



MASSACHUSETTS

Department of Elementary
and Secondary Education

*Release of Spring 2024
MCAS Test Items
from the
High School Biology
Paper-Based Test*

**July 2024
Massachusetts Department of
Elementary and Secondary Education**



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and Secondary Education

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Overview of High School Biology Test

The spring 2024 high school Biology test was administered in two formats: a computer-based version and a paper-based version. Most students took the computer-based test. The paper-based test was offered as an accommodation for eligible students who were unable to use a computer. More information can be found on the MCAS Test Administration Resources page at www.doe.mass.edu/mcas/admin.html.

Most of the operational items on the high school Biology test were the same, regardless of whether a student took the computer-based version or the paper-based version. In places where a technology-enhanced item was used on the computer-based test, an adapted version of the item was created for use on the paper test. These adapted paper items were multiple-choice or multiple-select items that tested the same Science content and assessed the same standard as the technology-enhanced item.

This document displays released items from the paper-based test. Released items from the computer-based test are available on the MCAS Resource Center website at mcas.pearsonsupport.com/released-items.

Test Sessions and Content Overview

The high school Biology test was made up of two separate test sessions. Each session included selected-response questions and constructed-response questions. On the paper-based test, the selected-response questions were multiple-choice items and multiple-select items, in which students select the correct answer(s) from among several answer options.

Standards and Reporting Categories

The high school Biology test was based on learning standards in the 2016 *Massachusetts Science and Technology/Engineering Curriculum Framework*. The Framework is available on the Department website at www.doe.mass.edu/frameworks/current.html.

The biology standards are grouped under the four content reporting categories listed below.

- Molecules to Organisms
- Heredity
- Evolution
- Ecosystems

Most items on the high school Biology test are also reported as aligning to one of three MCAS Science Practice Categories. The three practice categories are listed below.

- Practice Category A: Investigations and Questioning
- Practice Category B: Mathematics and Data
- Practice Category C: Evidence, Reasoning, and Modeling

More information about the practice categories is available on the Department website at www.doe.mass.edu/mcas/tdd/practice-categories.html.

The table at the conclusion of this document provides the following information about each released operational item: reporting category, standard covered, science practice category covered (if any), item type, and item description. The correct answers for released selected-response questions are also displayed in the table.

Reference Materials

Each student taking the paper-based version of the high school Biology test had sole access to a calculator.

During both high school Biology test sessions, the use of authorized bilingual word-to-word dictionaries and glossaries was allowed for students who are currently or were ever reported as English learners.

High School Biology

SESSION 1

This session contains 21 questions.

Directions

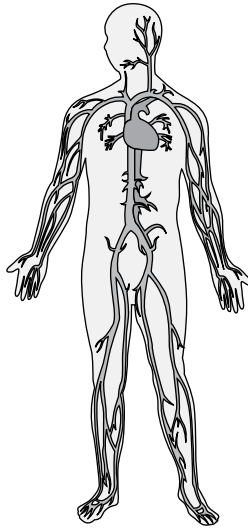
Read each question carefully and then answer it as well as you can. You must record all answers in this Test & Answer Booklet.

For some questions, you will mark your answers by filling in the circles in your Test & Answer Booklet. Make sure you darken the circles completely. Do not make any marks outside of the circles. If you need to change an answer, be sure to erase your first answer completely.

If a question asks you to show or explain your work, you must do so to receive full credit. Write your response in the space provided. Only responses written within the provided space will be scored.

- 1 Spiders grow until they reach adulthood. Which processes lead directly to growth by increasing the number of cells the spiders have?
- Ⓐ mitosis and cytokinesis
 - Ⓑ osmosis and active transport
 - Ⓒ photosynthesis and transpiration
 - Ⓓ aerobic and anaerobic respiration
- 2 An unfertilized egg from the European frog *Rana esculenta* has 13 chromosomes. A zygote of this species has 26 chromosomes.
- What causes the increase in chromosome number?
- Ⓐ The unfertilized egg undergoes meiosis.
 - Ⓑ Cell division occurs in the unfertilized egg.
 - Ⓒ DNA replication occurs in the unfertilized egg.
 - Ⓓ The unfertilized egg joins with a male gamete.

- 3 A diagram of a body system is shown.



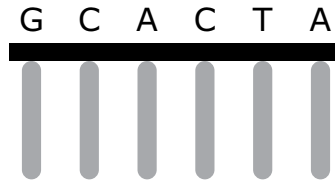
What is the primary function of this system?

- Ⓐ transmitting sensory nerve impulses
- Ⓑ preventing viruses from entering the body
- Ⓒ circulating nutrients and wastes through the body
- Ⓓ exchanging gases between the body and the environment

- 4 Which of the following **best** describes how carbon is cycled from the atmosphere to living organisms?

- Ⓐ Producers make organic compounds using light energy and carbon dioxide from the air.
- Ⓑ Consumers take in air to break the bonds in carbon compounds to obtain energy.
- Ⓒ Animals exhale carbon dioxide into the air during the process of breathing.
- Ⓓ Plants release carbon into the air during the process of transpiration.

- 5 A student created a model of a sequence of DNA nucleotides using craft sticks to represent nucleotides. One strand of the DNA model is shown.



What is the corresponding mRNA sequence for the DNA sequence?

Ⓐ



Ⓑ



Ⓒ

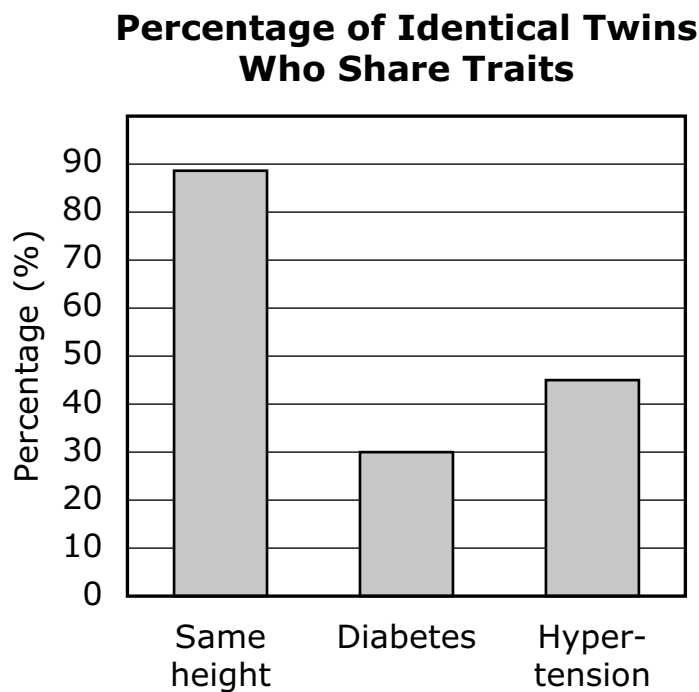


Ⓓ



This question has two parts.

