



MASSACHUSETTS
Department of Elementary
and Secondary Education

*Release of Spring 2023
MCAS Test Items
from the
High School Biology
Paper-Based Test*

**July 2023
Massachusetts Department of
Elementary and Secondary Education**



MASSACHUSETTS
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and Secondary Education

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Overview of High School Biology Test

The spring 2023 high school Biology test was a next-generation assessment that 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 STE 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 bilingual word-to-word dictionaries was allowed for current and former English learner students.

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 Adélie penguins are well adapted to Antarctica's cold climate. They eat fish off the coast of Antarctica and build nests on land. The average temperature in Antarctica has been increasing. Scientists claim that if this trend continues, it may have a negative effect on the penguins' ability to survive.

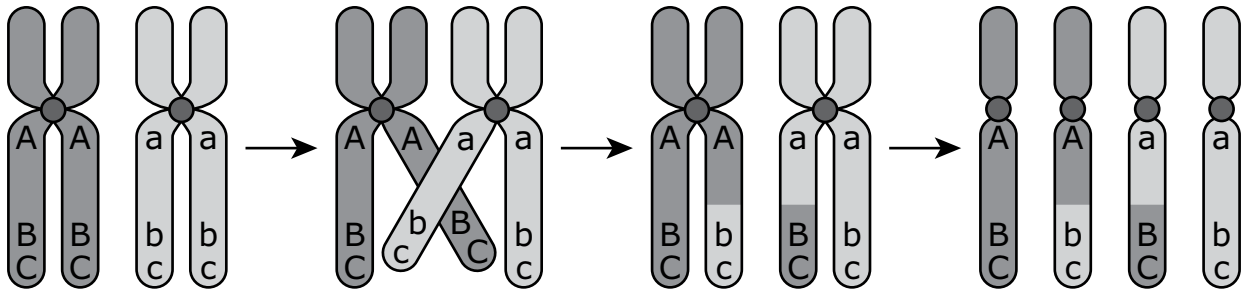
Which of the following best supports the scientists' claim?

- Ⓐ Melting ice will decrease the concentration of salt in the ocean.
 - Ⓑ Increasing ocean temperatures will reduce fish population sizes.
 - Ⓒ Increasing air temperatures will allow more plant species to grow.
 - Ⓓ Melting snow will increase the size of the area where the penguins live.
- 2 In some types of cattle, the allele for a spotted coat (**s**) is recessive to the allele for a solid-colored coat (**S**).

A cow with a spotted coat is mated with a bull that is homozygous for a solid coat. What percentage of the offspring are expected to have solid coats?

- Ⓐ 100%
- Ⓑ 75%
- Ⓒ 50%
- Ⓓ 25%

- 3 The diagram represents a process that occurs in chromosomes during meiosis. The letters represent different genes with different alleles.



This process is important for the survival of a species because it helps introduce which of the following into a population?

- (A) dominant genes
 - (B) gene mutations
 - (C) genetic variation
 - (D) polygenic traits
- 4 Scientists developed an antibiotic to fight harmful bacteria that cause infections. After several years of use, the antibiotic became less effective.
- Which of the following caused the antibiotic to become less effective?
- (A) Bacteria that were resistant to the antibiotic survived to produce more resistant bacteria.
 - (B) Bacteria that were not resistant to the antibiotic began to produce resistant bacteria through meiosis.
 - (C) Bacteria that were not resistant to the antibiotic learned how to protect themselves from the antibiotic.
 - (D) Bacteria that were resistant to the antibiotic lost their resistance with repeated exposure to the antibiotic.

- 5** Which of the following is an example of polygenic inheritance?
- Ⓐ Two alleles code for a mixture of black and white feathers in chickens.
 - Ⓑ Several genes with different alleles contribute to a range of eye colors in fruit flies.
 - Ⓒ A rabbit can have one of four fur coat colors because of four alleles for a single gene.
 - Ⓓ A plant that has the allele for red flowers and the allele for white flowers produces pink flowers.

This question has two parts.

- 6** A professional athlete often runs long distances. Some of the steps that enable the athlete to run are shown.

Step 1: The athlete eats food before running.

Step 2: The food is broken down into nutrients.

Step 3: Usable energy is produced from the nutrients.

Step 4: The athlete's muscles use the energy to contract.

Part A

Which of the following provides a more accurate step than the one shown?

- Ⓐ Step 1: The athlete completely digests food while chewing.
- Ⓑ Step 2: The only food molecules broken down into nutrients are fat molecules.
- Ⓒ Step 3: Usable energy is produced from the nutrients during cellular respiration.
- Ⓓ Step 4: The athlete's muscles produce glucose when they use energy to contract.

Part B

The athlete begins a long-distance run. As the athlete runs, their body produces more

- Ⓐ amino acids.
- Ⓑ carbon dioxide.
- Ⓒ nitrogen.
- Ⓓ oxygen.

- 7 A gamete of a domestic cat has 19 chromosomes. A student claims that a body cell of the cat contains 38 chromosomes.

Which of the following **best** describes the student's claim?

- Ⓐ The claim is correct because a sperm cell fertilizes an egg cell, resulting in a cell with 38 chromosomes.
 - Ⓑ The claim is incorrect because the egg and sperm cells have a total of 19 chromosomes when they combine.
 - Ⓒ The claim is incorrect because the egg and sperm cells divide and have a total of 76 chromosomes when they combine.
 - Ⓓ The claim is correct because a sperm cell carries all of the chromosomes and passes them to the egg cell, resulting in 38 chromosomes.
- 8 The pupfish is a type of fish that lives in small pools of water in the desert. A researcher studying desert ecosystems found that crayfish and mosquitofish had been introduced into some of these desert pools.

