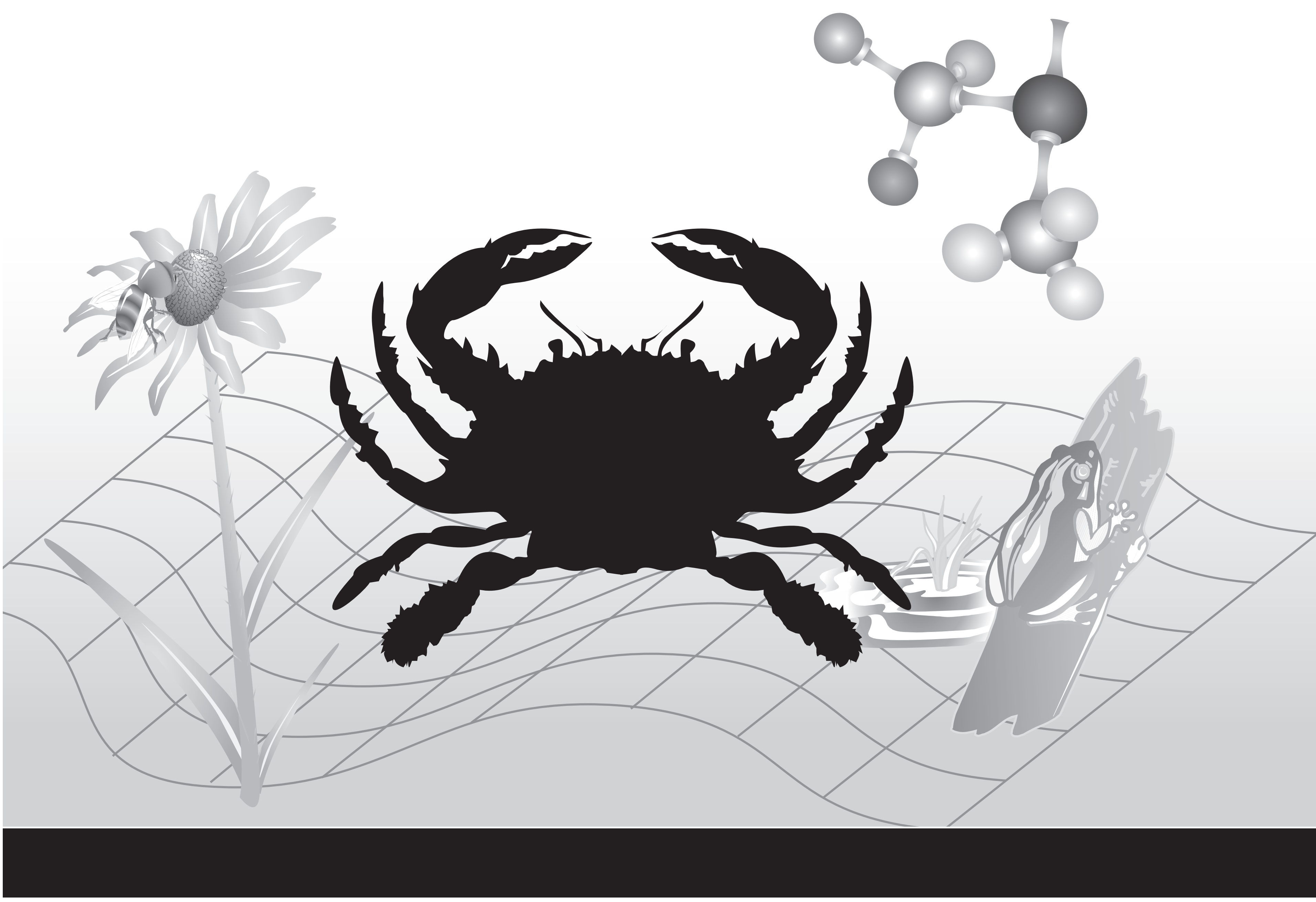
MCAP

Maryland Comprehensive Assessment Program



LS MISA

Life Science Maryland Integrated Science Assessment

