CAST Practice Test Questions
LIFE SCIENCE

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GUEST

The leaf beetle, *Chrysomela aeneicollis*, lives in the Sierra Nevada Mountains of California. Scientists studying the beetles found that exposure to high temperatures during the summer, when the eggs are laid and the larvae are developing, causes physiological stress. The impact is on metabolic enzymes and heat shock protein expression. One allele, *Pgi-4*, increased in frequency in the beetle population that was exposed to hotter, drier summers in the Sierra Nevada Mountains.

Complete the sentence about this change by selecting the correct words from the menus.

If the temperatures in the Sierra Nevada Mountains continue to increase, the frequency of the *Pgi-4* allele is expected to [▲▼] as a result of [▲▼].

✓
increase
decrease

✓
genetic drift
gene flow
natural selection
artificial selection

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GUEST

Students are investigating the relationship between human population density and biodiversity. The amount of forest cover was used as a measure of the biodiversity of an area. The students averaged human population density and forest cover from locations with a range of population densities. The graph shows the students' results.

Forest Cover and Human Population Density

Forest Cover (%) vs Human Population Density (per km^2)
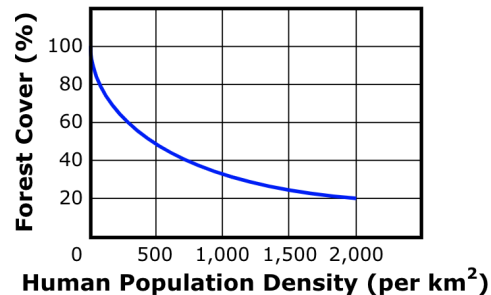
Part A

Select a phrase from the menu to complete the sentence.

Based on the graph, if the population density increases from 1 to 500 people/km^2, the forest cover will likely [▲▼] in that area.

✓
decrease by about 50%
decrease by about 500 km
double in size

Part B

The students identified four resource management strategies intended to help preserve forest cover and maintain biodiversity.
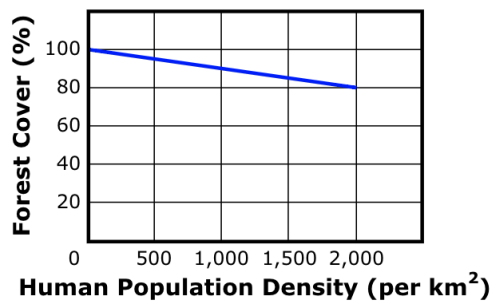
The students then ran computer simulations to graphically compare the different resource management strategies.

Which graph shows results for a resource management strategy that will **best** preserve forest cover as population density increases?
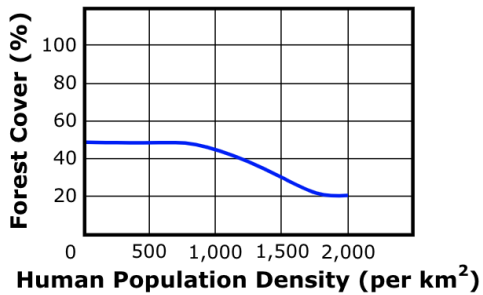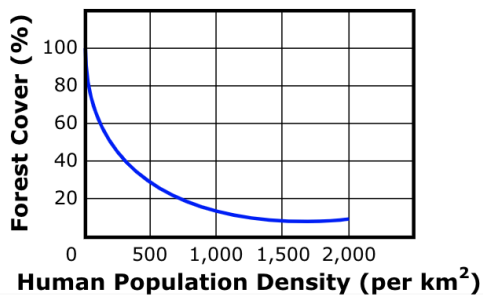
Ⓐ

