds with the trait would be favored to survive and pass their genes to the next generation. The scolding call would be advantageous to the adult bird using it to defend itself against a predator; the mobbing call would be advantageous to the young that are being protected from predator attack; and the warning call would be advantageous to both young and adult birds to warn them about a potential predator attack.
- B. The second claim, "*Birds with a mobbing call trait,*" and the fourth claim, "*A songbird born with defective hearing,*" are correctly labeled with *not reasonable*. The mobbing call trait will benefit the survival of the population as a whole by increasing the survival of young. This trait should persist since it promotes increased survival of young. A bird born with defective hearing would not be able to take advantage of the warning call that a predator was in the area and would be less likely to survive.
24. A. This phrase matches with *warning call* as only the warning call has a frequency that is outside of the range of detection by the sparrowhawk, which makes it much safer since the songbird can use it without being heard by the sparrowhawk.
- B. This phrase matches with *scolding call* as only the scolding call is used for a situation in which only an adult is in danger.
- C. This phrase matches with *mobbing call* as only the mobbing call is given by birds that are flying and swooping down on a predator that threatens a nest.
25. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> evaluate evidence and construct an explanation for the role of learning in group behavior (DCI); and use the concept of natural selection to explain how this learned behavior evolved (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for constructing an explanation</p> <p>Part 1: Two points are earned for explaining the mechanism by natural selection that allowed the calling behavior to become established in this species. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Adult songbirds that did not learn to use the warning call would be less able to protect their young, who could not help themselves because they did not recognize the predator. Songbirds with the ability to learn this defensive behavior could help defend their young. As a result, the songbirds with the learned behavior were better able to survive and help their offspring survive and reproduce.

Unit 10 Human Impacts on the Environment

Unit 10 Pretest

Item Analysis				
Item #	Key	Standards		DOK
1	B	HS-ESS3-2, DCI.HS-ESS3.A.2		1
2	B	HS-ESS3-3, DCI.HS-ESS3.C.1, CCC.NOS.HS.B.3		1
3	B	HS-ESS3-2, DCI.HS-ESS3.A.2		1
4	A	HS-ESS3-3, DCI.HS-ESS3.C.1		1
5	D	HS-ESS3-3, DCI.HS-ESS3.C.1, CCC.HS.G.1		1
6	A	HS-LS2-7, SEP.HS.D.1		1
7	D	HS-LS2-7		1
8	B	HS-LS2-7, CCC.STSE.HS.B.3		1
9	C	HS-LS2-7, SEP.HS.D.1		1
10	B	HS-ETS1-1, DCI.HS-ETS1.A.1		1
11	B	HS-ETS1-2, DCI.HS-ETS1.C.1, SEP.HS.C.1		1
12	C	HS-ETS1-2, DCI.HS-ETS1.C.1, CCC.STSE.HS.B.4		2
13	C	HS-ESS3-2, DCI.HS-ESS3.A.2, CCC.NOS.HS.C.3		2
14	C	HS-LS2-7, SEP.HS.D.1		2
15	B	HS-ETS1-1, DCI.HS-ETS1.A.1, CCC.HS.F.1		3

Unit 10 Lesson 1 Quiz – Human Population Growth and the Environment

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS2-1, DCI.HS-LS2.A.1, CCC.STSE.HS.B.1	471-472	1
2	B	HS-LS2-7, SEP.HS.D.1, CCC.HS.C.3	472	2
3	C	HS-LS2-7, SEP.HS.D.1, CCC.HS.G.2		2
4	C	HS-LS4-6, DCI.HS-LS4.D.2	473	2
5	A	HS-LS4-6, DCI.HS-LS4.D.2, CCC.STSE.HS.B.1	480	2
6	D	HS-LS4-6, DCI.HS-LS4.D.2, CCC.STSE.HS.B.2	478-480	2
7	B	HS-LS4-6, DCI.HS-LS4.D.2, CCC.NOS.HS.C.2	478	2
8	D	HS-LS4-6, DCI.HS-LS4.D.2	481-484	2
9	Rubric	HS-LS4-6, DCI.HS-LS4.D.2	480-481	2
10	Rubric	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.F.2	470-474	3
11	Rubric	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.A.2, CCC.HS.D.3	471-472	3
12	B	HS-LS2-7, SEP.HS.D.1, CCC.HS.B.1	475-476	2
13	A	HS-LS2-7, SEP.HS.D.1, CCC.HS.G.2	475-477	2
14	Rubric	HS-LS2-7, SEP.HS.B.1, CCC.HS.C.3	470-484	1
15	Rubric	HS-LS2-7, SEP.HS.D.1	470-474	2

9. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>To receive full credit, students should explain how desertification can negatively impact biodiversity, and then offer one proposed solution to the problem of desertification.</p> <p>Sample answer: Desertification can negatively impact biodiversity by causing microorganisms in the soil to die, which then makes it harder for that soil to support other forms of life. One possible solution to this problem is regularly aerating the soil and amending it with natural composts.</p>

10. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	The more people there are, the more demands people place on the environment and its resources, which are limited.

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> • Malthus claimed that the human population was growing much faster than Earth’s resources could support. • Earth’s population has increased from 1 billion to over 6 billion since Malthus wrote his essay, and this change is mainly due to technological advancements developed by humans, such as improvements in sanitation and industrial farming. • Malthus was not correct because he failed to account for the effects of technological improvement. However, the possibility of exceeding Earth’s carrying capacity could occur in the future.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Accept any two of the following: population, land ownership, land required to produce food, water, shelter, energy, or land used to store waste.

15. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample answer: The Asia Pacific region uses about 1 hectare per person, for a total of 3.5 billion hectares used by the region. North America uses about 10 hectares per person, for a total of 3.5 billion hectares used by the region. The total ecological footprint of the two regions is approximately the same, but the per-person footprint in North America is significantly larger. This could be partly because individuals in North America use more resources, on average, than individuals in Asia Pacific. This could also be partly due to the fact that very little land is available for use in Asia Pacific, and so more people have to use a smaller amount of land.</p>

Unit 10 Lesson 2 Quiz – Human Impacts on Biodiversity

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	C	HS-LS4-5, DCI.HS-LS4.D.2	489	2
2	C	HS-LS2-7, DCI.HS-LS4.C.4	487	1

3	D	HS-LS4-6, DCI.HS-LS4.D.2, CCC.STSE.HS.B.3	487-488	1
4	C	HS-LS4-6, DCI.HS-LS4.D.2	488	1
5	C	HS-LS4-6, DCI.HS-LS4.D.2	486, 495	2
6	A	HS-LS4-6, DCI.HS-LS4.D.2, CCC.HS.G.1	487-493	2
7	A	HS-LS4-6, DCI.HS-LS4.D.2, CCC.NOS.HS.C.1	488	1
8	C	HS-LS2-7, DCI.HS-LS4.D.1, SEP.HS.F.4	488-493	2
9	D	HS-LS2-7, DCI.HS-LS4.D.1, CCC.STSE.HS.B.3	491	2
10	D	HS-LS2-7, DCI.HS-LS4.D.1, CCC.HS.G.1	492	1
11	Rubric	HS-LS2-7, DCI.HS-LS4.C.4	487-488	2
12	Rubric	HS-LS2-7, DCI.HS-LS4.D.2	490-491	2
13	Rubric	HS-ESS3-6, DCI.HS-ESS2.D.4, SEP.HS.B.2, CCC.HS.D.3	493	2
14	Rubric	HS-LS4-5, DCI.HS-LS4.D.2	493	3
15	Rubric	HS-LS4-6, DCI.HS-LS4.D.2	494	3

11. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	Habitat destruction causes a loss of biodiversity.

12. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	To receive full credit, students should explain that the invasive mussel species can compete with native mussels enough to kill them. They should then explain that the spread of these mussels can be prevented with special types of paint that stop the mussels from attaching to the hulls of boats and ships, or with educational campaigns.

13. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> Species that are overhunted will experience population decline and will eventually become extinct. If this occurs, species richness will decrease. Also, reducing the population of a species reduces the genetic diversity of that species, leading to an overall decrease in biodiversity.

14. Use the rubric below to evaluate total points earned for this item. *[max point: 1]*

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> Sustainable fishing and hunting practices allow fish and other harvested animal populations to remain at sustainable levels by limiting the harvest season length, regulating the equipment used for harvest, and regulating the catch sizes, age, and/or sex of the harvested species.

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Sample Answer:</p> <ul style="list-style-type: none"> Some non-native species provide important ecosystem services, such as pollination of native flower species. Honeybees are considered invaluable pollinators of crops and producers of the honey that humans harvest.

Unit 10 Lesson 3 Quiz – Engineering Solutions to Environmental Impacts

Item Analysis				
Item #	Key	Standards	Page #	DOK
1	D	HS-LS4-6, DCI.HS-LS4.D.2	502-503	2
2	C	HS-LS4-6, DCI.HS-LS4.D.2	505	1
3	A	HS-LS4-6, DCI.HS-LS4.D.2	508	2
4	D	HS-ETS1-2, DCI.HS-ETS1.C.1, CCC.STSE.HS.B.4	499	2
5	A	HS-LS4-6, DCI.HS-LS4.D.2	505	1
6	A	HS-ETS1-2, DCI.HS-ETS1.C.1, SEP.HS.A.3	500	2
7	C	HS-LS4-6, DCI.HS-LS4.D.2	502-503	2
8	C	HS-ETS1-3, DCI.HS-ETS1.B.1	500	2
9	C	HS-ETS1-3, DCI.HS-ETS1.B.1	498-510	1
10	B	HS-ETS1-3, DCI.HS-ETS1.B.1	509	2
11	Rubric	HS-ETS1-2, DCI.HS-ETS1.C.1	498, 510	3
12	Rubric	HS-ETS1-2, DCI.HS-ETS1.C.1	499-500,	2
13	Rubric	HS-ETS1-3, DCI.HS-ETS1.B.1	506-507	2
14	Rubric	HS-ETS1-3, DCI.HS-ETS1.B.1	505	3
15	Rubric	HS-ETS1-3, DCI.HS-ETS1.B.1	506-508	2

11. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	<p>Answers will vary. Students should list three criteria that could be involved in building a fish ladder. Then they should select the criterion they feel is the highest priority and offer an explanation. Criteria could include that fish should be able to swim up the ladder to get past the dam, the fish ladder shouldn't require rebuilding the entire dam, the dam should still be able to hold enough water for the citizens of the city to use, and the ladder shouldn't be extremely expensive.</p> <p>Sample answer: Three criteria in the fish ladder project are: 1. Ensuring that more than half of the migrating salmon make it to their spawning grounds. 2. That water is still held behind the dam for human use. 3. Keeping costs of the project as low as possible. I think the most important criterion is the first one, making sure enough salmon make it past the dam. This is important because it is the main way to ensure that the species survives into the future. The town may have to spend some extra money to make sure the fish survive.</p>

12. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	To receive full credit, students should break up the goal of reducing waste into three smaller criteria that can make the project more manageable.
	Sample answer: Three criteria for this project could be: 1. Use pollution scrubbers to minimize any air pollution. 2. Use energy generated from the incinerator to power other landfill energy needs. 3. Develop an education campaign to encourage people to reduce, reuse, and recycle.

13. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	To receive full credit, students should describe at least two constraints related to cost, safety, reliability, or aesthetics.
	Sample answer: One constraint is that the barrels would not be large enough to hold the increase of water that the larger roof of an office building would create. A second constraint is aesthetics. People may not like the look of large barrels at every corner of an office building, with hoses connected to each barrel. A third possible constraint is that the hoses, or even the barrels themselves, could pose a safety risk.

14. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	To receive full credit, students should list cost as the biggest constraint, and then explain how the technology needs to change to produce a more marketable product.
	Sample answer: The biggest constraint to technology that can remove carbon dioxide from the open air is cost. The technology might become more appealing to investors, and eventually experience a drop in cost, if it led to the production of a marketable product, like pure CO ₂ .

15. Use the rubric below to evaluate total points earned for this item.

[max point: 1]

NGSS Constructed Response Answer – 1 Point	
Evidence of Mastery	To receive full credit, students should describe both a social/cultural impact AND an environmental impact of a wastewater treatment plant.
	Sample answer: One possible social or cultural impact is the fact that people do not like the idea of drinking wastewater, even if it has been thoroughly filtered and treated. This is a negative impact. The environmental impact of this plant would be positive, as it could reduce the amount of toxins that are in waterways.

Unit 10 Unit Test A – Human Impacts on the Environment

Item Analysis		
Item #	Standards	DOK
1	HS-LS2-7, DCI.HS-LS2.C.2	2
2	HS-ETS1-1, DCI.HS-ETS1.A.2	1
3	HS-ETS1-1, DCI.HS-ETS1.A.2, CCC.STSE.HS.B.3	2
4	HS-ETS1-1, DCI.HS-ETS1.A.1	2
5	HS-LS2-7, DCI.HS-LS4.D.1	1
6	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.NOS.HS.C.3	2
7	HS-ETS1-4, DCI.HS-ETS1.B.2	2

8	HS-LS2-7, DCI.HS-LS2.C.2	1
9	HS-LS2-7, DCI.HS-LS2.C.2, CCC.HS.G.1	2
10	HS-ETS1-1, DCI.HS-ETS1.A.2, CCC.HS.B.1	2
11	HS-ETS1-3, DCI.HS-ETS1.B.1	1
12	HS-ETS1-2, DCI.HS-ETS1.C.1, SEP.HS.F.4	2
13	HS-ETS1-1, DCI.HS-ETS1.A.2, SEP.HS.A.3	3
14	HS-LS4-6, DCI.HS-LS4.D.2, CCC.HS.B.3	3
15	HS-LS4-6, DCI.HS-LS4.D.2	2
16	HS-LS4-6, DCI.HS-LS4.D.2, CCC.HS.B.2	2
17	HS-LS4-6, DCI.HS-LS4.C.4	1
18	HS-LS4-6, DCI.HS-LS4.D.2, SEP.HS.E.1	3
19	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.HS.C.2	3
20	HS-LS2-2, DCI.HS-LS2.C.1, SEP.HS.E.2, CCC.HS.C.2	2
21	HS-ETS1-4, DCI.HS-ETS1.B.2, SEP.HS.E.3, CCC.HS.D.2	2
22	HS-LS2-7, DCI.HS-LS2.C.2, SEP.NOS.HS.C.1	2
23	HS-ETS1-2, DCI.HS-ETS1.C.1	2
24	HS-ETS1-1, DCI.HS-ETS1.A.2, SEP.HS.F.2	2
25	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.E.3	3

- A.** This is incorrect because nuclear power plants do not release methane, also methane does not damage DNA.

B. This is correct because coal plants do indeed release carbon dioxide as a by-product of burning coal. Carbon dioxide is a greenhouse gas, so it contributes to global warming.

C. This is incorrect because although airborne metals can cause neurological damage, industrial bakeries are not a source of them.

D. This is incorrect because although particulate matter does indeed cause respiratory problems, wind turbines do not release particulate matter.
- A.** This is incorrect because advances in medicine have allowed the average lifespan to increase, which allowed the human population to increase because older generations are able to live simultaneously with much younger generations.

B. This is correct because climate change did not account for a significant increase in human population during this time.

C. This is incorrect because declining infant mortality rates have allowed more people to live to adulthood and thereby have more children.

D. This is incorrect because more efficient farming practices have made it possible to feed a greater population and allowed people to eat more calories, which make it easier for them to give birth.
- A.** This is correct because the blades of wind turbines have been known to kill birds.

B. This is incorrect because wind turbines generate electricity but not enough to change weather patterns.

C. This is incorrect because wind turbines generate electricity. The turbines spin to rotate the generator, not to filter the air.

D. This is incorrect because wind turbines do not emit any particulate matter.

4. A. This is incorrect because dangerous chemicals produce undesirable waste.
B. This is correct because mass production reduces cost.
C. This is incorrect because scientists are looking for organic materials, not synthetic. In addition, solar panels do not themselves generate heat.
D. This is incorrect because difficult manufacturing adds to cost.
5. A. This is incorrect because hunting of a species that is under protection according to hunting laws and regulations does not reduce overharvesting.
B. This is incorrect because though this is a great practice for plants, it does not reduce overharvesting of animals.
C. This is incorrect because unlimited catch-size policies could cause the population of that species of bird to reduce dramatically, and possibly even place them in danger of becoming extinct.
D. This is correct because tax incentives will encourage sustainable fishing practices to prevent the loss of aquatic species to overfishing.
6. A. This is incorrect because habitat conservation is an environmental, not an economic, consideration.
B. This is incorrect because pH is a scientific factor.
C. This is correct because the cost of a technology is an economic consideration.
D. This is incorrect because the design of the pipes is an engineering consideration.
7. A. This is incorrect because providing additional resources for native species would not be a primary concern.
B. This is correct because damage to native species would be the primary concern regarding introducing this species.
C. This is incorrect because the goal of introducing the predator would be to make the invasive species extinct locally.
D. This is incorrect because, while this would be a concern of introducing the species, it would not be as serious as a concern as the species' effect on native species.
8. A. This is incorrect because irrigation would not be used for a natural prairie. Irrigation is an agricultural practice.
B. This is incorrect because increasing the length of time between controlled burns would actually make the prairies less healthy. Historically, the prairies burned every 1 to 5 years, but the time between burns is currently much longer, which gives other species the opportunity to become established in the prairie.
C. This is correct because most of the prairie land that has been lost has been converted into agriculture. Letting this agricultural land lay fallow or even converting it back to native prairie by planting appropriate species is one way to bring back some portion of the original prairie.
D. This is incorrect because although partridge peas are native nitrogen fixers, farming them would not allow for the other species that make up the prairie to flourish.
9. A. This is the correct because mowing twice was the most effective treatment.
B. This is incorrect because the early application of fungus had a greater effect.
C. This is incorrect because waiting to apply the fungus until later reduced its effectiveness.
D. This is incorrect because this method was less effective than mowing twice.
10. A. *Increases carrying capacity* matches the third and fourth events because people need access to clean drinking water and food grown through agriculture in order to survive.
B. *Decreases carrying capacity* matches the first event because plants are the base of the food webs from which humans acquire food. It matches the second event because an increase in ecological footprint means that the same amount of resources can support fewer people. It matches the fifth event because energy is

necessary to sustain systems that increase the carrying capacity for humans, so a reduction in available energy would lower capacity.

11. **1B.** *Decreases* belongs in the first box. Urbanization leads to reductions in the size of habitats.
- 2A. *Increases* belongs in the second box. Urbanization leads to increasing habitat fragmentation as roads and other human development break up habitats.
- 3B. *Decreases* belongs in the third box. Increases in habitat fragmentation reduce gene flow.
- 4B. *Decreases* belongs in the fourth box. Increases in habitat fragmentation cause the carrying capacity to be reduced.
- 5A. *Increases* belongs in the fifth box. Increases in habitat fragmentation leave populations more vulnerable to the effects of pollution and predation.
12. **A.** *Prevent flooding* is incorrect because this is a benefit and not a drawback of dams.
- B.** *Produce electricity* is incorrect because this describes a benefit and not a drawback of dams.
- C.** *Prevent silt deposition* is correct because silt deposition can be important to downstream ecosystems.
- D.** *Increase irrigation of crops* is incorrect because this describes a benefit and not a drawback of dams.
- E.** *Change downstream water quality* is correct because this can disrupt aquatic ecosystems downstream from the dam.
13. The correct answer is 39,000. If the minimum reduction is 35%, then the maximum remaining would be 65% of the initial value. Therefore, 65% of 60,000 metric tons is 39,000 metric tons.
14. **A.** This scenario could increase habitat destruction if the pesticides are carried into the habitat by wind or water, where they could cause a decline in the insects that other animals rely on for food.
- B.** This scenario would increase habitat destruction because logging removes tall trees that birds use for nesting.
- C.** This scenario decreases habitat destruction because it allows salmon to swim to the habitat in which they spawn and provide food for other species.
- D.** This scenario decreases habitat destruction because it allows more sustainable populations by preventing isolation.
- E.** This scenario decreases habitat destruction by preventing future forest fires that would eliminate the tall trees needed by this bird species. And it is carried out in rotation so that some shrubs that harbor the birds' source of food are always preserved.
15. **1B.** The subtraction function belongs in the first blank because the population will decrease in size with the number of snakes trapped and moved off the island.
- 2A. The addition function belongs in the first blank because the population will increase in size with the number of snakes released from care by pet owners.
16. The descriptions in order are 6, 5, 2, 4, 1, and 3. The process of acid rain starts when fossil fuels are burned, producing oxides that react with water in the air to form acids. These acids lower the pH of the rainwater, which is then introduced into the ecosystem, killing insects and aquatic life forms.
17. **A.** This is incorrect because coal is produced by nature at a very slow rate, and a finite supply of it exists.
- B.** This is correct because wind energy cannot be used up by humans.
- C.** This is correct because the sun will continue to provide solar power to Earth.
- D.** This is incorrect because petroleum is a fossil fuel that is produced in nature much more slowly than it is being used.
- E.** This is incorrect because there is a finite supply of natural gas available to use as an energy source.
- F.** This is correct because Earth produces so much heat that it would be impossible for humans to deplete it.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain how humans benefit from regulations that protect species from overharvesting (DCI); and 2. create a modification of a simulation of overharvesting to test a solution (SEP); and 3. explain the basis of the modification as it relates to solving an overharvesting problem (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining the solution</p> <p>Part 3: One point is earned for explaining that humans ultimately benefit from regulations that prevent practices that wipe out whole populations of organisms. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • If the regulation is not imposed, the simulation shows that the crab population will eventually decrease to zero because of overharvesting. This means that humans will not be able to eat crabs from this bay ever again. However, with regulations limiting crab harvesting, the crab population can be sustained so that the ecosystem remains in balance. This maintains good ecosystem health that benefits all species, including humans. Also, humans will continue to have a source of crabs for eating.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for describing a modification</p> <p>Part 1: One point is earned for describing a modification of the simulation that either reduces the rate of overharvesting or eliminates it by either removing fewer dice or adding more dice back in. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • One thing that could be changed to reduce the rate of overharvesting is to reduce the number of times you remove beads per turn from two to one. <p>1 point for explaining how modifications are a solution</p> <p>Part 2: One point is earned for explaining how the modification would translate into a decrease in overharvesting by anglers. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • This modification represents a regulation that could be imposed on anglers to limit the number of days that they are allowed to be out harvesting crabs. For example, instead of allowing them to harvest crabs over a 6-month period, allow them to harvest crabs over a 3-month period. That would give the crabs more time to reproduce and replace the numbers that were taken during harvesting.

19. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	The student is able to: 1. identify factors that could affect the city's energy generation needs in the future (DCI); and 2. determine how many incinerators are needed to power the city (CCC).
Evidence of Mastery of Disciplinary Core Ideas	2 points for correctly identifying two factors Part 2: Two points are earned for identifying factors that may change and affect the city's future energy generation needs. Factors may include the efficiency of the incinerators, the number of people per home, changes in population growth, the average energy needs per person, and the introduction of alternative sources of energy such as solar roofs. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none">Two factors that may change and affect the city's future energy generation needs are how much energy each person needs and changes in the population growth rate.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly determining the number of incinerators that are needed to power the city Part 1: One point is earned for determining the number of incinerators to build, the total number of homes (2.4 million) is divided by the number of homes that one incinerator would power (200,000), which results in the need for 12 new incinerators. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none">The new incinerators will produce enough energy to power 200,000 homes. Because the city's population will double to 2.4 million, divide 2.4 million by 200,000 to find the number of incinerators to build. The city will need to build 12 incinerators.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	The student is able to: 1. describe how fluctuations in the age of jack pine forests can challenge the habitat availability of a bird species (DCI); and 2. explain how fire may either benefit or harm animal populations (CCC); and 3. use mathematical thinking to design a solution to maintain constant habitat conditions for a bird species (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for describing optimal habitat for a bird species Part 1: One point is earned for describing the optimal habitat for the Kirtland's warbler is a jack pine forest that is between 10 and 20 years old. The data indicate that jack pine forests less than 5 years old and more than 25 years old do not supply the type of conditions needed by the Kirtland's warbler. Even within the age range of 5 to 25 years, the optimal age of a jack pine stand is between 10 and 20 years. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none">The optimal habitat for the Kirtland's warbler is a jack pine forest that is between 10 and 20 years old
Evidence of Mastery of Science and Engineering Practice	1 point for describing a plan to ensure optimal habitat Part 3: One point is earned for describing a plan to ensure the optimal habitat. The plan may include prescribed burning at specific times in different parts of a large jack pine forest on a rotating basis. The plan should reflect that there is a 5-year period between when a jack pine forest is burned and when it becomes suitable as a habitat for Kirtland's warblers and that at 25 years the forest has lost its ability to serve as a habitat. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none">Divide the jack pine forest can be divided into five sections so that every 5 years, a different section is burned. This means that every 25 years, a section would be burned again. This should each section enough time to reach its greatest useful age. It would also allow for different sections to serve as optimal habitats on a rotating basis so that there is always some optimal habitat available for the Kirtland's warbler.

Evidence of Mastery of Crosscutting Concepts	<p>1 point for constructing an explanation about how fire can help or harm populations</p> <p>Part 2: One point is earned for explaining how wildfires may benefit animal populations, such as by ensuring the growth of plants upon which they depend, and harm populations, such as by killing the animals directly or destroying their habitat. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Fire can be a benefit to a population by opening the seeds of plants that the animals depend upon, but it can harm a population by burning plants that the animals will eat.
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21. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain why scientists use computer simulations (DCI); and 2. draw conclusions from the computer simulation to determine whether a material is helpful in a geoengineering project (SEP); and 3. make an argument based on these conclusions regarding future geoengineering projects (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining that simulations help scientists model the future</p> <p>Part 1: One point is earned for explaining that scientists use computer simulations when other types of models, such as physical models, are not adequate. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • For some experiments, scientists cannot create physical models to represent the future. In these cases, they can use computers to use mathematical models representing the future.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly determining which compound is most effective at removing carbon dioxide from the atmosphere</p> <p>Part 2: One point is earned for correctly determining that harzburgite is more effective at removing carbon dioxide from than basalt. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Harzburgite removes more carbon dioxide from the atmosphere than basalt.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly making a claim based on evidence</p> <p>Part 3: One point is earned for providing an argument in favor of the use of enhanced weathering using evidence from the computer model. Since according to the computer model the use of harzburgite has the potential to decrease atmospheric carbon dioxide. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The computer model shows that harzburgite could bring down atmospheric carbon dioxide. Scientists could use this technique reduce global carbon dioxide levels.

22. A. This is incorrect because although the usage peaked in 2001, it later dropped off.
 B. This is incorrect because the fluctuations are not seasonal.
 C. This is correct because the number of fish using the ladder does not meet expectations.
 D. This is incorrect because the number of fish using the ladder increased between 2006 and 2008.
23. A. This factor is not an environmental tradeoff because cost does not impact the environment.
 B. This factor is not an environmental tradeoff because people's enjoyment does not impact the environment.
 C. This factor is an environmental tradeoff because the fish population would be saved but the greenhouse gases emitted would promote global climate change.
 D. This factor is an environmental tradeoff because river water that is introduced to other ecosystems may spread diseases or invasive species.

24. A. This scenario belongs in the *water quality* column because the microbes in the water can be harmful to human health.
- B. This scenario belongs in the *water quality* column because a chemical manufacturing plant can release pollutants into the water.
- C. This scenario belongs in the *water demand* column because fewer people means less water usage by the city.
- D. This scenario belongs in the *water quantity* column because increased reservoir levels would increase the amount of water available.
25. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. use constraints and environmental tradeoffs to determine the long-term reliability of a project (DCI); and 2. analyze the reliability of the well project using the graph (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying why the well was proposed Part 2: One point is earned for identifying that because the well project would not have changed the habitat of plants and animals living in and near waterways, the project should have been considered environmentally superior to the dam project. Although the well project would have protected more species of fish than the dam and not changed the landscape as much, it was projected to run out of water in the future. Therefore, the well project was too unreliable for the city's needs. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The well project was environmentally superior to the dam project because it would not have had as great an impact on other organisms.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly determining the reliability of a well project Part 1: One point is earned for analyzing the graph for the effects of wells on future water availability and determining that the city would have run out of water if it chose to use wells. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> According to the graph, the well project was projected to deplete groundwater at a rapid rate. If the city proceeded with the well project, it would have run out of water in the future.

Unit 10 Unit Test B – Human Impacts on the Environment

Item Analysis		
Item #	Standards	DOK
1	HS-LS2-7, DCI.HS-LS2.C.2	2
2	HS-ETS1-1, DCI.HS-ETS1.A.2	1
3	HS-ETS1-1, DCI.HS-ETS1.A.2, CCC.STSE.HS.B.3	2
4	HS-ETS1-1, DCI.HS-ETS1.A.1	2
5	HS-LS2-7, DCI.HS-LS4.D.1	1
6	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.NOS.HS.C.3	2
7	HS-ETS1-4, DCI.HS-ETS1.B.2	2
8	HS-LS2-7, DCI.HS-LS2.C.2	1
9	HS-LS2-7, DCI.HS-LS2.C.2, CCC.HS.G.1	2
10	HS-ETS1-1, DCI.HS-ETS1.A.2, CCC.HS.B.1	2
11	HS-ETS1-3, DCI.HS-ETS1.B.1	1

12	HS-ETS1-2, DCI.HS-ETS1.C.1, SEP.HS.F.4	2
13	HS-ETS1-1, DCI.HS-ETS1.A.2, SEP.HS.A.3	3
14	HS-LS4-6, DCI.HS-LS4.D.2, CCC.HS.B.3	3
15	HS-LS4-6, DCI.HS-LS4.D.2	2
16	HS-LS4-6, DCI.HS-LS4.D.2, CCC.HS.B.2	2
17	HS-LS4-6, DCI.HS-LS4.C.4	1
18	HS-LS4-6, DCI.HS-LS4.D.2, SEP.HS.E.1	3
19	HS-ETS1-3, DCI.HS-ETS1.B.1, CCC.HS.C.2	3
20	HS-LS2-2, DCI.HS-LS2.C.1, SEP.HS.E.2, CCC.HS.C.2	2
21	HS-ETS1-4, DCI.HS-ETS1.B.2, SEP.HS.E.3, CCC.HS.D.2	2
22	HS-LS2-7, DCI.HS-LS2.C.2, SEP.NOS.HS.C.1	2
23	HS-ETS1-2, DCI.HS-ETS1.C.1	2
24	HS-ETS1-1, DCI.HS-ETS1.A.2, SEP.HS.F.2	2
25	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.E.3	3

- This is incorrect because nuclear power plants do not release methane, and also methane does not damage DNA.
 - This is correct because coal plants do indeed release carbon dioxide as a by-product of burning coal. Carbon dioxide is a greenhouse gas, so it contributes to global warming.
 - This is incorrect because although airborne metals can cause neurological damage, industrial bakeries are not a source of them.
- This is incorrect because advances in medicine have allowed the average lifespan to increase, which allowed the human population to increase because older generations are able to live simultaneously with much younger generations.
 - This is correct because climate change did not account for a significant increase in human population during this time.
 - This is incorrect because declining infant mortality rates have allowed more people to live to adulthood and thereby have more children.
- This is correct because the blades of wind turbines have been known to kill birds.
 - This is incorrect because wind turbines generate electricity but not enough to change weather patterns.
 - This is incorrect because wind turbines do not emit any particulate matter.
- This is incorrect because dangerous chemicals produce undesirable waste.
 - This is correct because mass production reduces cost.
 - This is incorrect because heat dissipation is wasted energy.
- This is incorrect because hunting of a species that is under protection according to hunting laws and regulations does not reduce overharvesting.
 - This is incorrect because though this is a great practice for plants, it does not reduce overharvesting of animals.
 - This is correct because tax incentives will encourage sustainable fishing practices to prevent the loss of aquatic species to overfishing.
- This is incorrect because habitat conservation is an environmental, not an economic, consideration.
 - This is incorrect because pH is a scientific factor.

- C. This is correct because the cost of a technology is an economic consideration.
7. A. This is incorrect because providing additional resources for native species would not be a primary concern.
 B. This is correct because damage to native species would be the primary concern regarding introducing this species.
 C. This is incorrect because the goal of introducing the predator would be to make the invasive species extinct locally.
8. A. This is incorrect because irrigation would not be used for a natural prairie. Irrigation is an agricultural practice.
 B. This is incorrect because increasing the length of time between controlled burns would actually make the prairies less healthy. Historically, the prairies burned every 1 to 5 years, but the time between burns is currently much longer, which gives other species the opportunity to become established in the prairie.
 C. This is correct because most of the prairie land that has been lost has been converted into agriculture. Letting this agricultural land lay fallow or even converting it back to native prairie by planting appropriate species is one way to bring back some portion of the original prairie.
9. A. This is correct because mowing twice was the most effective treatment.
 B. This is incorrect because the early application of fungus had a greater effect.
 C. This is incorrect because this method was less effective than mowing twice.
10. A. *Increases carrying capacity* matches the bottom event because people need access to clean drinking water and food grown through agriculture in order to survive.
 B. *Decreases carrying capacity* matches the first event because plants are the base of the food webs from which humans acquire food. It also matches the second event because an increase in ecological footprint means that the same amount of resources can support fewer people.
11. 1B. *Decreases* belongs in the first box. Urbanization leads to reductions in the size of habitats.
 2A. *Increases* belongs in the second box. Urbanization leads to increasing habitat fragmentation as roads and other human development break up habitats.
 3B. *Decreases* belongs in the third box. Increases in habitat fragmentation reduce gene flow.
 4B. *Decreases* belongs in the fourth box. Increases in habitat fragmentation cause the carrying capacity to be reduced.
 5A. *Increases* belongs in the fifth box. Increases in habitat fragmentation leave populations more vulnerable to the effects of pollution and predation.
12. A. *Produce electricity* is incorrect because this describes a benefit and not a drawback of dams.
 B. *Prevent silt deposition* is correct because silt deposition can be important to downstream ecosystems.
 C. *Increase irrigation of crops* is incorrect because this describes a benefit and not a drawback of dams.
 D. *Change downstream water quality* is correct because this can disrupt aquatic ecosystems downstream from the dam.
13. The correct answer is 39,000. If the minimum reduction is 35%, then the maximum remaining would be 65% of the initial value. Therefore, 65% of 60,000 metric tons is 39,000 metric tons.
14. A. This scenario could increase habitat destruction if the pesticides are carried into the habitat by wind or water, where they could cause a decline in the insects that other animals rely on for food.
 B. This scenario would increase habitat destruction because logging removes tall trees that birds use for nesting.
 C. This scenario decreases habitat destruction because it allows salmon to swim to the habitat in which they spawn and provide food for other species.

15. **1B.** The subtraction function should be used since the population will decrease in size with the number of snakes trapped and moved off the island.
- 2A.** The addition function should be used since the population will increase in size with the number of snakes released from care by pet owners.
16. The descriptions in order are 6, 5, 2, 4, 1, and 3. The process starts when fossil fuels are burned, producing oxides that react with water in the air to form acids. These acids lower the pH of the rainwater, which is then introduced into the ecosystem, killing insects and aquatic life forms.
17. **A.** This is incorrect because coal is produced by nature at a very slow rate, and a finite supply of it exists.
B. This is correct because wind energy cannot be used up by humans.
C. This is correct because the sun will continue to provide solar power to Earth.
D. This is incorrect because petroleum is a fossil fuel that is produced in nature much more slowly than it is being used.
E. This is correct because Earth produces so much heat that it would be impossible for humans to deplete it.
18. Use the rubric below to evaluate total points earned for this item. *[max point: 3]*

DCI, SEP - 3 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. explain how humans benefit from regulations that protect species from overharvesting (DCI); and 2. describe a modification of a simulation of overharvesting to test a solution (SEP).
Evidence of Mastery of Disciplinary Core Ideas	2 points for explaining how modification helps Part 2: Two points are earned for explaining that humans ultimately benefit from regulations that prevent practices that wipe out whole populations of organisms. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • If the regulation is not imposed, the simulation shows that the crab population will eventually decrease to zero because of overharvesting. This means that humans will not be able to eat crabs from this bay ever again. However, with regulations limiting crab harvesting, the crab population can be sustained so that the ecosystem remains in balance. This maintains good ecosystem health that benefits all species, including humans. Also, humans will continue to have a source of crabs for eating.
Evidence of Mastery of Science and Engineering Practices	1 point for describing a modification Part 1: One point is earned for creating a modification of the simulation that either reduces the rate of overharvesting or eliminates it by either removing fewer dice or adding more dice back in. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> • One thing that could be changed to reduce the rate of overharvesting is to reduce the number of dice you roll per turn from five to three.

19. Use the rubric below to evaluate total points earned for this item. *[max point: 3]*

DCI, CCC - 3 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. determine how many incinerators are needed to power the city (CCC); and 2. identify factors that could affect the city's energy generation needs in the future (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly identifying two factors</p> <p>Part 2: Two points are earned for identifying factors that may change and affect the city's future energy generation needs. Factors may include the efficiency of the incinerators, the number of people per home, changes in population growth, the average energy needs per person, and the introduction of alternative sources of energy such as solar roofs. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Two factors that may change and affect the city's future energy generation needs are how much energy each person needs and changes in the population growth rate.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly determining the number of incinerators needed</p> <p>Part 1: One point is earned for explaining that to determine the number of incinerators to build, the total number of homes (2.4 million) is divided by the number of homes that one incinerator would power (200,000), which results in the need for 12 new incinerators. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The new incinerators will produce enough energy to power 200,000 homes. Because the city's population will be 2.4 million, divide 2.4 million by 200,000 to find the number of incinerators to build. The city will need to build 12 incinerators.

20. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe how fluctuations in the age of jack pine forests can challenge the habitat availability of a bird species (DCI); and explain how fire may either benefit or harm animal populations (CCC); and use mathematical thinking to design a solution to maintain constant habitat conditions for a bird species (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for describing optimal habitat for a bird species</p> <p>Part 1: One point is earned for interpreting the data in the graph to explain that the optimal habitat for the Kirtland's warbler is a jack pine forest that is between 10 and 20 years old. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data indicate that jack pine forests less than 5 years old and more than 25 years old do not supply the type of conditions needed by the Kirtland's warbler. Even within the age range of 5 to 25 years, the optimal age of a jack pine stand is between 10 and 20 years.
Evidence of Mastery of Science and Engineering Practice	<p>1 point for describing a plan to ensure optimal habitat</p> <p>Part 3: One point is earned for explaining how mathematical thinking can be applied to schedule prescribed burning in different parts of a large jack pine forest on a rotating basis. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The graph shows that there is a 5-year period between when a jack pine forest is burned and when it becomes suitable as a habitat for Kirtland's warblers. The graph also shows that at 25 years the forest has lost its ability to serve as a habitat. Therefore, a large jack pine forest can be divided into five sections so that every 5 years, a different section is burned. Five sections times 5 years would mean that it would take 25 years before the first section would be burned again. That would allow each section to reach its greatest useful age. It would also allow for different sections to serve as optimal habitats on a rotating basis so that there is always some optimal habitat available for the Kirtland's warbler.

Evidence of Mastery of Crosscutting Concepts	<p>1 point for constructing an explanation about how fire can help or harm populations</p> <p>Part 2: One point is earned for explaining how wildfires may benefit animal populations, such as by ensuring the growth of plants upon which they depend, and harm populations, such as by killing the animals directly or destroying their habitat. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Fire can be a benefit to a population by opening the seeds of plants that the animals depend upon, but it can harm a population by burning plants that the animals will eat.
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21. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain why scientists use computer simulations (DCI); and 2. draw conclusions from the computer simulation (SEP); and 3. make an argument based on these conclusions regarding future geoengineering projects (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining that simulations help scientists model the future</p> <p>Part 1: One point is earned for explaining that scientists use computer simulations when other types of models, such as physical models, are not adequate. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • For some experiments, scientists cannot create physical models to represent the future. In these cases, they can use computers to use mathematical models representing the future.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for determining which compound is most effective</p> <p>Part 2: One point is earned for correctly explaining that harzburgite is most effective. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Harzburgite removes more carbon dioxide from the atmosphere than basalt.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly making a claim based on evidence</p> <p>Part 3: One point is earned for providing an argument in favor of the use of enhanced weathering using evidence from the computer model. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Since according to the computer model the use of harzburgite has the potential to bring atmospheric carbon down below preindustrial levels, scientists could use this technique to reduce global climate change.

22. A. This is incorrect because the fluctuations are not seasonal.
 B. This is correct because the number of fish using the ladder does not meet expectations.
 C. This is incorrect because the number of fish using the ladder increased between 2006 and 2008.
23. A. This is not an environmental tradeoff because cost does not impact the environment.
 B. This is not an environmental tradeoff because people's enjoyment does not impact the environment.
 C. This is an environmental tradeoff because the fish population would be saved but the greenhouse gases emitted would promote global climate change.
24. A. This scenario belongs in the *water quality* column because the microbes in the water can be harmful to human health.
 B. This scenario belongs in the *water demand* column because fewer people means less water usage by the city.
 C. This scenario belongs in the *water quantity* column because increased reservoir levels would increase the amount of water available.

25. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. use constraints and environmental tradeoffs in evaluating a project (DCI); and 2. analyze the reliability of the well project using the graph (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying why the well was proposed Part 2: One point is earned for identifying that the well project was environmentally superior to the dam project because it would not have had as great an impact on other organisms. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Because the well project would not have changed the habitat of plants and animals living in and near waterways, the project should have been considered environmentally superior to the dam project. Although the well project would have protected more species of fish than the dam and not changed the landscape as much, it was projected to run out of water in the future. Therefore, the well project was too unreliable for the city's needs.
Evidence of Mastery of Science and Engineering Practices	1 point for correctly determining the reliability of a well project Part 1: One point is earned for analyzing the graph for the effects of wells on future water availability and predicting that the city would have run out of water if it chose to use wells. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> According to the graph, the well project was projected to deplete groundwater at a rapid rate. If the city proceeded with the well project, it would have run out of water in the future.

Middle-of-Year Test A

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-2, DCI.HS-LS1.A.3	1
2	HS-LS2-6, DCI.HS-LS2.C.1	1
3	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	2
4	HS-LS1-5, DCI.HS-LS1.C.1, SEP.HS.B.1	2
5	HS-LS2-5, DCI.HS-LS2.B.3	2
6	HS-LS2-5, DCI.HS-LS2.B.3	2
7	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	2
8	HS-LS1-7, DCI.HS-LS1.C.4, CCC.HS.E.3	2
9	HS-LS1-5, DCI.HS-LS1.C.1, SEP.HS.B.1	2
10	HS-LS1-7, DCI.HS-LS1.C.4, CCC.HS.E.3	2
11	HS-LS2-5, DCI.HS-LS2.B.3, CCC.HS.D.2	2
12	HS-LS1-3, DCI.HS-LS1.A.4	2
13	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.E.2	2
14	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4	2
15	HS-LS2-5, DCI.HS-LS2.B.3, SEP.HS.B.1	2
16	HS-LS2-3, DCI.HS-LS2.B.1, CCC.HS.E.4	2
17	HS-LS1-6, DCI.HS-LS1.C.2	2
18	HS-LS2-3, DCI.HS-LS2.B.1, SEP.HS.F.1	3
19	HS-LS1-3, DCI.HS-LS1.A.4, SEP.NOS.HS.A.3	2

20	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.E.2	2
21	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.C.1	3
22	HS-LS1-7, DCI.HS-LS1.C.3	2
23	HS-LS1-2, DCI.HS-LS1.A.3	2
24	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	3
25	HS-LS2-3, DCI.HS-LS2.B.1, CCC.HS.E.4	2
26	HS-LS2-3, DCI.HS-LS2.B.1, SEP.HS.C.1	2
27	HS-LS2-3, DCI.HS-LS2.B.1	1
28	HS-LS2-4, DCI.HS-LS2.B.2	2
29	HS-ETS1-1, DCI.HS-ETS1.A.2	2
30	HS-LS2-3, DCI.HS-LS2.B.1	2
31	HS-LS2-3, DCI.HS-LS2.B.1	3
32	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.E.2	2
33	HS-ETS1-1, DCI.HS-ETS1.A.2, CCC.STSE.HS.B.3	2
34	HS-LS2-6, DCI.HS-LS2.C.1, SEP.NOS.HS.C.2	2
35	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.E.2	3
36	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.F.1	3
37	HS-LS2-5, DCI.HS-LS2.B.3, CCC.HS.D.2	3
38	HS-LS1-7, DCI.HS-LS1.C.4	3
39	HS-LS1-7, DCI.HS-LS1.C.4, SEP.HS.B.1, CCC.HS.E.3	3
40	HS-LS2-4, DCI.HS-LS2.B.2	3
41	HS-LS1-6, DCI.HS-LS1.C.3	3
42	HS-LS2-6, DCI.HS-LS2.C.1, CCC.HS.G.1	2
43	HS-LS2-2, DCI.HS-LS2.C.1	2
44	HS-LS1-2, DCI.HS-LS1.A.3, CCC.HS.D.2	3
45	HS-LS2-2, DCI.HS-LS2.A.1	3
46	HS-LS2-2, DCI.HS-LS2.A.1, SEP.HS.E.2	3
47	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	3
48	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.E.2, CCC.HS.D.2	3
49	HS-LS2-1, DCI.HS-LS2.A.1	3
50	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.C.2	3

1. A. This is incorrect because villi are not organs. They are structures made up of several kinds of tissue, including epithelial tissue made up of the cells that contain microvilli. The small intestine is an organ, which is one component of an organ system.
- B. This is incorrect because villi are not organs; they are structures of the organ known as the small intestine. Microvilli are not tissues; they are parts of cells that form epithelial tissue. In addition, the small intestine is not an organ system; it is an organ that is part of the digestive system.
- C. This is correct because microvilli are structures on the cells that make up the epithelial tissue that lines villi, which are structures of the small intestine, an organ that is part of the digestive system.
- D. This is incorrect because microvilli are not organs. They are structures on the cells that make up the epithelial tissue that lines the villi. Villi are not cells but are made up of multiple tissues.