Practice Test

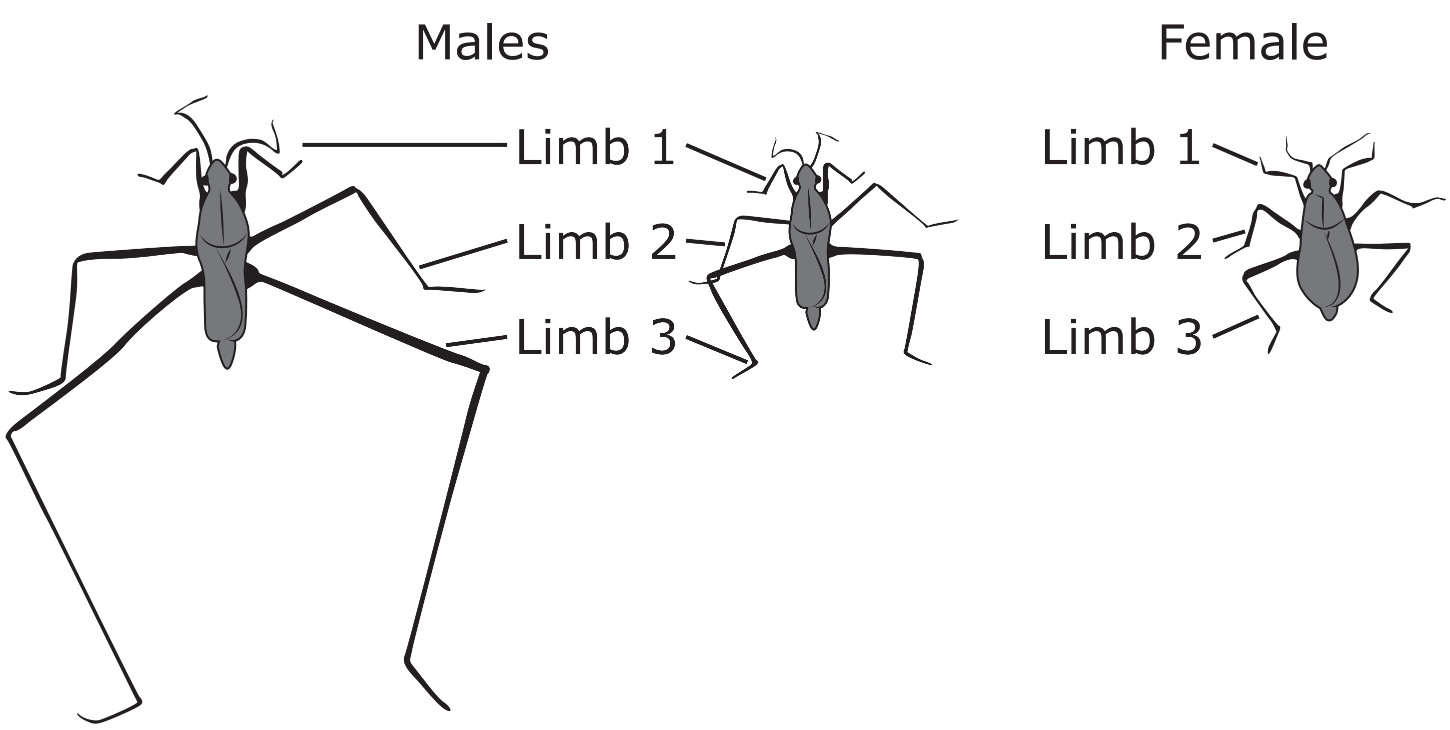
Session 1

Read the following information. Use the information to answer the questions.