Ⓑ

Ⓒ

Ⓓ
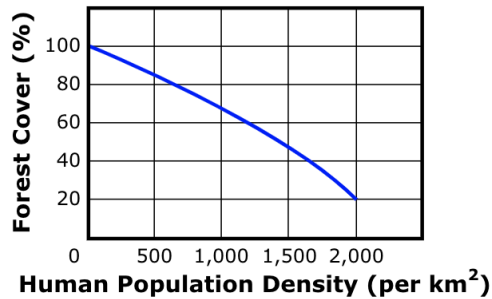
A biochemist conducted an experiment to follow the movement of glucose molecules in animal cells. Glucose with radioactively labeled carbon atoms was added to a culture of liver cells growing in a Petri dish. Over the next 18 hours, the biochemist assessed selected biomolecules in the culture for radioactivity. The results are shown in the table.

Presence of Radioactive Carbon

Biomolecule	3 Hours	6 Hours	9 Hours	12 Hours	15 Hours	18 Hours
Glucose	√	√	√	√		
Glycogen		√	√	√	√	√

Explain how adding labeled glucose molecules to the culture resulted in labeled glycogen **and** describe what happened to the labeled glucose molecules during the 18-hour period. Enter your answer in the box provided.

| 🖶 | **B** *I* U *I*ₓ | ≟ ≔ ≝ ≣ | ✂ 🗐 📋 ↤ ↦ | ᴬᴮᶜ | English ⬍ | Ω |

In a particular species of plant, yellow seed color is dominant to green seed color. Two plants of this species that are heterozygous for seed color are crossed.

What is the predicted ratio for seed color in the offspring of this cross?

Ⓐ 1 yellow : 3 green

Ⓑ 1 yellow : 1 green

Ⓒ 3 yellow : 1 green

Ⓓ 3 yellow : 2 green

Students are given an assignment to design a simulation that will model effects of human activity on biodiversity in a particular town. A student decides to model changes in the biodiversity of bird species caused by human activity in a forested park next to the school. The park is home to many native bird species. Near the park is a housing development and an industrial area.
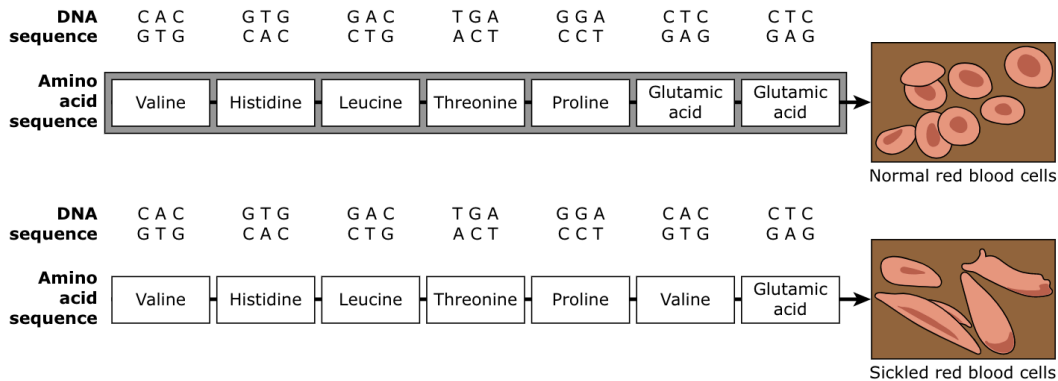
What **three** components should the students include in their simulation to **best** understand the effects of human activity on biodiversity?

☐ size of the park

☐ annual rainfall in the town

☐ number of native bird species in the park

☐ projected population growth in the town

☐ number of native herbivore species in the park

Sickle-cell disease is a group of genetic disorders that affect hemoglobin, which is the protein in red blood cells that binds to oxygen. The change to the hemoglobin molecule causes the red blood cells to have a crescent or sickled shape. The diagram shows a fragment of the DNA sequence for hemoglobin in a person without sickle-cell disease and in a person with the disease.

Part A

Select the amino acid change that reflects the mutation leading to sickled red blood cells.