After making this discovery, the researcher created three test ponds and put the following in each pond:

Pond 1: pupfish only

Pond 2: pupfish and crayfish

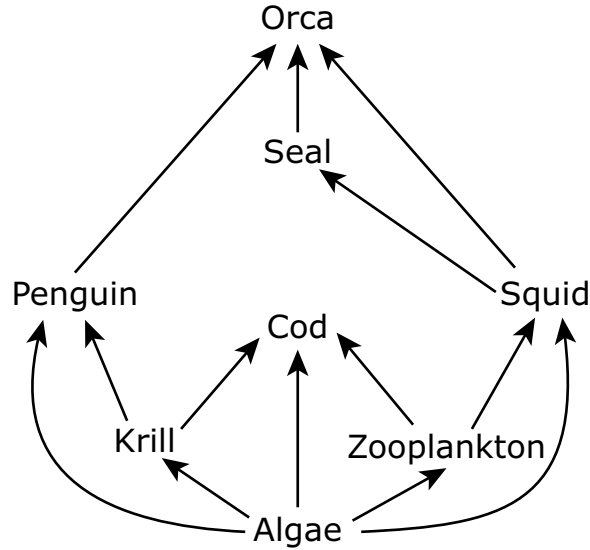
Pond 3: pupfish and mosquitofish

The researcher counted the number of each type of organism in each pond once a month for four months.

Which of the following describes what the researcher was **most likely** studying?

- Ⓐ how immigration affects population size
- Ⓑ how to increase biodiversity in the desert
- Ⓒ how invasive species affect native species
- Ⓓ how to decrease competition between predators

- 9 An Antarctic marine food web is shown.



An increase in the population size of which of the following will lead to the **greatest decrease** in the squid population?

- (A) algae
 - (B) cod
 - (C) penguins
 - (D) zooplankton
- 10 Keratin is a protein found in hair, nails, and feathers of animals. Which of the following elements is most abundant in keratin?
- (A) aluminum
 - (B) carbon
 - (C) iron
 - (D) zinc

- 11 The American toad and the Fowler's toad are closely related and found in the eastern part of North America. American toads breed in early summer, and Fowler's toads breed in late summer. The two types of toads have produced fertile offspring when bred in the laboratory. They do not produce fertile offspring in the wild.

Which of the following best explains why these two types of toads do not produce fertile offspring in the wild?

- Ⓐ The diets of each type of toad are changing.
- Ⓑ The genes in the gametes in each type of toad are different.
- Ⓒ An increase in gene flow occurred between the two types of toads.
- Ⓓ Behavioral differences between the two types of toads caused reproductive isolation.

The following section focuses on an inherited condition caused by a mutation in the *CFTR* gene.

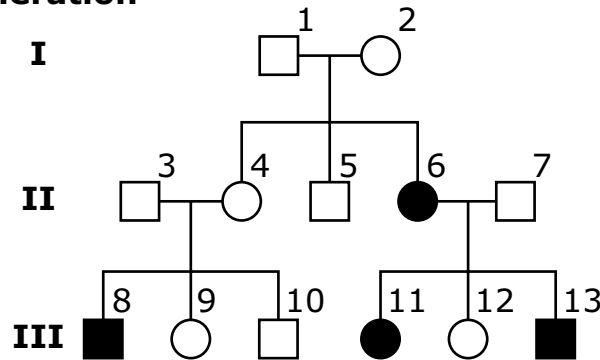
Read the information below and use it to answer the selected-response questions and constructed-response question that follow.

The *CFTR* gene is responsible for regulating the flow of water across cell membranes that produce mucus, sweat, saliva, and tears. Mucus is the substance that moistens and protects the lining of airways in the lungs, the digestive system, and other tissues in the body.

An inherited condition is caused by a mutation in the *CFTR* gene. For people with this *CFTR* mutation, the cells that make mucus produce a very thick mucus, which builds up. The buildup of thick mucus in the lungs can lead to severe breathing problems, such as frequent coughing and respiratory infections. A buildup of thick mucus in the pancreas can also disrupt digestion.

The diagram shows a pedigree for a family that is affected by this inherited condition.

Generation



Key		
	Has condition	Does not have condition
Male	■	□
Female	●	○

- 12 People with the CFTR mutation often experience digestive problems, which can result in weight loss. Which of the following **most likely** occurs as a result of the digestive problems?
- Ⓐ A large amount of sugar enters the bloodstream.
 - Ⓑ A large amount of oxygen is released to body cells.
 - Ⓒ Many nutrients are not absorbed into the bloodstream.
 - Ⓓ Salt is not absorbed quickly enough by the large intestine.
- 13 The pedigree shows which family members are affected by the CFTR mutation. For the person labeled 8 to have inherited the condition, the CFTR mutation must have been in the parents'
- Ⓐ brain cells.
 - Ⓑ heart cells.
 - Ⓒ lung cells.
 - Ⓓ sex cells.
- 14 People with the CFTR mutation often experience breathing problems. Which of the following is a direct result of these breathing problems?
- Ⓐ The filtration of toxins by the liver is increased.
 - Ⓑ The transport of nutrients in the body is reduced.
 - Ⓒ The diffusion of oxygen into the bloodstream is reduced.
 - Ⓓ The production of carbon dioxide in the body is increased.

This question has two parts.

- 15 The CFTR mutation most often occurs when three nucleotides from the gene sequence are deleted. The DNA sequence without the mutation and the DNA sequence with the mutation are shown.

DNA sequence without mutation: TAG TAG AAA CCA CAA

DNA sequence with mutation: TAG TAA CCA CAA

Part A

Which of the following is the mRNA sequence for the DNA sequence without the mutation?