- 6 Identical twins develop from a single fertilized egg. Scientists collected data about traits in identical twins. The graph shows the percentage of identical twins that share certain traits.



Part A

Based on the graph, which trait is more likely influenced by genetics than the other traits?

- Ⓐ same height
- Ⓑ diabetes
- Ⓒ hypertension

Part B

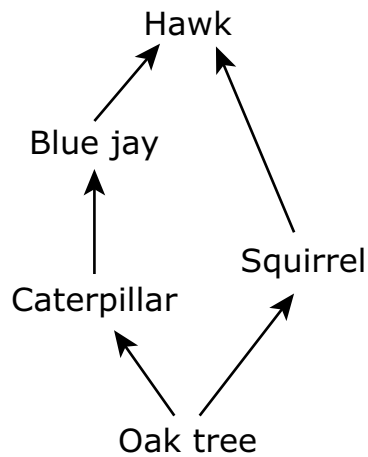
Scientists also collected data for certain traits in fraternal twins. Unlike identical twins, each fraternal twin develops from a different fertilized egg. The data indicate that approximately 60% of the time, one fraternal twin is the same height as the other fraternal twin.

Which of the following **best** explains why the percentage of fraternal twins that are the same height is different from the percentage of identical twins that are the same height?

- Ⓐ Fraternal twins have access to fewer foods than identical twins.
- Ⓑ Fraternal twins are exposed to more infections than identical twins.
- Ⓒ Fraternal twins share fewer genes with each other than identical twins do.
- Ⓓ Fraternal twins share more genes influenced by the environment than identical twins do.

- 7 Phytoplankton are microscopic aquatic organisms that perform photosynthesis. Phytoplankton support other aquatic organisms by producing
- Ⓐ carbon dioxide.
 - Ⓑ oxygen.
 - Ⓒ salt.
 - Ⓓ water.
- 8 A certain genetic condition is caused by a mutation in an animal. Answering which of the following questions would **best** determine whether the condition would be passed on to the animal's offspring?
- Ⓐ In what type of cell did the mutation occur?
 - Ⓑ Did the mutation change the appearance of the animal?
 - Ⓒ How many female offspring were produced by the animal?
 - Ⓓ Can the mutation travel through the body in the circulatory system?
- 9 Blood glucose levels rise after a person eats. When blood glucose levels rise, insulin from the pancreas is released. Insulin increases the transport of glucose into cells and stimulates the liver and muscle cells to store glucose as glycogen. As a result, blood glucose levels decrease and return to a normal level.
- Blood glucose levels returning to a normal level is an example of
- Ⓐ homeostasis.
 - Ⓑ osmosis.
 - Ⓒ reflex.
 - Ⓓ respiration.

- 10 A food web for a forest ecosystem is shown.



What is the role of the blue jay in the ecosystem?

- Ⓐ producer
- Ⓑ primary consumer
- Ⓒ secondary consumer
- Ⓓ tertiary consumer

What is the role of the caterpillar in the ecosystem?

- Ⓐ producer
- Ⓑ primary consumer
- Ⓒ secondary consumer
- Ⓓ tertiary consumer

What is the role of the squirrel in the ecosystem?

- Ⓐ producer
- Ⓑ primary consumer
- Ⓒ secondary consumer
- Ⓓ tertiary consumer

- 11** A frog's skin is very thin and has many capillaries. This allows the movement of oxygen and carbon dioxide directly across the frog's skin.

The frog's skin performs the same function as which of the following in the human body?

- Ⓐ alveoli
- Ⓑ sweat glands
- Ⓒ villi

This function of the frog's skin is most closely related to the function of which human body system?

- Ⓐ digestive
- Ⓑ excretory
- Ⓒ respiratory

The following section focuses on rock pocket mice.

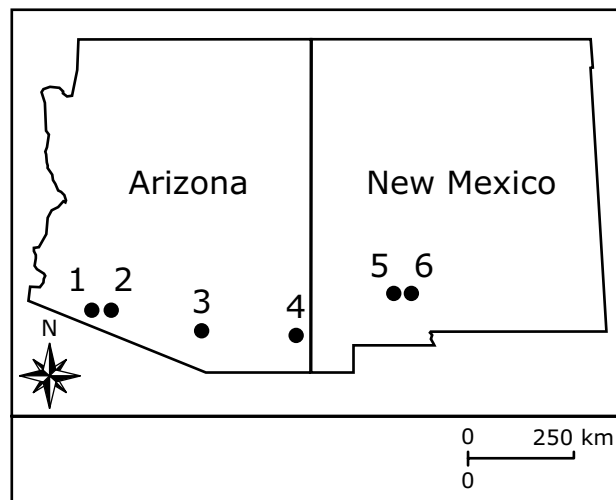
Read the information below and use it to answer the selected-response questions and constructed-response question that follow.

Rock pocket mice are small rodents that live in Arizona and New Mexico. They can have either light-colored fur or dark-colored fur. Fur color is determined by a group of pigments called melanin. Two types of melanin are pheomelanin and eumelanin. Mice with light-colored fur mostly have pheomelanin, whereas mice with dark-colored fur mostly have eumelanin.

In rock pocket mice, the *Mc1r* gene controls whether eumelanin or pheomelanin is produced. Scientists have identified two alleles, **D** and **d**, for the gene. The allele for dark-colored fur (**D**) is dominant to the allele for light-colored fur (**d**).

Most of the habitat for rock pocket mice consists of light-colored rock called granite. However, there are several areas where the mice live that are made up of dark-colored rock called basalt. Basalt rock formed when lava flowed over granite rock and cooled. Owls and other predators use their sense of sight to hunt rock pocket mice.

The map shows six study sites where scientists have observed these mice.



Scientists collected data on the fur color of rock pocket mice and the type of rock at each study site. The table shows the type of rock, the number of mice with light-colored fur, and the number of mice with dark-colored fur at each study site.