DNA sequence	C A C G T G	G T G C A C	G A C C T G	T G A A C T	G G A C C T	C T C G A G	C T C G A G
Amino acid sequence	Valine	Histidine	Leucine	Threonine	Proline	Glutamic acid	Glutamic acid

Normal red blood cells

DNA sequence	C A C G T G	G T G C A C	G A C C T G	T G A A C T	G G A C C T	C A C G T G	C T C G A G
Amino acid sequence	Valine	Histidine	Leucine	Threonine	Proline	Valine	Glutamic acid

Sickled red blood cells

Part B

Complete the sentences by selecting terms from the menus that **best** explain how a change in the DNA sequence can cause sickle-cell disease.

Each amino acid in a protein is coded for by [▲▼] nucleotides in the DNA. In sickled red blood cells, [▲▼] occurred, causing a different hemoglobin protein to be produced.

| ✓ |
|---|
| a point mutation |
| a deletion |
| a frameshift |

✓
two
three
four

Students in a class are designing an investigation to determine the effect running on a treadmill has on heart rate. They decide to have several students run for 20 minutes on a treadmill.

Which **two** data sets **must** the students collect in order to determine the effect exercise has on heart rate?

☐ the student's age

☐ the student's weight

☐ the student's resting heart rate prior to exercising

☐ the student's heart rate after running on the treadmill

☐ the distance the student can run on the treadmill in 20 minutes

Students created a computer model of an ecosystem process to predict the density of different tree species in an area over 100 years. The graph shows the outcomes of the model for one of the tree species.
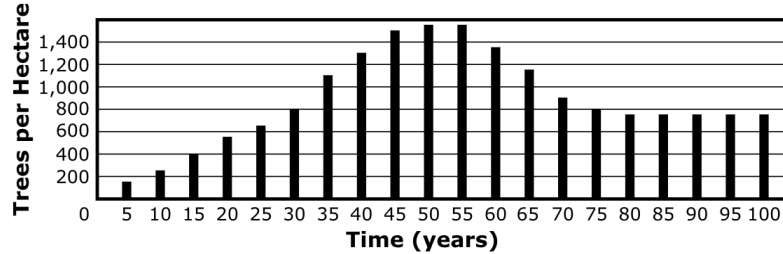
Complete the sentences by selecting from the menus. The process being modeled is **most likely** [_____ ▼] following a disturbance. In years 75 to 100, the population can **best** be described as having reached [_____ ▼].

✓
ecological succession
genetic drift
coevolution

✓
maximal growth
carrying capacity
maximal density

A student conducted an experiment to measure the effect of light on photosynthesis. The student placed small, disk-shaped pieces of fresh-cut leaves into several dishes with a bicarbonate solution and exposed each dish to a different intensity of light. The student observed bubbles and the number of leaf pieces that floated after 15 minutes of light exposure. The data are shown in the graph.
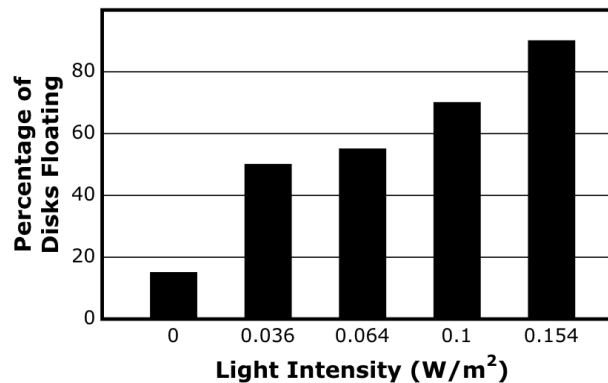
(Continued below…)

Drag the input and output to the chloroplast that **best** represent the variables in the experiment.

