Content Standard	**B.1.1:** Compare and contrast the shape and function of the essential biological macromolecules (i.e., carbohydrates, lipids, proteins, and nucleic acids), as well as how chemical elements (i.e., carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur) can combine to form these biomolecules.
Content Limits	Cover carbohydrates, lipids, proteins, and nucleic acids only. Exclude: Functional groups, breakdown of monomers, types of bonding in macromolecules, saturated vs. unsaturated fats, compounds and mixtures. Do not assess minerals and other compounds needed by organisms. Include that carbohydrates are the energy source used by the mitochondria, lipids make up the cell membrane and provide protection and structure, proteins include enzymes and structural components of most of the “body” of an organism, and DNA contains the code for making all life. Should not assume students have taken chemistry—extensive explanation of chemical formulas/models of large biomolecules is a limitation.
Construct-Relevant Vocabulary	adenine, amino acid, carbohydrate, cellulose, cytosine, dehydration reaction, deoxyribose, deoxyribose nucleic acid, enzyme, fatty acid, glycogen, guanine, hydrolysis, hydrophilic, hydrophobic, lipid, monosaccharide, nucleic acids, polypeptide, polysaccharide, protein, purine, pyrimidine, ribose, ribose nucleic acid, starch, synthesis, thymine, uracil
Recommended Response Mechanisms (Item Types)	Grid Item Multiple Choice Multi-Select Simulation Table Match Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students describe, explain, and/or sort descriptive statements about function and shape of the four biological macromolecules, including statements that apply to more than one category of macromolecule.	
Students identify, compare, contrast, and/or classify images of the biological macromolecules.	
Students explain, recognize, or sort the relationship between polymers and monomers (e.g., proteins are made of amino acids).	
Students discuss the different and important uses of each macromolecule in an organism or cell.	

Sample Item
Which of these statements best applies to carbohydrates? **A. provide the major energy source used by mitochondria** B. make up cell membranes, store energy, and provide insulation C. carry hereditary information and instructions for building molecules D. provide structural support and act as enzymes to catalyze metabolic reactions

Accessibility and Accommodation Considerations

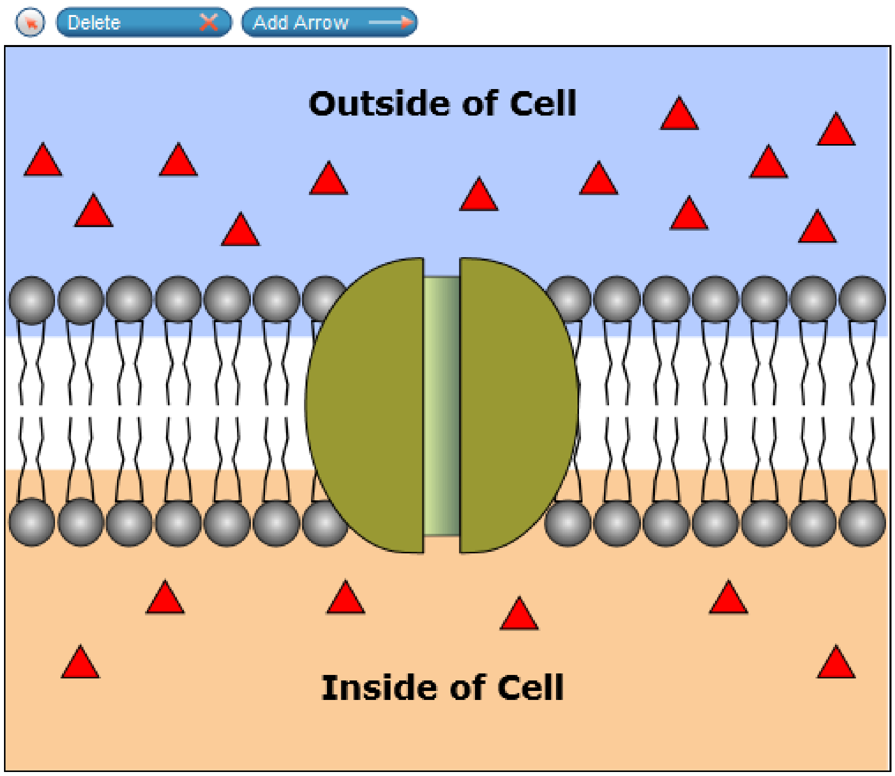
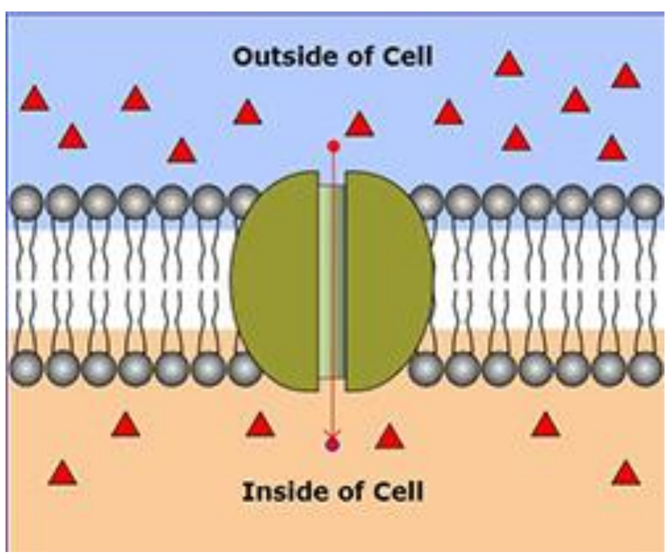
Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.1.2:** Analyze how the shape of a molecule determines its role in the many different types of cellular processes (e.g., metabolism, homeostasis, growth and development, and heredity) and understand that the majority of these processes involve proteins that act as enzymes.
Content Limits	Assess only the four major biomolecule groups (carbohydrates, lipids, proteins, and nucleic acids). Do not assess vitamins, co-enzymes, or cellular processes that play a role in feedback mechanisms. Do not include chemistry-specific information, including polarity, since students have no chemistry background. Questions should apply to specific cellular processes.
Construct-Relevant Vocabulary	active site, amino acid, carbohydrate, carbon, catalyst, denature, enzyme, glucose, lipid, macromolecule, nucleic acid, nucleotide, protein, reaction, reaction rate, reactivity, saturated, substrate, sugar, unsaturated
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students explain that enzymes are substrate-specific and increase the rate at which a reaction occurs.	
Students describe that conditions like high temperature and varying pH alter the shape of an enzyme’s active site, changing the rate of reaction.	
Students describe how a cell obtains, manufactures, and uses food, protein, and water with respect to protein synthesis, cellular respiration, and photosynthesis.	
Students identify the role of a molecule based on its shape, and explain how the shape of a molecule helps it fulfill its role in the cell.	
Sample Item	
What does the ribosome’s shape allow it to do during translation? A. enter the nucleus **B. attach to mRNA and tRNA** C. attach to proteins and DNA D. move easily through the cell membrane	

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.1.3:** Develop and use models that illustrate how a cell membrane regulates the uptake of materials essential for growth and survival while removing or preventing harmful waste materials from accumulating through the processes of active and passive transport.
Content Limits	Polarity should not be assessed. Limit to simple passive and active transport as defined by the evidence statements.
Construct-Relevant Vocabulary	bacteria, cell membrane, cell wall, cytoplasm, diffusion, energy, eukaryote, organelle, osmosis, prokaryote, selectively permeable
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students describe the structure and function of the cell membrane (i.e., the phospholipid bilayer, integral proteins, and carbohydrates).	
Students explain that molecules move passively down concentration gradients and require energy to move against concentration gradients, and predict how molecules/ions will move based on concentration gradient.	
Students construct analogies that describe how materials move in and out of cells across cell membranes (may be better for classroom assessments).	
Students compare active and passive transport, identify necessary components of cell transport, and draw an illustration of cell transport including osmosis, diffusion, facilitated diffusion, endocytosis, and/or exocytosis.	

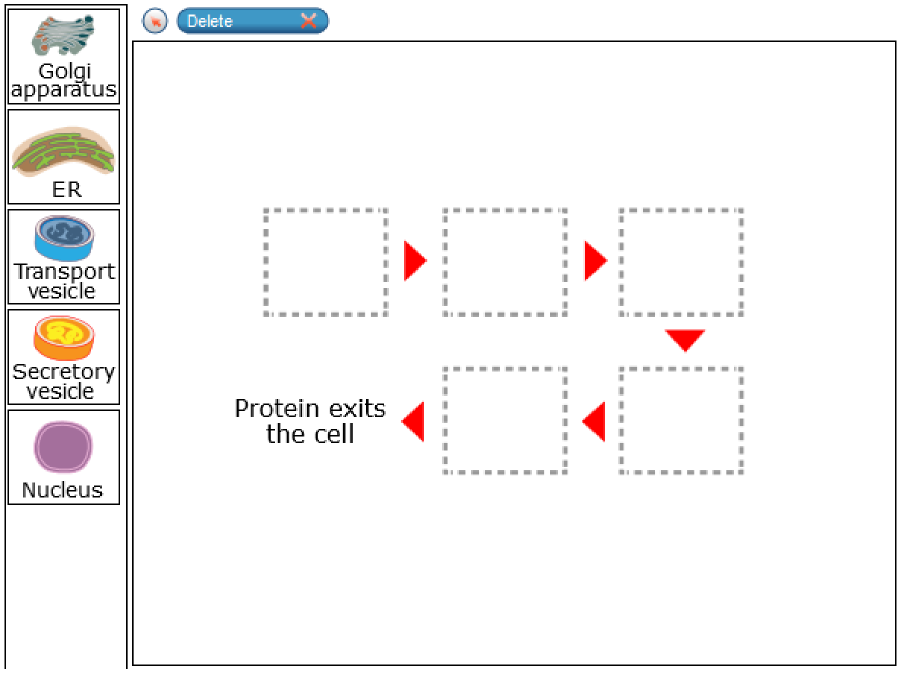
Sample Item
The picture shows part of a cell. The red triangles represent molecules. Use the Add Arrow button to draw **one** arrow to show the path and direction the molecules travel during facilitated diffusion.    Rubric: 

Accessibility and Accommodation Considerations

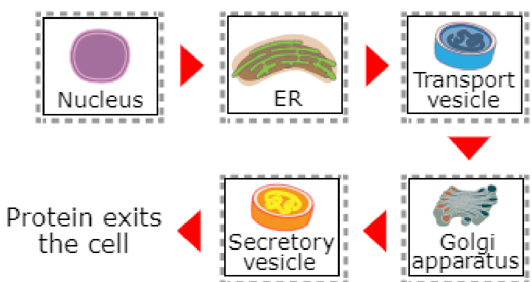
Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.1.4:** Develop and use models to illustrate how specialized structures within cells (i.e., nuclei, ribosomes, Golgi, endoplasmic reticulum) interact to produce, modify, and transport proteins.
Content Limits	Assess only the cell parts listed in the standard (focus on the parts involved in protein synthesis). Limit the scope of the Golgi and endoplasmic reticulum to their role in making, modifying, and transporting protein. Focus of the endoplasmic reticulum is on the rough endoplasmic reticulum, not on the smooth endoplasmic reticulum. Images of organelles should be labeled.
Construct-Relevant Vocabulary	active site, amino acid, bacteria, cell membrane, cell wall, cellular respiration, chloroplast, cytoplasm, diffusion, DNA, energy, eukaryote, mitochondrion, nucleotide, nucleus, organelle, osmosis, photosynthesis, prokaryote, protein, ribosome, RNA, sugar
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students identify, modify, and/or list steps of protein synthesis, including the order and location of each event, from the nucleus through the Golgi and transport/export by vesicles.	
Students assemble, modify, or complete a model of a cell focusing on protein synthesis.	