Limb Variations in Water Striders

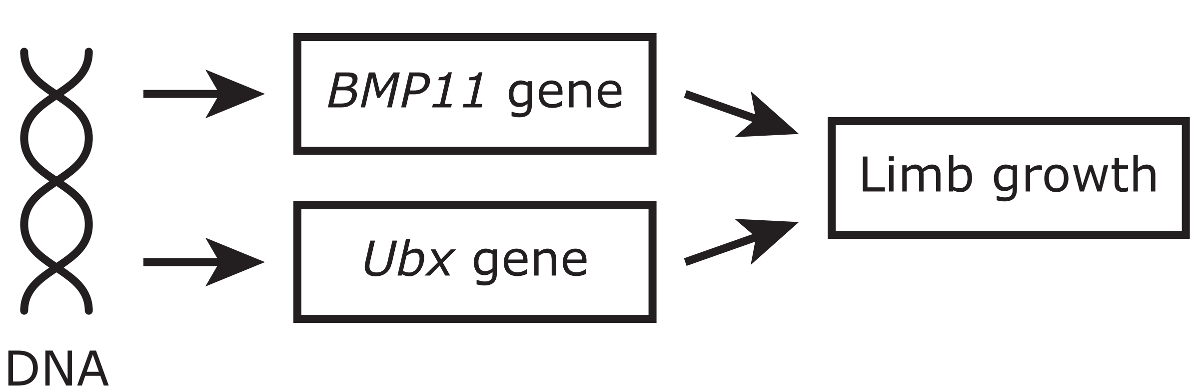
Water striders are a class of insects that can live on land and on water. Water striders are unique in that they can jump vertically from water surfaces. Male water striders differ from females in the size of their limbs, as shown in the diagram.

Water Striders



Limb 2 helps water striders paddle and limb 3 helps with jumping. In some male water striders, limb 3 is extremely long, which helps them jump higher and farther. The expression of two genes, the *Ubx* and *BMP11* genes, controls limb growth. The model shows the interaction of the *BMP11* and *Ubx* genes in water striders.