2.
 - A. *Many animals die* belongs with *Does Not Help Ecosystem Return* because this is part of the destruction of the forest and not its regeneration.
 - B. *Fire-heated seeds germinate* belongs with *Helps Ecosystem Return* as this will result in new plant and tree growth, which is essential for rebuilding the forest.
 - C. *Erosion on slopes increases* belongs with *Does Not Help Ecosystem Return* as erosion of soil from newly denuded slopes will cause loss of nutrients and water. It will work against the regeneration of the forest.
 - D. *Minerals are released from organic matter* belongs with *Helps Ecosystem Return* because the release of minerals will provide food for newly germinating plants, causing faster regrowth of vegetation.
3.
 - A. This is incorrect because the patient's blood sugar does fall back to normal when it gets too high.
 - B. This is incorrect because if the patient's liver were not responding to insulin, his blood sugar would not fall when it was high.
 - C. This is correct because the liver needs to respond to glucagon to add sugar to the blood.
 - D. This is incorrect because any hormone in the bloodstream will be delivered to liver cells unless the liver is completely cut off from circulation. If this were the case, liver tissue would begin to die and so would the patient.
4.
 - A. This is incorrect because sugar is formed, not broken down, during photosynthesis. In addition, light energy from the sun is not stored as thermal energy in water.
 - B. This is correct because the sun's energy is stored as chemical bonds in the high-energy sugar molecule.
 - C. This is incorrect because sugar is formed, not broken down, during photosynthesis. Sunlight energy is not stored in the oxygen gas.
 - D. This is incorrect because the sun's energy is not stored in the oxygen gas.
5.
 - A. This is correct because much of the carbon dioxide released by these plants will be dissolved in the surrounding ocean water.
 - B. This is incorrect because this process moves carbon from the atmosphere into plant tissues in the biosphere.
 - C. This is incorrect because this process moves carbon from animal tissues into the geosphere.
 - D. This is incorrect because this process moves carbon from animal and plant tissues in the biosphere into the atmosphere.
6.
 - 1B. The correct value is 120, obtained by adding the values for plant respiration (60) and microbial respiration and decomposition (60).
 - 2E. or 2F. The correct response is either *atmosphere* or *biosphere*, because carbon dioxide from land-based cellular respiration results from plant respiration and microbial respiration. Either response is acceptable.
 - 3I. or 3J. The correct response is either *atmosphere* or *biosphere*, because carbon dioxide from land-based cellular respiration results from plant respiration and microbial respiration. Either response is acceptable.
7. The events that led up to the contraction of a muscle begin with an electrochemical signal for voluntary muscle contraction that starts in the brain and travels through nerve fibers toward muscles. When the electrochemical signal reaches the nerve cells at neuromuscular junctions, chemicals called neurotransmitters are released to deliver the signal to the muscle cells. Muscle cells contract individually and then act together as a tissue for an entire muscle to contract.
8.
 - A. This is incorrect because energy cannot be created or destroyed.
 - B. This is incorrect because photosynthesis is the process powered by sunlight; cellular respiration is not.
 - C. This is correct because enzymes lower the activation energies of the reactions they catalyze.
 - D. This is incorrect because while enzymes may bend or flex molecules, they do not physically break and rearrange them.

9. **1C.** *Carbon dioxide* is correct because carbon dioxide is a reactant in the photosynthesis reaction.
- 2F.** *Glucose* is correct because glucose is a product of photosynthesis. Six molecules of carbon dioxide and six molecules of water combine with energy to produce one molecule of glucose.
- 3K.** *About 15,000* is correct because 2,500 excited chlorophyll molecules correspond to one molecule of oxygen gas. Six molecules of oxygen gas are produced alongside the production of one molecule of glucose; therefore, for each molecule of glucose produced, 15,000 chlorophyll molecules must be excited.
10. The first step in the transfer of energy from the sun to living organisms occurs when energy from sunlight is absorbed by the cells of photosynthetic organisms. That energy is stored in the form of glucose. The energy stored in the glucose molecule is released when glucose is broken down into pyruvate. The energy released by the breakdown of glucose is stored in the form of ATP. The energy stored by the ATP molecule is released when ATP is broken down to ADP and P. The energy released by ATP is used to power cellular processes.
11. **A.** This is incorrect because arrow 6 represents the burning of fossil fuels, which returns carbon dioxide to the atmosphere by a process other than respiration.
- B.** This is correct because arrow 1 represents plants taking carbon dioxide from the atmosphere for photosynthesis, and arrows 2 and 4 show the return of carbon dioxide to the atmosphere by respiration of plants and animals, respectively.
- C.** This is incorrect because arrow 2 represents plant respiration, not photosynthesis, and arrow 5 represents storage of carbon in fossil fuels, not respiration.
- D.** This is incorrect because arrow 5 represents storage of carbon in fossil fuels, not removal of carbon dioxide from the atmosphere for photosynthesis.
12. **A.** This is correct because the model shows a negative feedback system in which the increase of one hormone discourages the production of other hormones.
- B.** This is incorrect because the model shows a negative feedback system in which the increase of one hormone discourages, rather than encourages, the production of other hormones.
- C.** This is incorrect because the model shows a negative, not a positive, feedback system.
- D.** This is incorrect because the model shows a negative, not a positive, feedback system in which the increase of one hormone discourages, rather than encourages, the production of other hormones.
13. **1A.** *Glucose* is correct because glucose is the energy storage molecule that can be used for other purposes when energy is in excess.
- 2D.** *Alanine* is correct because it is the amino acid indicated in the diagram.
- 3E.** *Less* is correct because in times of starvation, the body would make this conversion only to gain usable energy.
- 4G.** *Cellular respiration* is correct because that is the name of the process in which sugar molecules are broken down for energy.
14. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI, SEP - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. identify relevant questions designed to begin the process of developing a practical solution in a specific real-world context based on conservation vs. development of a particular type of habitat (DCI); and 2. describe a reasonable tradeoff or compromise relevant to a particular situation based on scientific knowledge and prioritized criteria (SEP).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying relevant questions related to researching a solution</p> <p>Part 1: One point is earned for identifying two questions the city planners should ask as they prepare to make a decision about whether to develop or preserve the wetland area. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Two questions are: (1) Are there other areas where the houses could be built and not destroy as much vulnerable habitat?; and (2) Are there any endangered/threatened species living in this coastal wetland area?
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly describing the tradeoffs or potential compromises inherent in developing and refining solutions for complex real-world problems</p> <p>Part 2: One point is earned for describing one reasonable compromise the city planners could consider related to the preservation or development of the wetland. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Reasonable tradeoffs/compromises related to developing/preserving the wetland include developing the less vulnerable portion of the area and leaving the rest as habitat.

15. A. *Dead organisms* is correct for *adds carbon to the soil* because some carbon from the decaying organisms stays in the soil making the soil more fertile.
- B. *Photosynthesis* matches *removes carbon from the atmosphere* because this process uses carbon dioxide gas to build sugar molecules.
- C. *Animal respiration* matches *adds carbon to the atmosphere* because this process releases carbon dioxide gas as a waste product.
- D. *Mining of fossil fuels* is correct for *removes carbon from the geosphere* because that is where the fossil fuels are formed.
16. A. *Requires oxygen* belongs in the *Aerobic Respiration* column because only aerobic respiration uses oxygen to produce ATP.
- B. *Involves pyruvate* belongs in both the *Aerobic Respiration* and *Anaerobic Respiration* columns because both types of respiration begin with pyruvate following the splitting of a glucose molecule during glycolysis.
- C. *Produces more ATP* belongs in the *Aerobic Respiration* column because aerobic respiration is able to use oxygen to produce more ATP than anaerobic respiration.
- D. *May produce lactic acid* belongs in the *Anaerobic Respiration* column because lactic acid fermentation, one type of anaerobic respiration, results in the production of lactic acid.
- E. *Does not require oxygen* belongs in the *Anaerobic Respiration* column because anaerobic respiration produces a little energy without using oxygen.
17. A. *Carbon* belongs under *Obtained from Carbohydrates* because sugars contain the element carbon.
- B. *Energy* belongs under *Obtained from Carbohydrates* because sugars are used to produce ATP, the energy of cells.
- C. *Oxygen* belongs under *Obtained from Carbohydrates* because sugars contain the element oxygen.
- D. *Nitrogen* belongs under *Not Obtained from Carbohydrates* because sugars, unlike amino acids, do not contain the element nitrogen.
- E. *Hydrogen* belongs under *Obtained from Carbohydrates* because sugars contain the element hydrogen.
18. A. This is correct because the data show a continued decrease in pH (increase in acidity), which is correlated with a significant decline in coral growth rates.
- B. This is incorrect because, according to the data, the pH changes are not small. The projected pH change between 1865 and 2050 is 0.24, which correlates to a significant decrease in growth rates of corals.
- C. This is incorrect because the data show that growth rate will decline significantly because of a decrease in pH, and respiration is remaining the same.

- D. This is incorrect because the basic energy source for most ecosystems is sunlight, which drives photosynthesis. This source will not change, certainly not over a few decades. The laws that describe the natural world will operate in the future as they do today.
19. A. This is incorrect because the wide variation within groups and the small difference in the means suggest that there is no significant difference in body temperature recovery time between the two groups.
- B. This is incorrect because the lower mean recovery times for the cyclists would not support a claim that nonathletes are better at recovering from exercise.
- C. This is correct because the high variability within groups and the small difference in the mean body temperature recovery times for the two groups indicate that this is not a reliable difference, but the larger difference in mean heart rate recovery times suggests that there is a real difference between the two groups.
- D. This is incorrect because the heart rate results do show a substantial difference between the groups.
20. A. This is incorrect because if emigration is greater than the sum of birth and immigration, the rate will definitely be negative.
- B. This is correct because if the birth rate is greater than the sum of the death rate and the emigration rate, then no immigration is required to ensure that the growth rate is positive.
- C. This is incorrect because this inequality provides no valuable information in determining whether the growth rate is negative or positive.
- D. This is correct because if immigration exceeds the sum of death and emigration, then the growth rate would be positive even if there were no births.
- E. This is incorrect because emigration rate, not birth rate, should be subtracted from immigration for this inequality to ensure positive growth rate.
- F. This is correct because if the difference between the birth rate and the death rate exceeds the emigration rate, then the growth rate will definitely be positive, even if there is no immigration.
21. A. This is incorrect because the growth of the elephant population does not measure carrying capacity. They could be overshooting their carrying capacity and/or depleting ecosystem resources for the elephant population and other members of the community.
- B. This is incorrect because maintaining the elephant population by hunting is not a measure of what the carrying capacity should be. The measure should involve analysis of how well resources in the ecosystem are maintained.
- C. This is correct because the rapid and almost complete decline of canopy trees indicates that elephant populations, even when limited to 7,000 in the park, are seriously damaging this resource that the elephants and other community members depend on.
- D. This is incorrect because the fact that a resource has not been completely depleted is not a valid measure of carrying capacity. If an organism is living at its carrying capacity, it should be able to maintain, not deplete, the resources of its ecosystem.
22. A. *High-energy bonds form between phosphate groups* is correct because high-energy bonds in the reactants of cellular respiration are broken to be reformed into low-energy bonds, while the difference is released to be used to attach phosphate to adenosine diphosphate.
- B. *High-energy carbon-carbon bonds are broken in glucose* is correct because the carbon-carbon, carbon-hydrogen, and carbon-hydroxide bonds of the reactants of cellular respiration are broken to be reformed into low-energy bonds in the products with the difference released and used to make ATP.
- C. *Energy is released each time phosphate attaches to adenosine* is incorrect because energy is released from high-energy bonds into lower-energy bonds, with the difference being used to attach phosphate to adenosine diphosphate to make ATP. Later, energy can be released by breaking off a phosphate from ATP.
- D. *Low-energy carbon-carbon bonds are broken in carbon dioxide* is incorrect because the low-energy carbon-carbon bonds found in carbon dioxide are formed as products of cellular respiration, rather than broken as reactants of cellular respiration.

- E. *Low-energy carbon-oxygen bonds are formed to make carbon dioxide* is correct because low-energy bonds are formed in the products of cellular respiration, which allows the difference in energy to be released and used to attach a phosphate to adenosine diphosphate to make ATP.
23. The correct order is rods and cones, bipolar cells, ganglion cells, and optic nerve. Rods and cones are the light-receptor, or photoreceptor, cells. Although they are at the back of the retina, they must be stimulated first before the eye receives light. The light then enters a series of modified neural cells—in order, the bipolar and ganglion cells—that transform the light into electrical signals. Axons of the ganglion cells collect to form the optic nerve, which sends visual information (as electricity) to the brain. Thus, light stimulates the farthest cells (rods and cones) first and then travels backward to the ganglion cells and optic nerve.
24. A. This answer is incorrect because it would not increase understanding of immune function and would not show interaction between cells and tissues.
B. This answer is incorrect because it would not increase understanding of immune function and would not show interaction between cells and tissues.
C. This answer is incorrect because immune cells do not migrate into the epidermal tissue; they migrate between lymphatic tissue and dermal tissue.
D. This answer is correct because some memory T cells do attach to the dermis and play a role in initiating immune functions.
25. A. An increase in the rate of cellular respiration will increase the amount of carbon dioxide released into the atmosphere is True because cellular respiration produces carbon dioxide.
B. *A substitution of protein for glucose in cellular respiration will lead to an increase of the release of nitrogenous waste* is True because amino acids in proteins will be broken down and released as ammonia.
C. *An increase in the rate of cellular respiration will increase the amount of glucose available to organisms throughout the food chain* is False because glucose is produced from photosynthesis and not cellular respiration.
D. *A reduction in the amount of oxygen available for cellular respiration will decrease the amount of energy available to an organism to carry out life processes* is True because oxygen is needed to produce large amounts of ATP during cellular respiration.
26. 1A. *The control group* is correct because it was the only group with unexpected results.
2D. *More respiration* is correct because the control group would not be expected to show any respiration.
27. A. *Water* is correct for the second blank because sunlight, carbon dioxide from the air, and water are used as the reactants in photosynthesis.
B. *Aerobic* is correct for the seventh blank because cellular respiration occurs under both aerobic and anaerobic conditions. Glucose is completely broken down during cellular respiration when oxygen is present.
C. *Oxygen* is correct for the third blank because the products of photosynthesis are oxygen and sugars.
D. *Anaerobic* is correct for the eighth blank because cellular respiration occurs under both aerobic and anaerobic conditions, but cellular respiration can only be partially completed under anaerobic conditions.
E. *Carbon dioxide* is correct for the first blank because sunlight, carbon dioxide from the air, and water are used as the reactants in photosynthesis.
F. *Carbohydrates* is correct for the fourth blank and the sixth blank because glucose is a carbohydrate produced during photosynthesis, and carbohydrates are broken down during cellular respiration to produce energy.
G. *Cellular respiration* is correct for the fifth blank because carbohydrates are broken down during cellular respiration to provide energy needed for life processes.

28. A. *Most of the energy stored by corn is lost as it is transferred to chickens* is correct. Only about 10% of the energy is passed from one trophic level to the next.
- B. *The energy available to rodents is greater than the energy available to insects* is incorrect. Energy from corn is available to both rodents and insects.
- C. *About 10% of the energy stored by corn is lost when it is transferred to the insects* is incorrect. Approximately 90% of the energy is lost between trophic levels.
- D. *Energy is lost between each trophic level as heat released through cellular respiration* is correct. Heat is released as a result of cellular respiration.
- E. *The corn is able to convert 100% of the sun's energy to usable or stored chemical energy through photosynthesis* is incorrect. Only a small amount of light energy is converted into chemical energy in photosynthesis.
29. A. *Ethanol is a renewable energy source* is a correct selection because ethanol can be renewed by growing more corn.
- B. *Ethanol is a more efficient energy source than gasoline* is incorrect selection because ethanol contains less energy than gasoline.
- C. *Ethanol production can decrease the amount of crops needed for food* is an incorrect selection because this will not affect the need for food crops.
- D. *Ethanol use can decrease greenhouse gases compared with fossil fuel energy sources* is a correct selection because ethanol has lower carbon dioxide emissions than gasoline does.
30. A. This is incorrect because water and sunlight combine with carbon dioxide to produce oxygen and glucose in photosynthesis.
- B. This is incorrect because these are reactants in photosynthesis, and energy released during photosynthesis is not used in cellular respiration.
- C. This is correct because the products of photosynthesis—glucose and oxygen—are used in cellular respiration to provide energy for life processes.
- D. This is incorrect because this option includes both the products and reactants of photosynthesis.
31. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain the role of photosynthesis and respiration in the movement of matter and energy (DCI); and 2. explain the differences between the movement of matter and energy in the ecosystem (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the role of the processes in the movement of energy and matter</p> <p>Part 1: One point is earned for explaining the role of photosynthesis and respiration in the movement of matter and energy in the ecosystem. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Photosynthesis causes the production of carbohydrates, which contain stored energy. When animals consume the sugars, both the energy and the matter are moved to them. When the animal's cells carry out cellular respiration, the stored energy is released and the carbohydrates are broken down into simpler molecules. These molecules, once released by the animals, can again be used to form carbohydrates by plants. <p>1 point for explaining the differences between the movement of matter and energy</p> <p>Part 2: One point is earned for explaining how the movement of matter and energy through the ecosystem differ. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Unlike energy, the matter in an ecosystem is largely cycled within the ecosystem. The plant matter that is consumed by an animal will likely be used again in the future by a plant. However, energy in the ecosystem must be constantly supplied by the sun; it cannot be recycled endlessly into useful forms.
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32. A. *Human* is correct for *Level 3* because humans have the least energy available to them.
 B. *Corn* is correct for *Level 1* because the corn has the most energy available to it.
 C. *Chicken* is correct for *Level 2* because the chickens have more energy than the humans available to them, but less than the corn.
33. A. *Biomass is a more renewable source of energy than coal is a benefit* because the ability to renew an energy source is greatly advantageous.
 B. *Farmers might replace crops for food production with crops for energy production* is a risk because other areas will need to be cleared for food production. In addition, food may cost more if energy production results in use of food crops for energy production.
 C. *Use of electricity from biomass could lead to greater biomass removals from forests* is a risk because deforestation clears away plants that can remove the greenhouse gas carbon dioxide from the atmosphere. It also results in habitat loss.
 D. *Producing electricity from biomass could reduce the amount of land needed to dispose of waste in landfills* is a benefit because if biomass such as urban waste is used for energy production, it will be burned instead of put in landfills.
34. A. *The average winter temperature on the islands has increased by 5°F since 1961* is correct because this shows a trend toward warmer winters, although it does not provide evidence of the effect of climate change on the reindeer population.
 B. *Reindeer reproduction rates in 2012 were less than half of what they were in 2002* is correct because, combined with temperature data, this provides evidence that the population of reindeer is being affected.
 C. *The frequency of warm winters has increased by more than 100% during the past 40 years* is correct because a trend toward warmer winters combined with lower survival and reproductive rates for the reindeer in years with warm winters provide strong evidence that climate change is threatening the species.
 D. *The estimated reindeer population has ranged from 1,000 to 10,000 during the past 40 years* is incorrect because this does not describe a clear population trend.
 E. *Scientists believe that prior to 1990, about one in six winters was warm enough to cause starvation in the reindeer* is incorrect because that alone does not demonstrate a trend toward warmer winters.

35. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 2 Points	
Claims	The student is able to: 1. explain how matter and energy interact during the light-gathering phase of photosynthesis (DCI); and 2. identify how the matter within key molecules in photosynthesis influences how energy flows through them (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining how matter and energy interact during the light-gathering phase of photosynthesis Part 1: One point is earned for explaining that the two types of chlorophyll absorb light at slightly different wavelengths and thus maximize energy absorption. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Chlorophyll <i>a</i> absorbs light maximally at 450 nm and close to 700 nm. Chlorophyll <i>b</i> absorbs light maximally at 500 nm and 650 nm. Using both chlorophyll types allows the photosynthetic organism to absorb energy from that entire range of wavelengths and thus gather more energy per unit time.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly identifying the role of wavelengths of light on the cycling of matter Part 2: One point is earned for identifying the plant through which more matter would be expected to be cycled and explaining why. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The plant exposed to 450 nm light would have more matter cycling through it. The plant would have more carbon cycling through it because it would absorb more light by its chlorophyll, which would result in more carbon dioxide and water being converted into sugar.

36. A. This statement is incorrect because other radioactive elements would not have any bearing on the amount of radioactive carbon the plant incorporated during the experiment.
- B. This statement is correct because it explains why the scientist found radioactive carbon in the plant's sugar molecules.
- C. This statement is correct because it explains why the scientist found radioactive carbon in some of the plant's cellulose and proteins.
- D. This statement is incorrect because the half-life of carbon-14 is too long for an appreciable amount to have "gone missing" in just a few days.
- E. This statement is correct because it explains why some of the radioactive carbon the plant should have taken in was no longer inside the plant's tissues.

37. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	The student is able to: 1. describe the roles of photosynthesis and cellular respiration in the cycling of carbon (DCI); and 2. explain how change to one component of a model would change other components (CCC); and 3. use a model of the carbon cycle to describe relationships between components of the model (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the role of photosynthesis and cellular respiration in the carbon cycle</p> <p>Part 1: One point is earned for describing the relationship between plants and animals in the processes of photosynthesis and cellular respiration. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Plants carry out photosynthesis, in which atmospheric carbon is converted into chemical energy in the form of a complex carbohydrate. That energy flows through trophic levels in an ecosystem when animals consume plants and other animals. Animals carry out cellular respiration. Carbohydrates are converted into usable energy, and carbon dioxide is released into the atmosphere as a waste product.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining impacts of change in the carbon cycle</p> <p>Part 2: One point is earned for using the model to describe how the removal of trees could impact the amount of carbon on Earth. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The removal of trees would lead to less CO₂ cycling out of the atmosphere, which would lead to increased greenhouse effects. Fewer trees would also mean that fewer animals could be supported, which would mean that less carbon would be deposited in the soil. <p>1 point for correctly describing movement of carbon within a cycle</p> <p>Part 3: One point is earned for using the model to explain how carbon travels from the atmosphere to fossil fuels. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Plants incorporate atmospheric carbon into their biomass via photosynthesis. This carbon becomes incorporated into animals as they consume plants and then each other. As the animals die, their bodies decompose, and the carbon in their bodies can eventually become part of the soil or sediment. Over time, sediment rich in carbon can become compressed to form fossil fuels.

38. **A.** *Temperature of the chamber would increase* because heat is given off during respiration.
B. *Amount of ATP in the organism would increase* because that is the purpose of respiration.
C. *Amount of oxygen gas in the chamber would decrease* because it would be consumed during respiration.
D. *Amount of carbon dioxide in the chamber would increase* because it would be created during respiration.

39. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain the transfer of energy and matter involved in cellular respiration (DCI); and use a model to describe the inputs and outputs of cellular respiration (SEP); and explain the flow of matter between photosynthesis and cellular respiration (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the transfer of energy and matter in cellular respiration</p> <p>Part 2: One point is earned for explaining that the breaking and formation of bonds results in the energy used to make ATP. The process of cellular respiration is a chemical process in which the bonds of food and oxygen molecules are broken down and new compounds (ATP) are formed that can transport energy. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> During cellular respiration, bonds in glucose are broken and different bonds are formed in ATP.

Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly using the model to describe the inputs and outputs of cellular respiration</p> <p>Part 1: One point is earned for describing the inputs and outputs of the process shown in Steps 3 and 4, which are cellular respiration, and for describing the relationship between the inputs and outputs. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Cellular respiration is shown in Steps 3 and 4 of the model. The inputs are sugar and oxygen. The sugar is obtained from the plant. The outputs are carbon dioxide, water, and stored energy in the form of ATP.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining the flow of matter between the corn, environment, and cow in cellular respiration</p> <p>Part 3: One point is earned for explaining how oxygen and food molecules are rearranged in order to transfer the energy needed to sustain life's processes. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Food molecules from the corn contain energy, which is transferred to the animal's cells in the presence of oxygen. This energy sustains the animal's life processes, such as maintaining body temperature. This process releases energy as the matter is rearranged, when existing carbon bonds are broken and new bonds are formed, but matter and energy are neither created nor destroyed.

40. 1F. *Levels 1, 2, 3, 4, and 5* is correct because it depicts the role of decomposers at each trophic level, in which they process large amounts of organic material, return nutrients to the ecosystem in inorganic form, and release energy mostly as heat.

2G. *More than* is correct because decomposers utilize energy from every level of the tropic energy pyramid.

41. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain the benefit of producing glucose from amino acids (DCI); and explain why carbon-14 in glycogen would be used to measure gluconeogenesis (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the benefit of producing glucose from amino acids</p> <p>Part 1: One point is earned for explaining that, when food supplies are low, organisms can rearrange the atoms present in amino acids and fats to create glucose. The following answer, or an equivalent, is acceptable:</p> <ul style="list-style-type: none"> If food is in short supply, animals need to create their own glucose, which they can do from the atoms present in amino acids and fats. <p>1 point for correctly explaining why carbon-14 glycogen would be used to measure gluconeogenesis</p> <p>Part 2: One point is earned for explaining that researchers can measure the amount of carbon-14 present in liver glycogen to evaluate the rate of glucose production because if the liver is producing glycogen that contains carbon-14, that must come from glucose, which could only come from the amino acids. The following answer, or an equivalent, is acceptable:</p> <ul style="list-style-type: none"> The carbon-14 was initially only present in the amino acids added to the liver samples. The presence of carbon-14 in glycogen would mean that the liver cells used the carbon supply in the amino acids to create glucose.

42. A. *Recovery in the sea lion population* belongs in the *Stabilize Ecosystem* column because this would help stabilize the ecosystem by relieving the predation on sea otters by killer whales.
- B. *Increase in the killer whale population* belongs in the *Destabilize Ecosystem* column because this would further destabilize the ecosystem by increasing predation on sea otters.
- C. *Introduction of a parasite that kills sea urchins* belongs in the *Stabilize Ecosystem* column because the introduction of a parasite that kills sea urchins would help stabilize the ecosystem by protecting the kelp forests.

- D. *Introduction of another predator that eats sea otters* belongs in the *Destabilize Ecosystem* column because this would further destabilize the ecosystem by increasing the sea urchin population.
- E. *Change in water temperature that increases kelp growth rate* belongs in the *Stabilize Ecosystem* column because this would help stabilize the ecosystem by enabling the kelp forests to grow in spite of a greater sea urchin population.
43. 1A. *Increased* is correct because the number of palm seedlings present, after the peccary herds were gone, increased from 124 to 210.
- 2D. *Did eat palm seeds* is correct because the peccary is known to eat seeds, and the presence of the peccary herds decreased the number of palm seedlings.
- 3G. *120* is correct because the return of the herds is likely to have once again reduced the number of palm seedlings but is not likely to have caused the tree's extinction.
44. A. Selecting *causes release of insulin* is correct for *blood glucose too high* because high blood sugar causes the pancreas to release insulin into the bloodstream.
- B. Selecting *causes release of glucagon* is correct for *blood glucose too low* because low blood sugar leads to the release of glucagon, which causes glucose to be released into the blood.
- C. Selecting *caused by release of insulin* is correct for *glucose converted into glycogen* because insulin stimulates glycogen formation.
- D. Selecting *caused by release of glucagon* is correct for *glycogen converted into glucose* because glucagon causes glycogen to be broken down to release glucose.
45. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI Only - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. use data from tables and graphs to make hypotheses about factors affecting a population's carrying capacity (DCI); and 2. identify which factors increased and decreased based on data (DCI); and 3. explain how data regarding limiting factors within a population can be interpreted (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly hypothesizing regarding factors that determine carrying capacity</p> <p>Part 1: One point is earned for hypothesizing which limiting factors are most important in sea otter populations and defending the choice of those factors. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Based on the figure, the most important cause of death is shark bites. Also important are bacterial and protozoan infections, and slightly less important are intestinal parasites. Because these factors cause the highest percentage of deaths, they represent the most important limiting factors. <p>1 point for correctly identifying two causes of death that increased and two that decreased</p> <p>Part 2: One point is earned for identifying two causes of death that increased from 2000 to 2006 and two causes that decreased. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Causes of death that increased from 2000 to 2006 are bacterial infections, starvation/emaciation, intestinal parasites, and shark bites (any two of these are correct). Causes of death that decreased are human-caused deaths, algal toxins, and mating trauma (any two of these are correct). <p>1 point for correctly explaining why decreased percentages may not indicate lowered total numbers</p> <p>Part 3: One point is earned for explaining why decreased percentages may not mean decreased total numbers of sea otters killed. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The total number of animals autopsied in 2006 was twice the number autopsied in 2000. Ten percent of 23 animals is 2.3, and 10 percent of 52 animals is 5.2. Thus, even if the percentage declined, this does not mean the total number of sea otters killed decreased.

46. A. *Scenario A* belongs under the third column *Does Not Affect the Value of K* because while a disease killing several polar bears would temporarily reduce the population, it would not affect carrying capacity.
- B. *Scenario B* belongs under the second column *Decrease the Value of K* because the amount of sea ice decreases and polar bears need sea ice to hunt seals.
- C. *Scenario C* belongs under the first column *Increases the Value of K* because a decrease in killer whales leads to more seals, which increases K.
- D. *Scenario D* belongs under the first column *Increases the Value of K* because an increase in fish that the seals eat leads to more seals, which increases K.
47. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI, CCC - 3 Points	
Claims	The student is able to: 1. identify and then describe the internal changes that occur when a biological system begins to destabilize (DCI); and 2. explain how a biological system can detect changes that can disrupt homeostasis (CCC); and 3. describe a feedback mechanism for restabilizing the system and maintaining homeostasis (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing how internal factors change when a biological system destabilizes Part 1: One point is earned for identifying and describing the factors that change when a human body becomes dehydrated. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Internal body fluids, such as blood, interstitial fluids, and intracellular fluids, lose volume and become more concentrated.
Evidence of Mastery of Crosscutting Concepts	1 point for correctly explaining how a biological system responds to destabilization Part 2: One point is earned for explaining that the body must have some means of detecting the changes. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The body must have sensors for detecting changes in blood concentration and volume. 1 point for describing a feedback mechanism used to maintain homeostasis Part 3: One point is earned for describing the role of the kidneys and explaining how antidiuretic hormone must influence them. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The kidneys produce urine, which is a major route of water loss from the body. Antidiuretic hormone must influence the kidneys in such a way that they reduce the water content of the urine they produce, resulting in more water left inside the body.

48. A. 12 is not an answer, as it is the percent of the energy that is used to form biomass.
- B. 60 belongs in the second blank, because it is 12 percent of 500, which is the amount of energy that is used to form biomass each week.
- C. 88 does not belong in a blank, as it is the percent of energy that is lost.
- D. 440 belongs in the third blank, because it is 88 percent of 500, which is the amount of energy that is lost per week.
- E. 500 belongs in the first blank, because it is the number of kcal that is consumed by the organism each week.
49. A. *Trout competitor was introduced* is correct for *Time C* because the introduction of a competitive species would cause the trout population to decrease.
- B. *Fishing restrictions were put in place* is correct for *Time A* because restrictions would cause the population of the trout to increase.
- C. *Trout population reached carrying capacity* is correct for *Time B* because at this point the trout were at their carrying capacity according to the information in the stem.

50. A. Decrease belongs with Erosion causes vernal ponds to drain into rivers and Leopard frogs, which compete with wood frogs for food, are introduced to the ecosystem. Both would decrease the carrying capacity of wood frogs because fewer ponds means less space to lay eggs, and more competition reduces resources available to the frogs.
- B. Increase belongs with *Heavier-than-usual rainfall occurs in the forest*. This would increase the carrying capacity because the rainfall would increase the size of ponds to lay eggs.
- C. No effect belongs with *Disease temporarily reduces the spotted turtle population*. While this would affect the wood frog population, it would have no effect on the carrying capacity for the independent wood frog population.

Middle-of-Year Test B

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-2, DCI.HS-LS1.A.3	1
2	HS-LS2-6, DCI.HS-LS2.C.1	1
3	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	2
4	HS-LS1-5, DCI.HS-LS1.C.1, SEP.HS.B.1	2
5	HS-LS2-5, DCI.HS-LS2.B.3	2
6	HS-LS2-5, DCI.HS-LS2.B.3	2
7	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	2
8	HS-LS1-7, DCI.HS-LS1.C.4, CCC.HS.E.3	2
9	HS-LS1-5, DCI.HS-LS1.C.1, SEP.HS.B.1	2
10	HS-LS1-7, DCI.HS-LS1.C.4, CCC.HS.E.3	2
11	HS-LS2-5, DCI.HS-LS2.B.3, CCC.HS.D.2	2
12	HS-LS1-3, DCI.HS-LS1.A.4	2
13	HS-LS1-6, DCI.HS-LS1.C.2, CCC.HS.E.2	2
14	HS-ETS1-3, DCI.HS-ETS1.B.1, SEP.HS.F.4	2
15	HS-LS2-5, DCI.HS-LS2.B.3, SEP.HS.B.1	2
16	HS-LS2-3, DCI.HS-LS2.B.1, CCC.HS.E.4	2
17	HS-LS1-6, DCI.HS-LS1.C.2	2
18	HS-LS2-3, DCI.HS-LS2.B.1, SEP.HS.F.1	3
19	HS-LS1-3, DCI.HS-LS1.A.4, SEP.NOS.HS.A.3	2
20	HS-LS2-1, DCI.HS-LS2.A.1, SEP.HS.E.2	2
21	HS-LS2-1, DCI.HS-LS2.A.1, CCC.HS.C.1	3
22	HS-LS1-7, DCI.HS-LS1.C.3	2
23	HS-LS1-2, DCI.HS-LS1.A.3	2
24	HS-LS1-2, DCI.HS-LS1.A.3, SEP.HS.B.1	3
25	HS-LS2-3, DCI.HS-LS2.B.1, CCC.HS.E.4	2
26	HS-LS2-3, DCI.HS-LS2.B.1, SEP.HS.C.1	2
27	HS-LS2-3, DCI.HS-LS2.B.1	1
28	HS-LS2-4, DCI.HS-LS2.B.2	2
29	HS-ETS1-1, DCI.HS-ETS1.A.2	2

30	HS-LS2-3, DCI.HS-LS2.B.1	2
31	HS-LS2-3, DCI.HS-LS2.B.1	3
32	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.E.2	2
33	HS-ETS1-1, DCI.HS-ETS1.A.2, CCC.STSE.HS.B.3	2
34	HS-LS2-6, DCI.HS-LS2.C.1, SEP.NOS.HS.C.2	2
35	HS-LS1-5, DCI.HS-LS1.C.1, CCC.HS.E.2	3
36	HS-LS1-6, DCI.HS-LS1.C.2, SEP.HS.F.1	3
37	HS-LS2-5, DCI.HS-LS2.B.3, CCC.HS.D.2	3
38	HS-LS1-7, DCI.HS-LS1.C.4	3
39	HS-LS1-7, DCI.HS-LS1.C.4, SEP.HS.B.1, CCC.HS.E.3	3
40	HS-LS2-4, DCI.HS-LS2.B.2	3
41	HS-LS1-6, DCI.HS-LS1.C.3	3
42	HS-LS2-6, DCI.HS-LS2.C.1, CCC.HS.G.1	2
43	HS-LS2-2, DCI.HS-LS2.C.1	2
44	HS-LS1-2, DCI.HS-LS1.A.3, CCC.HS.D.2	3
45	HS-LS2-2, DCI.HS-LS2.A.1	3
46	HS-LS2-2, DCI.HS-LS2.A.1, SEP.HS.E.2	3
47	HS-LS1-3, DCI.HS-LS1.A.4, CCC.HS.G.3	3
48	HS-LS2-4, DCI.HS-LS2.B.2, SEP.HS.E.2, CCC.HS.D.2	3
49	HS-LS2-1, DCI.HS-LS2.A.1	3
50	HS-LS2-2, DCI.HS-LS2.A.1, CCC.HS.C.2	3

- This is incorrect because villi are not organs. They are structures made up of several kinds of tissue, including epithelial tissue made up of the cells that contain microvilli. The small intestine is an organ, which is one component of an organ system.
 - This is correct because microvilli are structures on the cells that make up the epithelial tissue that lines villi, which are structures of the small intestine, an organ that is part of the digestive system.
 - This is incorrect because microvilli are not organs. They are structures on the cells that make up the epithelial tissue that lines the villi. Villi are not cells but are made up of multiple tissues.
- Fire-heated seeds germinate* belongs with *Helps Ecosystem Return* as this will result in new plant and tree growth, which is essential for rebuilding the forest.
 - Erosion on slopes increases* belongs with *Does Not Help Ecosystem Return* as erosion of soil from newly denuded slopes will cause loss of nutrients and water. It will work against the regeneration of the forest.
 - Minerals are released from organic matter* belongs with *Helps Ecosystem Return* because the release of minerals will provide food for newly germinating plants, causing faster regrowth of vegetation.
- This is incorrect because the patient's blood sugar does fall back to normal when it gets too high.
 - This is incorrect because if the patient's liver were not responding to insulin, his blood sugar would not fall when it was high.
 - This is correct because the liver needs to respond to glucagon to add sugar to the blood.
- This is correct because the sun's energy is stored as chemical bonds in the high-energy sugar molecule.
 - This is incorrect because sugar is formed, not broken down, during photosynthesis. Sunlight energy is not stored in the oxygen gas.

- C. This is incorrect because the sun's energy is not stored in the oxygen gas.
5. A. This is correct because much of the carbon dioxide released by these plants will be dissolved in the surrounding ocean water.
 B. This is incorrect because this process moves carbon from the atmosphere into plant tissues in the biosphere.
 C. This is incorrect because this process moves carbon from animal and plant tissues in the biosphere into the atmosphere.
6. 1B. The correct value is 120, obtained by adding the values for plant respiration (60) and microbial respiration and decomposition (60).
 2E. The correct response is *biosphere*, because carbon dioxide from land-based cellular respiration results from plant respiration and microbial respiration.
7. The events that led up to the contraction of a muscle begin with an electrochemical signal for voluntary muscle contraction that starts in the brain and travels through nerve fibers toward muscles. When the electrochemical signal reaches the nerve cells at neuromuscular junctions, chemicals called neurotransmitters are released to deliver the signal to the muscle cells. Muscle cells then contract.
8. A. This is incorrect because energy cannot be created or destroyed.
 B. This is incorrect because photosynthesis is the process powered by sunlight; cellular respiration is not.
 C. This is correct because enzymes lower the activation energies of the reactions they catalyze.
9. 1B. *Carbon dioxide* is correct because carbon dioxide is a reactant in the photosynthesis reaction.
 2F. *About 15,000* is correct because 2,500 excited chlorophyll molecules correspond to one molecule of oxygen gas. Six molecules of oxygen gas are produced alongside the production of one molecule of glucose; therefore, for each molecule of glucose produced, 15,000 chlorophyll molecules must be excited.
10. The first step in the transfer of energy from the sun to living organisms occurs when energy from sunlight is absorbed by chloroplasts in the cells of photosynthetic organisms. That energy is stored in the form of glucose. The energy stored in the glucose molecule is released when glucose is broken down into pyruvate. The energy released by the breakdown of glucose is stored in the form of ATP.
11. A. This is incorrect because arrow 6 represents the burning of fossil fuels, which returns carbon dioxide to the atmosphere by a process other than respiration.
 B. This is correct because arrow 1 represents plants taking carbon dioxide from the atmosphere for photosynthesis, and arrows 2 and 4 show the return of carbon dioxide to the atmosphere by respiration of plants and animals, respectively.
 C. This is incorrect because arrow 2 represents plant respiration, not photosynthesis, and arrow 5 represents storage of carbon in fossil fuels, not respiration.
12. A. This is correct because the model shows a negative feedback system in which the increase of one hormone discourages the production of other hormones.
 B. This is incorrect because the model shows a negative feedback system in which the increase of one hormone discourages, rather than encourages, the production of other hormones.
 C. This is incorrect because the model shows a negative, not a positive, feedback system.
13. 1A. *Glucose* is correct because glucose is the energy storage molecule that can be used for other purposes when energy is in excess.
 2B. *Alanine* is correct because it is the amino acid indicated in the diagram.
 3C. *Less* is correct because in times of starvation, the body would make this conversion only to gain usable energy.

14. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. identify a relevant question designed to begin the process of developing a practical solution in a specific real-world context based on conservation vs. development of a particular type of habitat (DCI); and 2. describe a reasonable tradeoff or compromise relevant to a particular situation based on scientific knowledge and prioritized criteria (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying relevant question related to researching a solution Part 1: One point is earned for identifying one question the city planners should ask as they prepare to make a decision about whether to develop or preserve the wetland area. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Are there other areas where the houses could be built and not destroy as much vulnerable habitat?
Evidence of Mastery of Science and Engineering Practices	1 point for correctly showing understanding of the tradeoffs or potential compromises inherent in developing and refining solutions for complex real-world problems Part 2: One point is earned for describing one reasonable compromise the city planners could consider related to the preservation or development of the wetland. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Reasonable tradeoffs/compromises related to developing/preserving the wetland include developing the less vulnerable portion of the area and leaving the rest as habitat.

15. A. *Dead organisms* is correct for *adds carbon to the soil* because some carbon from the decaying organisms stays in the soil making the soil more fertile.
 B. *Photosynthesis* matches *removes carbon from the atmosphere* because this process uses carbon dioxide gas to build sugar molecules.
 C. *Animal respiration* matches *adds carbon to the atmosphere* because this process releases carbon dioxide gas as a waste product.
16. A. *Requires oxygen* belongs in the *Aerobic Respiration* column because only aerobic respiration uses oxygen to produce ATP.
 B. *Produces more ATP* belongs in the *Aerobic Respiration* column because aerobic respiration is able to use oxygen to produce more ATP than anaerobic respiration.
 C. *May produce lactic acid* belongs in the *Anaerobic Respiration* column because lactic acid fermentation, one type of anaerobic respiration, results in the production of lactic acid.
 D. *Does not require oxygen* belongs in the *Anaerobic Respiration* column because anaerobic respiration produces a little energy without using oxygen.
17. A. *Carbon* belongs under *Obtained from Carbohydrates* because sugars contain the element carbon.
 B. *Energy* belongs under *Obtained from Carbohydrates* because sugars are used to produce ATP, the energy of cells.
 C. *Oxygen* belongs under *Obtained from Carbohydrates* because sugars contain the element oxygen.
 D. *Nitrogen* belongs under *Not Obtained from Carbohydrates* because sugars, unlike amino acids, do not contain the element nitrogen.
18. A. This is correct because the data show a continued decrease in pH (increase in acidity), which is correlated with a significant decline in coral growth rates.
 B. This is incorrect because, according to the data, the pH changes are not small. The projected pH change between 1865 and 2050 is 0.24, which correlates to a significant decrease in growth rates of corals.