| Light energy | CO_2 | H_2O | Sugar | O_2 |
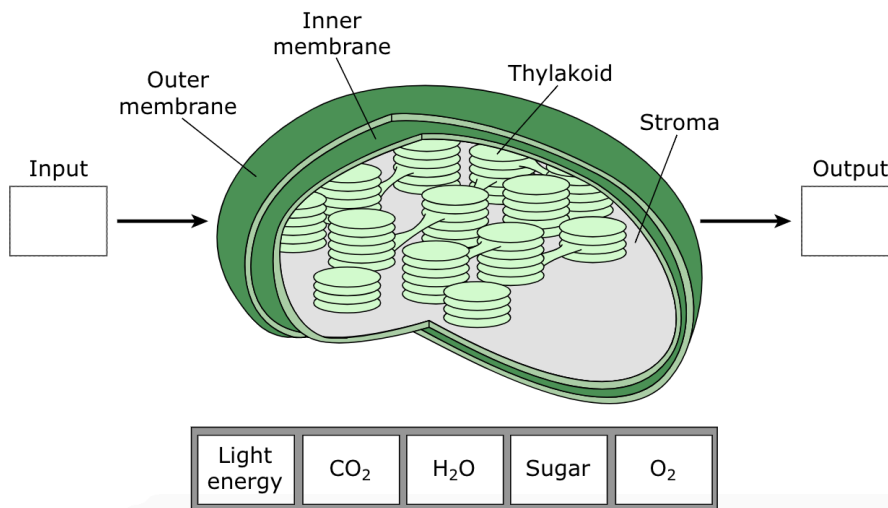
Cargo ships that transport goods require ballast water to remain safe and stable during their voyage. These ships collect water from their port of origin and release that same water at the final destination. The ballast water often contains aquatic organisms that are present in the water at the port of origin. The release of ballast water can introduce invasive species into an ecosystem. A regulatory agency is investigating several methods to prevent this from happening. The agency is interested in identifying solutions that meet the following criteria:

- Ensure that organisms are removed from ballast water
- Have minimal impact on the environment
- Are cost effective
- Are easy to implement

Based on the agency's criteria, select **three** methods that offer the **best** solution.

| Method	Effectiveness in Removing Organisms	Environmental Impact	Ease of Implementation	Cost
Oxidizing chemical treatment	Effective	Very harmful to environment	Easy	High
Nonoxidizing chemical treatment	Effective	Some impact to environment	Easy	Average
Filtration	Very effective	Little impact to environment	Medium	Average
Thermal treatment	Effective	No impact to environment	Hard	Average
Alternative technologies	Not very effective	No impact to environment	Hard	Average

Performance Task 1 Below:

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In this performance task, you will answer six questions.

A family plans to purchase two Californian rabbits. Californian rabbits are white with black points (ears, nose, feet, and tail) and exhibit temperature-influenced color expression. The family finds a breeder who sells the two breeds of rabbits pictured, Californian and New Zealand.
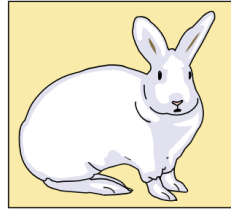
Californian rabbit   New Zealand rabbit

The family purchases two eight-week-old Californian kits (baby rabbits) from this breeder. The family takes the kits home and places them outdoors (30°C) in a rabbit hutch. After a few weeks, both rabbits are white with gray points rather than black points. The family members wonder if they received the correct breed of rabbits.

The family starts to research the genetics of coat color in rabbits and learns that color expression in rabbit coats is primarily influenced by five different genes, all found on one chromosome. These five genes account for 144 different color variations found in rabbits.

In researching the genetics of Californian rabbit colors, the family learns that possible colors for the points include black and gray. The family then focuses its research on the *c* gene (color gene) and the *d* gene (dense-dilute gene).

This table summarizes the genetic patterns and phenotypes of the *c* gene and *d* gene.

Inheritance Patterns of the *c* Gene and *d* Gene

Gene	Allele	Inheritance Pattern	Expressed Phenotype
c gene	c^h	Dominant	Himalayan (white body with colored points)
c gene	*c*	Recessive	White without points (albino)
d gene	*D*	Dominant	Black points (dense color)
d gene	*d*	Recessive	Gray points (dilute color)

Based on the rabbits' expressed phenotype of gray points, a member of the family argues that the rabbits' genotype for the *c* gene is *cc*.