Study Site	Type of Rock	Light-Colored Fur	Dark-Colored Fur
1	basalt	2	6
2	granite	10	1
3	granite	15	0
4	granite	5	0
5	granite	12	0
6	basalt	1	7

- 12 The pigment eumelanin contains the elements hydrogen and oxygen. What other two elements make up eumelanin?
- Ⓐ iron and nitrogen
 - Ⓑ carbon and nickel
 - Ⓒ carbon and nitrogen
 - Ⓓ calcium and potassium
- 13 Researchers want to determine whether the mice at site 5 have become a different species from the mice at site 6. An investigation designed to answer which of the following questions would **best** help researchers determine whether the mice at these two sites have become different species?
- Ⓐ Do the mice at sites 5 and 6 eat the same types of food?
 - Ⓑ Do the mice at sites 5 and 6 have similar population sizes?
 - Ⓒ Do the mice at sites 5 and 6 interbreed and produce fertile offspring?
 - Ⓓ Do the mice at sites 5 and 6 spend more time underground or above ground?
- 14 Scientists think that fur color in mice evolved through natural selection. Which of the following would have been necessary for natural selection to occur?
- Ⓐ variation in the alleles for fur color in mice
 - Ⓑ migration of mice with different fur colors
 - Ⓒ identical genetic sequences in mice
 - Ⓓ small populations of mice

This question has two parts.

- 15** Predation of rock pocket mice plays a role in their population sizes.

Part A

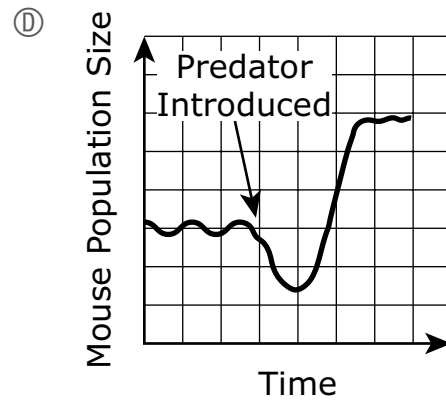
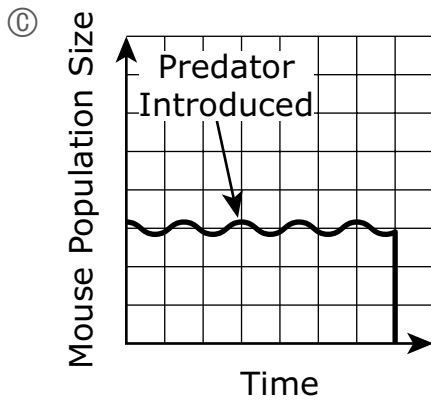
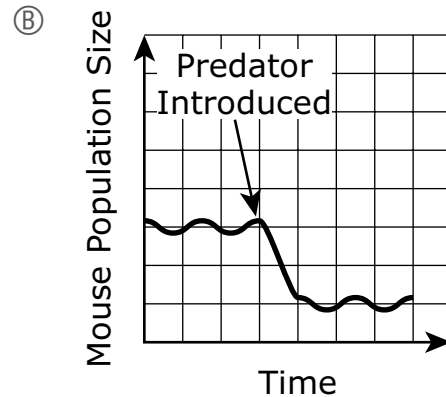
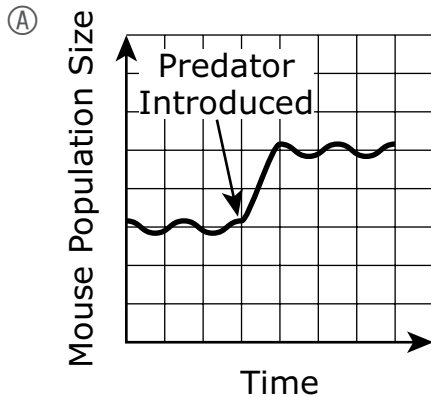
Scientists concluded that the primary selection pressure affecting fur color in rock pocket mice is predation. Which of the following best supports this conclusion?

- Ⓐ Mice with dark-colored fur have fewer offspring on basalt rock.
- Ⓑ Mice with dark-colored fur have decreased fitness on basalt rock.
- Ⓒ Mice with light-colored fur are more likely to survive and reproduce on granite rock.
- Ⓓ Mice with light-colored fur are more likely to mate with mice with dark-colored fur on granite rock.

Part B

A new predator that hunts rock pocket mice moves into site 3.

Which of the following graphs shows what will most likely happen to the rock pocket mouse population size at site 3 after 40 generations?



This question has three parts. Write your response on the next page. Be sure to label each part of your response.

16 Fur color in rock pocket mice is primarily controlled by the *Mc1r* gene.

- A. Two mice that are heterozygous for the *Mc1r* gene mate and produce offspring.

Using the allele symbols **D** and **d**, complete the Punnett square in Part A on the next page to show this cross.

- B. Based on the Punnett square, determine the percentage of offspring from this cross that are expected to have light-colored fur. Explain your answer.
- C. A student claims that having genotype **DD** or **Dd** would increase the fitness of a mouse living on granite rock.

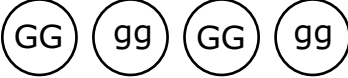
Explain why this student's claim is **not** supported by the information provided.

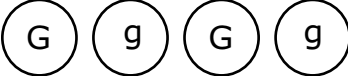
16

A.

[illegible]

- 17 Which of the following **best** represents the gametes produced from a diploid cell with genotype **Gg**?

Ⓐ 

Ⓑ 

Ⓒ 

Ⓓ 

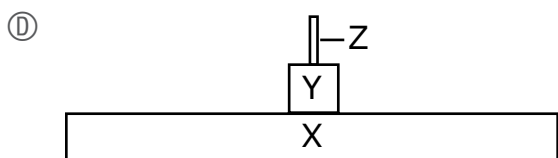
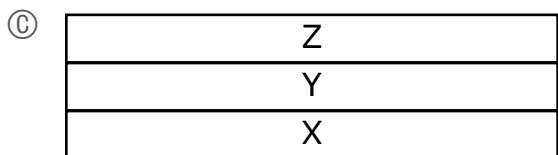
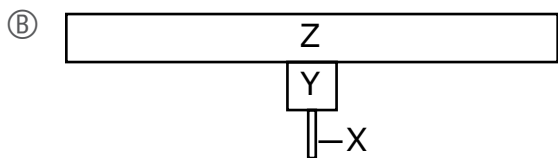
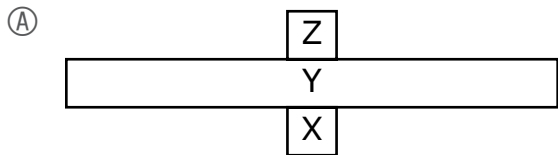
- 18 A certain organic molecule always contains a five-carbon sugar connected to a phosphate group and a nitrogenous base. This molecule belongs to which of the following groups?