- C. This is incorrect because the basic energy source for most ecosystems is sunlight, which drives photosynthesis. This source will not change, certainly not over a few decades. The laws that describe the natural world will operate in the future as they do today.
19. A. This is incorrect because the wide variation within groups and the small difference in the means suggest that there is no significant difference in body temperature recovery time between the two groups.
- B. This is incorrect because the lower mean recovery times for the cyclists would not support a claim that nonathletes are better at recovering from exercise.
- C. This is correct because the high variability within groups and the small difference in the mean body temperature recovery times for the two groups indicate that this is not a reliable difference, but the larger difference in mean heart rate recovery times suggests that there is a real difference between the two groups.
20. A. This is incorrect because if emigration is greater than the sum of birth and immigration, the rate will definitely be negative.
- B. This is correct because if the birth rate is greater than the sum of the death rate and the emigration rate, then no immigration is required to ensure that the growth rate is positive.
- C. This is incorrect because this inequality provides no valuable information in determining whether the growth rate is negative or positive.
- D. This is correct because if immigration exceeds the sum of death and emigration, then the growth rate would be positive even if there were no births.
- E. This is incorrect because emigration rate, not birth rate, should be subtracted from immigration for this inequality to ensure positive growth rate.
21. A. This is incorrect because the growth of the elephant population does not measure carrying capacity. They could be overshooting their carrying capacity and/or depleting ecosystem resources for the elephant population and other members of the community.
- B. This is incorrect because maintaining the elephant population by hunting is not a measure of what the carrying capacity should be. The measure should involve analysis of how well resources in the ecosystem are maintained.
- C. This is correct because the rapid and almost complete decline of canopy trees indicates that elephant populations, even when limited to 7,000 in the park, are seriously damaging this resource that the elephants and other community members depend on.
22. A. *High-energy bonds form between phosphate groups* is correct because high-energy bonds in the reactants of cellular respiration are broken to be reformed into low-energy bonds, while the difference is released to be used to attach phosphate to adenosine diphosphate.
- B. *High-energy carbon-carbon bonds are broken in glucose* is correct because the carbon-carbon, carbon-hydrogen, and carbon-hydroxide bonds of the reactants of cellular respiration are broken to be reformed into low-energy bonds in the products with the difference released and used to make ATP.
- C. *Energy is released each time phosphate attaches to adenosine* is incorrect because energy is released from high-energy bonds into lower-energy bonds, with the difference being used to attach phosphate to adenosine diphosphate to make ATP. Later, energy can be released by breaking off a phosphate from ATP.
- D. *Low-energy carbon-carbon bonds are broken in carbon dioxide* is incorrect because the low-energy carbon-carbon bonds found in carbon dioxide are formed as products of cellular respiration, rather than broken as reactants of cellular respiration.
- E. *Low-energy carbon-oxygen bonds are formed to make carbon dioxide* is correct because low-energy bonds are formed in the products of cellular respiration, which allows the difference in energy to be released and used to attach a phosphate to adenosine diphosphate to make ATP.

23. The correct order is rods and cones, bipolar cells, ganglion cells and then optic nerve. Rods and cones are the light-receptor, or photoreceptor, cells. Although they are at the back of the retina, they must be stimulated first before the eye receives light. The light then enters a series of modified neural cells—in order, the bipolar and ganglion cells—that transform the light into electrical signals. Axons of the ganglion cells collect to form the optic nerve, which sends visual information (as electricity) to the brain. Thus, light stimulates the farthest cells (rods and cones) first and then travels backward to the ganglion cells and optic nerve.
24. A. This answer is incorrect because it would not increase understanding of immune function and would not show interaction between cells and tissues.
 B. This answer is incorrect because it would not increase understanding of immune function and would not show interaction between cells and tissues.
 C. This answer is correct because some memory T cells do attach to the dermis and play a role in initiating immune functions.
25. A. An increase in the rate of cellular respiration will increase the amount of carbon dioxide released into the atmosphere is True because cellular respiration produces carbon dioxide.
 B. *An increase in the rate of cellular respiration will increase the amount of glucose available to organisms throughout the food chain* is False because glucose is produced from photosynthesis and not cellular respiration.
 C. *A reduction in the amount of oxygen available for cellular respiration will decrease the amount of energy available to an organism to carry out life processes* is True because oxygen is needed to produce large amounts of ATP during cellular respiration.
26. 1A. *The control group* is correct because it was the only group with unexpected results.
 2D. *More respiration* is correct because the control group would not be expected to show any respiration.
27. 1C. *Carbon dioxide* is correct for the first blank because sunlight, carbon dioxide from the air, and water are used as the reactants in photosynthesis.
 2A. *Water* is correct for the second blank because sunlight, carbon dioxide from the air, and water are used as the reactants in photosynthesis.
 3B. *Oxygen* is correct for the third blank because the products of photosynthesis are oxygen and sugars.
 4D. *Carbohydrates* is correct for the fourth blank and the sixth blank because glucose is a carbohydrate produced during photosynthesis, and carbohydrates are broken down during cellular respiration to produce energy.
 5E. *Cellular respiration* is correct for the fifth blank because carbohydrates are broken down during cellular respiration to provide energy needed for life processes.
28. A. *Most of the energy stored by corn is lost as it is transferred to chickens* is correct. Only about 10% of the energy is passed from one trophic level to the next.
 B. *The energy available to rodents is greater than the energy available to insects* is incorrect. Energy from corn is available to both rodents and insects.
 C. *Energy is lost between each trophic level as heat released through cellular respiration* is correct. Heat is released as a result of cellular respiration.
 D. *The corn is able to convert 100% of the sun's energy to usable or stored chemical energy through photosynthesis* is incorrect. Only a small amount of light energy is converted into chemical energy in photosynthesis.
29. A. *Ethanol is a renewable energy source* is a correct selection because ethanol can be renewed by growing more corn.
 B. *Ethanol is a more efficient energy source than gasoline* is incorrect selection because ethanol contains less energy than gasoline.

- C. *Ethanol production can decrease the amount of crops needed for food* is an incorrect selection because this will not affect the need for food crops.
- D. *Ethanol use can decrease greenhouse gases compared with fossil fuel energy sources* is a correct selection because ethanol has lower carbon dioxide emissions than gasoline does.
30. A. This is incorrect because water and sunlight combine with carbon dioxide to produce oxygen and glucose in photosynthesis.
- B. This is correct because the products of photosynthesis—glucose and oxygen—are used in cellular respiration to provide energy for life processes.
- C. This is incorrect because this option includes both the products and reactants of photosynthesis.
31. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain the role of photosynthesis and respiration in the movement of matter and energy (DCI); and 2. explain the differences between the movement of matter and energy in the ecosystem (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the role of the processes in the movement of energy and matter</p> <p>Part 1: One point is earned for explaining the role of photosynthesis and respiration in the movement of matter and energy in the ecosystem. The following response, or an equivalent is acceptable.</p> <ul style="list-style-type: none"> • Photosynthesis causes the production of carbohydrates, which contain stored energy. When animals consume the sugars, both the energy and the matter are moved to them. When the animal's cells carry out cellular respiration, the stored energy is released and the carbohydrates are broken down into simpler molecules. These molecules, once released by the animals, can again be used to form carbohydrates by plants. <p>1 point for explaining the differences between the movement of matter and energy</p> <p>Part 2: One point is earned for explaining how the movement of matter and energy through the ecosystem differ. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Unlike energy, the matter in an ecosystem is largely cycled within the ecosystem. The plant matter that is consumed by an animal will likely be used again in the future by a plant. However, energy in the ecosystem must be constantly supplied by the sun; it cannot be recycled endlessly into useful forms.

32. A. *Human* is correct for *Level 3* because humans have the least energy available to them.
- B. *Corn* is correct for *Level 1* because the corn has the most energy available to it.
- C. *Chicken* is correct for *Level 2* because the chickens have more energy than the humans available to them, but less than the corn.
33. A. *Biomass is a more renewable source of energy than coal* is a *benefit* because the ability to renew an energy source is greatly advantageous.
- B. *Farmers might replace crops for food production with crops for energy production* is a *risk* because other areas will need to be cleared for food production. In addition, food may cost more if energy production results in use of food crops for energy production.
- C. *Producing electricity from biomass could reduce the amount of land needed to dispose of waste in landfills* is a *benefit* because if biomass such as urban waste is used for energy production, it will be burned instead of put in landfills.

34. A. *The average winter temperature on the islands has increased by 5°F since 1961* is correct because this shows a trend toward warmer winters, although it does not provide evidence of the effect of climate change on the reindeer population.
- B. *Reindeer reproduction rates in 2012 were less than half of what they were in 2002* is correct because, combined with temperature data, this provides evidence that the population of reindeer is being affected.
- C. *The frequency of warm winters has increased by more than 100% during the past 40 years* is correct because a trend toward warmer winters combined with lower survival and reproductive rates for the reindeer in years with warm winters provide strong evidence that climate change is threatening the species.
- D. *The estimated reindeer population has ranged from 1,000 to 10,000 during the past 40 years* is incorrect because this does not describe a clear population trend.

35. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 2 Points	
Claims	The student is able to: <ol style="list-style-type: none"> 1. explain how matter and energy interact during the light-gathering phase of photosynthesis (DCI); and 2. identify how the matter within key molecules in photosynthesis influences how energy flows through them (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining how matter and energy interact during the light-gathering phase of photosynthesis</p> <p>Part 1: One point is earned for explaining that the two types of chlorophyll absorb light at slightly different wavelengths and thus maximize energy absorption. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Chlorophyll <i>a</i> absorbs light maximally at 450 nm and close to 700 nm. Chlorophyll <i>b</i> absorbs light maximally at 500 nm and 650 nm. Using both chlorophyll types allows the photosynthetic organism to absorb energy from that entire range of wavelengths and thus gather more energy per unit time.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly identifying the role of wavelengths of light on the cycling of matter</p> <p>Part 2: One point is earned for identifying the plant through which more matter would be expected to be cycled and explaining why. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The plant exposed to 450 nm light would have more matter cycling through it. The plant would have more carbon cycling through it because it would absorb more light by its chlorophyll, which would result in more carbon dioxide and water being converted into sugar.

36. A. This statement is incorrect because other radioactive elements would not have any bearing on the amount of radioactive carbon the plant incorporated during the experiment.
- B. This statement is correct because it explains why the scientist found radioactive carbon in the plant's sugar molecules.
- C. This statement is correct because it explains why the scientist found radioactive carbon in some of the plant's cellulose and proteins.
- D. This statement is incorrect because the half-life of carbon-14 does not help explain the findings of the scientist.

37. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. describe the roles of photosynthesis and cellular respiration in the cycling of carbon (DCI); and 2. explain how change to one component of a model would change other components (CCC); and 3. use a model of the carbon cycle to describe relationships between components of the model (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the role of photosynthesis and cellular respiration in the carbon cycle</p> <p>Part 1: One point is earned for describing the relationship between plants and animals in the processes of photosynthesis and cellular respiration. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Plants carry out photosynthesis, in which atmospheric carbon is converted into chemical energy in the form of a complex carbohydrate. That energy flows through trophic levels in an ecosystem when animals consume plants and other animals. Animals carry out cellular respiration. Carbohydrates are converted into usable energy, and carbon dioxide is released into the atmosphere as a waste product.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining impacts of change in the carbon cycle</p> <p>Part 2: Two points are earned for using the model to describe how the removal of trees could impact the biosphere, such as by decreasing the amount of carbon that is stored as wood. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The removal of trees would lead to less CO₂ cycling out of the atmosphere, which would lead to increased greenhouse effects. <p>1 point for correctly describing movement of carbon within a cycle</p> <p>Part 3: One point is earned for using the model to explain how carbon travels from the atmosphere to fossil fuels. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Plants incorporate atmospheric carbon into their biomass via photosynthesis. This carbon becomes incorporated into animals as they consume plants and then each other. As the animals die, their bodies decompose, and the carbon in their bodies can eventually become part of the soil or sediment. Over time, sediment rich in carbon can become compressed to form fossil fuels.

38. **A.** *Temperature of the chamber would increase* because heat is given off during respiration.

B. *Amount of oxygen gas in the chamber would decrease* because it would be consumed during respiration.

C. *Amount of carbon dioxide in the chamber would increase* because it would be created during respiration.

39. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP, CCC - 3 points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain the transfer of energy and matter involved in cellular respiration (DCI); and 2. use a model to describe the inputs and outputs of cellular respiration (SEP); and 3. explain the flow of matter between photosynthesis and cellular respiration (CCC).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the transfer of energy and matter in cellular respiration</p> <p>Part 2: One point is earned for explaining that the breaking and formation of bonds results in the energy used to make ATP. The process of cellular respiration is a chemical process in which the bonds of food and oxygen molecules are broken down and new compounds (ATP) are formed that can transport energy. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> During cellular respiration, bonds in glucose are broken and different bonds are formed in ATP.
Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly using the model to describe the inputs and outputs of cellular respiration</p> <p>Part 1: One point is earned for describing the inputs and outputs of the process shown in Steps 3 and 4, which are cellular respiration, and for describing the relationship between the inputs and outputs. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Cellular respiration is shown in Steps 3 and 4 of the model. The inputs are sugar and oxygen. The sugar is obtained from the plant. The outputs are carbon dioxide, water, and stored energy in the form of ATP.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for correctly explaining the flow of matter between the corn, environment, and cow in cellular respiration</p> <p>Part 3: One point is earned for explaining how oxygen and food molecules are rearranged in order to transfer the energy needed to sustain life's processes. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Food molecules from the corn contain energy, which is transferred to the animal's cells in the presence of oxygen. This energy sustains the animal's life processes, such as maintaining body temperature. This process releases energy as the matter is rearranged, when existing carbon bonds are broken and new bonds are formed, but matter and energy are neither created nor destroyed.

40. 1E. *Levels 1, 2, 3, 4, and 5* is correct because it depicts the role of decomposers at each trophic level, in which they process large amounts of organic material, return nutrients to the ecosystem in inorganic form, and release energy mostly as heat.

2G. *More than* is correct because decomposers utilize energy from every level of the trophic energy pyramid.

41. Use the rubric below to evaluate total points earned for this item. [max point: 2]

DCI Only - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain the benefit of producing glucose from amino acids (DCI); and explain why carbon-14 in glycogen would be used to measure glucose production (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining the benefit of producing glucose from amino acids</p> <p>Part 1: One point is earned for explaining that, when food supplies are low, organisms can rearrange the atoms present in amino acids and fats to create glucose. The following answer, or an equivalent, is acceptable:</p> <ul style="list-style-type: none"> If food is in short supply, animals need to create their own glucose, which they can do from the atoms present in amino acids and fats. <p>1 point for correctly explaining why carbon-14 glycogen would be used to measure glucose production</p> <p>Part 2: One point is earned for explaining that researchers can measure the amount of carbon-14 present in liver glycogen to evaluate the rate of glucose production because if the liver is producing glycogen that contains carbon-14, that must come from glucose, which could only come from the amino acids. The following answer, or an equivalent, is acceptable:</p> <ul style="list-style-type: none"> The carbon-14 was initially only present in the amino acids added to the liver samples. The presence of carbon-14 in glycogen would mean that the liver cells used the carbon supply in the amino acids to create glucose.

42. A. *Increase in the killer whale population* belongs in the *Destabilize Ecosystem* column because this would further destabilize the ecosystem by increasing predation on sea otters.
- B. *Introduction of a parasite that kills sea urchins* belongs in the *Stabilize Ecosystem* column because the introduction of a parasite that kills sea urchins would help stabilize the ecosystem by protecting the kelp forests.
- C. *Introduction of another predator that eats sea otters* belongs in the *Destabilize Ecosystem* column because this would further destabilize the ecosystem by increasing the sea urchin population.
- D. *Change in water temperature that increases kelp growth rate* belongs in the *Stabilize Ecosystem* column because this would help stabilize the ecosystem by enabling the kelp forests to grow in spite of a greater sea urchin population.
43. 1A. *Increased* is correct because the number of palm seedlings present, after the peccary herds were gone, increased from 124 to 210.
- 2D. *Did eat palm seeds* is correct because the peccary is known to eat seeds, and the presence of the peccary herds decreased the number of palm seedlings.
44. A. *Causes release of insulin* is correct for *blood glucose too high* because high blood sugar causes the pancreas to release insulin into the bloodstream.
- B. *Causes release of glucagon* is correct for *blood glucose too low* because low blood sugar leads to the release of glucagon, which causes glucose to be released into the blood.
- C. *Caused by release of glucagon* is correct for *glycogen converted into glucose* because glucagon causes glycogen to be broken down to release glucose.
45. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI Only - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. use data from tables and graphs to make hypotheses about factors affecting a population's carrying capacity (DCI); and 2. identify which factors increased and decreased based on data (DCI); and 3. explain how data regarding limiting factors within a population can be interpreted (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly hypothesizing regarding factors that determine carrying capacity</p> <p>Part 1: One point is earned for hypothesizing which limiting factors are most important in sea otter populations and defending the choice of those factors. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Based on the figure, the most important cause of death is shark bites. Also important are bacterial and protozoan infections, and slightly less important are intestinal parasites. Because these factors cause the highest percentage of deaths, they represent the most important limiting factors.
	<p>1 point for correctly identifying two causes of death that increased and two that decreased</p> <p>Part 2: One point is earned for identifying one cause of death that increased from 2000 to 2006, such as are bacterial infections, starvation/emaciation, intestinal parasites, and shark bites, and one cause that decreased, such as human-caused deaths, algal toxins, and mating trauma. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> A cause of death that increased from 2000 to 2006 was bacterial infections, and a cause of death that decreased was mating trauma.
	<p>1 point for correctly explaining why decreased percentages may not indicate lowered total numbers</p> <p>Part 3: One point is earned for explaining why decreased percentages may not mean decreased total numbers of sea otters killed. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The total number of animals autopsied in 2006 was twice the number autopsied in 2000. Ten percent of 23 animals is 2.3, and 10 percent of 52 animals is 5.2. Thus, even if the percentage declined, this does not mean the total number of sea otters killed decreased.

46. A. *Scenario A* belongs under the third column *Does Not Affect the Value of K* because while a disease killing several polar bears would temporarily reduce the population, it would not affect carrying capacity.
- B. *Scenario B* belongs under the second column *Decreases the Value of K* because the amount of sea ice decreases and polar bears need sea ice to hunt seals.
- C. *Scenario C* belongs under the first column *Increases the Value of K* because a decrease in killer whales leads to more seals, which increases K.

47. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> identify and then describe the internal changes that occur when a biological system begins to destabilize (DCI); and explain how a biological system must implement a feedback mechanism for restabilizing the system and maintaining homeostasis (CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing how internal factors change when a biological system destabilizes</p> <p>Part 1: One point is earned for identifying and describing the factors that change when a human body becomes dehydrated. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Internal body fluids, such as blood, interstitial fluids, and intracellular fluids, lose volume and become more concentrated.
Evidence of Mastery of Crosscutting Concepts	<p>2 points for correctly explaining how a biological system responds to destabilization and uses a feedback mechanism to maintain homeostasis</p> <p>Part 2: Two points are earned for explaining that the body must have some means of detecting the changes. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The body must have sensors for detecting changes in blood concentration and volume.

48. A. 60 belongs in the second blank, because it is 12 percent of 500, which is the amount of energy that is used to form biomass each week.
- B. 440 belongs in the third blank, because it is 88 percent of 500, which is the amount of energy that is lost per week.
- C. 500 belongs in the first blank, because it is the number of kcal that is consumed by the organism each week.
49. A. *Trout competitor was introduced* is correct for *Time C* because the introduction of a competitive species would cause the trout population to decrease.
- B. *Fishing restrictions were put in place* is correct for *Time A* because restrictions would cause the population of the trout to increase.
- C. *Trout population reached carrying capacity* is correct for *Time B* because at this point the trout were at their carrying capacity according to the information in the stem.
50. A. *Decrease* belongs with *Erosion causes vernal ponds to drain into rivers*. It would decrease the carrying capacity of wood frogs because fewer ponds means less space to lay eggs.
- B. *Increase* belongs with *Heavier-than-usual rainfall occurs in the forest*. This would increase the carrying capacity because the rainfall would increase the size of ponds to lay eggs.
- C. *No effect* belongs with *Disease temporarily reduces the spotted turtle population*. While this would affect the wood frog population, it would have no effect on the carrying capacity for the independent wood frog population.