***BMP11* Gene, *Ubx* Gene, and Limb Growth**



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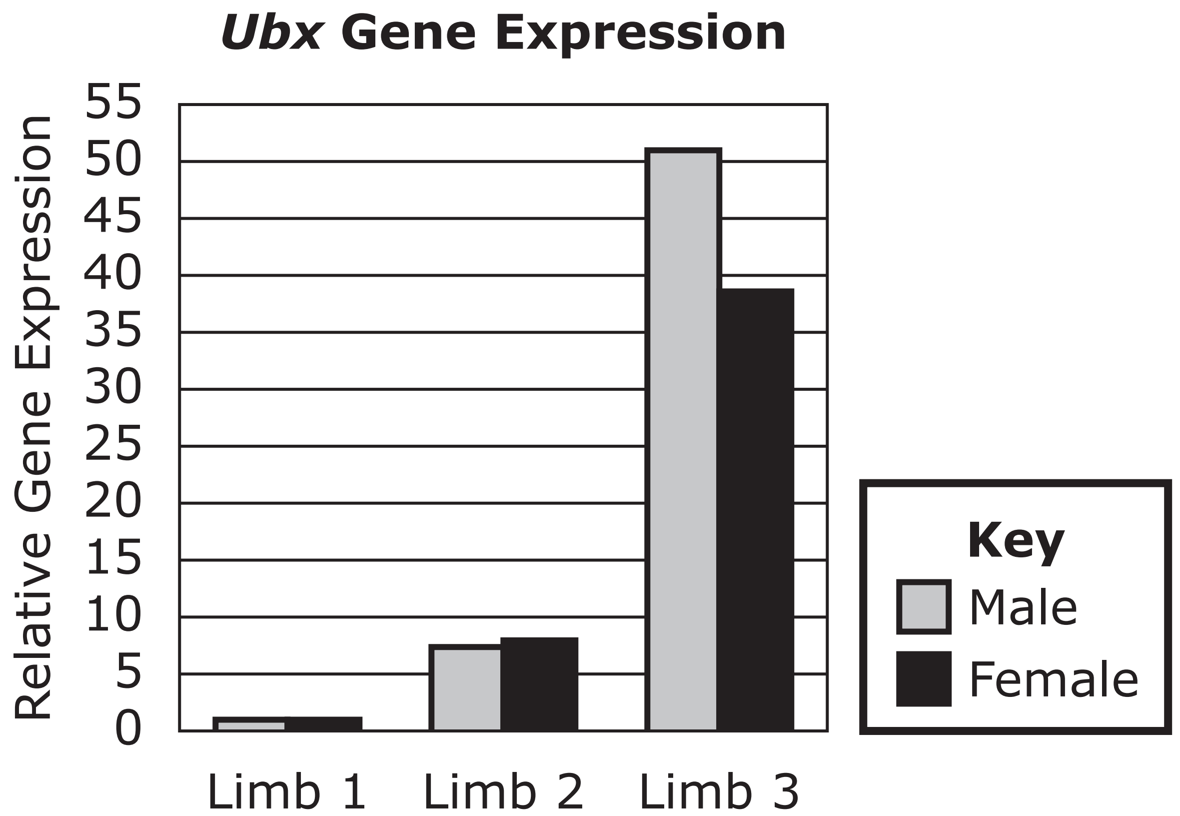
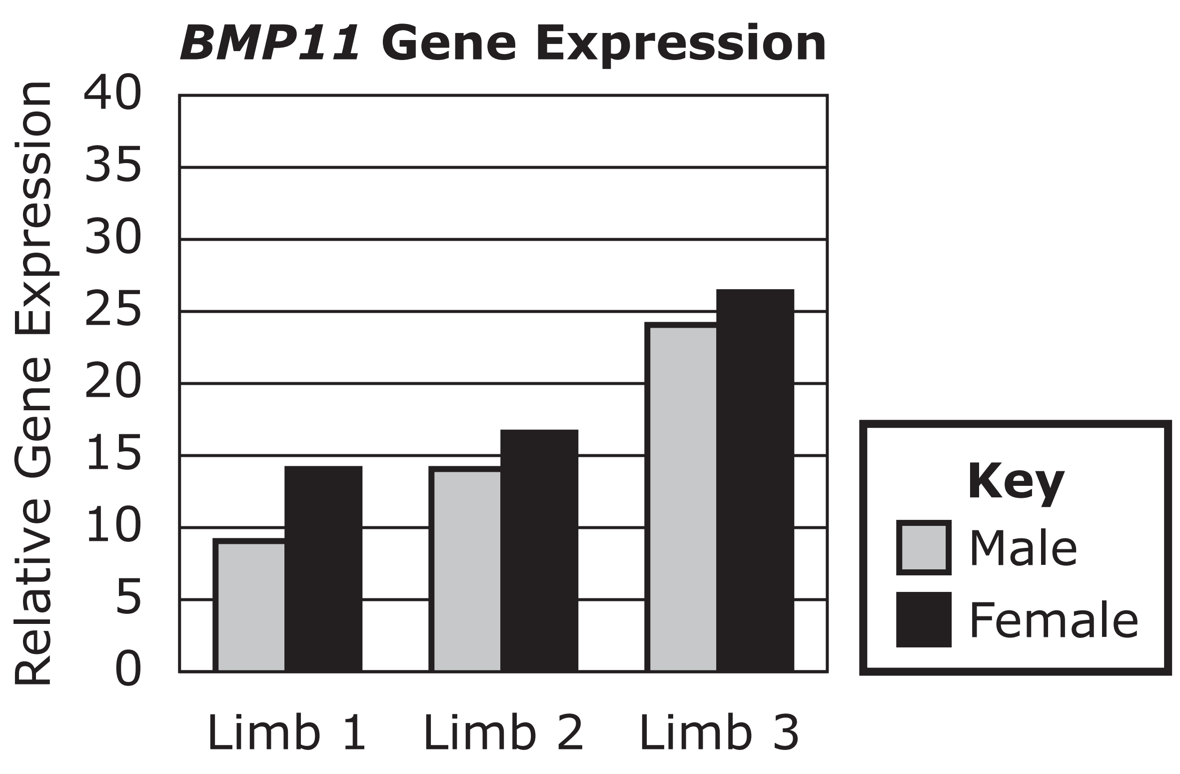
Scientists measured the expression of the *BMP11* and *Ubx* genes in female and male water striders during limb growth. The graphs show the collected data.