- Ⓐ ATC ATC TTT GGT GTT
- Ⓑ UAG UAG AAA CCA CAA
- Ⓒ AUC AUC UUU GGU GUU
- Ⓓ UUG UGG UUU CUA CUA

Part B

The table shows the amino acids coded for by mRNA codons.

mRNA Codon Table

UUU Phe	UCU Ser	UAU Tyr	UGU Cys
UUC Phe	UCC Ser	UAC Tyr	UGC Cys
UUA Leu	UCA Ser	UAA STOP	UGA STOP
UUG Leu	UCG Ser	UAG STOP	UGG Trp
CUU Leu	CCU Pro	CAU His	CGU Arg
CUC Leu	CCC Pro	CAC His	CGC Arg
CUA Leu	CCA Pro	CAA Gln	CGA Arg
CUG Leu	CCG Pro	CAG Gln	CGG Arg
AUU Ile	ACU Thr	AAU Asn	AGU Ser
AUC Ile	ACC Thr	AAC Asn	AGC Ser
AUA Ile	ACA Thr	AAA Lys	AGA Arg
AUG Met	ACG Thr	AAG Lys	AGG Arg
GUU Val	GCU Ala	GAU Asp	GGU Gly
GUC Val	GCC Ala	GAC Asp	GGC Gly
GUA Val	GCA Ala	GAA Glu	GGA Gly
GUG Val	GCG Ala	GAG Glu	GGG Gly

Based on the information, which amino acid is missing in the protein produced by the CFTR mutation?

- Ⓐ Glu
- Ⓑ Phe
- Ⓒ Ser
- Ⓓ Val

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

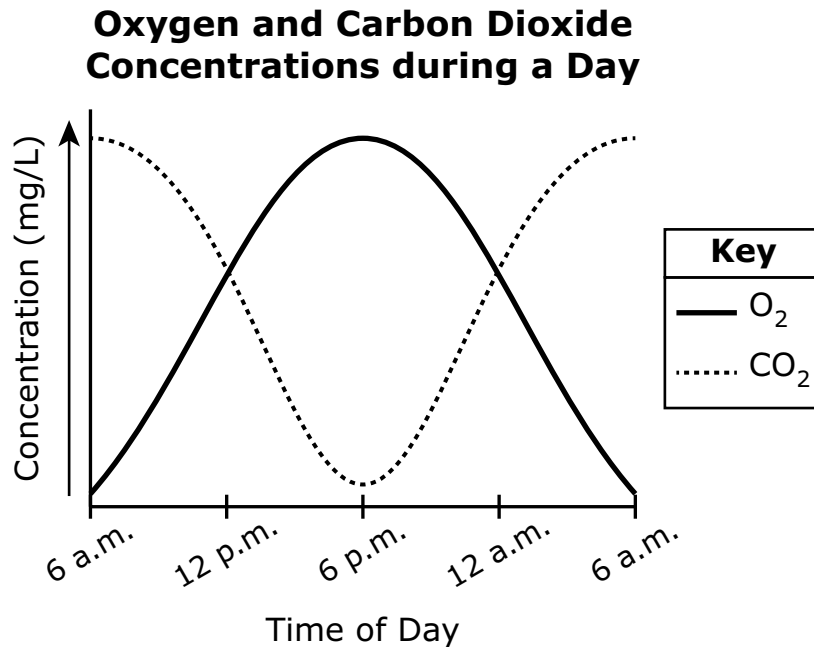
16 The condition caused by the CFTR mutation is controlled by a single gene with two alleles, **D** and **d**.

- A. Based on the pedigree, identify the most likely inheritance pattern (codominant, dominant, recessive, or sex-linked) for the condition.
- B. The person labeled 12 in the pedigree has a biological child with a person who is heterozygous for the condition.

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

- C. Based on your Punnett square in Part B, determine the probability that the child from this cross will inherit the condition. Explain your reasoning.

- 17 The graph shows how concentrations of dissolved oxygen (O_2) and carbon dioxide (CO_2) gases change in pond water on a warm, sunny day.



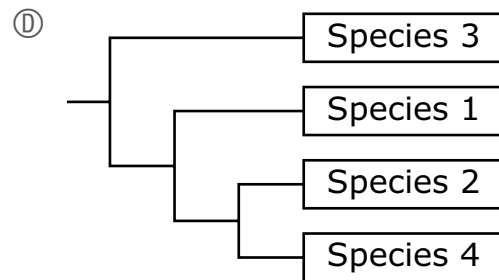
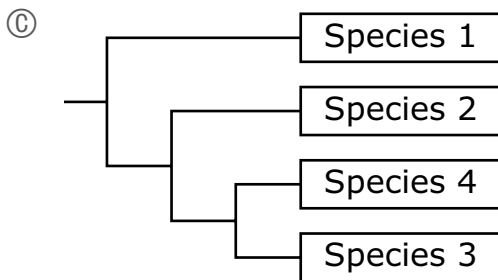
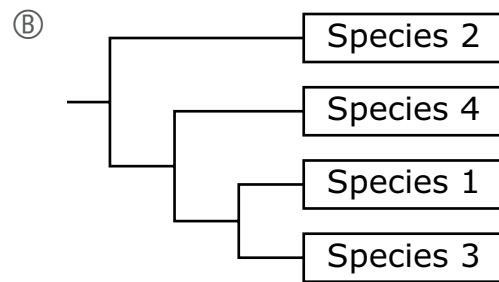
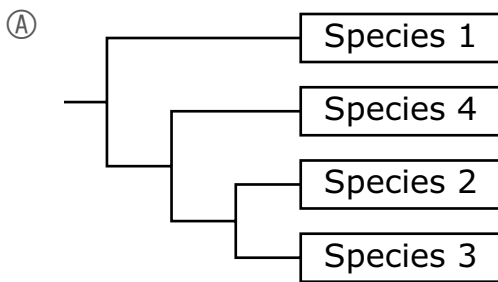
Based on the graph, which of the following best compares two processes occurring between 6 a.m. and 6 p.m.?

- (A) The rate of transpiration is greater than the rate of combustion.
- (B) The rate of combustion is greater than the rate of transpiration.
- (C) The rate of photosynthesis is greater than the rate of cellular respiration.
- (D) The rate of cellular respiration is greater than the rate of photosynthesis.