- Ⓐ carbohydrates
- Ⓑ lipids
- Ⓒ nucleic acids
- Ⓓ proteins

- 19 An ecosystem has three trophic levels: X, Y, and Z. The table lists some organisms that belong to each of these trophic levels.

Trophic Level	Organisms
X	berry bush, tree
Y	small bird, mouse
Z	fox, owl

Which of the following diagrams represents the relative amount of available energy at each trophic level?



This question has four parts. Write your response on the next page. Be sure to label each part of your response.

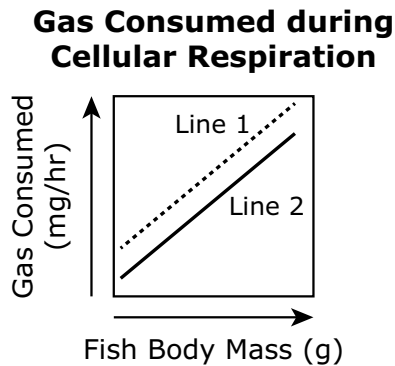
- 20** The upland sandpiper is a type of bird that is endangered in Massachusetts. Scientists are studying factors affecting death rates and birth rates in upland sandpiper populations.
- A. Assume immigration and emigration rates are equal in an upland sandpiper population.

Describe how the birth rate must compare with the death rate for the size of this population to increase.
 - B. Identify **two** environmental factors that could affect the death rate in an upland sandpiper population.
 - C. Determine whether **each** factor you identified in Part B would increase or decrease the death rate in the upland sandpiper population. Explain your reasoning for **each** factor.
 - D. Identify **one** environmental factor, other than the factors you identified in Part B, that could affect the birth rate in the upland sandpiper population. Describe how this factor affects the birth rate **and** explain your reasoning.

20

This question has four parts. Write your response on the next page. Be sure to label each part of your response.

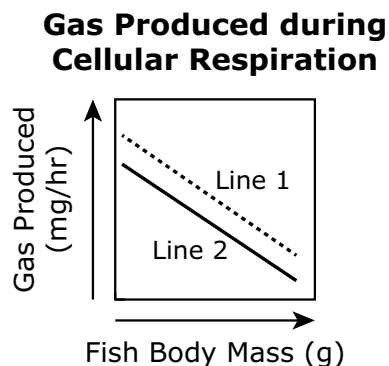
- 21** A scientist measured the cellular respiration rates of zebrafish while at rest and while actively swimming. The incomplete graph shows the data collected by the scientist.



- A. Identify the gas consumed by the fish, represented by the y-axis of the graph.
- B. Identify the line that most likely shows the data from actively swimming zebrafish. Explain your reasoning.
- C. The scientist repeats the experiment, but instead of measuring the gas consumed by the fish, the scientist measures the gas produced by the fish.

Identify the gas that is produced by the fish while at rest and while actively swimming.

- D. A student predicts that a graph showing the gas produced during cellular respiration will look like the graph shown.



Is the student's prediction correct? Explain your reasoning.

21

High School Biology

SESSION 2

This session contains 21 questions.

Directions

Read each question carefully and then answer it as well as you can. You must record all answers in this Test & Answer Booklet.

For some questions, you will mark your answers by filling in the circles in your Test & Answer Booklet. Make sure you darken the circles completely. Do not make any marks outside of the circles. If you need to change an answer, be sure to erase your first answer completely.

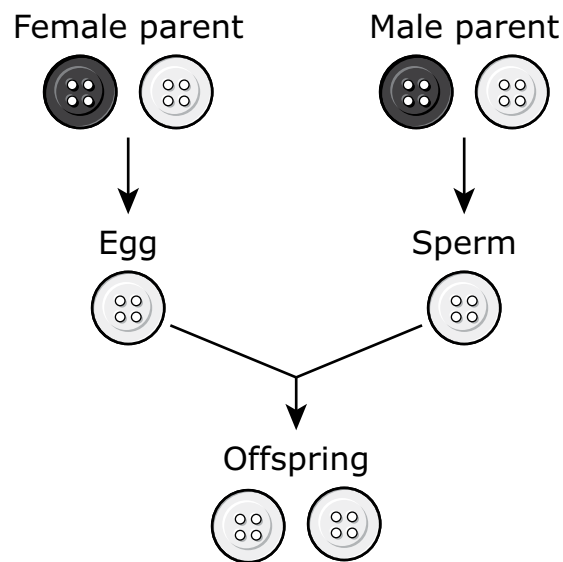
If a question asks you to show or explain your work, you must do so to receive full credit. Write your response in the space provided. Only responses written within the provided space will be scored.

- 22** *C. elegans* is a small roundworm. Two alleles of a single gene determine the roundworm's motion. The recessive allele (**r**) codes for a wave pattern of motion, and the dominant allele (**R**) codes for a spiral, or "roller," pattern of motion.

Roundworms with a roller pattern of motion have which of the following genotypes?

- Ⓐ **rr** only
 - Ⓑ **RR** only
 - Ⓒ **rr** or **Rr**
 - Ⓓ **RR** or **Rr**
- 23** Which of the following is a reproductive advantage that bacteria have but viruses do not?
- Ⓐ Bacteria are able to reproduce by meiosis.
 - Ⓑ Bacteria have a nucleus to control reproduction.
 - Ⓒ Bacteria can replicate their DNA without a host cell.
 - Ⓓ Bacteria have mitochondria to supply energy for cell division.

- 24 Students use buttons to model the inheritance of a genetic trait. Black and white buttons represent alleles of a single gene. The diagram shows part of the students' model.