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Winged and Wingless Water Striders

Water striders also exhibit differences in their wings. Some have wings and others do not. While wings allow the water striders to travel to different habitats, the weight of the wings can make the water striders move more slowly. During summer, water striders live in aquatic habitats, but the insects hibernate as the weather gets cold. In the spring, water striders emerge from hibernation and mate.

Scientists studied the survival rates of winged and wingless water striders after hibernation. Scientists collected water striders from a pond. The water striders were kept in moist containers at 6°C for 30 days. The containers simulated the natural hibernation environment. Scientists counted the number of surviving water striders at the end of the 30 days. They also recorded the wing type and gender at this time.

Water Strider Survival Experiment

Sex	Condition	Wing Type: Winged	Wing Type: Wingless
Males	Alive	27	48
Males	Dead	1	12
Females	Alive	51	51
Females	Dead	4	15
	Total	83	126

GO ON

Scientists also compared the reproductive abilities of winged and wingless water striders. They observed 30 winged and 30 wingless females. Scientists recorded the number of eggs laid by the females for 13 days after fertilization.

Eggs Laid by Water Striders

Days Eggs Were Collected	Total Number of Eggs Laid: Winged	Total Number of Eggs Laid: Wingless
1–8	0	0
9	9	49
10	41	45
11	111	174
12	36	152
13	156	102
Total	353	522

GO ON

1 Which question's answer would provide the **most** information on the role of the *BMP11* gene in limb growth in water striders?

A Where on the chromosome is the *BMP11* gene located?

B Is the *BMP11* gene found in male and female water striders?

C Is there a difference in the expression of the *BMP11* gene in males versus females?

D How many copies of the *BMP11* gene are present on the water strider chromosome?

2 Which question did scientists **most likely** ask to determine the role of the *Ubx* gene in water striders?

A Which other genes does the *Ubx* gene interact with?

B Do all water striders express the *Ubx* gene during limb growth?

C Does the *Ubx* gene lead to the synthesis of any proteins?

D How does the expression of the *Ubx* gene correlate with limb size?

3 Which statement compares gene expression in limb 3?

A Gene expression of *Ubx* is about 10% lower in females than in males.

B Gene expression of *Ubx* is about 20% lower in females than in males.

C Males express about 75% fewer of the *BMP11* genes than females.

D Males express about 90% fewer of the *BMP11* genes than females.

GO ON

4

Part A

Which question about the expression of the *BMP11* gene would provide information about limb development in water striders?

A During limb growth, does the expression of the *BMP11* gene result in the synthesis of BMP11 DNA?

B During limb growth, does the expression of the BMP11 protein result in the synthesis of BMP11 amino acids?

C During limb growth, does the expression of the *BMP11* gene result in the synthesis of BMP11 amino acids?

D During limb growth, does the expression of the BMP11 protein result in the synthesis of BMP11 DNA?

Part B

Which question about the expression of the BMP11 and *Ubx* genes would provide information about limb growth?

A Do higher levels of only *BMP11* gene expression result in longer limbs in water striders?

B Do higher levels of only *Ubx* gene expression result in longer limbs in water striders?

C Do lower levels of *Ubx* gene expression result in longer limbs in water striders?