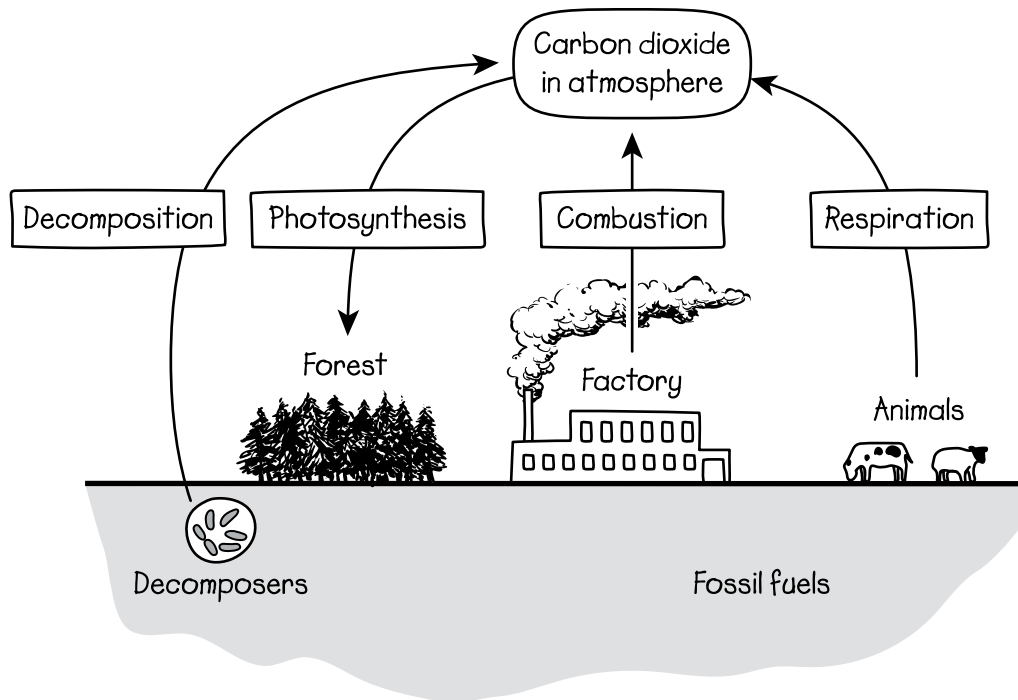
- 18 The table shows the percentages of DNA similarity among four animal species.

Species	DNA Similarity
1 and 2	98.4%
2 and 3	96.8%
2 and 4	98.8%
3 and 4	96.9%
4 and 1	98.4%

Use the information in the table to determine the evolutionary relatedness among the four species. Which cladogram shows how the species are related?



- 19 A student drew a model to represent the carbon cycle, as shown. The arrows represent four processes in the carbon cycle.

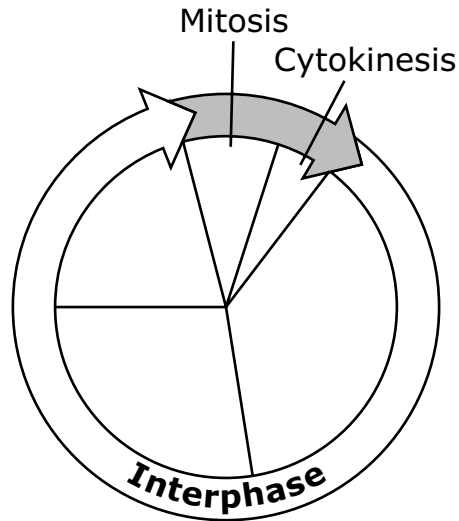


Select **two** changes the student could make to improve the model.

- Ⓐ Draw an arrow from the fossil fuels pointing to the factory, since fossil fuels provide energy to the factory.
- Ⓑ Draw an arrow from the forest pointing to the carbon dioxide in the atmosphere, since plants perform photosynthesis.
- Ⓒ Draw arrows from the forest and animals pointing to the decomposers, since decomposers break down dead organisms.
- Ⓓ Draw an arrow from the carbon dioxide in the atmosphere pointing to the animals, since animals perform cellular respiration.

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

- 20 An adult human body contains trillions of cells. Body cells go through the stages of the cell cycle. A diagram of the cell cycle is shown.



- A. Describe **two** events that occur during the interphase stage of the cell cycle.
- B. Mitosis and cytokinesis are important stages of the cell cycle.

Explain why mitosis must occur before cytokinesis.

- C. Describe one way a person's body would be affected if cells stopped going through mitosis and cytokinesis.

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

- 21** The comb on the top of a chicken's head may be full size, intermediate size, or small size. The small-size comb is called a pea comb. A chicken with a pea comb is shown.



- A. The allele for a full-size comb (**H**) and the allele for the pea comb (**h**) show incomplete dominance.

Using allele symbols, identify the genotype of a chicken with a pea comb.

- B. Chickens with pea combs have an advantage in cold climates because the pea comb reduces the amount of heat loss the chicken experiences.

Describe how the frequencies of the **H** allele and the **h** allele are expected to compare in a wild chicken population that lives in a cold climate.

- C. Explain how the allele frequencies you described in Part B could be produced as a result of natural selection.

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 As an ant population moves across the forest floor, flying insects move away. Some birds follow the ants, catching and eating the flying insects.

Which of the following **best** explains the relationship between the birds and the ants?

- Ⓐ It is commensal because it benefits the birds and has no effect on the ants.
 - Ⓑ It is commensal because it benefits the ants and has no effect on the birds.
 - Ⓒ It is parasitic because it benefits the birds and has a negative effect on the ants.
 - Ⓓ It is parasitic because it benefits the ants and has a negative effect on the birds.
- 23 The birth rate is about the same as the death rate in population X. Which of the following changes would be expected to **increase** the size of population X the most?
- Ⓐ a large increase in both the emigration rate and the immigration rate
 - Ⓑ a large decrease in both the emigration rate and the immigration rate
 - Ⓒ a large decrease in the emigration rate and a large increase in the immigration rate
 - Ⓓ a large increase in the emigration rate and a large decrease in the immigration rate

- 24 In a laboratory, cell parts were separated using a centrifuge. The table shows four samples of cell parts that were isolated.