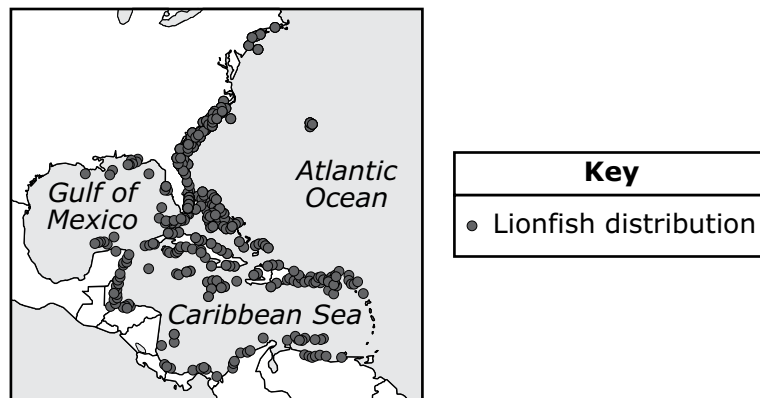


Which of the following is **best** illustrated by this model?

- Ⓐ A gene's alleles segregate when sex cells form.
- Ⓑ All of the parents' alleles are passed on to the offspring.
- Ⓒ Alleles of a gene can be dominant, recessive, incompletely dominant, or codominant.
- Ⓓ Dominant alleles occur on the X chromosome and recessive alleles occur on the Y chromosome.

This question has two parts.

- 25 The lionfish is an invasive species. Lionfish were first seen off the coast of Florida in 1990. From 1990 to 2010, the lionfish population rapidly increased along the east coast. The map shows the distribution of lionfish in 2010.



Part A

Which of the following **best** explains what most likely happened in the areas where lionfish invaded?

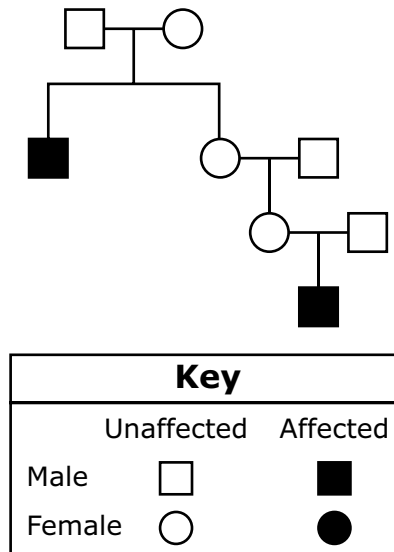
- Ⓐ The biodiversity of the native species decreased.
- Ⓑ The lionfish population reached carrying capacity.
- Ⓒ The death rate was higher than the birth rate for lionfish.
- Ⓓ The native species changed their traits to become more competitive.

Part B

Which of the following **best** explains the change in the number of lionfish from 1990 to 2010?

- Ⓐ Lionfish took many years to reproduce.
- Ⓑ Lionfish were mainly active at night.
- Ⓒ Lionfish had little genetic diversity.
- Ⓓ Lionfish had no natural predators.

- 26** A single gene with two alleles is responsible for a certain genetic condition in humans. Females that are heterozygous for the condition are called carriers and do not have symptoms of the genetic condition. Males cannot be carriers. The pedigree models the pattern of inheritance for this genetic condition.



Which of the following best describes the allele that causes this genetic condition?

- Ⓐ It is a recessive allele on the X chromosome.
- Ⓑ It is a recessive allele on the Y chromosome.
- Ⓒ It is a dominant allele on the X chromosome.
- Ⓓ It is a codominant allele on the Y chromosome.

- 27** A human gamete typically contains 23 chromosomes. Two human gametes combine to produce a zygote.

Which of the following is the **best** evidence that an error occurred during the formation of one of these gametes?

- Ⓐ The zygote has two copies of chromosome 21.
- Ⓑ The zygote has three copies of chromosome 21.
- Ⓒ The zygote has 23 chromosomes from each gamete.
- Ⓓ The zygote has some of the same chromosomes as the gametes.

- 28 DDT is an insecticide, a chemical that kills insects. When DDT was first introduced, it killed most of the mosquitoes that transmit the disease malaria. However, DDT is no longer effective against most mosquitoes.

Which of the following **best** explains why DDT is no longer effective against most mosquitoes?

- Ⓐ Genetic mutations caused by DDT gave all exposed mosquitoes resistance.
- Ⓑ Climate change increased the population of mosquitoes that transmit malaria.
- Ⓒ Crossing over produced a new species of mosquito with a different number of chromosomes.
- Ⓓ Natural selection increased the frequency of the allele for DDT resistance in the mosquito population.

- 29 Adenine (A) makes up 32% of a DNA molecule. Which table shows the correct percentage of each of the other nucleotide bases in the DNA molecule?

Ⓐ

Nucleotide Base	Percentage of DNA Molecule
adenine (A)	32
cytosine (C)	32
guanine (G)	18
thymine (T)	18

Ⓑ

Nucleotide Base	Percentage of DNA Molecule
adenine (A)	32
cytosine (C)	18
guanine (G)	18
thymine (T)	32

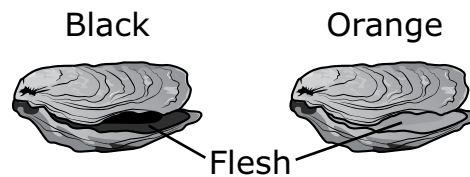
Ⓒ

Nucleotide Base	Percentage of DNA Molecule
adenine (A)	32
cytosine (C)	64
guanine (G)	18
thymine (T)	16

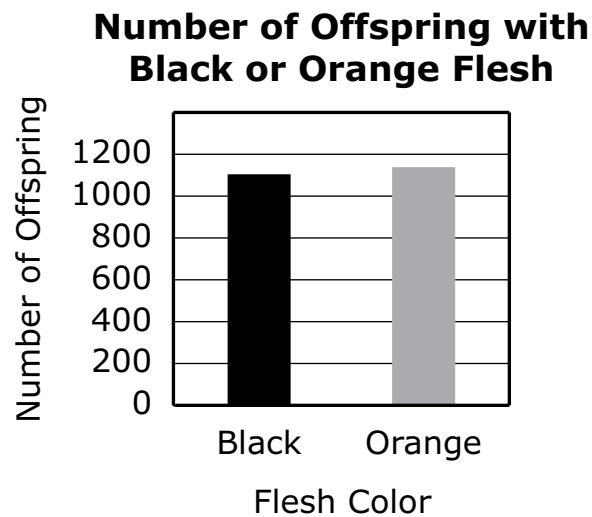
Ⓓ

Nucleotide Base	Percentage of DNA Molecule
adenine (A)	32
cytosine (C)	18
guanine (G)	16
thymine (T)	64

- 30 In a species of oyster, the color of the oysters' flesh is controlled by a single gene with two alleles, **B** and **b**. The allele for black flesh (**B**) is dominant to the allele for orange flesh (**b**). The diagram shows each type of oyster.