D Do lower levels of *BMP11* and *Ubx* gene expression result in longer limbs in water striders?

GO ON

5 Based on the Eggs Laid by Water Striders table, which statements describe the effect of wing type on the reproductive ability of water striders? Select two that apply.

A On day 10, winged females laid 41 eggs and wingless females laid 45 eggs, indicating that wing type has a significant impact on reproductive ability.

B Almost 85% of the eggs collected on day 9 were laid by wingless females, indicating that the wingless trait provides a reproductive advantage.

C Over 50 fewer eggs were collected from wingless females than winged females on day 13, indicating that the winged trait provides a late reproductive advantage.

D On day 11, wingless females laid twice as many eggs as winged females, indicating that the wingless trait has a significant reproductive advantage.

E About 60% of the eggs were laid by wingless females, indicating that the wingless trait provides an overall reproductive advantage.

6 Use data analysis to determine if the winged trait has a positive or negative effect on the survival and reproduction of water striders.

Enter your answer in the space provided.

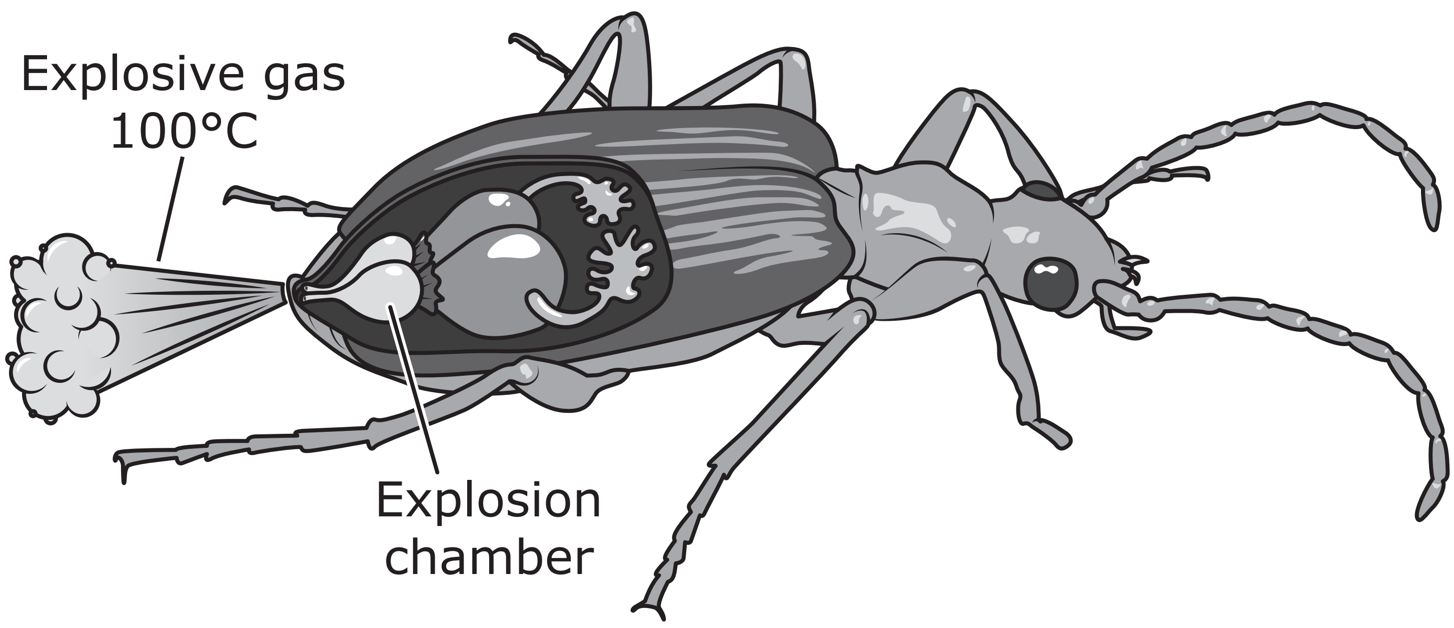
GO ON

Read the following information. Use the information to answer the questions.