Sample Item
Protein synthesis requires the interaction of the Golgi apparatus, the nucleus, secretory vesicles, transport vesicles, and the endoplasmic reticulum (ER). Place the organelles into the blank boxes to model the steps of protein synthesis.



Rubric:



Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.1.5:** Develop and use a model to illustrate the hierarchical organization of interacting systems (cell, tissue, organ, organ system) that provide specific functions within multicellular organisms.
Content Limits	Do not assess specific tissue types or organs. Do not assess the interactions at the molecular level that give rise to different tissue types. Use animals, but not plants, as the context in the assessment.
Construct-Relevant Vocabulary	body systems, cell, cellular respiration, circulatory, digestive, excretory, external stimuli, function, immune, integumentary, muscle, nervous, organ, reproductive, respiratory, skeletal, structure, tissue
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students place levels of organization in order as described in the standard.	
Students explain that cells are organized into tissues, tissues organized into organs, organs into organ systems; each with distinct functions and composed of different types of cells.	
Sample Item	

An air conditioning system in an office building can be used to model the circulatory system in a multicelluar organism.

The parts and function of the air conditioning system are given in Table 1.

Identify how the parts of the air conditioning system can model the circulatory system in a multicellular organism.

Table 1. Air Conditioning System Parts and Function

Part	Function
Air Ducts	Channels that allow cool air from air conditioning units to move to different parts of the building
Air Conditioning Unit	Moves cool air through the first floor

Click on each blank box to:

- Identify the levels in the organizational hierarchy of multicellular organisms that each of the parts of the air conditioning system represent.
- Identify the function of each level in the organizational hierarchy of the circulatory system in a multicellular organism.

Organization of School Building	**Hierarchy of Multicellular Organisms**		**Function**	
Air Ducts	[▾]	Cells Organ **Tissue** Organ System	[▾]	Binds to oxygen **Blood vessels carry blood** Pumps blood through arteries and veins Exchanges oxygen and carbon dioxide with blood
Air Conditioning Unit	[▾]	Cells **Organ** Tissue Organ System	[▾]	Binds to oxygen Blood vessels carry blood **Pumps blood through arteries and veins** Exchanges oxygen and carbon dioxide with blood
Cool Air	[▾]	**Cells** Organ Tissue Organ System	[▾]	**Binds to oxygen** Blood vessels carry blood Pumps blood through arteries and veins Exchanges oxygen and carbon dioxide with blood

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.2.1:** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
Content Limits	Do not assess light/dark reactions and NAD^+/NADH molecules, the electron transport chain, or other specific steps of photosynthesis. Do not assess specific parts of a chloroplast. Do not use chemical formulas for sugars or chemical equations.
Construct-Relevant Vocabulary	algae, amino acid, ATP, autotroph(s), bond, carbon dioxide, cellular respiration, chemical equation, chlorophyll, chloroplast, cytoplasm, energy, energy flow, glucose, heterotroph(s), hydrocarbon, mitochondria, net transfer, nucleus, organic, photosynthesis, protein, vacuole
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students explain photosynthesis in terms of reactants (light energy, carbon dioxide, and water) and products (oxygen and sugar/glucose) and express that it takes place in chloroplasts.	
Students select the most accurate descriptive model of photosynthesis.	
Students describe the source of photosynthesis reactants and where the products go/what they are used for.	
Students explain that light energy is necessary to create ATP, that plants and algae grown without light cannot perform photosynthesis.	
Sample Item	
Which of the following describes the basic process that occurs in photosynthesis? A. Carbon dioxide and oxygen combine to form water and heat. B. Sugar and oxygen react to form water, chemical energy, and heat. C. Light energy is used to split sugar molecules into oxygen and carbon dioxide. **D. Light energy is used to transform water and carbon dioxide into oxygen and sugar.**	

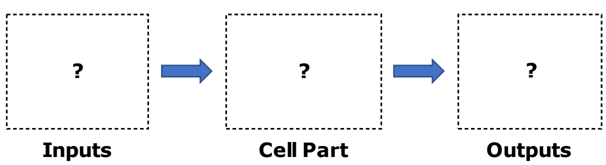
Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.2.2:** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
Content Limits	Do not assess the specific stages of respiration (e.g., glycolysis, Krebs cycle, electron transport chain). Do not assess specific locations within the mitochondria. Do not assess the term “chemiosmosis.”
Construct-Relevant Vocabulary	adenine, amino acid, ATP, carbon dioxide, cellular, chemical bonds, cytoplasm, cytosol, energy, energy transfer, enzymes, glucose (including chemical formula), glycolysis, mitochondria, molecules, nitrogen, oxygen, phosphate, photosynthesis, reaction, respiration, sugar, water
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students describe/explain cellular respiration in terms of reactants/inputs and products/outputs and express that it takes place in the mitochondria.	
Students select the best descriptive model of cellular respiration.	
Students explain that cellular respiration creates ATP, which is a form of energy that cells use to do work.	
Students show that the products are rearrangements of the reactants.	
Sample Item	

An incomplete model of cellular respiration is given in Figure 1.

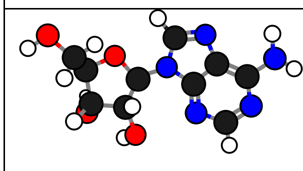
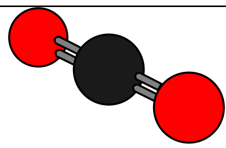
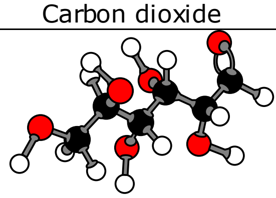
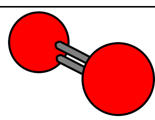
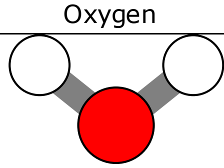
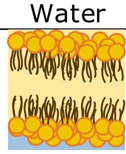
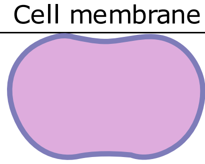
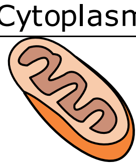
Figure 1. Cellular Respiration Model



Part A

Use the pictures of the possible model parts to complete the model given in Figure 1. The pictures are not to scale.

- Select the boxes to identify all inputs in the model.
- Select the box to identify all of the cell parts in the model.
- Select the boxes to identify all outputs in the model.
- Select the box to identify all parts that are not included in the model.

Possible Model Part	Inputs	Cell Part	Outputs	Not Relevant
 ATP			X	
 Carbon dioxide			X	
 Glucose	X			
 Oxygen	X			
 Water			X	
 Cell membrane				X
 Cytoplasm		X		
 Mitochondria				X

Part B

Which statement best describes what the model in part A shows?

A. New atoms form, absorbing energy.
B. Bonds rearrange, releasing energy.
C. Bonds break, releasing more energy than is absorbed.
D. Atoms rearrange, neither absorbing nor releasing energy.

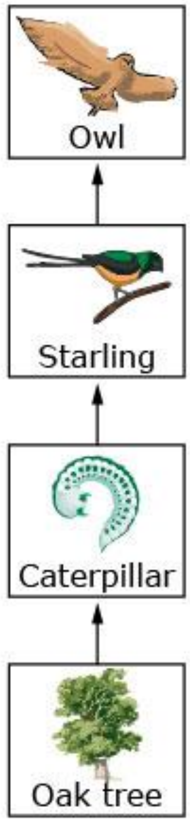
Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.2.3:** Use mathematical and/or computational representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
Content Limits	Do not assess potassium, phosphorus, sulfur, or various other cycles. Do not include biochemical reactions other than photosynthesis, cellular respiration, and nitrogen fixation.
Construct-Relevant Vocabulary	adenine triphosphate (ATP), atoms, cellular respiration, chemical equation/process/reaction, decomposer, energy requirements of living systems, equilibrium of ecosystems, flow of matter, food web, hydrocarbon, interdependent, molecules, nutrient, photosynthesis, predator-prey relationship, producer, solar energy, transfer system, trophic level
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students describe or interpret data that show carbon dioxide used by photosynthetic organisms was released during cellular respiration (photosynthetic organisms release oxygen, which organisms use during cellular respiration).	
Students describe the reduction of energy from one energy source to another. Students compare energy amounts in various organisms/trophic levels in an energy pyramid or food web/chain.	
Students use the approximate 10% rule to estimate the amount of energy in other trophic levels when given the amount of energy in one trophic level.	
Students complete or analyze for accuracy an energy, mass, or numbers pyramid.	

Sample Item
Figure 1 shows energy flow in a forest ecosystem food web.

Figure 1. Energy Flow in a Forest Ecosystem



The table shows that 100 g of caterpillars contain 430 k cal.

Enter a value in each blank cell to estimate the energy from the caterpillar available to the starling and the owl. Then, estimate the energy from the oak tree that was available to the caterpillars.