End-of-Year Test A

Item Analysis		
Item #	Standards	DOK
1	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.2	1
2	HS-LS1-1, DCI.HS-LS1.A.2	1
3	HS-LS4-2, DCI.HS-LS4.B.1	1
4	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.1	2
5	HS-LS4-6, DCI.HS-ETS1.B.2	2
6	HS-LS2-7, DCI.HS-LS4.D.2	2
7	HS-LS4-5, DCI.HS-LS4.C.4, SEP.HS.G.1	2
8	HS-LS1-4, DCI.HS-LS1.B.1	2
9	HS-LS3-1, DCI.HS-LS1.A.2	2
10	HS-LS4-1, DCI.HS-LS4.A.1	2
11	HS-LS4-6, DCI.HS-LS4.D.2, CCC.HS.B.1	2
12	HS-LS1-1, DCI.HS-LS1.A.1	2
13	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.2	2
14	HS-LS4-4, DCI.HS-LS4.C.2	2
15	HS-LS4-1, DCI.HS-LS4.A.1, CCC.NOS.HS.A.1	2
16	HS-LS4-3, DCI.HS-LS4.C.3, SEP.HS.D.2	2
17	HS-LS2-7, DCI.HS-LS4.D.1	2
18	HS-LS4-4, DCI.HS-LS4.C.2, CCC.HS.B.1	2
19	HS-LS4-2, DCI.HS-LS4.B.1, SEP.HS.F.1	2

20	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.A.1	3
21	HS-LS2-7, DCI.HS-ETS1.B.1	2
22	HS-LS4-4, DCI.HS-LS4.C.2, SEP.HS.F.1, CCC.HS.B.1	2
23	HS-ETS1-4, DCI.HS-ETS1.B.2, SEP.HS.F.4	2
24	HS-LS2-8, DCI.HS-LS2.D.1, SEP.NOS.HS.C.2	2
25	HS-LS4-6, DCI.HS-LS4.C.4	3
26	HS-LS4-2, DCI.HS-LS4.B.1, CCC.HS.B.1	2
27	HS-LS1-4, DCI.HS-LS1.B.1	2
28	HS-LS4-4, DCI.HS-LS4.C.2, CCC.NOS.HS.A.1	2
29	HS-LS3-2, DCI.HS-LS3.B.2	3
30	HS-LS3-3, DCI.HS-LS3.B.2	3
31	HS-LS3-2, DCI.HS-LS3.B.2, SEP.HS.G.3	2
32	HS-LS3-1, DCI.HS-LS3.A.1, SEP.HS.A.1	2
33	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.B.1	2
34	HS-LS3-3, DCI.HS-LS3.B.2, CCC.HS.C.3	2
35	HS-LS4-2, DCI.HS-LS4.C.1	3
36	HS-LS2-2, DCI.HS-LS2.C.1, SEP.NOS.HS.C.1	2
37	HS-LS3-2, DCI.HS-LS3.B.1	3
38	HS-LS3-3, DCI.HS-LS3.B.2, CCC.NOS.HS.B.3	2
39	HS-LS4-6, DCI.HS-LS4.D.2, SEP.HS.E.1	3
40	HS-ETS1-4, DCI.HS-ETS1.B.2	2
41	HS-LS4-5, DCI.HS-LS4.C.5	3
42	HS-LS1-1, DCI.HS-LS1.A.1, CCC.HS.F.1	3
43	HS-LS2-8, DCI.HS-LS2.D.1, CCC.HS.B.1	3
44	HS-LS2-7, DCI.HS-LS2.C.2, CCC.HS.G.1	3
45	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.H.2	3
46	HS-LS1-1, DCI.HS-LS1.A.2	3
47	HS-LS4-4, DCI.HS-LS4.C.2, SEP.HS.F.1	3
48	HS-LS2-7, DCI.HS-LS2.C.2, SEP.HS.F.4	3
49	HS-LS2-8, DCI.HS-LS2.D.1	3
50	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.B.1	3

1.
 - A. This is incorrect because it models the meiosis process.
 - B. This is correct because the process of mitosis begins with one cell that replicates to form two identical daughter cells.
 - C. This is incorrect because it models sexual reproduction, in which two haploid cells combine to create a single diploid cell.
 - D. This is incorrect because it models polyploidy in plants, the heritable condition of possessing more than two complete sets of chromosomes.

2. The first step in the process is that DNA uncoils at the location of a gene. Then a strand of mRNA that matches the DNA is made. Next, a ribosome assembles around the mRNA. Then the first tRNA, with an amino acid attached, attaches to the mRNA start codon. After this, additional tRNAs attach to the mRNA and add amino acids to the chain. Finally, the ribosome reaches a stop codon and the protein is released.
3.
 - A. This is incorrect because genetic history is not the best predictor of whether a population is likely to undergo natural selection.
 - B. This is incorrect because population size is not the best predictor of whether a population is likely to undergo natural selection.
 - C. This is correct because genetic differences and variation in traits are the best predictors of whether a population is likely to undergo natural selection.
 - D. This is incorrect because this describes a species that is unlikely to survive a change in conditions.
4.
 - A. This statement is true because each gene contains, in its sequence, the information that determines the order of amino acids in the protein. Different sequences of amino acids produce proteins with very different structures.
 - B. This statement is true because it is the sequence of nucleotide bases on the DNA strand (gene) that determines the uniqueness of the protein. The sequence is transcribed to mRNA and used by tRNA to pull amino acids into a specific sequence based on the DNA sequence.
 - C. This statement is false because, first, two genes are used—one for each protein, and second, because transcription of one gene will always produce the same mRNA. This is guaranteed because bases on DNA are complementary to those on RNA.
 - D. This statement is false because, first, two genes are used and, second, the same 20 amino acids (in different sequences) are used to make all proteins.
5.
 - A. This is incorrect because adding fire would lead to more grass and sagebrush and fewer trees, as shown in the model and in the table comparing the landscape with fire with the landscape without fire.
 - B. This is correct because adding fire would lead to more grass and sagebrush and fewer trees, as shown in the model and in the table comparing the landscape with fire with the landscape without fire. This would improve habitat for sagebrush wildlife.
 - C. This is incorrect because adding fire would lead to more grass and sagebrush and fewer trees, which would improve wildlife habitat.
 - D. This is incorrect because, while adding fire would lead to more grass and sagebrush and fewer trees, this would improve habitat for sagebrush wildlife, so wildlife should not decline.
6.
 - A. This statement is incorrect because the colony density of the insect did not change, which means that there is no evidence to support that the insect is sensitive to the insecticide.
 - B. This statement is correct because the colony density of species B clearly decreased after the insecticide was applied.
 - C. This statement is correct because the fact that the colony density of species C decreased suggests that they are traveling for food.
 - D. This statement is incorrect because there has been no year in which the colony density of species B increased, compared with the previous year.
 - E. This statement is correct because the colony density of species C increased in the final year of the study.
 - F. This is incorrect because species B and C were affected, even though they did not live where the insecticide was applied.
7.
 - A. This statement is an incorrect selection because the feedback loop can happen without climate change and it does not support the fire feedback loop explanation for the spread of cheatgrass.
 - B. This statement is an incorrect selection because this research supports an alternative explanation for the spread of cheatgrass by grazing and does not support the fire feedback loop explanation.

- C. This statement is a correct selection because evidence for an increase in cheatgrass on recently burned sites supports the fire feedback loop explanation for the spread of cheatgrass.
 - D. This statement is a correct selection because this supports the fire feedback loop explanation for the spread of cheatgrass.
 - E. This statement is a correct selection because it provides a mechanism for the spread of cheatgrass into new areas, supporting the fire feedback loop explanation.
8. A. This statement is correct for the second illustration because mitosis involves the separation of the DNA and division of the nucleus to form two nuclei within the parent cell.
- B. This statement is correct for the fourth illustration because each daughter cell contains one complete set of DNA that is identical to the DNA of the parent cell.
- C. This statement is correct for the third d illustration because, following mitosis, the cell divides and the membrane pinches together to separate the two halves of the cell, each containing one of the new nuclei.
- D. This statement is correct for the first description because this is the stage, along with two growth stages, that must be complete before a cell can divide.
9. A. This is incorrect because tissues are made up of cells, and proteins carry out the work of cells.
- B. This is incorrect because it describes the role of RNA, not the role of DNA.
- C. This is incorrect because DNA molecules remain intact in the nucleus, and the subunits of DNA and proteins are different.
- D. This is correct because DNA contains the genetic information the cell uses to guide protein assembly.
10. A. *The ant limb* does not match with any of the options because it is an invertebrate with an outer exoskeleton not made of homologous bones, and it does not have analogous wings either.
- B. *The fly limb* correctly follows *The bat limb is analogous to* because the bat wing and the fly wing have similar functions but quite different, unrelated structures.
- C. *The human limb* correctly follows *The whale limb is homologous to* because the whale limb and the human limb have similar underlying bone arrangements, as do all related mammalian vertebrates.
- D. *Close evolutionary relationships* correctly follows *Homologous features show* because homologous structures and the close evolutionary relationships they imply indicate relatively recent shared ancestors.
- E. *Distant evolutionary relationships* does not match with any of the options because analogous structures do not show any evidence of evolutionary relationships.
- F. *No evidence of an evolutionary relationship* correctly follows *Analogous features show* because analogous features have similar functions due to similar adaptations but no ancestral relatedness.
11. A. This is correct because the primary risk of greater fishing restrictions is economic loss to commercial fisheries, while the gain is increased survival of adult turtles with fewer caught in fishing gear.
- B. This is incorrect because the primary risk of greater fishing restrictions is economic loss to commercial fisheries, and the primary impact of reducing accidental capture is increased survival of adults. Enhanced reproduction is a secondary impact of increased survival of adults.
- C. This is incorrect because the primary risk of greater fishing restrictions is economic loss, not gain, to commercial fisheries. The primary impact of reducing accidental capture is increased survival of adults. A secondary impact of increased survival of adults is higher, not lower, reproduction rates.
- D. This is incorrect because the primary impact of greater fishing restrictions is on the fishing industry, not beach development, and on the survival of adults, not hatchlings.
12. A. The art of the red blood cell belongs with *its shape allows it to move through very narrow blood vessels* because the round shape of the red blood cell allows it to be pushed through blood vessels more easily.
- B. The art of the skeletal muscle cell belongs with *its striated pattern allows it to contract and relax to produce movement* because skeletal muscle cells are specialized to contract and relax in order to move the body.

- C. The art of the intestinal epithelial cell belongs with *its large surface area allows it to absorb nutrients from digested food* because these cells are specialized to have a large surface area on the interior of the small intestine to maximize absorption of nutrients.
- D. The art of the nerve cell belongs with *its branched extensions and insulating layer of cells allow it to transmit electrochemical signals to and from other cells* because nerve cells are designed to transmit signals throughout the body by action potentials, which are generated by an ion concentration gradient.

13. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	The student is able to: 1. describe how damaged nucleotides would lead to damaged chromosomes being passed on in mitosis (or the inability of that cell to even perform mitosis) (DCI); and 2. explain the connection between damaged DNA, mitosis frequency, and cancerous cells (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the role the radiation damage could play in mitosis Part 1: One point is earned for explaining how damage done to the cell by radiation would impact mitosis. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Nucleotides that have been damaged by radiation will lead to damaged chromosomes. During mitosis, if the DNA replication has not been repaired, the damage may be so extensive that it causes mitosis to stop, or the damaged chromosomes may be passed on to the new cells.
Evidence of Mastery of Crosscutting Concepts	2 points for making the connection between nucleotides and cancerous cells Part 2: Two points are earned for explaining how damaged nucleotides cause unchecked cell growth. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Damaged nucleotides in a cell can lead to damaged chromosomes, which can lead to cells passing on damaged chromosomes during mitosis. A cell that undergoes mitosis more frequently is more likely to pass on a copy of a damaged chromosome, which could lead to a malignant growth.

14. A. This species is *not likely to survive* because a species with a low reproductive rate is less likely to leave enough offspring to survive under stressful conditions.
- B. This species is *likely to survive* because a species living deep, where temperature changes are minimal, will be less affected by rising temperatures and more likely to survive and reproduce.
- C. This species is *not likely to survive* because a species having little or no variation may lack the alleles necessary to withstand high temperatures. Populations with greater variation are more likely to have individuals that will survive and reproduce.
- D. This species is *likely to survive* because if offspring survive well in warm temperatures they will grow to adulthood and have a chance to reproduce, even when the temperature rises permanently.
- E. This species is *likely to survive* because a species used to temperature variation is adapted and able to survive under varying conditions. As the temperature rises, there will be individuals who can survive and reproduce.
15. A. This is incorrect because DNA sequences of noncoding regions are more likely to diverge over time because there is less selection pressure for them to stay the same and be evolutionarily conserved.
- B. This is correct because one would expect selection pressure to continue to conserve the important functional genes over time, with the nonconserved, noncoding regions diverging over time.
- C. This is incorrect because one would expect the sequences of important genes to stay the same over time, with the less important DNA sequences changing over time.
- D. This is incorrect because it is more likely that important gene sequences stay evolutionarily conserved and thus stay the same because of the importance of their function.

16. The correct equation for the line of best fit is $-0.3 (\text{years}) + 3.9$.

17. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. compare the biodiversity in the two areas based on the provided data (DCI); and 2. explain that human activities can contribute to species loss and decreasing biodiversity (DCI).
Evidence of Mastery of Disciplinary Core Ideas	2 points for correctly comparing the biodiversity from the two sites and explaining that human activities can contribute to the loss of biodiversity Part 1: One point is earned for using the provided data to correctly identify that the nature reserve has greater arthropod diversity than the grazing land. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The data suggest that the nature reserve has greater biodiversity of arthropods than the grazing area because 87 species were identified at the nature reserve, and only 66 species were found at the grazing land site. Part 2: One point is earned for explaining that human activities like grazing livestock can alter natural ecosystems, causing the loss or extinction of species. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Grazing may have removed grass and other small plants. It could also change the soil composition. These changes could lead to the loss of total arthropod species and decreased biodiversity.

18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	The student is able to: 1. identify an agent of selective pressure and explain the need to apply it to a population to see whether an adaptation will result (DCI); and 2. describe empirical evidence that an agent of selective pressure can cause adaptation (DCI, CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining how to apply selective pressure to a population Part 1: One point is earned for explaining how to apply selective pressure to the orchid population. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The scientist should release female wasps among the orchids while the orchids are in full bloom with males already present.
Evidence of Mastery of Crosscutting Concepts	1 point for describing the empirical evidence of selective pressure Part 2: One point is earned for describing that the scientist should see changes in reproductive success when female wasps are present. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The scientist should see a reduction in reproductive success in flowers that fully bloom while the female wasps are present and an increase in reproductive success in flowers that bloom earlier or later.

19. A. This statement is *False* because all of the bacteria in dish A died.

B. This statement is *True* because natural selection favored particular genetic variation in a few individuals that led to their survival and reproductive success over time. This is evolution by natural selection.

C. This statement is *True* because antibiotics created a selective force on the population; this drives evolution.

D. This statement is *False* because no cells, or individuals, in dish A survived the antibiotics treatment.

E. This statement is *True* because a few individuals in dish B survived the application of antibiotics, and that led to their reproductive success.

20. A. This is correct because species C and D have similar anatomies and the most similar eggshell genes as well, having only three base-pair differences.
- B. This is incorrect because the fact that the eggshell genes of species D and E are the most different suggests that their most recent common ancestor was the oldest, not the youngest.
- C. This is incorrect because evidence from anatomy alone is not as strong as evidence from anatomy and DNA together. Note that these two species have 22 base-pair differences.
- D. This is incorrect because even though species A and B have similar anatomical features, they also have 13 base-pair differences. This figure is greater than the number of such differences for some other species pairs.
21. A. This is incorrect because the global use of plankton nets would also result in the removal of plankton from all parts of the world's oceans.
- B. This is correct because recycling microplastics has the potential to reduce the amount of ocean microplastics in the long term without removing or harming plankton.
- C. This is incorrect because ocean currents would sweep plankton into the ocean cleanup array barriers right along with microplastics, so plankton would also be extracted from the oceans.
- D. This is incorrect because plant-derived bioplastics are designed to break down efficiently only in commercial composting systems, not inside marine animals.
22. 1B. *Quickly* is correct because a high reproductive rate is related to a higher rate of adaptation. These species will be able to adapt faster with shorter generation times than their competitors.
- 2C. *More likely* is correct because high rates of pollen and seed dispersal contribute to a higher reproductive rate and more chances for a species to adapt.
- 3D. *Less likely* is correct because a slower reproductive rate is related to species being unable to adapt quickly enough to changing conditions as compared with their competitors.
- 4F. *Decline and go extinct* is correct because a species that cannot adapt quickly enough is more likely to not survive and more likely to become extinct.
23. A. *Protect marine areas* belongs in the third blank because it would provide a benefit to fisheries but would not strongly affect coastal flooding.
- B. *Restore sand dunes* belongs in the first blank because it would help prevent coastal flooding but would not provide many benefits to local fisheries.
- C. *Create wetland buffers* belongs in the second blank because it would help reduce the damage of coastal flooding and would help provide benefits to local fisheries.
24. A. This statement is correct because the new evidence suggests that the alarm calls of one species may benefit other unrelated bird species.
- B. This statement is not a correct selection. Group alarm calls may allow birds to spend more time in exposed areas where there is more food available, but this does not explain why birds lose weight without the alarm calling of other bird species.
- C. This statement is correct because this is a logical explanation that could account for why birds lose weight due to spending time producing their own calls when they cannot hear the warnings of other bird calls.
- D. This statement is not a correct selection. Though it may be true that alarm calling reduces predation risk within a group, this is not supported by the new evidence.
- E. This statement is correct because the new evidence suggests that when birds can't hear other species' alarm calls, they are more likely to allocate important energy to producing their own calls.
25. A. This is incorrect because this would most likely lead to an increase in the population of periwinkle.
- B. This is incorrect because this would most likely lead to an increase in the crab population.
- C. This is incorrect because this would most likely lead to an increase in the crab population.

- D. This is correct because this change would decrease the periwinkle population, which would decrease the crab population.
26. A. *The glacier that deposited the sand retreated from Nebraska at some time during the past 10,000 years* is incorrect because it describes the time when the environment changed; it does not describe a direct cause of the change in fur color.
- B. *It is estimated that it will take about 8,000 years for the entire mouse population to become light-colored* is incorrect because it is a statement about the time required for this particular evolutionary change, not the cause of it.
- C. *The light-colored mice show no differences in behavior or internal physiology from the dark-colored mice* is incorrect because similarity of behavior or physiology is not evidence of evolution.
- D. *Predators catch more of the dark-colored mice because they are not as well camouflaged against the sand* is correct because it describes the selective pressure necessary to drive the mouse population to become predominantly light-colored.
- E. *Fur color in the deer mice is determined by different versions of a single gene, and these versions are present in the mouse population* is correct because it describes the necessary genetic variation.
27. A. This answer is incorrect because epidermal cells are only moving and not reproducing, as they would in mitosis.
- B. This answer is incorrect because cells do not lose their functions when they undergo mitosis. Mitosis refers only to the replication of DNA and the formation of two identical cells from one cell.
- C. This answer is correct because mitosis does result in the formation of new, identical cells from the original cells.
- D. This answer is correct because new cells formed during mitosis have the same replicated DNA and because mitosis is highly controlled. It stops when cell numbers are sufficient to carry out the needed function.
- E. This answer is incorrect because turning genes on or off to form new and different types of tissues occurs during cell differentiation, not cell division.
28. A. *Newts use a lot of energy making TTX* is correct for *Disadvantage for Newt* because newts that use more energy to produce TTX have less energy available to use for reproduction.
- B. *Newts with high amounts of TTX can escape predators* is correct for *Advantage for Newt* because these newts have a better chance of surviving to reproduce.
- C. *Snakes with TTX resistance move more slowly than other snakes* is correct for *Disadvantage for Snake* because snakes that move slowly may be less likely to escape predators and survive to reproduce.
- D. *Snakes with TTX resistance can eat newts that other animals cannot* is correct for *Advantage for Snake* because snakes that have a greater variety of food have an advantage over their competitors.
29. A. This statement is true. The researchers found differences in gene expression for many genes involved in important brain functions between the two groups.
- B. This statement is false. There is no mention of the researchers inducing any mutations or introducing or knocking out any genes.
- C. This statement is false. There is no mention of significant genetic differences between the two groups of mice.
- D. This statement is true. Type 1 genes carry out functions important to memory and learning, and their expression increased.
- E. This statement is false. Type 2 genes carry out functions that do not directly promote memory and learning.

30. **1B.** *Higher* is correct, because type 1 and 3 genes showed increased expression.
2C. *Are* is correct, because these genes are directly involved in the formation of memory.
3A. *Lower* is correct, because the rate of expression of type 2 genes was shown to be lower in the experiment.
4D. *Are not* is correct, because type 2 genes are involved in processes that are active when the brain is not involved in the formation of memory.
31. **A.** This is incorrect, because the researchers did not breed the mice.
B. This is correct, because the training room environment caused gene expression to change.
C. This is incorrect, because the mice had no opportunities to breed, and thus spread new genetic combinations that occur during meiosis, during the experiment.
D. This is incorrect, because mutations were not introduced into the mouse population.
32. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ul style="list-style-type: none"> describe what stabilization of a physiological characteristic would look like (DCI); and describe an investigation to demonstrate how feedback stabilizes a system (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing what researchers would likely see in the results</p> <p>Part 2: One point is earned for describing that the researchers should see the memory, learning, and gene expression return to baseline levels after the training sessions stop. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The researchers would see memory, learning, and gene expression levels move back toward baseline levels (the levels measured in the original experiment's native group).
Evidence of Mastery of Science and Engineering Practices	<p>2 points for correctly describing control and experimental groups</p> <p>Part 1: Two points are earned for describing that the control group should consist of mice that are exposed to training sessions that continue for the duration of the experiment and that the experimental group should consist of mice that experience training sessions long enough to show gains in memory and learning, and changes in gene expression. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The control should be a group of mice that experience the training environment daily during the whole experiment. The experimental group should be a group of mice that would at first go through training to increase their memory and learning scores, after which their training would be stopped for several days and their memory and learning scores remeasured.

33. **A.** *Mutation* would be the most likely cause of new version of a brain enzyme because mutations introduce novel genetic sequences into a genome.
B. *Chromosomal crossover* would be the most likely cause of genes being found in a novel pattern. Crossover events cause the shuffling of genes, and can result in new combinations of genes.
C. *Environmental conditions* would be the most likely cause of genetically similar mice showing differing levels of gene and trait expression.
34. **A.** This is incorrect. This answer is the result of converting 40% to the decimal 0.4 and then squaring it, resulting in 0.16, or 16%. This represents the percent of individuals with 2 copies of the allele, not the percent with none.
B. This is incorrect. This answer is the result of simply dividing the allele frequency by 2.
C. This is correct. If the relative frequency of the allele A is 40%, that means that 60% of the time the gene will have an allele other than A, which is equal to the decimal 0.6. The chance of a mouse getting two copies of the gene that each have an allele other than A would then be 0.6^2 , which is 0.36, or 36%.
D. This is incorrect, because this is just the relative frequency of all other alleles of the gene.