Bombardier Beetle Defense

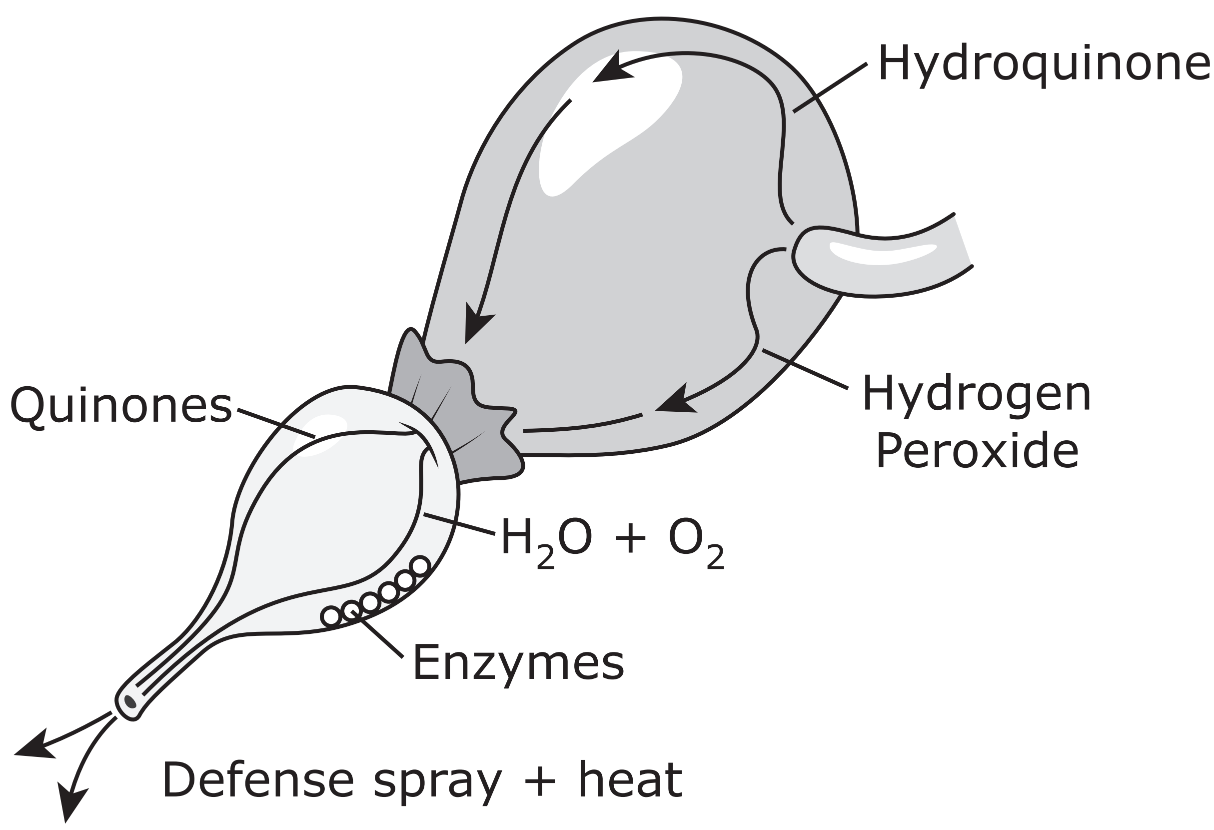
Bombardier beetles are meat eaters and hunt on the ground or in trees. The beetles are known for the defense mechanism that gives them their name. When disturbed, the beetles eject a hot, poisonous chemical spray from the tip of their abdomen. The reaction is so explosive it makes a popping sound.