Sample	Isolated Cell Parts
A	nuclei
B	mitochondria
C	cell membranes
D	ribosomes

After the cell parts were isolated, RNA and amino acids were added to each sample. After some time, the samples were tested for proteins.

Which sample most likely contained newly made proteins?

- Ⓐ sample A
- Ⓑ sample B
- Ⓒ sample C
- Ⓓ sample D

This question has two parts.

- 25 The flamingo is a type of bird. Young flamingos have white and gray feathers. By the time they are 3–6 years old, their feathers have become pink. The pink color is caused by the flamingo’s diet. Flamingos eat shrimp, which have red and orange pigments. When a flamingo stops eating shrimp, its feathers lose their pink color over time.

Part A

Which of the following best describes the cause of feather color in flamingos at different ages?

- Ⓐ Pink feather color in adult flamingos and white and gray feathers in young flamingos are both most directly caused by genetic factors.
- Ⓑ Pink feather color in adult flamingos and white and gray feathers in young flamingos are both most directly caused by environmental factors.
- Ⓒ Pink feather color in adult flamingos is most directly caused by genetic factors and white and gray feathers in young flamingos are most directly caused by environmental factors.
- Ⓓ Pink feather color in adult flamingos is most directly caused by environmental factors and white and gray feathers in young flamingos are most directly caused by genetic factors.

Part B

The pink color of flamingo feathers demonstrates that the phenotype for feather color

- Ⓐ changes.
- Ⓑ stays the same.

However, the genotype for feather color

- Ⓐ changes.
- Ⓑ stays the same.

- 26** A particular human disease results from mutations in a nucleotide sequence that encodes a protein responsible for transporting ions across the cell membrane. The sequence is more than 6000 nucleotides long, and there are many known mutations that can cause the disease. One example is a mutation at nucleotide 1609, which results in a stop codon rather than a codon for an amino acid.

Which of the following describes the expected result of this mutation?

- Ⓐ The transport of ions across the membrane stops because the protein is nonfunctional.
 - Ⓑ The transport of ions across the membrane slows down because the protein is smaller than it should be.
 - Ⓒ The transport of ions across the membrane speeds up because the protein is produced faster than it should be.
 - Ⓓ The transport of ions across the membrane occurs in the opposite direction because the protein has an irregular shape.
- 27** Which of the following is the best example of speciation due to geographic isolation?
- Ⓐ A coral species casts all of its gametes out into the water when conditions are right for reproduction.
 - Ⓑ Two groups of birds share a summer breeding habitat but migrate to different locations in Mexico for the winter.
 - Ⓒ A plant species produces seeds that stick to the fur of mammals and get distributed to distant locations to germinate.
 - Ⓓ Descendants of fruit flies that colonized the Hawaiian Islands from the mainland cannot successfully breed with mainland fruit flies.

- 28 A plant called downy thornapple stores its seeds in pods. The texture of the pods is genetically determined. The allele for spiny pods (**S**) is dominant to the allele for smooth pods (**s**).

A plant that has smooth pods is crossed with a homozygous plant that has spiny pods. What percentage of the offspring are expected to have smooth pods?

- Ⓐ 0%
 - Ⓑ 25%
 - Ⓒ 50%
 - Ⓓ 100%
- 29 Which of the following describes how the liver interacts with the circulatory system?
- Ⓐ It supplies oxygen to the blood.
 - Ⓑ It redirects blood flow in the body.
 - Ⓒ It produces hemoglobin for red blood cells.
 - Ⓓ It converts toxic compounds in blood to less toxic compounds.

- 30 Carolina chickadees are small birds found in the southeastern United States. The chickadees eat insects that feed only on native plants in their habitat.

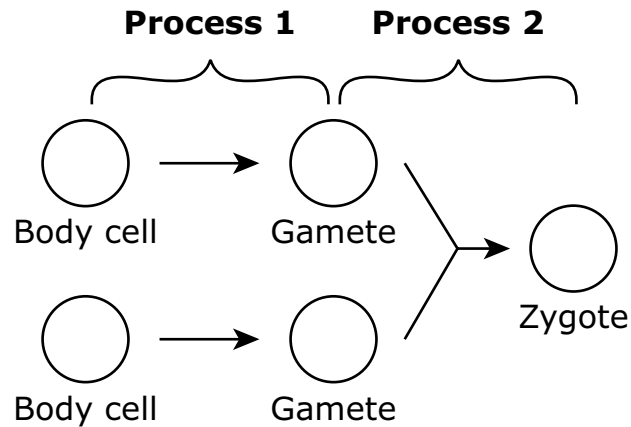
Which of the following would **most likely** occur if an invasive plant species were introduced into the chickadees' habitat?

- Ⓐ The chickadee population size would increase because more insects would be available to eat.
 - Ⓑ The chickadee population size would remain unchanged because chickadees do not eat the invasive plants.
 - Ⓒ The chickadee population size would decrease because the invasive plants would outcompete native plants.
 - Ⓓ The chickadee population size would increase because the number of producers in the ecosystem would increase.
- 31 Pronghorn antelope are herbivores that live in an area that includes much of the western United States. Wild horses and domestic sheep that also live in the area eat the same types of grasses as the pronghorn antelope. Coyotes and bobcats in the area prey on the antelope.

Which of the following would most likely **increase** the carrying capacity for the pronghorn antelope?

- Ⓐ a ban on hunting bobcats in the area
- Ⓑ a new law that allows more sheep to be raised in the area
- Ⓒ a dry winter that decreases the number of plants that grow in the area
- Ⓓ a viral disease that decreases the population size of the wild horses in the area

- 32 The diagram represents two cell processes.



What processes are represented in the diagram?