Organism	Energy (k cal /100 g)
Owl	**4.3**
Starling	**43**
Caterpillar	430
Oak tree	**4300**

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.2.4:** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
Content Limits	N/A
Construct-Relevant Vocabulary	atmosphere, biosphere, carbon, carbon dioxide, cellular respiration, chemical, chemical process, conservation, consumer, convert, cycle, decomposer, ecosystem, environment, food web, geosphere, human, hydrocarbon, hydrosphere, matter, microbes, organism, photosynthesis, photosynthetic plants, plant, plant matter, producer, product, react, recycle, store, transform
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students describe the sequence of steps in carbon cycle processes (cellular respiration, photosynthesis, combustion, etc.) and how carbon moves between the biosphere, atmosphere, hydrosphere, and geosphere.	
Students refine and/or correct models of carbon cycle processes.	
Students explain where each reactant/product originates when given both chemical equations for the processes.	
Sample Item	

Students use themselves to build a model of the carbon cycle. They form five groups to represent different parts of the cycle.

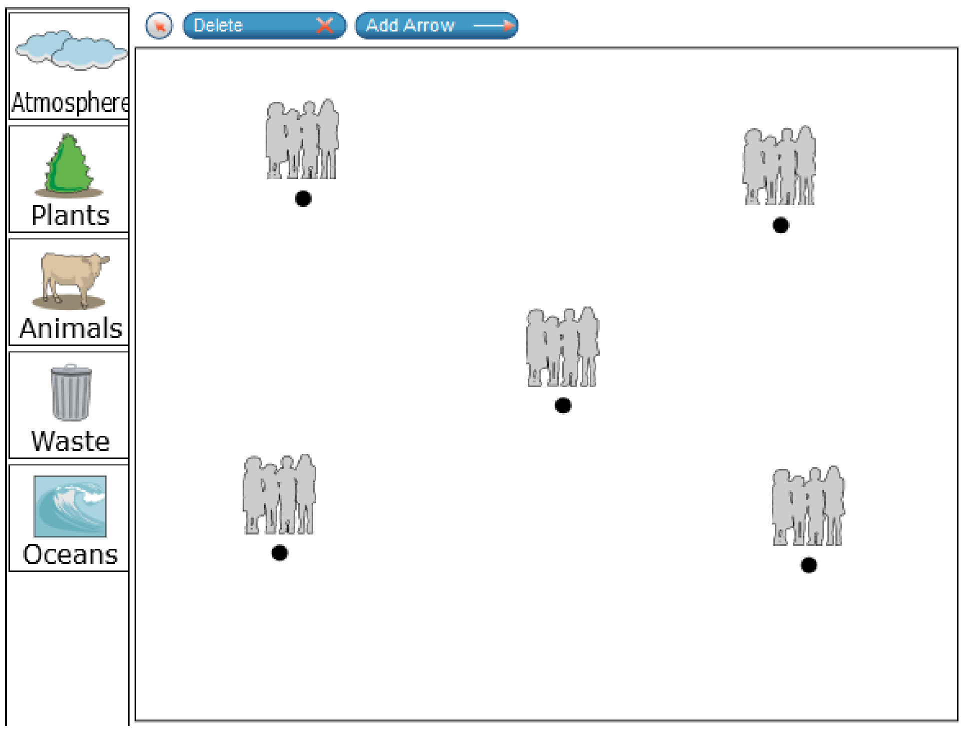
Select one process in the carbon cycle to model.

A. Cellular respiration
B. Photosynthesis

The five student groups and several parts of the carbon cycle are given.

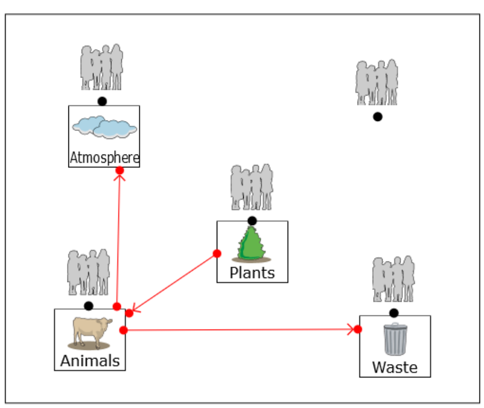
Click and drag one part of the carbon cycle to each of the black dots beneath the student groups. Then, use the Add Arrow button to draw arrows between the groups. The arrows will represent how each group transfers carbon to other groups.

- Make sure to click and drag only one part of the carbon cycle to each group.

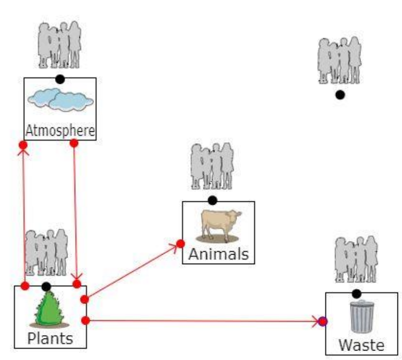


Rubric:

If “cellular respiration” is selected:



If “photosynthesis” is selected:



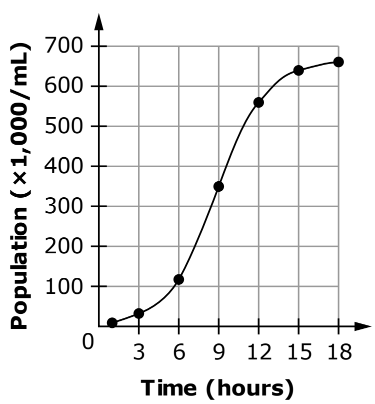
Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.3.1:** Use mathematical and/or computational representation to explain why the carrying capacity ecosystems can support is limited by the available energy, water, oxygen, and minerals and by the ability of ecosystems to recycle the remains of dead organisms.
Content Limits	Do not assess types of growth curves (e.g., S vs. J). Focus on the causes for different growth patterns instead.
Construct-Relevant Vocabulary	abiotic, abundance, anthropogenic, biotic, birth(s), carrying capacity, climate change, competition, death(s), disturbance, emigrants, equilibrium of ecosystems, exponential, finite, fluctuation, generation, immigrants, interdependent, invasive species, limiting resources, logistic, negative feedback, overexploitation, population, population control, predation, rebounding, resilient, stable, sustain, urbanization
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Given data, students generate a graph showing population change.	
Students explain what is happening during different time periods shown in a graph.	
Students explain and/or identify the patterns or trends during different time periods shown in a graph (e.g., population growing, eventually leveling off as carrying capacity is reached).	
Given data, students explain population growth in an ecosystem in terms of limiting factors.	
Students analyze a data table that contains information about two different ecosystems.	
Students compare and contrast the available resources to determine whether either, neither, or both of the ecosystems have reached carrying capacity.	
Sample Item	

A yeast population grown in a laboratory is given in Figure 1.

Figure 1. Yeast Populatior over Time



Click on the boxes to identify a reason for the population trend during three different time periods.

	Hours 1-6	Hours 6-12	Hours 12-18
The yeast population doubles every 90 minutes.		X	
Ethanol builds up in the yeast's environment.			X
Wild yeast cells adjust to the laboratory environment.	X		

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.3.2:** Design, evaluate, and refine a model which shows how human activities and natural phenomena can change the flow of matter and energy in an ecosystem and how those changes impact the environment and biodiversity of populations in ecosystems of different scales, as well as how these human impacts can be reduced.
Content Limits	Do not assess specific types of ecological successions. Provide enough context to answer the item, and focus on Indiana-based scenarios.
Construct-Relevant Vocabulary	atmosphere, atoms, biodiversity, biosphere, carbon, carbon dioxide, carbon footprint, carrying capacity, climate, competition, compounds, conversation biology, conservation of energy, conservation of matter, ecosystems, endangered species, extinction, geosphere, greenhouse effect, hydrogen, hydrosphere, introduced species, molecules, nitrogen, overharvesting, oxygen, photosynthesis, population, seasonal changes, species, threatened species, urbanization
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students design/describe a solution to an environmental problem to show how impacts can be reduced (e.g., habitat restoration, reduction in non-renewable consumption, etc.).	
Students explain how communities with greater diversity are more resistant to factors that create change.	
Students describe how humans can affect biodiversity, and/or explain how human impact has altered an ecosystem, and/or propose remedies for negative human impacts and identify ways to preserve natural resources.	
Students evaluate data presented to determine what effect it might have on an environment and/or propose solutions based on those data.	
Sample Item	
Karner blue butterflies live in areas of Indiana where lupines grow. Lupines are fast-growing flowering plants that grow in open spaces. The adult butterflies lay their eggs on lupine leaves and feed on the flowers' nectar. The butterfly larvae feed on the lupine leaves. The butterfly and the lupine go through life stages during spring and summer, as given in Table 1.	

Table 1. Karner Blue Butterfly and Lupine Life Stages by Month

	April	May	June	July	August
Karner Blue Butterfly	Few larvae hatch and grow	Larvae grow into adults	Adults lay eggs, many larvae that hatch and grow	Adults lay eggs that survive through the winter	Eggs remain inactive through the winter
Lupine	Plants grow leaves	Plants grow leaves and flowers bloom	Seeds mature and disperse	No more growth	No more growth

The habitat of the Karner blue butterfly has become overgrown. Scientists want to restore the habitat. They suggest using a controlled burn to clear away dead plant material.

Part A

During which month would the controlled burn have the least impact on the butterfly population?

A. April
B. May
C. June
D. July
E. August

Part B

Select the **two** statements that support your answer in part A.

A. Both larvae and adults.
B. The lupines are done growing.
C. Most of the larvae are about to hatch.
D. Eggs are hatching and becoming adults.
E. The lupines have dispersed their seeds.

Part C

What additional step can scientists take to positively impact the butterflies' habitat?

A. Add herbicides to prevent the growth of plants other than lupines.
B. Stop the controlled burns and rely on natural wildfires in the future.
C. Introduce another insect to provide competition for space on the lupines.
D. Spread lupine seeds and young plants to new and different locations.

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.3.3:** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, and identify the impact of changing conditions or introducing non-native species into that ecosystem.
Content Limits	Whenever possible, use scenarios relevant to Indiana. Do not require students to distinguish types of succession or to know the causes of mass extinctions on the assessment.
Construct-Relevant Vocabulary	biodiversity, biosphere, carbon cycle, carbon dioxide, conditions, consistent, consumer, decomposer, disturbance, ecosystem, emergence, environment, equilibrium, extinction, fire, flood, fluctuation, force, habitat, human impact, invasive, native, niche, nitrogen cycle, non-native, organism, overgrazing, photosynthesis, primary succession, producer, resilience, resources, secondary succession, species, stable, storm, succession, water cycle
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students identify the claim that is best supported, citing specific evidence, when given two or more claims that explain the impact of a change to an ecosystem (including the introduction of non-native species).	
Students select the most likely result or impact from a specific change to environmental conditions or introduction of a non-native species in an ecosystem.	
Students explain and/or identify that non-native species may be less successful in diverse communities and that non-native species may become invasive in environments in which limiting factors such as predators have been removed.	
Students evaluate data, tables, and/or graphs to determine what effect an environmental change or non-native species might have on an environment.	
Students evaluate data to determine what effect an environmental change or non-native species may have on an ecosystem.	
Sample Item	
Deer were introduced to an island forest reserve in 1970. The forest management monitored the deer population over 12 years. They also documented environmental factors that could affect the deer. The data are given in Table 1.	