35. A. This is incorrect because a sudden behavioral change is highly unlikely. The probability is much higher that, given the drought and lack of seeds, the change occurred simply because of increased death rates among competitors. More fit birds (those able to eat smaller seeds and avoid competing with large ground finches) survived.
- B. This is incorrect because a severe drought is a stressful condition. Under these conditions, animals produce fewer offspring, not more.
- C. This is correct because, under severe drought conditions, with limited food, the large ground finch, with its larger beak, would out-compete the medium ground finch. More of the latter would die. Those remaining would have smaller beaks that would allow them to eat smaller seeds.
- D. This is incorrect because it is highly unlikely that a new mutation would suddenly appear. It is much more likely that natural selection acted on already existing variation in the medium ground finch.
36. 1C. The average loss per year was roughly 15,000 square kilometers.
- 2G. The rate was *higher*, as the slope of the line was steeper during 1994-1998 than it was from 2010 to 2014.
37. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI Only - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. identify the products of meiosis (DCI); and 2. identify new genetic combinations that could result from crossing over (DCI); and 3. explain the type of experimental evidence that reveals the occurrence of crossing over (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for identifying the products of meiosis</p> <p>Part 1: One point is earned for identifying the genotypes of the gametes produced by each of the two plants if no crossing over occurs. Plant 1 can only produce gametes with the <i>rt</i> allele combination. Plant 2 can only produce gametes with the <i>RT</i> and <i>rt</i> allele combinations. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Plant 1 can only produce gametes with the <i>rt</i> allele combination. Plant 2 can only produce gametes with the <i>RT</i> and <i>rt</i> allele combinations. <p>1 point for identifying the genetic combinations that could result from crossing over</p> <p>Part 2: One point is earned for identifying that Plant 1 could only produce gametes with the <i>rt</i> allele combination. Plant 2 could produce gametes with all four allele combinations: <i>RT</i>, <i>rt</i>, <i>Rt</i>, and <i>rT</i>. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Plant 1 could still only produce gametes with the <i>rt</i> allele combination. Plant 2 could now produce gametes with all four allele combinations: <i>RT</i>, <i>rt</i>, <i>Rt</i>, and <i>rT</i>. <p>1 point for explaining experimental evidence of crossing over</p> <p>Part 3: One point is earned for correctly explaining how the presence of crossing over would be observable in the offspring of the two plants. In the case of no crossing over, all offspring would be tall with round seeds or short with wrinkled seeds. If crossing over occurred, some offspring would be short with round seeds or tall with wrinkled seeds. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • In the case of no crossing over, all offspring would be tall with round seeds or short with wrinkled seeds. If crossing over occurred, some offspring (likely a small percentage) would be short with round seeds or tall with wrinkled seeds.

38. A. This statement is correct for *operating database of DNA sequences in humans* because a computer program would be the best way to store and work with very large amounts of information.
- B. This statement is correct for *obtaining information from very small amounts of DNA* because a machine like this would be able to produce larger quantities of DNA to study.
- C. This statement is correct for *diagnosing inherited diseases early* because this method would allow specific gene sequences associated with inherited diseases to be identified in people.

39. A. This is correct because if no trees are cut and no cattle are grazed, then changes would probably result from nature, not humans or their activities.
- B. This is incorrect because although removal of some people would help determine the effects of overpopulation, irrigation would add another factor. Researchers would not be able to distinguish between the effects of lower population and the effects of irrigation.
- C. This is incorrect because this potential solution would combine a test of overpopulation with another factor, the cutting of trees. Tree cutting is done by people, but it is only one of many human activities and represents an indirect, not a direct, effect of overpopulation.
- D. This is incorrect because keeping the same number of people on the land would not test the effects of overpopulation. This scenario would test the effect of pasturing cattle. Although increasing human population leads to more cattle and more erosion, cutting trees also increases erosion. The best way to test for the effects of people would be to remove the people.
40. A. This statement is *False*. The computer responded to information provided by humans. It operated very rapidly and made increasingly better guesses, but it was following its programming rather than thinking like a human does.
- B. This statement is *True*. The data on planaria and the simulations were provided by human scientists. The computer ran the simulations on these data that it was directed to run.
- C. This statement is *True*. A key advantage of computers is the huge amounts of data they can process.
- D. This statement is *False*. It did develop a theory, but this does not show that its operation was like that of a human brain. It was simply able to process and connect huge amounts of data very quickly, doing in three days what humans had never been able to do in more than 100 years.
- E. This statement is *True*. A key advantage of computers is their ability to connect data points very rapidly in meaningful ways.

41. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI Only - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. explain immediate effects of an asteroid impact on photosynthesis (DCI); and 2. explain long-term effects of an asteroid on plant and animal species (DCI); and 3. compare the likelihood of extinction for small versus large animals (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining the immediate effects of an asteroid impact on photosynthesis</p> <p>Part 1: One point is earned for explaining how changed environmental factors resulting from an asteroid impact would reduce photosynthesis by blocking sunlight, and how this would disrupt the food web and lead to the extinction of many vertebrate species. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The combination of factors in the early weeks and months would have drastically lowered photosynthesis. Dust and smoke would have decreased sunlight reaching Earth. Freezing temperatures would have killed some plants. This would have led to food shortages and starvation of vertebrate (and other) species. <p>1 point for explaining the long-term effects of an asteroid on plant and animal species</p> <p>Part 2: One point is earned for explaining how changed environmental factors in the years after the asteroid impact could impact living organisms, such as by increasing temperatures and changing weather patterns. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The later greenhouse effect would have had the opposite effect. After the air was clear and sunlight was available, the high temperatures would increase photosynthesis, providing more food for animals. There would be a new explosion of life to replenish lost species and fill now-empty niches. However, because of previous extinctions, the types of both plants and animals would be different. Some organisms that could not tolerate warmer temperatures would be more likely to go extinct. <p>1 point for comparing the likelihood of extinction for small versus large animals</p> <p>Part 3: One point is earned for comparing the likelihood of extinction of large vs. small land animals. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Large animals (such as dinosaurs) would have been much more vulnerable to extinction because they need so much more food and would be more likely to die of starvation. Small animals would have been more likely to find the small amounts of food needed and, therefore, survive to reproduce. Small animals might have had much larger populations than large animals, so some members of their populations would have been more likely to survive. Also, they would have been able to hide (for example, in dens or burrows) to avoid the worst environmental damage.
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42. A. This is incorrect because the exterior shape of the organ is not related to the process of protein synthesis.
 B. This is correct because the insulin gene must be transcribed into mRNA as part of the protein production process.
 C. This is incorrect because the specific number of cells is not essential to the process.
 D. This is correct because the mRNA produced through transcription must be translated into a protein.
 E. This is incorrect because the entire human genome would contain many genes that would not need transcription and translation in this experiment.
 F. This is correct because the gene for insulin must be present to generate the protein product.
43. 1B. *Lone* is correct because if lone dots are attacked more frequently, the idea that predator behavior causes grouping is supported.
 2A. *Grouped* is correct because grouped dots should be attacked less frequently if predators focus on eliminating lone dots from the population.
 3C. *Predator* is correct because the predator is influencing prey behavior.
 4D. *Prey* is correct because it is the behavior of the prey that is influenced by the attacking predator.
44. 1A. *Stable* is correct because, while it varies by season, the population does not show a clear increasing or decreasing trend over the years. The population appears stable based on the data.
 2G. *On an annual cycle* is correct because there is no apparent increase in population over the three years as would be expected from habitat improvement, nor is there an overall decline as would be expected from habitat loss, predators, and parasites. Though there is some random variation, the basic pattern shown in the data is of an annual population cycle.

45. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. use fossil evidence and DNA sequences to explain the identification of a common ancestor among species (DCI); and 2. use fossil evidence and DNA sequences to describe the relationships among species (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly determining the common ancestor and explaining the reasoning</p> <p>Part 1: One point is earned for determining a common ancestor based on fossil age and explaining relationship based on age and DNA sequences. The common ancestor is represented by Species 3. This can be determined by the age of the fossil, which is the oldest, and the similarity between the DNA of Species 3 and the next oldest Species 5. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The common ancestor is represented by Species 3, which is the oldest, at 1.0 million years. The DNA for Species 3 is almost exactly like the next oldest Species 5, except for one change.
Evidence of Mastery of Science and Engineering Practices	<p>2 points for correctly describing the relationships among the species and explaining the reasoning</p> <p>Part 2: Two points are earned for describing the relationships among the five species and justifying the reasoning using fossil age and differences in DNA sequences. Species 3 is the common ancestor. Species 5 is next because it has only one change in the second codon, and is the second oldest fossil. Species 4 is next, and has three changes from the common ancestor. Species 1 and 2 are the youngest because they are most different from Species 3. They have the same change in the first nucleotide (GAC becomes AAC), so they are more closely related to each other than to Species 4. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Species 3 is the oldest. Then Species 5 is next because it has only one change in the second codon, and is the second oldest fossil. Species 4 is next. It has three changes from the common ancestor. Species 1 and 2 are the youngest because they are most different from Species 3. They have the same change in the first codon, GAC becomes AAC, so they are more closely related to each other than to Species 4.

46. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI Only - 3 Points	
Claims	The student is able to: 1. identify how DNA codons relate to the amino acid sequence of proteins (DCI); and 2. explain how substitution and deletion mutations affect the formation of proteins (DCI); and 3. explain the importance of having multiple codons to code for each amino acid (DCI).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying the amino acids</p> <p>Part 1: One point is earned for identifying the amino acids coded for in the original DNA segment and in the segment after substitution. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Original segment: isoleucine, alanine, proline. Segment after mutation 1: isoleucine, alanine, proline. Segment after mutation 2: methionine, histidine, proline. <p>1 point for correctly explaining the effects of each mutation</p> <p>Part 2: One point is earned for explaining how the substitution and deletion mutations affected the resulting protein. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Mutation 1 did not change the sequence of amino acids in the protein, so it will have no effect on the protein. Mutation 2 resulted in a new sequence of amino acids, and it could change the structure and affect the function of the protein. <p>1 point for correctly explaining why it could be beneficial to have more than one codon</p> <p>Part 3: One point is earned for explaining the importance of having multiple codons to code for the same amino acid. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> When more than one codon codes for the same amino acid, fewer protein errors result because some changes in codons (usually substitutions) result in the same amino acid.

47. **1B.** Selecting *pale owls over dark owls* is correct because the first graph shows there is greater rate of survival for the pale owls over the dark owls with increasing snow levels in snowier winters.

2D. Selecting *greater survival* is correct because the second graph shows that the frequency of dark owls increased; thus, dark owls had increasing survival rates from 1960 to 2008.

3E. Selecting *warmers winters* is correct because with decreasing snow depth in milder or warmer winters, there is less advantage for pale owls over dark owls.

4G. Selecting *disfavored* is correct because natural selection that normally disfavors the dark owls and favors the pale owls in snowier winters is not occurring with milder winters. Thus, selection disfavoring the dark owls is decreasing with milder winters.

48. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. identify advantages and disadvantages of reducing pesticide use (DCI); and 2. identify advantages and disadvantages of allowing native species to grow along roadsides (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly identifying an advantage and a disadvantage of reducing pesticide use</p> <p>Part 2: One point is earned for identifying one advantage and one disadvantage of reducing pesticide use. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> One advantage is that it might reduce the amount of pesticides that the bees are exposed to. A possible disadvantage is that it may be less effective in controlling destructive pests.

Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly identifying an advantage and a disadvantage of allowing native vegetation to grow back along crop edges and roadsides</p> <p>Part 1: One point is earned for identifying one advantage and one disadvantage of allowing native vegetation to grow. Advantages can include that a more diverse source of food would be available to bees. Possible disadvantages may include that people may find it aesthetically less pleasing, the wild vegetation may allow weeds to grow into the crops, and the wild vegetation may attract destructive insects. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> An advantage is that it increases availability of food for bees, and a disadvantage is that it may allow weeds to grow into the crops.
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49. **A.** This answer is incorrect because this factor is a result of the evolution, but not a cause of it.
- B.** This answer is incorrect because it actually suggests a barrier to the evolution of this behavior, since this action would likely increase the risks of the squirrel making the call.
- C.** This answer is correct because this ensures that the rewards will be shared by squirrels that are genetically similar to the one making the call.
- D.** This answer is incorrect because it is not a major factor in causing the call; it is just combining a group behavior with an act aimed at individual survival.
- E.** This answer is correct because unless the chances of survival were increased, there would be no driving force to evolve this behavior.
50. **1B.** 50% is correct because 50% of their sons would express the trait.
- 2A.** 0% is correct because only the sons, not daughters, would express the trait if the father does not also express the trait.
- 3C.** 100% is correct because the gene would be passed on to 100% of their daughters.
- 4E.** *Will not* is correct because the daughters can only be carriers of the gene if the mother does not have the gene.
- 5H.** 2 is correct, because, as females, they will have 2 X-chromosomes.

End-of-Year Test B

Item #	Item Analysis	DOK
1	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.2	1
2	HS-LS1-1, DCI.HS-LS1.A.2	1
3	HS-LS4-2, DCI.HS-LS4.B.1	1
4	HS-LS1-1, DCI.HS-LS1.A.2, CCC.HS.F.1	2
5	HS-LS4-6, DCI.HS-ETS1.B.2	2
6	HS-LS2-7, DCI.HS-LS4.D.2	2
7	HS-LS4-5, DCI.HS-LS4.C.4, SEP.HS.G.1	2
8	HS-LS1-4, DCI.HS-LS1.B.1	2
9	HS-LS3-1, DCI.HS-LS1.A.2	2
10	HS-LS4-1, DCI.HS-LS4.A.1	2
11	HS-LS4-6, DCI.HS-LS4.D.2, CCC.HS.B.1	2
12	HS-LS1-1, DCI.HS-LS1.A.1	2
13	HS-LS1-4, DCI.HS-LS1.B.1, CCC.HS.D.2	2
14	HS-LS4-4, DCI.HS-LS4.C.2	2

15	HS-LS4-1, DCI.HS-LS4.A.1, CCC.NOS.HS.A.1	2
16	HS-LS4-3, DCI.HS-LS4.C.3, SEP.HS.D.2	2
17	HS-LS2-7, DCI.HS-LS4.D.1	2
18	HS-LS4-4, DCI.HS-LS4.C.2, CCC.HS.B.1	2
19	HS-LS4-2, DCI.HS-LS4.B.1, SEP.HS.F.1	2
20	HS-LS4-1, DCI.HS-LS4.A.1, CCC.HS.A.1	3
21	HS-LS2-7, DCI.HS-ETS1.B.1	2
22	HS-LS4-4, DCI.HS-LS4.C.2, SEP.HS.F.1, CCC.HS.B.1	2
23	HS-ETS1-4, DCI.HS-ETS1.B.2, SEP.HS.F.4	2
24	HS-LS2-8, DCI.HS-LS2.D.1, SEP.NOS.HS.C.2	2
25	HS-LS4-6, DCI.HS-LS4.C.4	3
26	HS-LS4-2, DCI.HS-LS4.B.1, CCC.HS.B.1	2
27	HS-LS1-4, DCI.HS-LS1.B.1	2
28	HS-LS4-4, DCI.HS-LS4.C.2, CCC.NOS.HS.A.1	2
29	HS-LS3-2, DCI.HS-LS3.B.2	3
30	HS-LS3-3, DCI.HS-LS3.B.2	3
31	HS-LS3-2, DCI.HS-LS3.B.2, SEP.HS.G.3	2
32	HS-LS3-1, DCI.HS-LS3.A.1, SEP.HS.A.1	2
33	HS-LS3-2, DCI.HS-LS3.B.1, CCC.HS.B.1	2
34	HS-LS3-3, DCI.HS-LS3.B.2, CCC.HS.C.3	2
35	HS-LS4-2, DCI.HS-LS4.C.1	3
36	HS-LS2-2, DCI.HS-LS2.C.1, SEP.NOS.HS.C.1	2
37	HS-LS3-2, DCI.HS-LS3.B.1	3
38	HS-LS3-3, DCI.HS-LS3.B.2, CCC.NOS.HS.B.3	2
39	HS-LS4-6, DCI.HS-LS4.D.2, SEP.HS.E.1	3
40	HS-ETS1-4, DCI.HS-ETS1.B.2	2
41	HS-LS4-5, DCI.HS-LS4.C.5	3
42	HS-LS1-1, DCI.HS-LS1.A.1, CCC.HS.F.1	3
43	HS-LS2-8, DCI.HS-LS2.D.1, CCC.HS.B.1	3
44	HS-LS2-7, DCI.HS-LS2.C.2, CCC.HS.G.1	3
45	HS-LS4-1, DCI.HS-LS4.A.1, SEP.HS.H.2	3
46	HS-LS1-1, DCI.HS-LS1.A.2	3
47	HS-LS4-4, DCI.HS-LS4.C.2, SEP.HS.F.1	3
48	HS-LS2-7, DCI.HS-LS2.C.2, SEP.HS.F.4	3
49	HS-LS2-8, DCI.HS-LS2.D.1	3
50	HS-LS3-1, DCI.HS-LS3.A.1, CCC.HS.B.1	3

1. A. This is incorrect because it models the meiosis process.
 B. This is correct because the process of mitosis begins with one cell that replicates to form two identical daughter cells.
 C. This is incorrect because it models polyploidy in plants, the heritable condition of possessing more than two complete sets of chromosomes.
2. The first step is a strand of mRNA being made that matches the DNA. Next, a ribosome assembles around the mRNA. Then the first tRNA, with an amino acid attached, attaches to the mRNA start codon. After this, additional tRNAs attach to the mRNA and add amino acids to the chain. Finally, the ribosome reaches a stop codon and the protein is released.
3. A. This is incorrect because genetic history is not the best predictor of whether a population is likely to undergo natural selection.
 B. This is incorrect because population size is not the best predictor of whether a population is likely to undergo natural selection.
 C. This is correct because genetic differences and variation in traits are the best predictors of whether a population is likely to undergo natural selection.
4. A. This statement is true because each gene contains, in its sequence, the information that determines the order of amino acids in the protein. Different sequences of amino acids produce proteins with very different structures.
 B. This statement is true because it is the sequence of nucleotide bases on the DNA strand (gene) that determines the uniqueness of the protein. The sequence is transcribed to mRNA and used by tRNA to pull amino acids into a specific sequence based on the DNA sequence.
 C. This statement is false because, first, two genes are used—one for each protein, and second, because transcription of one gene will always produce the same mRNA. This is guaranteed because bases on DNA are complementary to those on RNA.
5. A. This is correct because adding fire would lead to more grass and sagebrush and fewer trees, as shown in the model and in the table comparing the landscape with fire with the landscape without fire. This would improve habitat for sagebrush wildlife.
 B. This is incorrect because adding fire would lead to more grass and sagebrush and fewer trees, which would improve wildlife habitat.
 C. This is incorrect because, while adding fire would lead to more grass and sagebrush and fewer trees, this would improve habitat for sagebrush wildlife, so wildlife should not decline.
6. A. This statement is incorrect because the colony density of the insect did not change, which means that there is no evidence to support that the insect is sensitive to the insecticide.
 B. This statement is correct because the colony density of species B clearly decreased after the insecticide was applied.
 C. This statement is correct because the fact that the colony density of species C decreased suggests that they are traveling for food.
 D. This statement is incorrect because there has been no year in which the colony density of species B increased, compared with the previous year.
 E. This statement is correct because the colony density of species C increased in the final year of the study.
7. A. This statement is an incorrect selection because the feedback loop can happen without climate change and it does not support the fire feedback loop explanation for the spread of cheatgrass.
 B. This statement is an incorrect selection because this research supports an alternative explanation for the spread of cheatgrass by grazing and does not support the fire feedback loop explanation.
 C. This statement is a correct selection because evidence for an increase in cheatgrass on recently burned sites supports the fire feedback loop explanation for the spread of cheatgrass.

- D. This statement is a correct selection because this supports the fire feedback loop explanation for the spread of cheatgrass.
- E. This statement is a correct selection because it provides a mechanism for the spread of cheatgrass into new areas, supporting the fire feedback loop explanation.
8. A. This statement is correct for the first illustration because mitosis involves the separation of the DNA and division of the nucleus to form two nuclei within the parent cell.
- B. This statement is correct for the third illustration because each daughter cell contains one complete set of DNA that is identical to the DNA of the parent cell.
- C. This statement is correct for the second illustration because, following mitosis, the cell divides and the membrane pinches together to separate the two halves of the cell, each containing one of the new nuclei.
9. A. This is incorrect because tissues are made up of cells, and proteins carry out the work of cells.
- B. This is incorrect because DNA molecules remain intact in the nucleus, and the subunits of DNA and proteins are different.
- C. This is correct because DNA contains the genetic information the cell uses to guide protein assembly.
10. A. *The ant limb* does not match with any of the options because it is an invertebrate with an outer exoskeleton not made of homologous bones, and it does not have analogous wings either.
- B. *The fly limb* correctly follows *The bat limb is analogous to* because the bat wing and the fly wing have similar functions but quite different, unrelated structures.
- C. *The human limb* correctly follows *The whale limb is homologous to* because the whale limb and the human limb have similar underlying bone arrangements, as do all related mammalian vertebrates.
- D. *Close evolutionary relationships* correctly follows *Homologous features show* because homologous structures and the close evolutionary relationships they imply indicate relatively recent shared ancestors.
- E. *No evidence of an evolutionary relationship* correctly follows *Analogous features show* because analogous features have similar functions due to similar adaptations but no ancestral relatedness.
11. A. This is correct because the primary risk of greater fishing restrictions is economic loss to commercial fisheries, while the gain is increased survival of adult turtles with fewer caught in fishing gear.
- B. This is incorrect because the primary risk of greater fishing restrictions is economic loss to commercial fisheries, and the primary impact of reducing accidental capture is increased survival of adults. Enhanced reproduction is a secondary impact of increased survival of adults.
- C. This is incorrect because the primary risk of greater fishing restrictions is economic loss, not gain, to commercial fisheries. The primary impact of reducing accidental capture is increased survival of adults. A secondary impact of increased survival of adults is higher, not lower, reproduction rates.
12. A. The art of the red blood cell belongs with *its shape allows it to move through very narrow blood vessels* because the round shape of the red blood cell allows it to be pushed through blood vessels more easily.
- B. The art of the skeletal muscle cell belongs with *its striated pattern allows it to contract and relax to produce movement* because skeletal muscle cells are specialized to contract and relax in order to move the body.
- C. The art of the intestinal epithelial cell belongs with *its large surface area allows it to absorb nutrients from digested food* because these cells are specialized to have a large surface area on the interior of the small intestine to maximize absorption of nutrients.

13. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, CCC - 3 Points	
Claims	The student is able to: 1. describe how damaged nucleotides would lead to damaged chromosomes being passed on in mitosis (or the inability of that cell to even perform mitosis) (DCI); and 2. explain the connection between damaged DNA, mitosis frequency, and cancerous cells (CCC).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly explaining the role the radiation damage could play in mitosis Part 1: One point is earned for explaining how damage done to the cell by radiation would impact mitosis. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Nucleotides that have been damaged by radiation will lead to damaged chromosomes. During mitosis, if the DNA replication has not been repaired, the damage may be so extensive that it causes mitosis to stop, or the damaged chromosomes may be passed on to the new cells.
Evidence of Mastery of Crosscutting Concepts	2 points for correctly making the connection between nucleotides and cancerous cells Part 2: Two points are earned for explaining how damaged nucleotides cause unchecked cell growth. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Damaged nucleotides in a cell can lead to damaged chromosomes, which can lead to cells passing on damaged chromosomes during mitosis. A cell that undergoes mitosis more frequently is more likely to pass on a copy of a damaged chromosome, which could lead to a malignant growth.