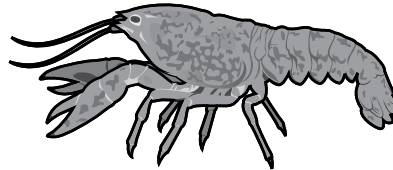
- Ⓐ Process 1 is translation and process 2 is replication.
- Ⓑ Process 1 is mitosis and process 2 is crossing over.
- Ⓒ Process 1 is growth and process 2 is reproduction.
- Ⓓ Process 1 is meiosis and process 2 is fertilization.

The following section focuses on marbled crayfish.

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

Crayfish are freshwater crustaceans that look like small lobsters. They are found in many parts of the world. Crayfish typically reproduce sexually, but the marbled crayfish reproduces asexually.

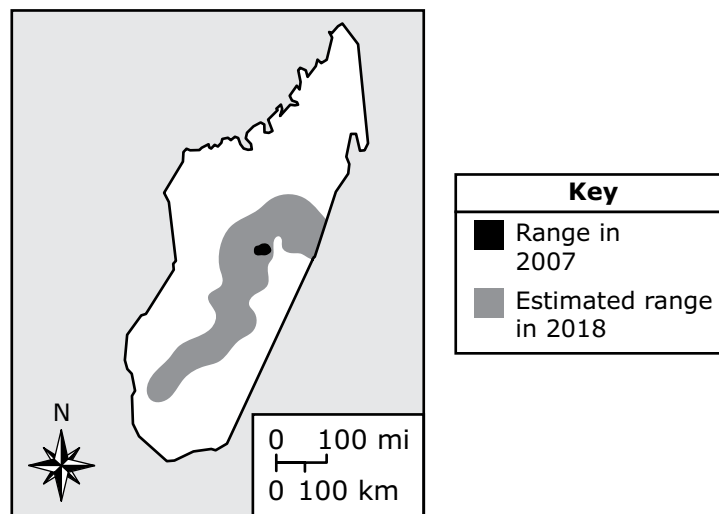
The marbled crayfish was first discovered in an aquarium in 1995 and was not originally found in the wild. Since then, it has been released into the wild. Because the marbled crayfish can reproduce asexually, a single crayfish can start a new population in the wild. It has become an invasive species across Europe and in parts of Africa. A picture of the marbled crayfish is shown.



Madagascar is an island about 400 km off the coast of Eastern Africa. In 2003, the marbled crayfish was introduced to Madagascar. Since then, it has spread quickly across Madagascar and lives in the same areas where several native crayfish species live. The native crayfish species reproduce sexually.

The map shows the range of marbled crayfish across Madagascar in 2007 and 2018.

Spread of Marbled Crayfish in Madagascar



- 33 Scientists think that the marbled crayfish evolved from another type of crayfish, the slough crayfish. Which of the following **best** supports the scientists' hypothesis that the slough crayfish is an ancestor of the marbled crayfish?
- Ⓐ Slough crayfish and marbled crayfish have the same number of legs.
 - Ⓑ Slough crayfish and marbled crayfish can be found in the same habitats.
 - Ⓒ The genome of the slough crayfish is very similar to the genome of the marbled crayfish.
 - Ⓓ The ecological role of the slough crayfish is very similar to the ecological role of the marbled crayfish.
- 34 A native Madagascar crayfish population may be better able to survive than the marbled crayfish population if a disease were introduced into their habitat.
- Which of the following **best** explains why a native Madagascar crayfish population may be better able to survive if a disease were introduced?
- Ⓐ Native Madagascar crayfish reproduce sexually and have less genetic variation.
 - Ⓑ Native Madagascar crayfish reproduce sexually and have more genetic variation.
 - Ⓒ Native Madagascar crayfish reproduce slowly and will be less exposed to the disease.
 - Ⓓ Native Madagascar crayfish reproduce quickly and will be less exposed to the disease.

- 35** The energy needed for cell growth in marbled crayfish is provided by the process of
- Ⓐ active transport.
 - Ⓑ cellular respiration.
 - Ⓒ mitosis.
 - Ⓓ transpiration.

This question has two parts.

- 36** Marbled crayfish live in fresh water. Fresh water has a low concentration of sodium compared to the concentration inside crayfish cells.

Part A

Which of the following best describes the movement of sodium and water between a crayfish cell and its freshwater environment?

- Ⓐ Both sodium and water move into the cell.
- Ⓑ Both sodium and water move out of the cell.
- Ⓒ Sodium moves into the cell, and water moves out of the cell.
- Ⓓ Sodium moves out of the cell, and water moves into the cell.

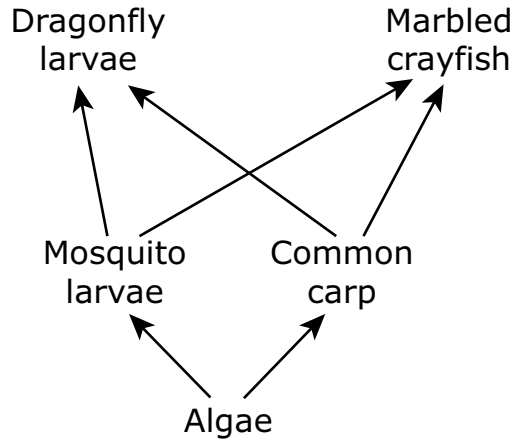
Part B

Which of the following describes how cell membranes of crayfish cells help to maintain homeostasis of the crayfish?

- Ⓐ The cell membranes allow only glucose into the cell.
- Ⓑ The cell membranes allow only certain waste products to leave the cell.
- Ⓒ The cell membranes allow only certain materials into and out of the cell.
- Ⓓ The cell membranes allow only proteins to leave the cell and only oxygen to enter the cell.

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

- 37** An aquatic food web with the marbled crayfish is shown.



- Identify the ecological role (decomposer, producer, primary consumer, or secondary consumer) of the marbled crayfish.
- Describe how a large increase in the size of the marbled crayfish population would most likely affect the size of the dragonfly population. Explain your reasoning.
- Identify the organism in the food web that has the most available energy. Explain your answer.