Table 1. Island Forest Reserve Data

Year	Deer Population	Deer Offspring	Wolf Population	Deer Hunted by Humans	Square Miles of Vegetation
1971	2125	800	15	18	500
1972	2350	855	12	16	467
1973	2586	931	16	20	442
1974	2889	954	12	19	387
1975	3168	1008	11	16	314
1976	3222	1133	15	17	231
1977	2697	882	15	18	182
1978	2133	849	14	20	155
1979	2049	750	16	19	133
1980	2001	730	13	19	137
1981	1995	726	18	16	144
1982	1992	734	19	15	148

Which statement is the **best** explanation of the data?

A. The deer population decreased because fewer offspring were produced between 1980 and 1982.
B. The deer population decreased because there was less vegetation between 1977 and 1979.
C. The deer population increased because there was less hunting by humans between 1974 and 1976.
D. The deer population increased because there was less predation by wolves between 1971 and 1973.

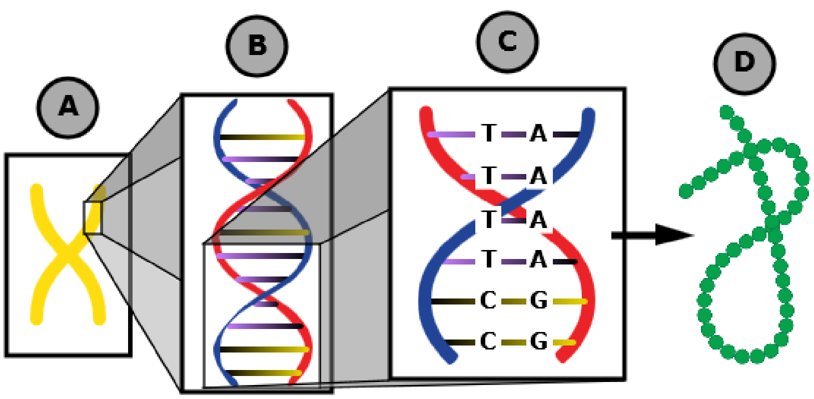
Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.4.1:** Develop and revise a model that clarifies the relationship between DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
Content Limits	Do not assess the distinction between chromatids and chromosomes, centromeres, telomeres, and histones.
Construct-Relevant Vocabulary	allele, codominance, diploid, dominant, F1, F2, fertilization, genome, genotype, haploid, incomplete dominance, meiosis, mitosis, parent generation, pedigree, phenotype, protein, Punnett square, recessive, replication, sequencing, sex-linked, transcription, translation, zygote
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students select the best representation of multiple models of DNA and/or chromosomes, such as double-helical structure of DNA, nucleotide-pairing, etc.	
Students explain or revise statements about the relationship between DNA and chromosomes.	
Students explain that genes are sections of DNA that coil into chromosomes (a section of DNA codes for a specific protein, which influences specific traits).	
Students identify the parts of a chromosome (DNA and proteins).	
Sample Item	

Structures responsible for the inheritance of traits in organisms are modeled in Figure 1.

Figure 1. Model



Click on the blank box in the **Structure** column to match each structure with its function in the inheritance of traits in organisms. Then, click on the blank box in the **Letter** column to match each structure to a letter in the model.

Function	Structure		Letter	
Contains many sections of genetic code that determine traits		Gene Protein **Chromosome** DNA molecule		**A** B C D
The genetic information that determines an organism's phenotype		Gene Protein Chromosome **DNA molecule**		A **B** C D
A sequence of amino acids, which are coded for by genetic material		Gene **Protein** Chromosome DNA molecule		A B C **D**
A section of genetic material that codes for specific functions or processes		**Gene** Protein Chromosome DNA molecule		A B **C** D

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.4.2:** Construct an explanation for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
Content Limits	Do not assess the subcomponents of a nucleotide. Do not assess specific knowledge of errors resulting from any deletions or insertions. Do not assess specific mechanisms of gene regulation.
Construct-Relevant Vocabulary	adenine, base, cell, chromosome, cytosine, deoxyribose, DNA, double helix, function, gene, genetic, guanine, hydrogen bond, molecule, nucleated cell, nucleotide, nucleus, phosphate, protein, RNA, structure, thymine, transcription
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students explain how the structure of DNA determines the structure of proteins and why proteins are essential to life.	
Students explain that DNA consists of small sections called genes which code for proteins (all genes in a particular cell are not expressed).	
Students describe the flow of information in the cell from DNA to RNA to proteins.	
Sample Item	

The steps list the processes of protein formation.

The steps given are out of order.

A. A ribosome attaches to mRNA.
B. mRNA travels outside the nucleus.
C. A polypeptide is released from the ribosome.
D. An mRNA strand forms from a section of DNA.
E. Ribosomes link amino acids in a chain, according to the order of the bases in mRNA.

Which sequence is the correct order of these steps?

A. A, D, C, B, E
B. D, C, B, A, E
C. A, E, C, B, D
D. D, B, A, E, C

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.4.3:** Construct a model to explain that the unique shape and function of each protein is determined by the sequence of its amino acids, and thus is determined by the sequence of the DNA that codes for this protein.
Content Limits	Include codon chart for any items that require it. Do not assess specific types of mutations: insertions, deletions, missense, nonsense, non-disjunction, etc.
Construct-Relevant Vocabulary	active site, amino acid, anti-codon, codon, DNA, nucleotide, protein, protein folding, reaction, reactivity, ribosome, RNA, sub-unit, transcription, translation
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students explain that DNA codes for a specific protein and the order of amino acids determines the shape/function of that protein.	
Students describe how a mutation may affect the structure and function of a protein.	
Students determine the mRNA that would be transcribed, then translate the mRNA into a sequence of amino acids using a codon chart provided with a strand of DNA.	
Sample Item	

Table 1 is a codon chart.

Table 1. Codon Chart

Second Position

First Position	U	C	A	G	Third Position
U	Phe	Ser	Tyr	Cys	**U**
	Phe	Ser	Tyr	Cys	**C**
	Leu	Ser	*Stop*	*Stop*	**A**
	Leu	Ser	*Stop*	Trp	**G**
C	Leu	Pro	His	Arg	**U**
	Leu	Pro	His	Arg	**C**
	Leu	Pro	Gln	Arg	**A**
	Leu	Pro	Gln	Arg	**G**
A	Ile	Thr	Asn	Ser	**U**
	Ile	Thr	Asn	Ser	**C**
	Ile	Thr	Lys	Arg	**A**
	Met	Thr	Lys	Arg	**G**
G	Val	Ala	Asp	Gly	**U**
	Val	Ala	Asp	Gly	**C**
	Val	Ala	Glu	Gly	**A**
	Val	Ala	Glu	Gly	**G**

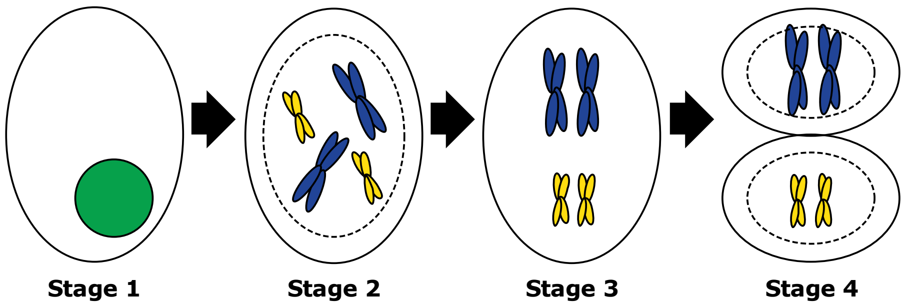
Transcribe the DNA triplet in each row into the mRNA codon. Then, translate those mRNA codons into the resulting amino acid.

DNA Triplet	mRNA Codon	Amino Acid
AGT	**UCA**	**Ser**
CCA	**GGU**	**Gly**

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.4.4:** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
Content Limits	Do not assess the specific phases of mitosis. Do not use terms “haploid” or “diploid.”
Construct-Relevant Vocabulary	anaphase, chiasmata, chromatin modification, cleavage furrow, cytokinesis, cytoplasmic determinants, enhancers, G1 phase, G2 phase, inductive signals, interphase, kinetochore, metaphase, metaphase plate, microtubule, post-transcriptional regulation, noncoding RNAs, prophase, S phase, spindle, telophase, transcription factors, transcription regulation initiation
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students select or describe the role of mitosis as the connector between zygote and complex, multicellular organisms.	
Students recognize that cell differentiation results from different gene expression of identical DNA sequences, and describe the role of cell differentiation in producing levels of structural organization in multicellular organisms.	
Students explain that mitosis is part of the cell cycle that creates identical daughter cells, and that multicellular organisms use mitosis for growth and to repair and replace damaged cells.	
Students select the best explanation of the process of mitosis and/or differentiation.	
Students revise or correct explanations or models of mitosis and/or differentiation.	

Sample Item
An incorrect model of cellular division (mitosis) is given in Figure 1. **Figure 1. Incorrect Model of Cellular Division (Mitosis)**    Which stage of cellular division first introduces an error into this model? A. Stage 1 B. Stage 2 **C. Stage 3** D. Stage 4

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.4.5:** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and (3) mutations caused by environmental factors.
Content Limits	Do not assess the phases/stages and specific reactions of meiosis. Do not use "haploid" or "diploid." Do not assess specific types of mutations: insertions, deletions, missense, nonsense, non-disjunction, etc.
Construct-Relevant Vocabulary	autosome, chromosome, crossing over, daughter cell, fertilization, gamete, independent assortment, meiosis, mitosis, mutation, parent cell, recombination, replication, variation, zygote
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students defend a claim that variation could still occur when given situations in which one of the three methods of variation is eliminated.	
Students explain that meiosis results in genetically different cells that typically contain half the chromosome number of the parent cell.	
Students describe how meiosis occurs, causing gametes to contain half the number of chromosomes and why this is important for fertilization to take place.	
Students describe how variation is introduced in sexual reproduction due to meiosis (independent assortment and crossing over) and how random fertilization also creates variation.	
Students predict the possible outcomes and/or describe different causes when given a simple mutation.	
Sample Item	
Which of these does NOT result from meiosis? A. Gametes are formed. **B. A zygote is produced.** C. Mixing of genetic material during chromosome replication (crossing-over). D. Daughter cells are produced with half the number of chromosomes of the parent cell.	