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Based on this information, complete the sentence by selecting the **best** phrase from the menu.

✓
  Crossing over during meiosis
  Environmental mutation
  Gene cloning

is primarily responsible for the 144 different color variations found in rabbits.

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GUEST

Which scientifically correct question **best** challenges the family member's argument?

Ⓐ   Do the rabbits have the correct number of chromosomes and corresponding genes?

Ⓑ   Does biological sex have any influence on the expression of the rabbits' *c* gene?

Ⓒ   Do the rabbits have a phenotype (albino) consistent with the *cc* genotype?

Ⓓ   Does having the *cc* genotype affect the color of the rabbits' coats?

In anticipation of a heat wave, the family members move the rabbits from their outdoor hutch $(30°C)$ to an air-conditioned room $(20°C)$ inside their home.

Several days after the rabbits were moved, their gray points turned black. The family decides to take the rabbits to a veterinarian who treats and also breeds Californian rabbits.

Refer to this table for genetic information about the c gene and d gene.

Inheritance Patterns of the c Gene and d Gene

Gene	Allele	Inheritance Pattern	Expressed Phenotype
c gene	c^h	Dominant	Himalayan (white body with colored points)
c gene	c	Recessive	White without points (albino)
d gene	D	Dominant	Black points (dense color)
d gene	d	Recessive	Gray points (dilute color)

The family finds an online simulation that allows them to observe how temperature affects the rabbits' point color, assuming that the rabbits have at least one copy of the Himalayan allele (c^h). Depending on the air temperature, the c^h allele controls point color expression by interacting with the d gene.

This table shows the simulation results for expressed point color in rabbits with the c^h allele.

Simulation Results

	DD	Dd	dd
20°C	Black pointed	Black pointed	Gray pointed
30°C	Gray pointed	Gray pointed	Gray pointed

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Which **three** questions should the family ask their veterinarian that would **most likely** help the family understand the genetic basis for the recent color change of the rabbits?

☐ Is it possible for these rabbits to be heterozygous for the c gene, since the rabbits seem to express the Himalayan allele (c^h)?

☐ Is it possible for these rabbits to be heterozygous for the d gene, since they now have black points rather than gray points?

☐ Is it possible that the rabbits have eaten an unfamiliar food that has caused a change to their genetic make-up?

☐ Is it possible that the rabbits have contracted a parasite and this is affecting the expression of the c gene?

☐ Is it possible that the lower temperature of the room had an effect on the expression of the c gene?

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GUEST

Based on the simulation results and assuming that the rabbits inherited at least one Himalayan allele (c^h), select the words from the menus that **best** complete the sentence.

Temperatures 30°C and higher will act on the [⬍] of Californian rabbits and cause the expression of the [⬍] phenotype even if the rabbits inherited a dominant allele for the gene.

✓

   albino
   gray-pointed
   black-pointed

✓

   color gene
   dense-dilute gene

The two rabbits eventually mate and the female gives birth to six kits. The kits are being raised in a 20°C room. One kit is albino and five are black pointed.

A family member suggests using this Punnett square to model the inheritance of the *d* gene for the newborn kits.

	D	**d**
d	Dd	dd
d	Dd	dd

Refer to these tables for genetic and environmental information about the *c* gene and *d* gene.

Inheritance Patterns of the *c* Gene and *d* Gene

Gene	Allele	Inheritance Pattern	Expressed Phenotype
c gene	c^h	Dominant	Himalayan (white body with colored points)
c gene	*c*	Recessive	White without points (albino)
d gene	*D*	Dominant	Black points (dense color)
d gene	*d*	Recessive	Gray points (dilute color)

Simulation Results

	DD	**Dd**	**dd**
20°C	Black pointed	Black pointed	Gray pointed
30°C	Gray pointed	Gray pointed	Gray pointed

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Which scientifically correct question would **best** challenge the conclusions made about the kits' genotypes from the suggested Punnett square?