An oyster with black flesh was crossed with an oyster with orange flesh. The graph shows the number of offspring produced with each flesh color.



Which cross most likely produced the number and type of offspring represented in the graph?

- (A) **Bb** × **bb**
- (B) **Bb** × **Bb**
- (C) **BB** × **bb**
- (D) **BB** × **Bb**

- 31** Although the kidneys account for only 0.4% of a human's body weight, about 25% of the blood pumped out of the heart travels to the kidneys. Which of the following explains why such a large amount of blood passes through the kidneys?
- Ⓐ The kidneys exchange carbon dioxide for oxygen in the blood.
 - Ⓑ The kidneys filter the blood to remove wastes and regulate blood volume.
 - Ⓒ The kidneys absorb ATP from the blood needed for cellular respiration in body cells.
 - Ⓓ The kidneys secrete an enzyme that digests proteins and other macromolecules found in blood.

- 32 Heritability estimates are used to describe the extent to which a trait is determined by genetics compared to other factors. Heritability estimates range from 0 (the trait is not due to genes) to 1 (the trait is only due to genes). The heritability estimates of some traits in female sheep are shown in the table.

Trait	Heritability Estimates
adult body weight	0.40
birth weight	0.15
milk production	0.10

If a sheep farmer wanted to breed sheep for traits, the farmer would be **least** successful when selectively breeding for

- Ⓐ birth weight and milk production.
- Ⓑ adult body weight and birth weight.
- Ⓒ milk production and adult body weight.

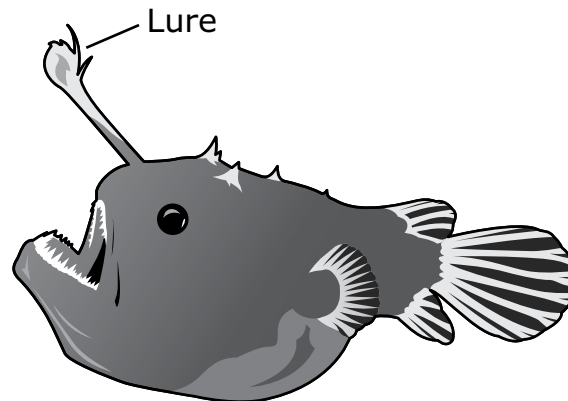
The farmer would be least successful when selectively breeding for those traits because they are mostly a result of

- Ⓐ genetics.
- Ⓑ the environment.

The following section focuses on deep-sea anglerfish.

Read the information below and use it to answer the selected-response questions and constructed-response question that follow.

An anglerfish is a type of fish that can live in the ocean at depths of more than 1,000 meters, where there is no sunlight. The female anglerfish has an organ called a lure, which produces light. The diagram shows a female anglerfish.



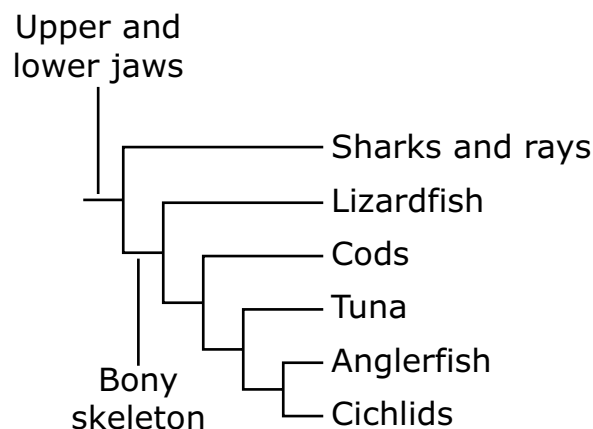
A female anglerfish uses the light from the lure to attract prey and mates. Bacteria in the lure generate the light. To speed up the chemical reaction that produces the light, the bacteria produce an organic molecule called luciferase.

Male anglerfish are much smaller than females. Males have an enhanced sense of smell that allows them to track the scent of a female. A female anglerfish typically mates with several males. Before a male mates with a female, he attaches to her with his teeth. The male obtains nutrients from the female's blood when he is attached to her. A female may have several males attached to her at one time. Individual eggs are fertilized by the sperm of the different males attached to the female as she lays her eggs.

33 Based on its function, what type of organic molecule is luciferase?

- Ⓐ carbohydrate
- Ⓑ lipid
- Ⓒ nucleic acid
- Ⓓ protein

34 The diagram shows the evolutionary relationships between anglerfish and several other groups of fish.



Based on the diagram, which of the following **best** supports the claim that anglerfish are more closely related to lizardfish than to sharks and rays?

- Ⓐ Anglerfish and lizardfish have bony skeletons, but sharks and rays do not.
- Ⓑ Anglerfish and lizardfish do not have bony skeletons, but sharks and rays do.
- Ⓒ Anglerfish and lizardfish have upper and lower jaws, but sharks and rays do not.
- Ⓓ Anglerfish and lizardfish do not have upper and lower jaws, but sharks and rays do.

- 35** Which of the following provides the best evidence that the female anglerfish and the bacteria in its lure have a mutualistic relationship?
- Ⓐ The anglerfish consumes the bacteria for nutrients.
 - Ⓑ The bacteria and the anglerfish use the same resources for nutrients.
 - Ⓒ The bacteria use nutrients from the anglerfish, but the anglerfish does not benefit from the bacteria.
 - Ⓓ The anglerfish provides nutrients to the bacteria, and the bacteria produce light needed by the anglerfish.

This question has two parts.

- 36** A male anglerfish attaches to a female anglerfish using his teeth. When the male attaches to the female, some of the female's cells are damaged.

Part A

What process replaces the damaged cells of the female anglerfish?

- Ⓐ diffusion
- Ⓑ meiosis
- Ⓒ mitosis
- Ⓓ respiration

Part B

How do the cells produced by the process you identified in Part A compare with their parent cells?

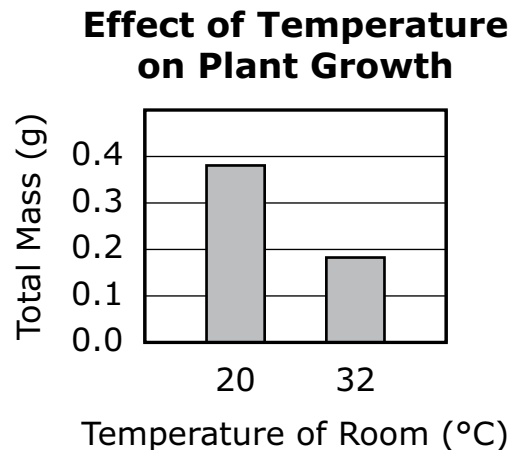
- Ⓐ They are genetically identical to their parent cells.
- Ⓑ They are genetically different from their parent cells.
- Ⓒ They have a mix of genetic material from both parent cells.
- Ⓓ They have one-half the chromosome number of their parent cells.