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.4.6:** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
Content Limits	Punnett squares should be limited to one trait.
Construct-Relevant Vocabulary	allele, carrier, character, codominance, complete dominance, dominant, F_1 generation, F_2 generation, fertilization, gamete, gene, genotype, heredity, heterozygous, homozygous, incomplete dominance, Mendelian genetics, P generation, pedigree, phenotype, probability, Punnett square, recessive, sex-linked traits, trait, zygote
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students calculate phenotypic and genotypic ratios using a Punnett square.	
Students predict genotypes and phenotypes of parents based on offspring.	
Students describe the limitations and merits of Punnett squares as predictive models of offspring characteristics at the population level.	
Students compare different inheritance patterns within or among populations (e.g., codominance, incomplete dominance, dominant/recessive).	

Sample Item
In giraffes, the allele for albinism (*m*) is recessive to the dominant allele for pigmentation (*M*). The phenotypes of the offspring from two parent giraffes are shown in Table 1.

Table 1. Phenotypes of Giraffe Offspring

Phenotype	Number of Offspring
Albino	4
Pigmented	3

Click on each blank box to select the likely genotypes of the offspring's parents.

Parents	Genotype	
Parent 1		**mm** Mm MM
Parent 2		mm **Mm** MM

OR

Parents	Genotype	
Parent 1		mm **Mm** MM
Parent 2		**mm** Mm MM

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.5.1:** Evaluate anatomical and molecular evidence to provide an explanation of how organisms are classified and named based on their evolutionary relationships into taxonomic categories.
Content Limits	Do not assess kingdom, phylum, class, order, family, genus, or species.
Construct-Relevant Vocabulary	analogous, anatomical, ancestor, ancestry, diversity, evolve, extinct, extinction, fossil, homologous, mineral, multicellular, organelles, organism, radioactive dating, species, structure, unicellular
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students place organisms into taxonomic categories based on evolutionary information such as DNA, amino acid sequences, anatomical features, etc.	
Students use phylogenetic trees to explain common ancestry.	
Students interpret/explain the relationships among the different organisms given a cladogram or phylogenetic tree.	
Students identify closely related species given molecular and anatomical evidence.	

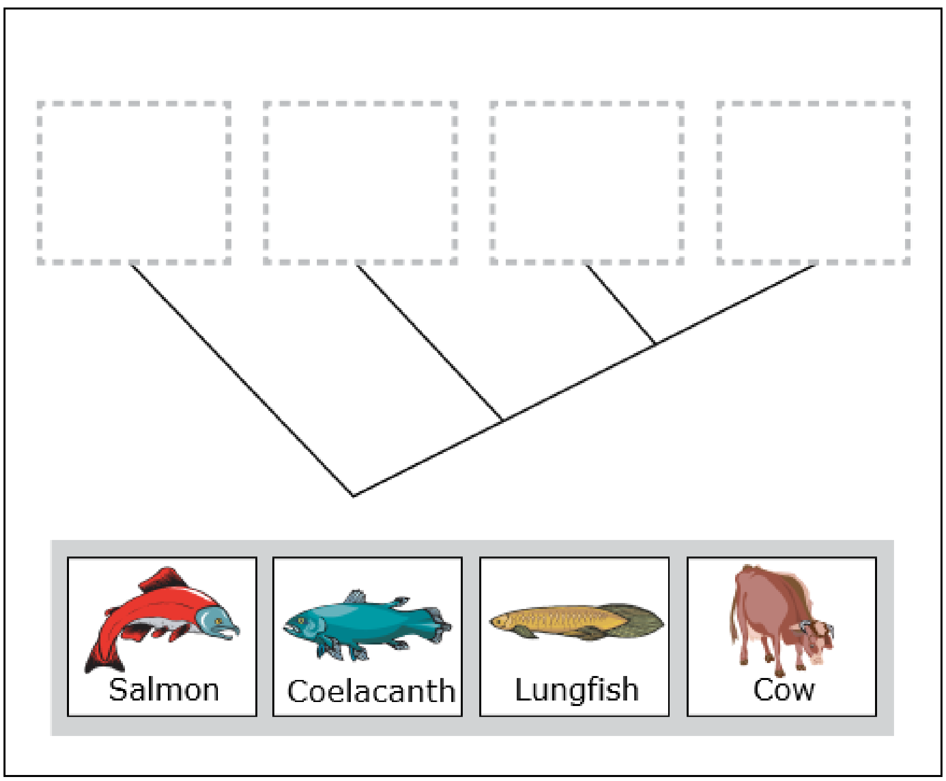
Sample Item

Table 1 gives physical traits of four different animals.

	Salmon	Coelacanth	Lungfish	Cow
Jaws	X	X	X	X
Rounded Fins		X	X	
Lungs		X	X	X
Four Legs with Toes				X

New genetic research indicates that cows and lungfishes produce a protein that the salmon and coelacanth do not produce.

Move an organism into each box to construct a cladogram showing relationships among salmon, coelacanth, lungfish, and cows, based on the data in Table 1 and the findings about the protein



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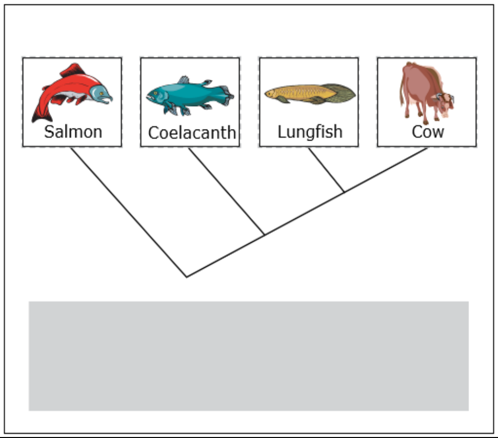


Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.5.2:** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence including both anatomical and molecular evidence.
Content Limits	Do not include specific different types of evolution (divergent, convergent, etc.). Do not assess the definitions of "analogous" or "vestigial structures."
Construct-Relevant Vocabulary	amino acids, analogous structures, cladogram, common ancestry, comparative anatomy, descent with modification, DNA sequencing, electrophoresis, embryology, evolution, evolutionary tree, fossil record, gene flow, genetic drift, genetic sequencing, genetic variation, genome, heritable traits, homologous structures, molecular, mutation, natural selection, nucleotides, phenotype, sedimentary layers, species, vestigial structures
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text

Evidence Statements
Students use at least two different types of evidence to explain evolution, such as anatomical (fossil or extant) or molecular evidence.
Students describe the concepts that homologous traits indicate common ancestry and analogous traits do not and that vestigial traits indicate a recent ancestor used that structure for a purpose that is no longer needed.
Students explain how molecular and anatomical evidence support the theory of evolution and common ancestry.
Students select evidence that best supports a claim regarding evolutionary relationships given data sets.

Sample Item

Scientists look at the shoulder and arm bones in two groups of dinosaurs.

Both groups:

- are extinct;
- walked on two legs;
- ate meat.

Some anatomical characteristics of both groups are given in Table 1.

Table 1. Arm Features of Two Dinosaur Groups

Group A	Group T
• Lower arm bones are short • Elbow joint cannot bend • Fingers are short and small	• Lower arm bones are long • Elbow joint bends • Fingers are long with large claws

Scientists hypothesize that these two groups are related. They also hypothesize that the arms of dinosaur group A are vestigial structures.

An older fossil is found that may be a recent common ancestor of these two groups. Select **three** characteristics of this new fossil that would support this hypothesis.

A. Ate plants
B. Small fingers
C. Large hind legs
D. Claws on fingers
E. Elbows that bend
F. Short lower arm bones

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.5.3:** Apply concepts of statistics and probability to support a claim that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
Content Limits	Do not assess the term Hardy–Weinberg or the actual formula. Do not assess the term directional selection.
Construct-Relevant Vocabulary	adaptation, allele, directional selection, diversifying (disruptional) selection, fitness, gene, heritability, mean, natural selection, stabilizing selection, standard deviation, trait, variation, vestigial structure
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students answer questions by applying percentages and rates when given survival and reproduction data based on traits in a population.	
Students identify which organisms have an advantageous trait when given reproductive rates.	
Students explain that since traits are reflective of genes, the genotypes of advantageous traits increase in frequency.	
Students predict what the future would bring to a species given a set of potential environmental conditions.	
Students calculate proportions of the number of organisms after different amounts of time, under differing conditions.	
Sample Item	

In areas of England in the 1800s, white peppered moths perched on light colored trees. White moths were more common than black moths during that time. Then, pollution increased and soot covered the trees making them dark. The black moth population increased because predators could spot white moths more easily on the darkened tree trunks.

What biological principle does this situation demonstrate?

A. Individual traits in an organism reflect its genotype.
B. Toxins have a greater effect on some organisms than on others.
C. When a population of a single species is separated geographically, they become different species.
D. The number of organisms with an advantageous heritable trait increases in a population over time.