Ⓐ Why is only one kit albino?

Ⓑ Why do only some of the kits have black points?

Ⓒ What are the genotypes of the two parent rabbits for the *d* gene?

Ⓓ Can you make a prediction of point color without knowing the genotype of the *c* gene?

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Based on the information in the tables, explain how **both** genetic and environmental factors can affect point color variation in Californian rabbits. Enter your answer in the box provided.

| 🖶 | **B** | *I* | U̲ | I̲ₓ | ≟ | ≔ | ⇥ | ⇤ | ✂ | 🗐 | 📋 | ↶ | ↷ | ᴬᴮꟲ | English ⬍ | Ω |

Performance Task 2 Below:

In this performance task, you will answer six questions.

Silver carp are an invasive species of fish that is not native to the United States. However, populations of silver carp now inhabit the rivers of the United States and can be found throughout the Mississippi River system.

Silver carp feed on phytoplankton, including algae, consuming up to 20% of their body weight daily. Carp can lay hundreds of thousands of eggs at a time, several times a year. They are capable of jumping over barriers, including low dams, and can travel to new areas when flooding connects previously unconnected bodies of water. This picture shows a silver carp.

Silver carp

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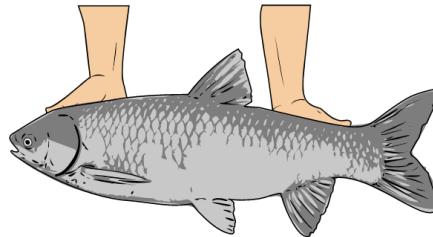
Silver carp were intentionally introduced by humans to solve an environmental problem. Which claim is **best** supported by this information?

Ⓐ Silver carp were placed in fish farms to control the growth of algae.

Ⓑ Silver carp were used to introduce new genes into the native fish populations.

Ⓒ Silver carp were introduced to improve the natural beauty of the aquatic landscape.

Ⓓ Silver carp were introduced to help increase rates of photosynthesis because they support algae populations.

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Complete this sentence by selecting the **best** phrase from the menu.

Silver carp in the Mississippi River are considered an invasive species and have altered the ecosystem of the river because they [⬍].

✓
interbreed with native fish species
out-compete native fish species for food
increase the amount of dissolved oxygen in the water

Currently, there are several dams that control the movement of water between Lake Michigan and the Mississippi River. Each dam has a lock system to allow the movement of ships between the two areas. Click play to watch the animation on how a lock operates.

Gates closed   Gates closed

▶ lock chamber

Filling valve closed   Drain valve closed
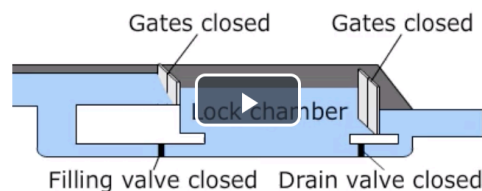
An additional method to stop the movement of silver carp into the Great Lakes would be to construct steel cables attached to the bottom of the canal. The cables would create a pulsating field of electricity that would discourage fish from passing through the barrier.