This question has two parts. Write your response on the next page. Be sure to label each part of your response.

- 37** Anglerfish may have difficulty finding a mate because the anglerfish's environment is dark, and the number of individuals in a population is relatively small.
- A. Explain why a male anglerfish's sense of smell is important to the male's survival in this environment.
 - B. Describe the evolutionary advantage of multiple males fertilizing the eggs of a female anglerfish. Explain your reasoning.

37

- 38 Students investigated the effect of temperature on plant growth by growing two groups of plants. One group of plants was grown in a 20°C room, and the other group was grown in a 32°C room. All other conditions for the plants were the same. At the end of the investigation, the total mass of the plants from each group was measured. The graph shows the students' results.



Which of the following best explains why the total mass of the plants from each group was different?

- Ⓐ The plants grown at 20°C produced more glucose during photosynthesis.
- Ⓑ The plants grown at 32°C produced more glucose during cellular respiration.
- Ⓒ The plants grown at 32°C produced more carbon dioxide during photosynthesis.
- Ⓓ The plants grown at 20°C produced more carbon dioxide during cellular respiration.

39 When the concentration of oxygen is greater outside a cell than inside the cell, oxygen will move into the cell without the assistance of proteins or additional energy. This movement of oxygen is an example of what process?

- Ⓐ active transport
- Ⓑ osmosis
- Ⓒ photosynthesis
- Ⓓ simple diffusion

40 An offspring with a genetic mutation had a lower amount of muscle mass than expected. The offspring's parents did not have the allele for the mutation.

Which of the following is the most likely cause of the offspring's mutation?

- Ⓐ random pairing in the parents' gametes
- Ⓑ a dominant gene in the offspring's DNA
- Ⓒ a replication error in the offspring's DNA
- Ⓓ chromosomes crossing over in the parents' body cells

This question has two parts.

- 41** For the human body to function normally, blood pH must be maintained between 7.35 and 7.45. When carbon dioxide levels in the blood rise, the pH of the blood decreases. The body then reacts to restore normal blood pH.

Part A

A feedback loop that maintains blood pH is activated when a person exercises. Which of the following shows how this feedback loop works to maintain blood pH?

- Ⓐ 1. Person starts running.
2. Brain cells detect decreasing blood pH.
3. Blood pH decreases.
4. Brain sends messages to the muscles that control breathing.
5. Muscle cells release more carbon dioxide into the blood.
6. Breathing rate increases, more carbon dioxide is exhaled, and blood pH increases.
- Ⓑ 1. Person starts running.
2. Muscle cells release more carbon dioxide into the blood.
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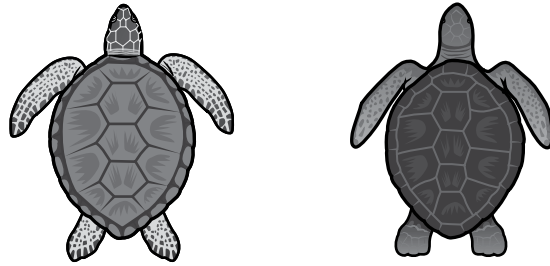
Part B

Which of the following **best** explains why this process is referred to as a negative feedback loop?

- Ⓐ Carbon dioxide is removed from the body.
- Ⓑ It is harmful to have a decrease in blood pH.
- Ⓒ While a person is running, the brain sends signals to muscles.
- Ⓓ As carbon dioxide in the blood decreases, blood pH returns to normal.

This question has four parts. Write your response on the next page. Be sure to label each part of your response.

- 42** While most green sea turtles have tan skin and shells, a small population of green sea turtles in the eastern Pacific Ocean have evolved to have black skin and shells. These turtles are commonly known as black sea turtles. The diagram shows a green sea turtle and a black sea turtle.



Green sea turtle

Black sea turtle

- A. A scientist wonders whether the black color in this sea turtle population is a result of natural selection.

Write a testable question that scientists could answer to determine whether natural selection plays a role in the black sea turtle's color.

- B. Some scientists think that green sea turtles and black sea turtles are separate species.

Besides physical characteristics, identify **one** piece of evidence that scientists can use to determine whether green sea turtles and black sea turtles are separate species.

- C. Explain how the type of evidence you identified in Part B can be used by scientists to determine whether the green sea turtles and black sea turtles are separate species.

- D. Other scientists think that green sea turtles and black sea turtles may become separate species because they are geographically isolated from each other.

Explain how geographically isolating a small group of turtles from a larger population of turtles can lead to the two populations becoming separate species.