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

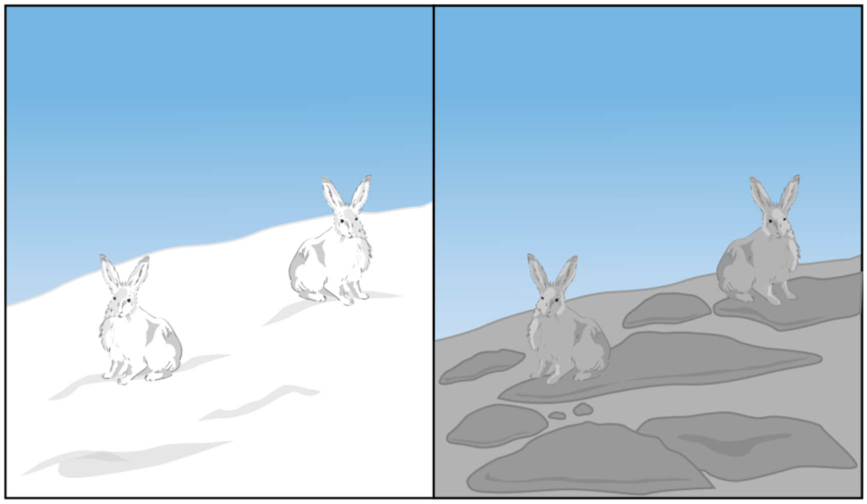
Content Standard	**B.5.4:** Evaluate evidence to explain the role of natural selection as an evolutionary mechanism that leads to the adaptation of species, and to support claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and/or (3) the extinction of other species.
Content Limits	Evidence will be limited to that of the natural world.
Construct-Relevant Vocabulary	abiotic, adaptation, advantageous, beneficial change, biotic, bottleneck effect, detrimental change, distribution, diverge, emergence, evolution, founder effect, frequency, gene, gene flow, gene pool, genetic variation, geographic isolation, heritable, hybrid, island effect, microevolution, mutation, natural selection, population, proliferation, recombination, sexual reproduction, speciation
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students use evidence to explain how natural selection played a role in any trends in the data when given graphs with changes in the number of species over time and data about the environment.	
Students explain that changes in the environment can make a trait more or less advantageous and natural selection will increase/decrease its frequency in the population.	
Students explain that individuals get selected for or against based on traits that they possess, which plays a factor in evolution's acting on populations over generations.	
Students interpret situations regarding how various factors lead to the emergence or extinction of a species.	
Sample Item	
Long-tailed weasels (*Mustela frenata*) are found in the Rocky Mountains. They change colors over the course of the year. They are brown in the summer. They are white in the winter. Over the next century, winter is predicted to begin later in the year. Winter is also predicted to be shorter in length. Which statement explains how changes in the timing and length of winter will affect long-tailed weasels in the Rocky Mountains? A. Genetic diversity of the weasels will decrease. B. The population size of the weasels will decrease. C. Natural selection will result in a greater number of white weasels. **D. The number of weasels that change from brown to white in January will increase.**	

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.5.5:** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
Content Limits	Do not assess types of natural selection.
Construct-Relevant Vocabulary	abiotic, adaptation, advantageous, beneficial change, biotic, bottleneck effect, detrimental change, distribution, diverge, emergence, evolution, founder effect, frequency, gene, genetic variation, geographic isolation, heritable, island effect, mutation, natural selection, proliferation, recombination, sexual reproduction
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students explain how one or more of the four factors play a role in the process of evolution/natural selection given a scenario.	
Students compare characteristics of multiple species and predict and/or justify which has a better chance of survival, based on evidence.	
Sample Item	
A population of rabbits live an arctic ecosystem. Over several decades the amount of snowfall in this ecosystem decreases. The changing in snowfall amounts and the rabbits that are common in both situations are given in Figure 1.	

Figure 1. Changing Arctic Ecosystem



Which factor explains the changing rabbit population?

- **A. The fur color trait is passed on from parents to offspring.**
- B. The rabbits have been able to easily find unlimited food and shelter supplies.
- C. The rabbits have only produced a few offspring while the ecosystem has been changing.
- D. Rabbits with white fur have been better able to hide from predators in the changing ecosystem.

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**B.5.6:** Analyze and interpret data for patterns in the fossil record and molecular data that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
Content Limits	Do not assess geological eras/epochs or carbon dating methods. Do not assess the definitions of uniformitarianism, gradualism, or punctuated equilibrium.
Construct-Relevant Vocabulary	anatomical, ancestor, ancestry, diversity, evolve, extinct, extinction, fossil, mineral, multicellular, nucleus, organelle, organism, radioactive dating, sedimentary rock, species, structure, unicellular, volcanic rock
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Multiple Choice Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students explain how a given pattern in the fossil record and/or molecular data shows how organisms evolved/became extinct over time.	
Students select situations that abide by or violate uniformitarianism, gradualism, and/or punctuated equilibrium.	
Students use molecular, fossil record, and anatomical similarities to describe relationships among taxa.	
Sample Item	
Which conclusion is supported by Earth's fossil record? A. Organisms no longer evolve. **B. Species have changed over time.** C. All organisms leave fossil evidence. D. The total number of species on Earth has remained constant over time.	

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

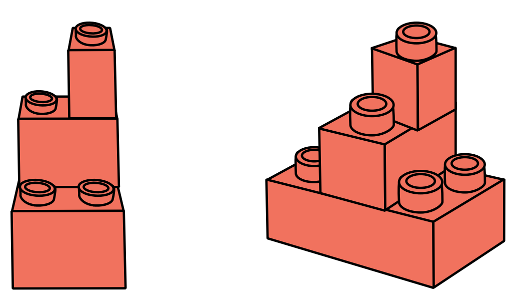
Content Standard	**SEPS.1:** Posing questions (for science) and defining problems (for engineering) A practice of science is posing and refining questions that lead to descriptions and explanations of how the natural and designed world(s) work, and these questions can be scientifically tested. Engineering questions clarify problems to determine criteria for possible solutions and identify constraints to solve problems about the designed world.
Content Limits	This SEPS can be assessed in conjunction with IAS B.4.2, B.5.2, and B.5.5.
Construct-Relevant Vocabulary	constraint, criteria, data, design, experiment, impact, investigation, solution, variable
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response
DOK	2
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students evaluate, propose, or clarify questions and/or design problems to see if they are testable and relevant.	
Students generate questions based on a scenario that can be answered by scientific investigations.	
Students identify criteria and constraints for design solutions.	
Sample Item	

Students use toy bricks to model the process that generates an enzyme-substrate complex.

These are the steps the students followed:

1. The teacher builds the substrate, as given in Figure 1.

Figure 1. Substrate



Front view Side view

2. The teacher provides two DNA sequences for part of the normal enzyme, as given in Table 1. The normal enzyme fits, or locks, with the substrate.

Table 1. Normal Enzyme: DNA Sequence and Mutated DNA Sequence

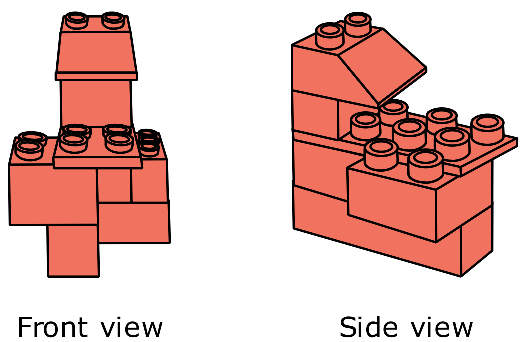
DNA Sequence	CGA–TAA–TCA–TAA–CAA–GAT-ACC-GTG-TAA-CTA
Mutated DNA Sequence	CGA–TAA–TAA–TAA–CAA–GAT-ACC-GTG-TAA-CTA

3. The students use the Universal Genetic Code to determine which amino acid sequence is coded for by each DNA strand.

4. The students use a key to match amino acid sequences to toy brick shapes.

5. The students use the resulting toy brick sequences to build two models of the normal enzyme. One model is given in Figure 2.

Figure 2. Normal Enzyme



Select the **two** questions the students can answer if they follow the described steps.

A. Why do DNA mutations occur?
B. **How do DNA mutations affect the functions of proteins?**
C. Why do mutated proteins have no effect on the structure of DNA?
D. How does the structure of DNA determine the structure of proteins?
E. How does the way an enzyme and a substrate fit together affect the structure of DNA?

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**SEPS.2:** Developing and using models and tools A practice of both science and engineering is to use and construct conceptual models that illustrate ideas and explanations. Models are used to develop questions, predictions, and explanations; analyze and identify flaws in systems; build and revise scientific explanations and proposed engineered systems; and communicate ideas. Measurements and observations are used to revise and improve models and designs. Models include, but are not limited to: diagrams, drawings, physical replicas, mathematical representations, analogies, and other technological models. Another practice of both science and engineering is to identify and correctly use tools to construct, obtain, and evaluate questions and problems. Utilize appropriate tools while identifying their limitations. Tools include, but are not limited to: pencil and paper, models, a ruler, a protractor, a calculator, laboratory equipment, safety gear, a spreadsheet, experimental data collection software, and other technological tools.
Content Limits	This SEPS can be assessed in conjunction with IAS B.1.1, B.1.2, B.1.5, B.4.1, and B.4.3. Context/models/graphs/tools should be grade-level appropriate.
Construct-Relevant Vocabulary	constraint, criteria, data, design, experiment, impact, investigation, limitation, solution, variable
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response Grid Item (GI) Simulation (Sim) Technology-Enhanced
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students develop (assemble from components; construct graphs; correct/refine/revise an existing model) a model to test their questions.	
Students analyze a given model to identify/construct questions/predictions.	
Students select the most appropriate model/tool in each situation and explain their selection.	
Students use appropriate tools to accomplish tasks during an investigation.	
Sample Item	
Neurons are the smallest functional unit of the nervous system. Neurons and neuroglial cells form nerves, which provide a pathway for nerve impulses. The nervous system also includes the brain, the spinal column, and other components.	

A student created this model after reading the passage.

cells → tissues → organs → organ systems → organism

Based on the student's model, neurons would best be identified as [▾]

because they [▾]

cells	are part of a body system
tissues	consist of more than one type of cell
organs	**are the basic unit of the nervous system**

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**SEPS.3:** Constructing and performing investigations Scientists and engineers are constructing and performing investigations in the field or laboratory, working collaboratively as well as individually. Researching analogous problems in order to gain insight into possible solutions allows them to make conjectures about the form and meaning of the solution. A plan to a solution pathway is developed prior to constructing and performing investigations. Constructing investigations systematically encompasses identified variables and parameters generating quality data. While performing, scientists and engineers monitor and record progress. After performing, they evaluate to make changes to modify and repeat the investigation if necessary.
Content Limits	This SEPS can be assessed in conjunction with IAS B.2.3, B.3.1, B.4.6, B.5.3, and B.5.6. Analogous problems need to be grade-level appropriate.
Construct-Relevant Vocabulary	constraint, control, criteria, data, dependent variable, design, experiment, impact, independent variable, investigation, limitation, solution, variable
Recommended Response Mechanisms (Item Types)	Extended Response
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students select or describe methods of researching problems to identify solutions and how to reach those solutions by using a systematic approach.	
Students can identify all needed controls and independent/dependent variables in an investigation.	
Students plan, perform, evaluate, and/or modify a planned or simulated scientific investigation.	

Sample Item

Students plan an experiment to investigate how matter cycles among organisms in a water ecosystem.