14. A. This species is *not likely to survive* because a species with a low reproductive rate is less likely to leave enough offspring to survive under stressful conditions.
- B. This species is *likely to survive* because a species living deep, where temperature changes are minimal, will be less affected by rising temperatures and more likely to survive and reproduce.
- C. This species is *not likely to survive* because a species having little or no variation may lack the alleles necessary to withstand high temperatures. Populations with greater variation are more likely to have individuals that will survive and reproduce.
- D. This species is *likely to survive* because if offspring survive well in warm temperatures they will grow to adulthood and have a chance to reproduce, even when the temperature rises permanently.
15. A. This is incorrect because DNA sequences of noncoding regions are more likely to diverge over time because there is less selection pressure for them to stay the same and be evolutionarily conserved.
- B. This is correct because one would expect selection pressure to continue to conserve the important functional genes over time, with the nonconserved, noncoding regions diverging over time.
- C. This is incorrect because one would expect the sequences of important genes to stay the same over time, with the less important DNA sequences changing over time.

16. The correct equation for the line of best fit is $-0.3 (\text{years}) + 3.9$.

17. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI Only - 2 Points	
Claims	The student is able to: 1. compare the biodiversity in the two areas based on the provided data (DCI); and 2. explain that human activities can contribute to species loss and decreasing biodiversity (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>2 points for correctly comparing the biodiversity from the two sites and explaining that human activities can contribute to the loss of biodiversity</p> <p>Part 1: One point is earned for comparing the provided data to correctly identify that the nature preserve has greater arthropod diversity than the grazing land. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The data suggest that the nature preserve has greater biodiversity of arthropods than the grazing area because 87 species were identified at the nature preserve, and only 66 species were found at the grazing land site. <p>Part 2: One point is earned for explaining that human activities like grazing livestock can alter natural ecosystems, causing the loss or extinction of species. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Grazing may have removed grass and other small plants. It could also change the soil composition. These changes could lead to the loss of total arthropod species and decreased biodiversity.
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18. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, CCC - 2 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> identify an agent of selective pressure and explain the need to apply it to a population to see whether an adaptation will result (DCI); and describe empirical evidence that an agent of selective pressure can cause adaptation (DCI, CCC).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly explaining how to apply selective pressure to a population</p> <p>Part 1: One point is earned for explaining how to apply selective pressure to the orchid population. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The scientist should release female wasps among the orchids while the orchids are in full bloom with males already present.
Evidence of Mastery of Crosscutting Concepts	<p>1 point for describing the empirical evidence of selective pressure</p> <p>Part 2: One point is earned for describing that the scientist should see changes in reproductive success when female wasps are present. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The scientist should see a reduction in reproductive success in flowers that fully bloom while the female wasps are present and an increase in reproductive success in flowers that bloom earlier or later.

19. A. This statement is *False* because all of the bacteria in dish A died.
- B. This statement is *True* because natural selection favored particular genetic variation in a few individuals that led to their survival and reproductive success over time. This is evolution by natural selection.
- C. This statement is *True* because antibiotics created a selective force on the population; this drives evolution.
- D. This statement is *False* because no cells, or individuals, in dish A survived the antibiotics treatment.
20. A. This is correct because species C and D have similar anatomies and the most similar eggshell genes as well, having only three base-pair differences.
- B. This is incorrect because the fact that the eggshell genes of species D and E are the most different suggests that their most recent common ancestor was the oldest, not the youngest.
- C. This is incorrect because evidence from anatomy alone is not as strong as evidence from anatomy and DNA together. Note that these two species have 22 base-pair differences.

21. A. This is incorrect because the global use of plankton nets would also result in the removal of plankton from all parts of the world's oceans.
- B. This is correct because recycling microplastics has the potential to reduce the amount of ocean microplastics in the long term without removing or harming plankton.
- C. This is incorrect because plant-derived bioplastics are designed to break down efficiently only in commercial composting systems, not inside marine animals.
22. 1B. *Quickly* is correct because a high reproductive rate is related to a higher rate of adaptation. These species will be able to adapt faster with shorter generation times than their competitors.
- 2C. *More likely* is correct because high rates of pollen and seed dispersal contribute to a higher reproductive rate and more chances for a species to adapt.
- 3F. *Decline and go extinct* is correct because a species that cannot adapt quickly enough is more likely to not survive and more likely to become extinct.
23. A. *Protect marine areas* belongs in the third blank because it would provide a benefit to fisheries but would not strongly affect coastal flooding.
- B. *Restore sand dunes* belongs in the first blank because it would help prevent coastal flooding but would not provide many benefits to local fisheries.
- C. *Create wetland buffers* belongs in the second blank because it would help reduce the damage of coastal flooding and would help provide benefits to local fisheries.
24. A. This statement is correct because the new evidence suggests that the alarm calls of one species may benefit other unrelated bird species.
- B. This statement is not a correct selection. Group alarm calls may allow birds to spend more time in exposed areas where there is more food available, but this does not explain why birds lose weight without the alarm calling of other bird species.
- C. This statement is correct because this is a logical explanation that could account for why birds lose weight due to spending time producing their own calls when they cannot hear the warnings of other bird calls.
- D. This statement is not a correct selection. Though it may be true that alarm calling reduces predation risk within a group, this is not supported by the new evidence.
- E. This statement is correct because the new evidence suggests that when birds can't hear other species' alarm calls, they are more likely to allocate important energy to producing their own calls.
25. A. This is incorrect because this would most likely lead to an increase in the population of periwinkle as the crab population would decline.
- B. This is incorrect because this would most likely lead to an increase in the periwinkle population due to reduced predation.
- C. This is correct because this change would decrease the periwinkle population by reducing its food supply.
26. A. *It is estimated that it will take about 8,000 years for the entire mouse population to become light-colored* is incorrect because it is a statement about the time required for this particular evolutionary change, not the cause of it.
- B. *The light-colored mice show no differences in behavior or internal physiology from the dark-colored mice* is incorrect because similarity of behavior or physiology is not evidence of evolution.
- C. *Predators catch more of the dark-colored mice because they are not as well camouflaged against the sand* is correct because it describes the selective pressure necessary to drive the mouse population to become predominantly light-colored.
- D. *Fur color in the deer mice is determined by different versions of a single gene, and these versions are present in the mouse population* is correct because it describes the necessary genetic variation.
27. A. This answer is incorrect because epidermal cells are only moving and not reproducing, as they would in mitosis.

- B. This answer is incorrect because cells do not lose their functions when they undergo mitosis. Mitosis refers only to the replication of DNA and the formation of two identical cells from one cell.
- C. This answer is correct because mitosis does result in the formation of new, identical cells from the original cells.
- D. This answer is correct because new cells formed during mitosis have the same replicated DNA and because mitosis is highly controlled. It stops when cell numbers are sufficient to carry out the needed function.
28. A. *Newts use a lot of energy making TTX* is correct for *Disadvantage for Newt* because newts that use more energy to produce TTX have less energy available to use for reproduction.
- B. *Newts with high amounts of TTX can escape predators* is correct for *Advantage for Newt* because these newts have a better chance of surviving to reproduce.
- C. *Snakes with TTX resistance move more slowly than other snakes* is correct for *Disadvantage for Snake* because snakes that move slowly may be less likely to escape predators and survive to reproduce.
- D. *Snakes with TTX resistance can eat newts that other animals cannot* is correct for *Advantage for Snake* because snakes that have a greater variety of food have an advantage over their competitors.
29. A. This statement is true. The researchers found differences in gene expression for many genes involved in important brain functions between the two groups.
- B. This statement is false. There is no mention of the researchers inducing any mutations or introducing or knocking out any genes.
- C. This statement is false. There is no mention of significant genetic differences between the two groups of mice.
- D. This statement is true. Type 1 genes carry out functions important to memory and learning, and their expression increased.
30. 1B. *Higher* is correct because type 1 and 3 genes showed increased expression.
- 2C. *Are* is correct because these genes are directly involved in the formation of memory.
- 3A. *Lower* is correct because the rate of expression of type 2 genes was shown to be lower in the experiment.
31. A. This is incorrect, because the researchers did not breed the mice.
- B. This is correct, because the training room environment caused gene expression to change.
- C. This is incorrect, because the mice had no opportunities to breed, and thus spread new genetic combinations that occur during meiosis, during the experiment.
32. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI, SEP - 3 Points	
Claims	The student is able to: 1. describe what stabilization of a physiological characteristic would look like (DCI); and 2. describe investigation to demonstrate how feedback stabilizes a system (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly describing what researchers would likely see in the results Part 2: One point is earned for describing that the researchers should see the memory, learning, and gene expression return to baseline levels after the training sessions stop. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The researchers would see memory, learning, and gene expression levels move back toward baseline levels (the levels measured in the original experiment's native group).

Evidence of Mastery of Science and Engineering Practices	<p>2 points for correctly describing control and experimental groups</p> <p>Part 1: Two points are earned for describing that the control group should consist of mice that are exposed to training sessions that continue for the duration of the experiment and that the experimental group should consist of mice that experience training sessions long enough to show gains in memory and learning, and changes in gene expression. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The control should be a group of mice that experience the training environment daily during the whole experiment. The experimental group should be a group of mice that would at first go through training to increase their memory and learning scores, after which their training would be stopped for several days and their memory and learning scores remeasured.
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33. A. *Mutation* would be the most likely cause of new version of a brain enzyme because mutations introduce novel genetic sequences into a genome.
- B. *Chromosomal crossover* would be the most likely cause of genes being found in a novel pattern. Crossover events cause the shuffling of genes, and can result in new combinations of genes.
- C. *Environmental conditions* would be the most likely cause of genetically similar mice showing differing levels of gene and trait expression.
34. A. This is incorrect because this is the percentage that could have two copies of the allele.
- B. This is incorrect, because the allele frequency was doubled instead of squared to find the answer.
- C. This is correct. If the relative frequency of the allele A is 40%, that means that 60% of the time the gene will have an allele other than A, which is equal to the decimal 0.6. The chance of a mouse getting two copies of the gene that each have an allele other than A would then be 0.6^2 , which is 0.36, or 36%.
35. A. This is incorrect because a sudden behavioral change is highly unlikely. The probability is much higher that, given the drought and lack of seeds, the change occurred simply because of increased death rates among competitors. More fit birds (those able to eat smaller seeds and avoid competing with large ground finches) survived.
- B. This is incorrect because a severe drought is a stressful condition. Under these conditions, animals produce fewer offspring, not more.
- C. This is correct because, under severe drought conditions, with limited food, the large ground finch, with its larger beak, would out-compete the medium ground finch. More of the latter would die. Those remaining would have smaller beaks that would allow them to eat smaller seeds.
36. 1B The average loss per year was roughly 15,000 square kilometers.
- 2E. The rate was *higher*, as the slope of the line was steeper during 1994-1998 than it was from 2010 to 2014.
37. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI Only - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> describe new genetic combinations that could result from crossing over (DCI); and explain the type of experimental evidence that reveals the occurrence of crossing over (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly describing genetic combinations</p> <p>Part 1: One point is earned for describing that Plant 1 could only produce gametes with the <i>rt</i> allele combination. Plant 2 could produce gametes with all four allele combinations: <i>RT</i>, <i>rt</i>, <i>Rt</i>, and <i>rT</i>. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Plant 1 could still only produce gametes with the <i>rt</i> allele combination. Plant 2 could now produce gametes with all four allele combinations: <i>RT</i>, <i>rt</i>, <i>Rt</i>, and <i>rT</i>. <p>2 points for explaining evidence of crossing over</p> <p>Part 2: Two points are earned for correctly explaining how the presence of crossing over would be observable in the offspring of the two plants. In the case of no crossing over, all offspring would be tall with round seeds or short with wrinkled seeds. If crossing over occurred, some offspring would be short with round seeds or tall with wrinkled seeds. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> In the case of no crossing over, all offspring would be tall with round seeds or short with wrinkled seeds. If crossing over occurred, some offspring (likely a small percentage) would be short with round seeds or tall with wrinkled seeds.
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38. A. This statement is correct for *operating database of DNA sequences in humans* because a computer program would be the best way to store and work with very large amounts of information.
- B. This statement is correct for *obtaining information from very small amounts of DNA* because a machine like this would be able to produce larger quantities of DNA to study.
- C. This statement is correct for *diagnosing inherited diseases early* because this method would allow specific gene sequences associated with inherited diseases to be identified in people.
39. A. This is correct because if no trees are cut and no cattle are grazed, then changes would probably result from nature, not humans or their activities.
- B. This is incorrect because this potential solution would combine a test of overpopulation with another factor, the cutting of trees. Tree cutting is done by people, but it is only one of many human activities and represents an indirect, not a direct, effect of overpopulation.
- C. This is incorrect because keeping the same number of people on the land would not test the effects of overpopulation. This scenario would test the effect of pasturing cattle. Although increasing human population leads to more cattle and more erosion, cutting trees also increases erosion. The best way to test for the effects of people would be to remove the people.
40. A. This statement is *False*. The computer responded to information provided by humans. It operated very rapidly and made increasingly better guesses, but it was following its programming rather than thinking like a human does.
- B. This statement is *True*. The data on planaria and the simulations were provided by human scientists. The computer ran the simulations on these data that it was directed to run.
- C. This statement is *True*. A key advantage of computers is the huge amounts of data they can process.
- D. This statement is *False*. It did develop a theory, but this does not show that its operation was like that of a human brain. It was simply able to process and connect huge amounts of data very quickly, doing in three days what humans had never been able to do in more than 100 years.
41. Use the rubric below to evaluate total points earned for this item. [max point: 3]

DCI Only - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> explain immediate effects of an asteroid impact on photosynthesis (DCI); and explain long-term effects of an asteroid on plant and animal species (DCI); and compare the likelihood of extinction for small versus large animals (DCI).

Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for explaining the immediate effects of an asteroid impact on photosynthesis</p> <p>Part 1: One point is earned for explaining how changed environmental factors resulting from an asteroid impact would reduce photosynthesis by blocking sunlight, and how this would disrupt the food web and lead to the extinction of many vertebrate species. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The combination of factors in the early weeks and months would have drastically lowered photosynthesis. Dust and smoke would have decreased sunlight reaching Earth. Freezing temperatures would have killed some plants. This would have led to food shortages and starvation of vertebrate (and other) species. <p>1 point for explaining the long-term effects of an asteroid on plant and animal species</p> <p>Part 2: One point is earned for explaining how changed environmental factors in the years after the asteroid impact could impact living organisms, such as by increasing temperatures and changing weather patterns. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> The later greenhouse effect would have had the opposite effect. After the air was clear and sunlight was available, the high temperatures would increase photosynthesis, providing more food for animals. There would be a new explosion of life to replenish lost species and fill now-empty niches. However, because of previous extinctions, the types of both plants and animals would be different. Some organisms that could not tolerate warmer temperatures would be more likely to go extinct. <p>1 point for comparing the likelihood of extinction for small versus large animals</p> <p>Part 3: One point is earned for comparing the likelihood of extinction of large vs. small land animals. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> Large animals (such as dinosaurs) would have been much more vulnerable to extinction because they need so much more food and would be more likely to die of starvation. Small animals would have been more likely to find the small amounts of food needed and, therefore, survive to reproduce. Small animals might have had much larger populations than large animals, so some members of their populations would have been more likely to survive. Also, they would have been able to hide (for example, in dens or burrows) to avoid the worst environmental damage.
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42. A. This is incorrect because the exterior shape of the organ is not related to the process of protein synthesis.
 B. This is correct because the insulin gene must be transcribed into mRNA as part of the protein production process.
 C. This is incorrect because the specific number of cells is not essential to the process.
 D. This is correct because the mRNA produced through transcription must be translated into a protein.
 E. This is correct because the gene for insulin must be present to generate the protein product.
43. 1B. *Lone* is correct because if lone dots are attacked more frequently, the idea that predator behavior causes grouping is supported.
 2A. *Grouped* is correct because grouped dots should be attacked less frequently if predators focus on eliminating lone dots from the population.
 3C. *Predator* is correct because the predator is influencing prey behavior.
 4D. *Prey* is correct because it is the behavior of the prey that is influenced by the attacking predator.
44. 1A. *Stable* is correct because, while it varies by season, the population does not show a clear increasing or decreasing trend over the years. The population appears stable based on the data.
 2E. *On an annual cycle* is correct because there is no apparent increase in population over the three years as would be expected from habitat improvement, nor is there an overall decline as would be expected from habitat loss, predators, and parasites. Though there is some random variation, the basic pattern shown in the data is of an annual population cycle.

45. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI, SEP - 3 Points	
Claims	<p>The student is able to:</p> <ol style="list-style-type: none"> 1. use fossil evidence and DNA sequences to explain the identification of a common ancestor among species (DCI); and 2. use fossil evidence and DNA sequences to describe the relationships among species (SEP).
Evidence of Mastery of Disciplinary Core Ideas	<p>1 point for correctly determining the common ancestor and explaining the reasoning</p> <p>Part 1: One point is earned for determining a common ancestor based on fossil age and explaining relationship based on age and DNA sequences. The common ancestor is represented by Species 3. This can be determined by the age of the fossil, which is the oldest, and the similarity between the DNA of Species 3 and the next oldest Species 5. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • The common ancestor is represented by Species 3, which is the oldest, at 1.0 million years. The DNA for Species 3 is almost exactly like the next oldest Species 5, except for one change.
Evidence of Mastery of Science and Engineering Practices	<p>2 points for correctly describing the relationships among the species and explaining the reasoning</p> <p>Part 2: Two points are earned for describing the relationships among the five species and justifying the reasoning using fossil age and differences in DNA sequences. Species 3 is the common ancestor. Species 5 is next because it has only one change in the second codon, and is the second oldest fossil. Species 4 is next, and has three changes from the common ancestor. Species 1 and 2 are the youngest because they are most different from Species 3. They have the same change in the first nucleotide (GAC becomes AAC), so they are more closely related to each other than to Species 4. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • Species 3 is the oldest. Then Species 5 is next because it has only one change in the second codon, and is the second oldest fossil. Species 4 is next. It has three changes from the common ancestor. Species 1 and 2 are the youngest because they are most different from Species 3. They have the same change in the first codon, GAC becomes AAC, so they are more closely related to each other than to Species 4.

46. Use the rubric below to evaluate total points earned for this item.

[max point: 3]

DCI Only - 3 Points	
Claims	The student is able to: 1. identify how DNA codons relate to the amino acid sequence of proteins (DCI); and 2. explain how substitution and deletion mutations affect the formation of proteins (DCI); and 3. explain the importance of having multiple codons to code for each amino acid (DCI).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying the amino acids Part 1: One point is earned for identifying the amino acids coded for in the original DNA segment and in the segment after substitution. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> Original segment: isoleucine, alanine, proline. Segment after mutation: methionine, histidine, proline. 1 point for correctly explaining the effects of each mutation Part 2: One point is earned for explaining how the mutations affected the resulting protein. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> The mutation resulted in a new sequence of amino acids, and it could change the structure and affect the function of the protein. 1 point for correctly explaining why it could be beneficial to have more than one codon Part 3: One point is earned for explaining the importance of having multiple codons to code for the same amino acid. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> When more than one codon codes for the same amino acid, fewer protein errors result because some changes in codons (usually substitutions) result in the same amino acid.

47. **1B.** Selecting *pale owls over dark owls* is correct because the first graph shows there is greater rate of survival for the pale owls over the dark owls with increasing snow levels in snowier winters.

2D. Selecting *greater survival* is correct because the second graph shows that the frequency of dark owls increased; thus, dark owls had increasing survival rates from 1960 to 2008.

3E. Selecting *warmers winters* is correct because with decreasing snow depth in milder or warmer winters, there is less advantage for pale owls over dark owls.

48. Use the rubric below to evaluate total points earned for this item.

[max point: 2]

DCI, SEP - 2 Points	
Claims	The student is able to: 1. identify how reducing pesticide use will affect the environment (DCI); and 2. identify advantages and disadvantages of allowing native species to grow along roadsides (SEP).
Evidence of Mastery of Disciplinary Core Ideas	1 point for correctly identifying an advantage and a disadvantage of reducing pesticide use Part 2: One point is earned for identifying one advantage and one disadvantage of reducing pesticide use. The following response, or an equivalent, is acceptable. <ul style="list-style-type: none"> One advantage is that it might reduce the amount of pesticides that the bees are exposed to. A possible disadvantage is that it may be less effective in controlling destructive pests.

Evidence of Mastery of Science and Engineering Practices	<p>1 point for correctly identifying an advantage and a disadvantage of allowing native vegetation to grow back along crop edges and roadsides</p> <p>Part 1: One point is earned for identifying one advantage and one disadvantage of allowing native vegetation to grow. Advantages can include that a more diverse source of food would be available to bees. Possible disadvantages may include that people may find it aesthetically less pleasing, the wild vegetation may allow weeds to grow into the crops, and the wild vegetation may attract destructive insects. The following response, or an equivalent, is acceptable.</p> <ul style="list-style-type: none"> • An advantage is that it increases availability of food for bees, and a disadvantage is that it may allow weeds to grow into the crops.
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49. A. This answer is incorrect because it actually suggests a barrier to the evolution of this behavior, since this action would likely increase the risks of the squirrel making the call.
- B. This answer is correct because this ensures that the rewards will be shared by squirrels that are genetically similar to the one making the call.
- C. This answer is incorrect because it is not a major factor in causing the call; it is just combining a group behavior with an act aimed at individual survival.
- D. This answer is correct because unless the chances of survival were increased, there would be no driving force to evolve this behavior.
50. 1B. 50% is correct because 50% of their sons would express the trait.
- 2A. 0% is correct because only the sons, not daughters, would express the trait if the father does not also express the trait.
- 3C. 100% is correct because the gene would be passed on to 100% of their daughters.
- 4E. *Will not* is correct because the daughters can only be carriers of the gene if the mother does not have the gene.

Expectations for

peers

Focus in class...

Expectations for self...

Value...

Speaking norms...

Listening norms...