This map shows the location of the electric barriers and the lock and dams of the Chicago Area Waterway System.
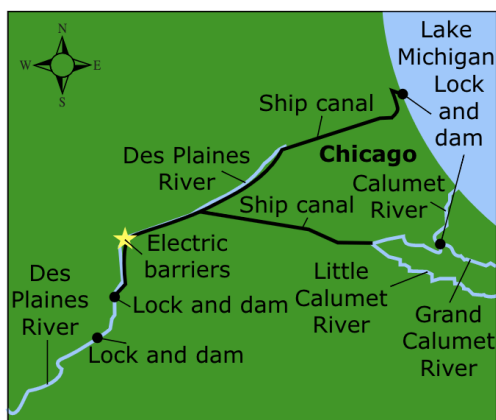
This map shows the locations of the Mississippi River, Lake Michigan, and the canal system.
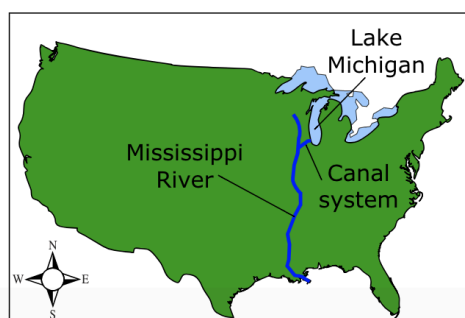
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GUEST

Which **two** are the **most likely** reasons that the electric barriers are needed in addition to locks and dams to control the movement of silver carp?

☐ Silver carp are attracted to dams.

☐ The dams cannot prevent the movement of silver carp.

☐ When ships move through the locks, the silver carp can follow them.

☐ The electric barriers use renewable energy, while the locks are powered by fossil fuels.

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GUEST

Although the electrical barrier acts to repel the silver carp, it is not perfect. Which statement **best** describes a disadvantage of the electric barrier solution?

Ⓐ The barrier is powered by renewable energy sources.

Ⓑ The barrier is too far from Lake Michigan to be effective in controlling silver carp populations.

Ⓒ Silver carp are not killed by the electricity; therefore, they might still get past the barrier and move into Lake Michigan.

Ⓓ All fish in the area will be prevented from moving past the barrier; therefore, eventually no fish will be found in Lake Michigan.

Recreational fishing is very popular in the Great Lakes, due to the many native species of desirable fish. It also provides billions of dollars and tens of thousands of jobs to the region. Silver carp are not considered desirable for recreational fishing; if they entered the Great Lakes, they would replace the native fish. This table summarizes the recreational fishing income from the Great Lakes.

Income from Great Lakes Fishing Activity in Selected States and All States Combined

State	Jobs	Income Received
Illinois	1,500	$175,000,000
Indiana	4,200	$395,000,000
Michigan	8,300	$1,002,000,000
New York	3,300	$369,000,000
Ohio	9,900	$809,000,000
All States	58,000	$7,000,000,000

Local stakeholders claim that investing $228 million of federal funds to block silver carp from entering the Great Lakes would be beneficial for this region's economy.

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GUEST

Based on the data table, which **two** states would be **most** affected from the introduction of silver carp into the Great Lakes?

- ☐ Illinois
- ☐ Indiana
- ☐ Michigan
- ☐ New York
- ☐ Ohio

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GUEST

Use **two** pieces of evidence to support the investment of $228 million to block silver carp from entering the Great Lakes. Explain why the evidence supports such an investment. Enter your answer in the box provided.

| 🖶 | **B** | *I* | <u>U</u> | I_x | ≔ | ⋮≡ | ⫤ | ⫣ | ✂ | 🗐 | 📋 | ↶ | ↷ | ᴬᴮᶜ | English ⇕ | Ω |

Performance Task 3 Below:

In this performance task, you will answer six questions.

You will be using fruit flies, *Drosophila melanogaster*, to study genetics. Fruit flies are studied because they have a short life cycle and have only 4 pairs of chromosomes. The flies will be crossed to observe the inheritance patterns of eye color and wing shape. The fruit flies are kept in jars with pieces of banana to serve as a nutrient source. The fruit flies were ordered from a supply company, and each jar contains its own phenotype. You will use the jars containing different fruit flies to answer questions. Click the play button to watch the animation.