- 38** Which of the following explains why a human infant is genetically similar to, but not identical to, its mother?
- Ⓐ The infant's cells undergo mitosis as it develops from fertilization to birth.
 - Ⓑ The set of chromosomes that an infant inherits is determined by natural selection.
 - Ⓒ The infant's genetic material is translated by both the mother's and the father's cells.
 - Ⓓ Half of the infant's genetic material comes from the mother and half comes from the father.

- 39** Milk contains a high concentration of the carbohydrate lactose. What is the basic structure of lactose?
- Ⓐ two monosaccharides joined together
 - Ⓑ a chain of amino acids in a helix shape
 - Ⓒ two fatty acids joined to a phosphate group
 - Ⓓ a chain of alternating sugar and phosphate groups

- 40 A strawberry farmer makes the crosses described in the table.

Cross	Parent 1 Phenotype	Parent 2 Phenotype	Offspring Phenotype
1	true breeding for yellow fruit	true breeding for yellow fruit	100% yellow
2	true breeding for yellow fruit	true breeding for red fruit	100% red
3	true breeding for red fruit	true breeding for red fruit	100% red

Which of the following would be expected to produce the **most** offspring with the heterozygous genotype?

- Ⓐ crossing two offspring from cross 1
- Ⓑ crossing two offspring from cross 3
- Ⓒ crossing an offspring from cross 1 with an offspring from cross 2
- Ⓓ crossing an offspring from cross 1 with an offspring from cross 3

This question has two parts.

- 41 In April 2009, a new type of influenza virus that became known as 2009 H1N1 was reported in the United States. The number of reported cases grew rapidly. By June 2009, 70 countries were reporting outbreaks of the virus.

Part A

Which of the following was **most** responsible for the rapid spread of the 2009 H1N1 virus?

- Ⓐ The virus often killed a host cell after infecting the cell.
- Ⓑ The virus reproduced only before entering and infecting a host cell.
- Ⓒ The genetic material of a host cell was used when new viral particles were produced.
- Ⓓ Only a few simple structures needed to be made when new viral particles were produced by a host cell.

Part B

Which of the following **best** explains why new types of influenza viruses, such as 2009 H1N1, can develop?

- Ⓐ Rapid reproduction allows mutations to be introduced into viral populations.
- Ⓑ When viruses reproduce using many cell parts, they are able to develop new types of organelles.
- Ⓒ Viruses travel slowly from one host to another and are able to break down more organic material.
- Ⓓ The genetic material of viruses is constantly changed by environmental factors like radiation, and the viruses are able to grow larger.

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

- 42** A student is studying how flowering plants and insects affect oxygen (O₂) and carbon dioxide (CO₂) concentrations in the air.
- A. Identify the cellular process performed **only** by the flowering plants that affects the concentrations of O₂ and CO₂ in the air.
- B. Identify the cellular process performed by both the flowering plants and the insects that affects the concentrations of O₂ and CO₂ in the air.
- C. During an experiment, the student measured the initial concentrations of O₂ and CO₂ in three flasks, added organisms to some of the flasks, sealed the flasks, and placed them under a light. After 12 hours, the student measured the concentrations of O₂ and CO₂ in the flasks. The results for each flask are shown in the table.

Row	Flask Contents	Initial O ₂ Concentration (%)	Final O ₂ Concentration (%)	Initial CO ₂ Concentration (ppm)*	Final CO ₂ Concentration (ppm)*
1	?	20.8	20.8	373	375
2	?	20.9	19.6	371	454
3	?	20.7	22.1	374	267

*parts per million

During the experiment, the student had forgotten to identify the contents of each flask. Each of the three flasks contained one of the following: two plants and one insect; one insect; or no organisms.

Identify the contents of **each** flask based on the data in rows 1, 2, and 3. Explain your reasoning using data from the table and the processes you identified in Parts A and B. Include the row numbers in your response.

High School Biology
Spring 2023 Released Operational Items

PBT Item No.	Page No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description	Correct Answer**
1	3	<i>Ecology</i>	HS.LS.2.6	C. Evidence, Reasoning, and Modeling	SR	Describe how an environmental change would most likely affect the survival of a species.	B
2	3	<i>Heredity</i>	HS.LS.3.3	B. Mathematics and Data	SR	Determine the percentage of offspring from a given cross that would be expected to inherit a particular trait.	A
3	4	<i>Heredity</i>	HS.LS.3.2	C. Evidence, Reasoning, and Modeling	SR	Interpret a model of crossing over and describe how crossing over increases genetic variation.	C
4	4	<i>Evolution</i>	HS.LS.4.4	None	SR	Describe how bacterial reproduction and survival can result in an antibiotic becoming less effective over time.	A
5	5	<i>Heredity</i>	HS.LS.3.4	None	SR	Identify an example of polygenic inheritance.	B
6	6	<i>Molecules to Organisms</i>	HS.LS.1.7	None	SR	Describe how a step in a model can be improved to more accurately describe how usable energy is produced by an athlete and identify a product of cellular respiration.	C;B
7	7	<i>Heredity</i>	HS.LS.3.1	None	SR	Use evidence about the number of chromosomes in gametes and body cells to support a claim.	A
8	7	<i>Ecology</i>	HS.LS.2.7	A. Investigations and Questioning	SR	Analyze the setup of an experiment to determine the purpose of the investigation about invasive species.	C
9	8	<i>Ecology</i>	HS.LS.2.2	C. Evidence, Reasoning, and Modeling	SR	Analyze a food web to determine how an increase in one population would affect another population.	B
10	8	<i>Molecules to Organisms</i>	HS.LS.1.6	None	SR	Identify which element is most abundant in a protein.	B
11	9	<i>Evolution</i>	HS.LS.4.5	C. Evidence, Reasoning, and Modeling	SR	Explain why closely related organisms may not produce fertile offspring in the wild.	D
12	11	<i>Molecules to Organisms</i>	HS.LS.1.2	None	SR	Describe how an inherited mutation most likely affects the functioning of the digestive system.	C
13	11	<i>Heredity</i>	HS.LS.3.2	None	SR	Identify the type of cell that can pass a mutation from parent to offspring.	D
14	11	<i>Molecules to Organisms</i>	HS.LS.1.2	None	SR	Describe how an inherited mutation can affect the functioning of the respiratory system.	C
15	12–13	<i>Molecules to Organisms</i>	HS.LS.1.1	C. Evidence, Reasoning, and Modeling	SR	Determine the mRNA sequence for a given DNA sequence and determine the missing amino acid of a protein produced as a result of a mutation.	C;B
16	14	<i>Heredity</i>	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	CR	Analyze a pedigree to determine the inheritance pattern for a condition, complete a Punnett square for a given cross, determine the probability of inheriting the condition, and explain how the probability was determined.	