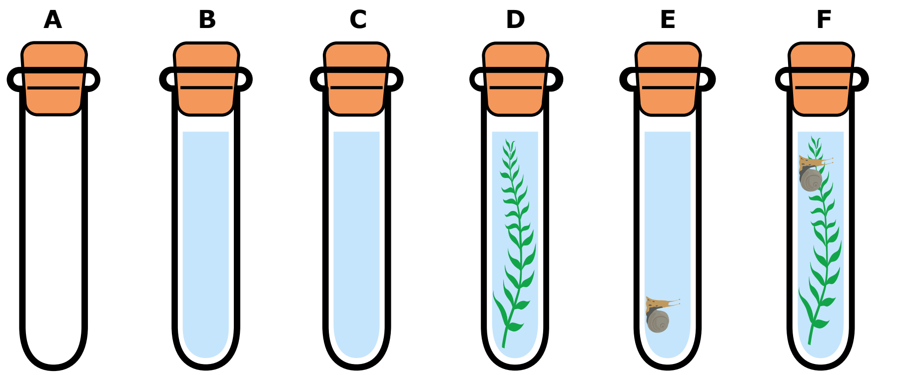
These are the materials available for the experiment.

Materials

- 6 test tubes and stoppers
- 1 test tube rack
- 60 milliliters distilled water
- 10 milliliters indicator that changes the color of liquid when carbon dioxide is present
- 6 sprigs plant that lives in water
- 6 snails animal that lives in water

The contents of six test tubes that can be used in the experiment are given in Figure 1.

Figure 1. Test Tubes to Possibly Use in Experiment



A	B	C	D	E	F
• No water	• 10 mL water	• 10 mL water	• 10 mL water	• 10 mL water	• 10 mL water
• No drop of indicator	• No drop of indicator	• 1 drop of indicator	• 1 drop of indicator	• 1 drop of indicator	• 1 drop of indicator
• No sprig	• No sprig	• No sprig	• 1 sprig	• No sprig	• 1 sprig
• No snail	• No snail	• No snail	• No snail	• 1 snail	• 1 snail

Click on the blank box next to each test tube in the table to select its purpose in the students' experiment.

Test Tube	Purpose in Experiment	
A		**No purpose** Serves as a control Provides evidence of the cycling of carbon dioxide Provides evidence of the production of carbon dioxide Provides evidence of the consumption of carbon dioxide
B		**No purpose** Serves as a control Provides evidence of the cycling of carbon dioxide Provides evidence of the production of carbon dioxide Provides evidence of the consumption of carbon dioxide
C		No purpose **Serves as a control** Provides evidence of the cycling of carbon dioxide Provides evidence of the production of carbon dioxide Provides evidence of the consumption of carbon dioxide
D		No purpose Serves as a control Provides evidence of the cycling of carbon dioxide Provides evidence of the production of carbon dioxide **Provides evidence of the consumption of carbon dioxide**
E		No purpose Serves as a control Provides evidence of the cycling of carbon dioxide **Provides evidence of the production of carbon dioxide** Provides evidence of the consumption of carbon dioxide
F		No purpose Serves as a control **Provides evidence of the cycling of carbon dioxide** Provides evidence of the production of carbon dioxide Provides evidence of the consumption of carbon dioxide

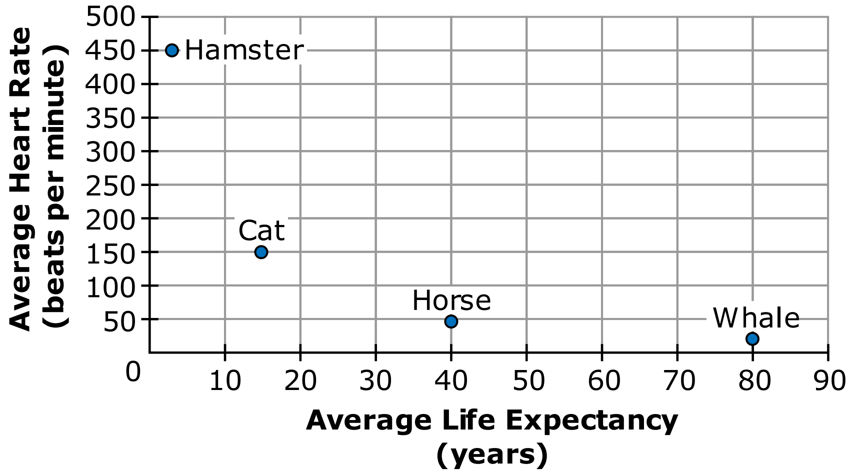
Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**SEPS.4:** Analyzing and interpreting data Investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists and engineers use a range of tools to identify the significant features in the data. They identify sources of error in the investigations and calculate the degree of certainty in the results. Advances in science and engineering make analysis of proposed solutions more efficient and effective. Scientists and engineers analyze their results by continually asking themselves questions; possible questions may be, but are not limited to: “Does this make sense?”, “Could my results be duplicated?”, and/or “Does the design solve the problem with the given constraints?”
Content Limits	This SEPS can be assessed in conjunction with IAS B.2.3, B.3.1, B.4.6, B.5.3, and B.5.6. Data must be presented in a grade-level appropriate format.
Construct-Relevant Vocabulary	constraint, control, criteria, data, dependent variable, design, error, experiment, impact, independent variable, investigation, limitation, solution, variable
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students investigate sets of data to extrapolate information, to support or refute the validity of a claim, to determine relationships among variables, and/or to determine the answer to a question.	
Students identify an outlier or outliers from a pattern; students can make predictions/conclusions about what may have happened to result in outliers.	
Students evaluate data to examine whether a model adequately represents a scenario and discuss errors related to the difference between the model and the scenario.	
Students analyze/interpret/compare data from graphs, tables, and charts.	
Students create a graph, table, or chart to organize information.	

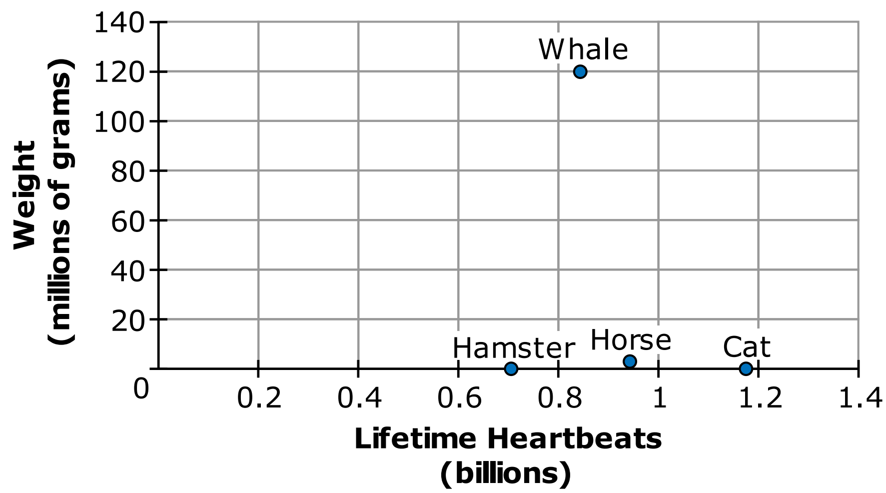
Sample Item
Average heart rates and life expectancies for four mammals are given in Figure 1.

Figure 1. Heart Rate vs. Life Expectancy



Average body weights and total number of lifetime heartbeats for the same four mammals are given in Figure 2.

Figure 2. Weight vs. Lifetime Heartbeat



Part A

Identify the relationship between average heart rate and life expectancy. Support your conclusion with data from Figure 1.

Type your answer in the space provided.

Part B

Identify the relationship that can be inferred from the average weight and the life expectancy of these mammals. Support your inference with data from Figure 1 and Figure 2.

Type your answer in the space provided.

Rubric:

Part A

- As heart rates increase, life expectancies decrease. (or the converse)

OR

- As life expectancies increase, heart rates decrease. (or the converse)

OR

- Mammals with low heart rates live longer. (or the converse)

Part B

- No relationship between the mammals' weights and life expectancies can be supported by the data.

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

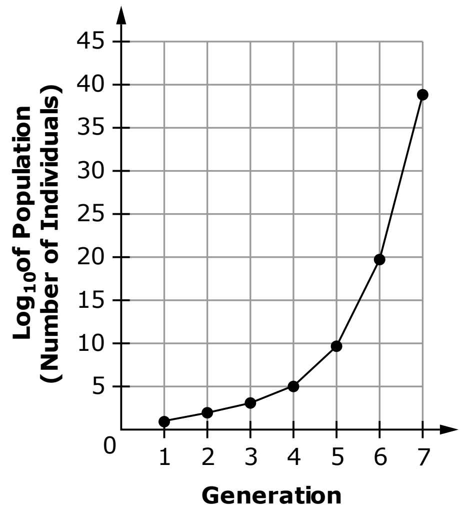
Content Standard	**SEPS.5:** Using mathematics and computational thinking In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Scientists and engineers understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
Content Limit	This SEPS can be assessed in conjunction with IAS B.2.3, B.3.1, B.4.6, and B.5.3. Consideration should be given so that mathematical concepts do not interfere with the SEPS being assessed. Use only whole numbers.
Construct-Relevant Vocabulary	constraint, control, criteria, data, dependent variable, design, experiment, impact, independent variable, investigation, limitation, quantitative, solution, trend, variable
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students explain that mathematics and computation support science and can be used to predict, confirm, and/or express information.	
Students interpolate and/or extrapolate data based on a pattern or trend.	
Students evaluate data and present those data in concise, organized form.	
Students perform mathematical calculations associated with biological systems and processes.	
Sample Item	

A population of protists grow according to the data given in Table 1 and Figure 1.

Table 1. Protist Population Growth

Generation	Population
1	4
2	16
3	2.6×10^{2}
4	6.6×10^{4}
5	4.3×10^{9}
6	1.8×10^{19}
7	3.4×10^{38}

Figure 1. Protist Population Growth



Predict the population of the next generation using the trend shown in Table 1 and Figure 1. In your response, include the following:

- The expected population size for the eighth generation,
- A description of how you calculated the population for the eighth generation, and
- An explanation of how the trend in population growth would change if resources became limited for the protists.

Type your answer in the space provided.

Rubric:

- the expected population size of 1.2×10^{77} (or any correctly rounded version of 1.156×10^{77}) for the eighth generation (1 point),
- a statement that the population was calculated based on exponential growth OR the equation for exponential growth (Population = N^2 using any variables) OR the specific calculation $(3.4 \times 10^{38})^2$ shown (1 point), and
- an explanation that the population would increase more slowly, level-off, and/or decrease if resources became limited for the protists (1 point).

Partial credit is available for any of the three point selections.

Exemplar:
The 8th generation would have a population of 1.2×10^{77} which I calculated from $(3.4 \times 10^{38})^2$. Since exponential population growth assumes no limitations of resources, the protist population would increase less quickly if resources became limited.