42

High School Biology

Spring 2024 Released Operational Items

PBT Item No.	Page No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description	Correct Answer (SR)**
1	3	<i>Molecules to Organisms</i>	HS.LS.1.4	None	SR	Identify cellular processes that lead to growth of an organism.	A
2	3	<i>Heredity</i>	HS.LS.3.1	None	SR	Explain why there is difference in chromosome number between an egg cell and a zygote.	D
3	4	<i>Molecules to Organisms</i>	HS.LS.1.2	C. Evidence, Reasoning, and Modeling	SR	Describe the function of a body system based on a diagram.	C
4	4	<i>Ecology</i>	HS.LS.2.5	None	SR	Describe how carbon is cycled from the atmosphere to living organisms.	A
5	5	<i>Molecules to Organisms</i>	HS.LS.1.1	C. Evidence, Reasoning, and Modeling	SR	Complete a model of the transcription of a DNA sequence.	B
6	6	<i>Heredity</i>	HS.LS.3.4	B. Mathematics and Data	SR	Analyze a graph to determine which trait is most influenced by genetics and explain why some individuals share more traits than others.	A;C
7	8	<i>Molecules to Organisms</i>	HS.LS.1.5	None	SR	Determine how photosynthetic phytoplankton support other organisms in an ecosystem.	B
8	8	<i>Heredity</i>	HS.LS.3.2	A. Investigations and Questioning	SR	Identify a question that, when answered, would determine whether a genetic condition can be passed to offspring.	A
9	8	<i>Molecules to Organisms</i>	HS.LS.1.3	None	SR	Determine that blood glucose levels returning to normal is an example of homeostasis.	A
10	9	<i>Ecology</i>	HS.LS.2.4	C. Evidence, Reasoning, and Modeling	SR	Interpret a food web to determine the ecological roles of several organisms.	C;B;B
11	10	<i>Molecules to Organisms</i>	HS.LS.1.2	C. Evidence, Reasoning, and Modeling	SR	Determine the parts of the respiratory system in humans that are most closely related to the movement of oxygen and carbon dioxide.	A;C
12	13	<i>Molecules to Organisms</i>	HS.LS.1.6	None	SR	Identify two elements found in a certain organic molecule.	C
13	13	<i>Evolution</i>	HS.LS.4.5	A. Investigations and Questioning	SR	Identify a testable question that, when answered, would help researchers determine whether speciation has occurred.	C
14	13	<i>Evolution</i>	HS.LS.4.2	None	SR	Describe a condition that is necessary for natural selection to occur.	A
15	14	<i>Ecology</i>	HS.LS.2.2	B. Mathematics and Data	SR	Analyze data to determine which evidence best supports a conclusion that a population was affected by predation and analyze graphs to determine which one best shows how a population changed over time.	C;B
16	16	<i>Heredity</i>	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	CR	Complete a Punnett square for a genetic cross between two heterozygous individuals, determine the percentage of offspring that would inherit a certain trait, and explain how the trait affects the fitness of an individual in a particular environment.	

PBT Item No.	Page No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description	Correct Answer (SR)**
17	18	<i>Heredity</i>	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Determine the gametes that would be produced by a parent cell with a given genotype.	B
18	18	<i>Molecules to Organisms</i>	HS.LS.1.6	None	SR	Classify an organic molecule based on its chemical components.	C
19	19	<i>Ecology</i>	HS.LS.2.4	C. Evidence, Reasoning, and Modeling	SR	Identify the model that shows the relative amount of energy in different trophic levels.	D
20	20	<i>Ecology</i>	HS.LS.2.1	None	CR	Compare birth and death rates in a population that is increasing and explain how environmental factors could affect the death rate and birth rate in a population.	
21	22	<i>Molecules to Organisms</i>	HS.LS.1.7	B. Mathematics and Data	CR	Identify the gas consumed and the gas produced during cellular respiration, analyze a graph to determine when organisms are moving and at rest, and analyze another graph to determine whether a prediction is correct and explain the reasoning.	
22	25	<i>Heredity</i>	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	SR	Determine the possible genotypes of an organism based on the organism's phenotype.	D
23	25	<i>Evolution</i>	HS.LS.4.4	None	SR	Identify a reproductive advantage that bacteria have but viruses do not.	C
24	26	<i>Heredity</i>	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Describe how a model shows the segregation of alleles during meiosis.	A
25	27	<i>Ecology</i>	HS.LS.2.7	C. Evidence, Reasoning, and Modeling	SR	Describe how the introduction of an invasive species affects the biodiversity of native species in an ecosystem and explain how an invasive species may increase over time.	A;D
26	28	<i>Heredity</i>	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	SR	Analyze a pedigree to determine the inheritance pattern of a genetic condition.	A
27	28	<i>Heredity</i>	HS.LS.3.2	None	SR	Determine which evidence would best support a claim that an error occurred during meiosis.	B
28	29	<i>Evolution</i>	HS.LS.4.2	C. Evidence, Reasoning, and Modeling	SR	Explain how an insect population can become resistant to a pesticide after many generations.	D
29	30	<i>Molecules to Organisms</i>	HS.LS.1.6	B. Mathematics and Data	SR	Determine the percentages of three DNA nucleotide bases when given the percentage of the fourth nucleotide base.	B
30	31	<i>Heredity</i>	HS.LS.3.3	B. Mathematics and Data	SR	Interpret a graph of offspring phenotypes to determine the genotypes of the parental cross.	A
31	32	<i>Molecules to Organisms</i>	HS.LS.1.2	None	SR	Explain why a large amount of blood passes through the kidneys in humans.	B

PBT Item No.	Page No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description	Correct Answer (SR)**
32	33	<i>Heredity</i>	HS.LS.3.4	B. Mathematics and Data	SR	Analyze heritability data to determine the traits that are more likely determined by the environment than by genetics.	A;B
33	35	<i>Molecules to Organisms</i>	HS.LS.1.1	None	SR	Classify a type of organic molecule based on its function.	D
34	35	<i>Evolution</i>	HS.LS.4.1	C. Evidence, Reasoning, and Modeling	SR	Analyze a cladogram to support a claim about the relatedness of organisms.	A
35	36	<i>Ecology</i>	HS.LS.2.1	C. Evidence, Reasoning, and Modeling	SR	Describe evidence of two organisms having a mutualistic relationship.	D
36	37	<i>Molecules to Organisms</i>	HS.LS.1.4	None	SR	Identify the process that replaces damaged cells in an organism and describe the genetic makeup of the cells produced by the process.	C;A
37	38	<i>Evolution</i>	HS.LS.4.2	C. Evidence, Reasoning, and Modeling	CR	Explain why individuals with a particular trait are more likely to survive in a certain environment and how having multiple mates can increase genetic diversity in a population.	
38	40	<i>Molecules to Organisms</i>	HS.LS.1.5	B. Mathematics and Data	SR	Interpret a graph to determine which temperature supported more plant growth and determine the gas produced and the process performed by the plants.	A
39	41	<i>Molecules to Organisms</i>	HS.LS.1.3	None	SR	Identify the process used to move oxygen across a cell membrane.	D
40	41	<i>Heredity</i>	HS.LS.3.2	None	SR	Determine the cause of a mutation in an offspring.	C
41	42	<i>Molecules to Organisms</i>	HS.LS.1.3	C. Evidence, Reasoning, and Modeling	SR	Complete a model of a feedback loop and explain why the model is a negative feedback loop.	B;D
42	44	<i>Evolution</i>	HS.LS.4.5	A. Investigations and Questioning	CR	Write a testable question that, when answered, could determine whether a trait is the result of natural selection, explain how a piece of evidence could support two organisms being different species, and explain how geographic isolation can lead to speciation.	

* Science item types are: selected-response (SR) and constructed-response (CR).

** Answers are provided here for selected-response items only. Sample responses and scoring guidelines for constructed-response items will be posted to the Department's website later this year.