PBT Item No.	Page No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description	Correct Answer**
17	16	<i>Ecology</i>	HS.LS.2.5	B. Mathematics and Data	SR	Analyze a graph to compare the rates of photosynthesis and cellular respiration in an aquatic ecosystem.	C
18	17	<i>Evolution</i>	HS.LS.4.1	C. Evidence, Reasoning, and Modeling	SR	Select a cladogram showing the relatedness between species based on DNA evidence.	D
19	18	<i>Ecology</i>	HS.LS.2.5	C. Evidence, Reasoning, and Modeling	SR	Determine two changes that would improve a carbon cycle model.	C,A
20	19	<i>Molecules to Organisms</i>	HS.LS.1.4	None	CR	Describe events of interphase, explain why mitosis must occur before cytokinesis, and explain the effect on the human body if a person's cells stopped going through mitosis and cytokinesis.	
21	21	<i>Evolution</i>	HS.LS.4.2	C. Evidence, Reasoning, and Modeling	CR	Determine a genotype for a trait based on an inheritance pattern, describe the expected allele frequencies in a population, and explain how changes in allele frequencies can be a result of natural selection.	
22	24	<i>Ecology</i>	HS.LS.2.2	None	SR	Determine the type of symbiotic relationship between two species.	A
23	24	<i>Ecology</i>	HS.LS.2.2	None	SR	Identify changes that would result in an increase in the size of a population.	C
24	25	<i>Molecules to Organisms</i>	HS.LS.1.1	None	SR	Determine the cell part most responsible for protein synthesis.	D
25	26	<i>Heredity</i>	HS.LS.3.4	C. Evidence, Reasoning, and Modeling	SR	Identify whether a characteristic of an animal is most directly caused by genetic factors or environmental factors, and determine whether the animal's phenotype and genotype change or stay the same.	D;A;B
26	27	<i>Heredity</i>	HS.LS.3.2	C. Evidence, Reasoning, and Modeling	SR	Determine how a particular mutation would be expected to affect the function of the resulting protein.	A
27	27	<i>Evolution</i>	HS.LS.4.5	None	SR	Identify an example of speciation due to geographic isolation.	D
28	28	<i>Heredity</i>	HS.LS.3.3	B. Mathematics and Data	SR	Determine the expected percentage of offspring with a certain phenotype for a given cross.	A
29	28	<i>Molecules to Organisms</i>	HS.LS.1.2	None	SR	Describe the interaction between the liver and the circulatory system.	D
30	29	<i>Ecology</i>	HS.LS.2.7	None	SR	Describe the impact of an invasive plant species in an ecosystem.	C
31	29	<i>Ecology</i>	HS.LS.2.1	None	SR	Identify an environmental change that would most likely increase the carrying capacity for a given population.	D
32	30	<i>Heredity</i>	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Use a model to show the process of meiosis and fertilization.	D
33	32	<i>Evolution</i>	HS.LS.4.1	None	SR	Determine the type of evidence that best supports a claim about the relatedness of two species.	C

PBT Item No.	Page No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description	Correct Answer**
34	32	<i>Evolution</i>	HS.LS.4.2	C. Evidence, Reasoning, and Modeling	SR	Explain why one species may be better able to survive a disease outbreak than another species.	B
35	33	<i>Molecules to Organisms</i>	HS.LS.1.7	None	SR	Identify the process that produces energy for cell growth.	B
36	34	<i>Molecules to Organisms</i>	HS.LS.1.3	C. Evidence, Reasoning, and Modeling	SR	Determine whether substances would be expected to move into or out of cells based on their concentration gradients, and describe how cell membranes help to maintain homeostasis.	D;C
37	35	<i>Ecology</i>	HS.LS.2.4	C. Evidence, Reasoning, and Modeling	CR	Identify the ecological role of an organism in an ecosystem, analyze a food web to determine how an increase in one population would affect another population, and explain why producers have the most available energy in an ecosystem.	
38	37	<i>Heredity</i>	HS.LS.3.1	None	SR	Explain why a human infant is genetically similar to, but not identical to, its mother.	D
39	38	<i>Molecules to Organisms</i>	HS.LS.1.6	None	SR	Identify the monomers that make up an organic macromolecule.	A
40	39	<i>Heredity</i>	HS.LS.3.3	A. Investigations and Questioning	SR	Analyze phenotypic data for several genetic crosses to determine the cross that would produce the most heterozygous offspring.	D
41	40	<i>Evolution</i>	HS.LS.4.4	C. Evidence, Reasoning, and Modeling	SR	Determine the cause of the rapid spread of a virus and explain how new types of viruses can develop.	D;A
42	41	<i>Molecules to Organisms</i>	HS.LS.1.5	B. Mathematics and Data	CR	Determine that photosynthesis is a process performed only by plants and that cellular respiration is a process performed by both plants and animals; analyze data to determine whether flasks in an experiment contain plants, animals, or both and explain the reasoning.	

* Science and Technology/Engineering 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.