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**SEPS.6:** Constructing explanations (for science) and designing solutions (for engineering) Scientists and engineers use their results from the investigation in constructing descriptions and explanations, citing the interpretation of data, and connecting the investigation to how the natural and designed world(s) work. They construct or design logical coherent explanations or solutions of phenomena that incorporate their understanding of science and/or engineering or a model that represents it, and are consistent with the available evidence.
Content Limits	This SEPS can be assessed in conjunction with IAS B.4.2, B.5.2, and B.5.5. Evidence and data is limited to the natural world.
Construct-Relevant Vocabulary	constraint, control, criteria, data, dependent variable, design, evidence, experiment, impact, independent variable, investigation, limitation, rationale, representation, solution, trend, variable
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students describe how results can be used as evidence.	
Students use scientific evidence as the basis for the explanation of a phenomenon.	
Students make evidence-based claims about evolutionary phenomena.	

Sample Item

The *Babiana* plant has tube-shaped flowers that are close to the ground. Some *Babiana* plants grow a tall stalk, as given in Figure 1.

Figure 1. *Babiana* Plant

Biologists want to understand the purpose of this stalk. They made these observations about *Babiana* plants:

- they are pollinated by sunbirds;
- sunbirds do not often visit plants growing among many other types of flowers;
- sunbirds regularly visit plants growing among few or no other flowers;
- plants that receive few sunbird visits have short stalks.

Construct a conclusion about *Babiana* stalks that is supported by these observations.

Type your answer in the space provided.

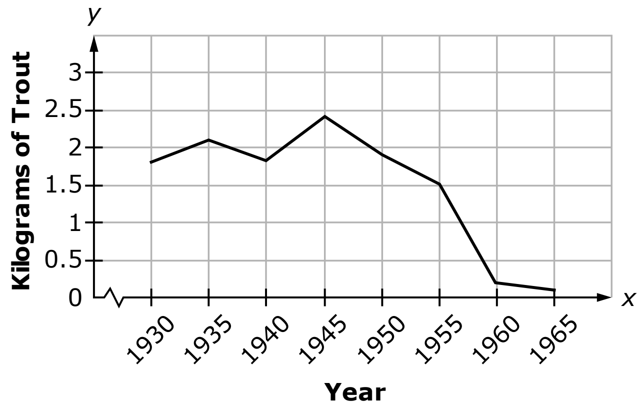
Rubric:
The student indicates that *Babiana* plants have the stalk to attract sunbirds.

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**SEPS.7:** Engaging in argument from evidence Scientists and engineers use reasoning and argument based on evidence to identify the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation, the process by which evidence-based conclusions and solutions are reached, to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.
Content Limits	This SEPS can be assessed in conjunction with IAS B.3.3, B.4.5, B.5.1, and B.5.4. Evidence and data is limited to the natural world.
Construct-Relevant Vocabulary	argument, constraint, criteria, data, design, evidence, impact, representation, result, solution, trend
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students support an argument with evidence or explain why an argument is not supported.	
Students select which argument the evidence supports, and/or justifies their choice with evidence when given competing conclusions or ideas.	
Students compare and contrast opposing conclusions/explanations/solutions.	
Students evaluate evidence supporting an argument and/or which argument in a set is supported by evidence.	
Students analyze data and construct arguments that are supported by evidence, including arguments from multiple viewpoints.	
Sample Item	
About 200 kilograms of trout were harvested from Lake Michigan in 1960. The amount of trout harvested from Lake Michigan from 1930 to 1965 is given in Figure 1.	

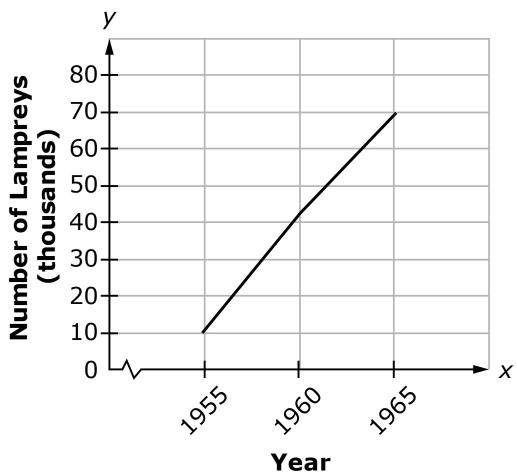
Figure 1. Kilograms of Trout Harvested from Lake Michigan between 1930 – 1965



The first sea lamprey was found in Lake Michigan in 1936. Sea lampreys are parasitic fish native to the Atlantic Ocean.

The number of sea lamprey caught in Lake Michigan from 1955-1965 is given in Figure 2.

Figure 2. Number of Lampreys Caught in Lake Michigan between 1955 – 1965



Use Figures 1 and 2 to explain the decline in the number of trout harvested from Lake Michigan.

Type your answer in the space provided.

Rubric:

The sea lamprey did not evolve in the Great Lakes and there are no natural predators, competitors, or pathogens to slow the growth of their population. They are parasitic fish that feed on trout.

Evidence the students should use:

- Sea Lamprey's caught increased from 1955 to 1960.
- Trout harvested from 1950-1960.

Accessibility and Accommodation Considerations

Allowable Tools	N/A
Literacy Considerations	Definitions of construct-irrelevant words may be provided when necessary.
Visual and Auditory Considerations	Graphics will be provided in formats that are accessible to students with varying abilities, including students who are blind or visually impaired. Graphics should only contain content that will help students understand or process information. Those that do not contribute to the student's understanding should not be included. Graphics that cannot be brailled will be provided to blind/visually impaired students through a verbal or written description when possible. American Sign Language – N/A for this standard
Linguistic Complexity	Rating to be completed after all final edits have been applied and approved by IDOE.

Content Standard	**SEPS.8:** Obtaining, evaluating, and communicating information Scientists and engineers need to communicate clearly and articulate the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations, as well as, orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.
Content Limits	This SEPS can be assessed in conjunction with IAS B.4.2, B.5.2, and B.5.5. Sources and information are limited to descriptions of the natural world.
Construct-Relevant Vocabulary	bias, constraint, control, credible, criteria, data, design, error, impact, repetition, solution
Recommended Response Mechanisms (Item Types)	Constructed Response Extended Response
DOK	3
Model Task	
Context	Context Required
Allowable Stimulus Material	data tables, graphs, simulations, animations, graphics, text
Evidence Statements	
Students identify mechanisms by which scientists and engineers communicate ideas and critique work. (B.5.2; B.5.5)	
Students compare and combine information from multiple texts, considering the strengths of the information and the credibility of the sources. (B.4.2; B.5.2; B.5.5)	
Students communicate findings (e.g., written, tables, diagrams, graphs, models, and equations) from a scientific investigation. (B.4.2; B.5.2; B.5.5)	
Students evaluate and critique the results of given science investigations. (B.4.2; B.5.2; B.5.5)	
Sample Item	

Males (M) and females (F) in a typical herd of bighorn sheep have masses given in Table 1.

Table 1. Bighorn Sheep Masses

Female Sheep	Mass Range (kg)
F1	80-90
F2	50-60
F3	40-50
F4	30-40
F5	40-50
F6	50-60
F7	40-50

Male Sheep	Mass Range (kg)
M1	70-80
M2	120-130
M3	100-110
M4	90-100
M5	100-110
M6	90-100
M7	100-110

Figures A–D show these data in different ways.

Figure A. Mass of Bighorn Sheep

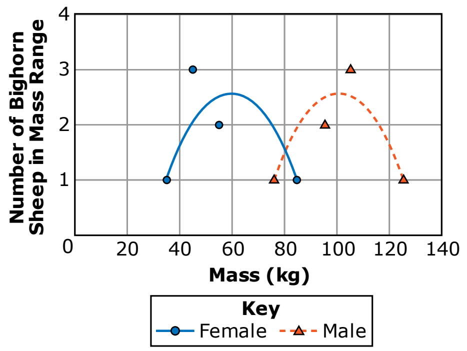


Figure B. Mass of Bighorn Sheep

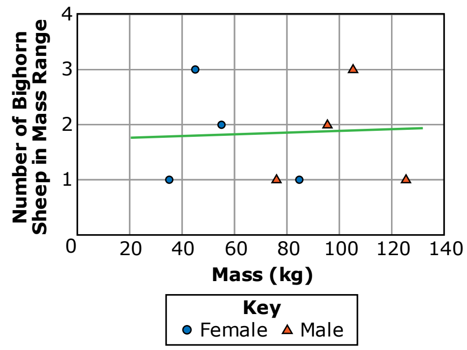


Figure C. Mass of Bighorn Sheep

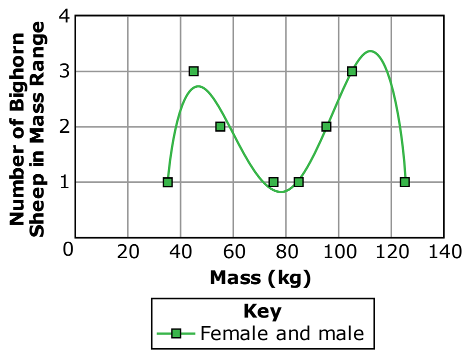
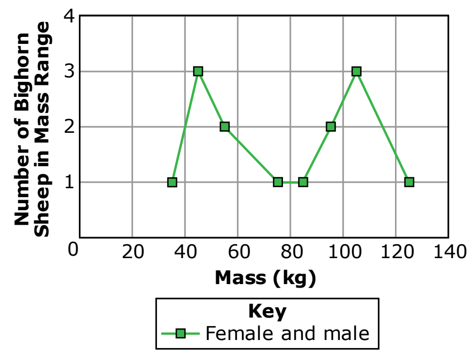


Figure D. Mass of Bighorn Sheep



Identify which graph shows the mass distribution for females and males in the general bighorn sheep population. Provide an explanation to support your selection. Your response should include the following:

- Identification of Figure A, B, C, or D,
- Explanation of why one or two lines is appropriate, and
- Explanation of why the shape of the line(s) is the most logical way to display these data.

Type your answer in the space provided.

Rubric:

- Figure A identified as the graph showing mass distribution of female and male bighorn sheep (1 point),

AND

- Explanation stating that females and males should be separate on the graph (1 point),

AND

- Explanation indicating that trend lines use the few data points to extrapolate a trend for the general population (1 point).

Partial credit is available for any of the three point selections.

Exemplar:
Figure A shows female and male bighorn sheep mass distributions for the general population. Since females and males are different sizes, their masses are graphed separately. The parabolic trend lines use the four data points to show the expected mass distribution for females and males in the general population.

Accessibility and Accommodation Considerations

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