Red eyes	Brown eyes	Long wings	Short wings
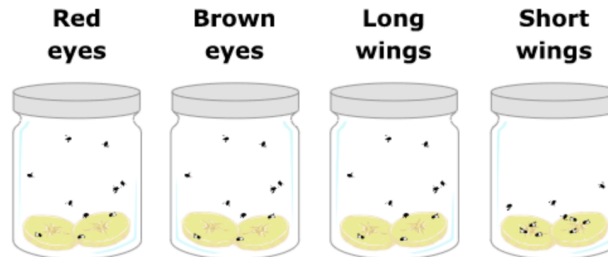
A long-winged fly is crossed with a short-winged fly and allowed to mate. The phenotype of the offspring is observed and recorded in the table below.

Fly Phenotype	Number Observed
	146
	0

2

Based on the results in the data table, explain why there are no flies with short wings. Type your answer in the box below.

To further the study, two flies from the offspring of the F1 generation are crossed and produce an F2 generation.

F1

The number and phenotype of the offspring are shown below.

	54 flies	53 flies
	55 flies	52 flies

F2 generation

GUEST

What percent of the F2 generation is expected to be heterozygous for long wings?

_____ %

1	2	3
4	5	6
7	8	9
0	.	▯/▯

GUEST

Using "A" to represent the dominant trait and "a" to represent the recessive trait, what are the genotypes of the parents in the F1 generation?

A	a

Using the Punnett square provided, drag the correct parents that would be expected to produce approximately 50% homozygous brown-eyed offspring and 50% heterozygous offspring.

rr

RR

Rr

Rr	rr
Rr	rr
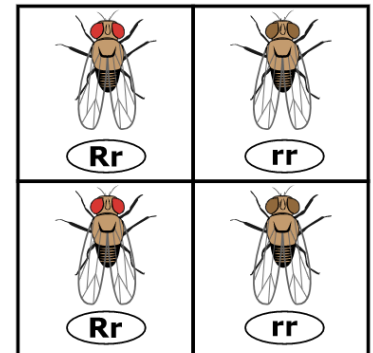
To allow the students to observe an additional trait, the teacher gives them a fly with a darker body color than the other flies, which have a lighter body color. The students crossed the dark-body-colored fly with the light-body-colored fly. The cross is represented in the Punnett square below.

Parent Cross

Light body color

Dark body color
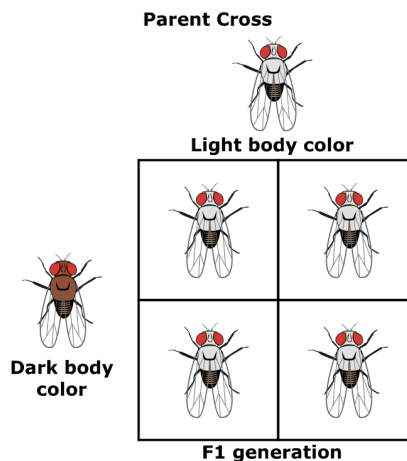
F1 generation

The students then crossed two flies from the F1 generation and recorded the following results:

    162 light-body-colored fruit flies
   52 dark-body-colored fruit flies

Explain how the dark body color of the fruit flies remained in the gene pool.

The Punnett square shows the possible results of a cross between two flies from the F1 generation.

Click on the lines in the circle to create a pie graph representing the percent of offspring of each genotype in the Punnett square.

Drag the genotype into the appropriate section of the pie chart based on the results in the Punnett square.

| 53 | 49 |
| 50 | 48 |
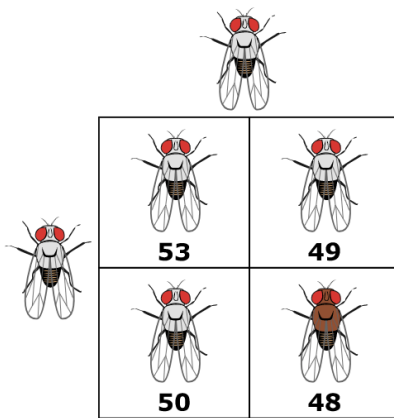
F2 generation

Percent of Each Genotype

BB

bb

Bb