Bombardier Beetle



The main component of the beetle spray irritates the eyes and the respiratory system of vertebrates. The beetle uses glucose to make this irritant. The glucose combines with other elements to form the chemical spray. First the beetle converts glucose ($C_6H_{12}O_6$) into quinic acid ($C_7H_{12}O_6$). Quinic acid is then converted into hydroquinone ($C_6H_6O_2$). The hydroquinone reacts with hydrogen peroxide (H_2O_2) to produce the spray. The reaction produces heat, which brings the mixture to near the boiling point. The gas produced drives the ejection from the abdomen. The diagram shows the abdomen of the beetle where the reaction occurs.

Chemical Reaction Chamber

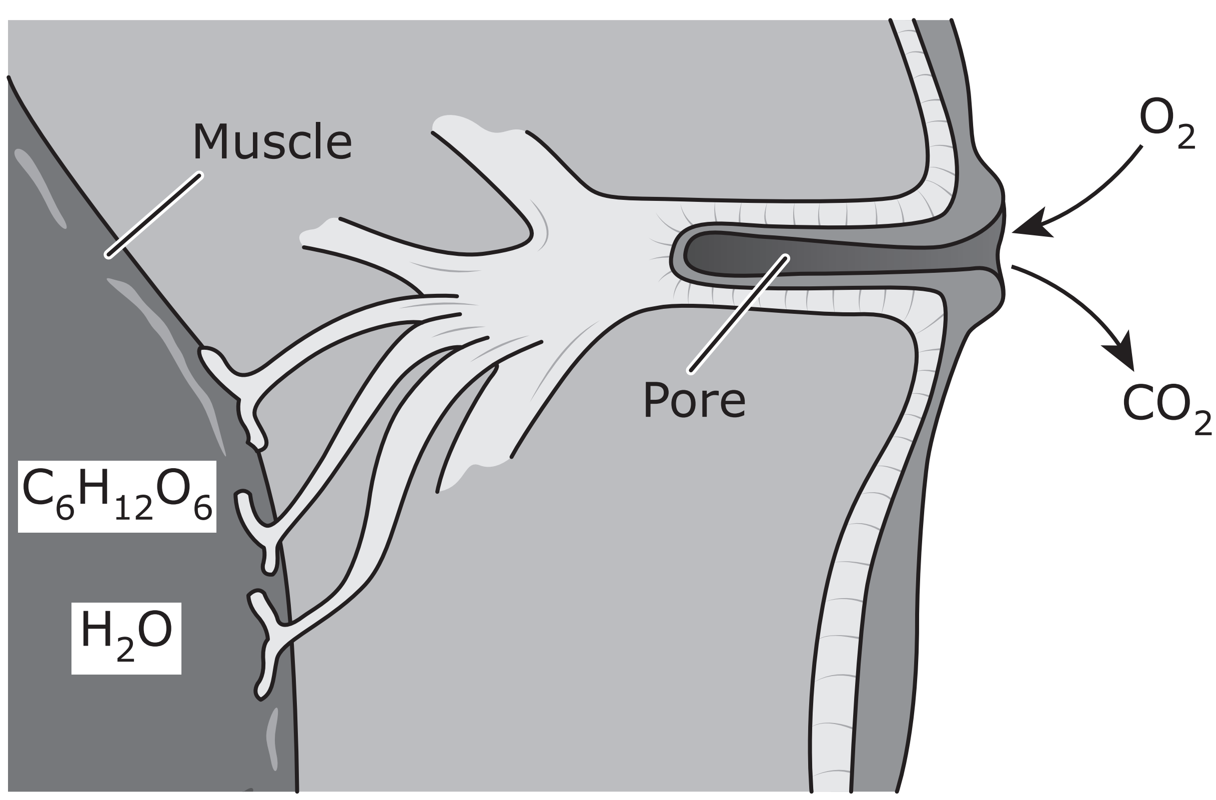


GO ON

Muscles Control Reactions

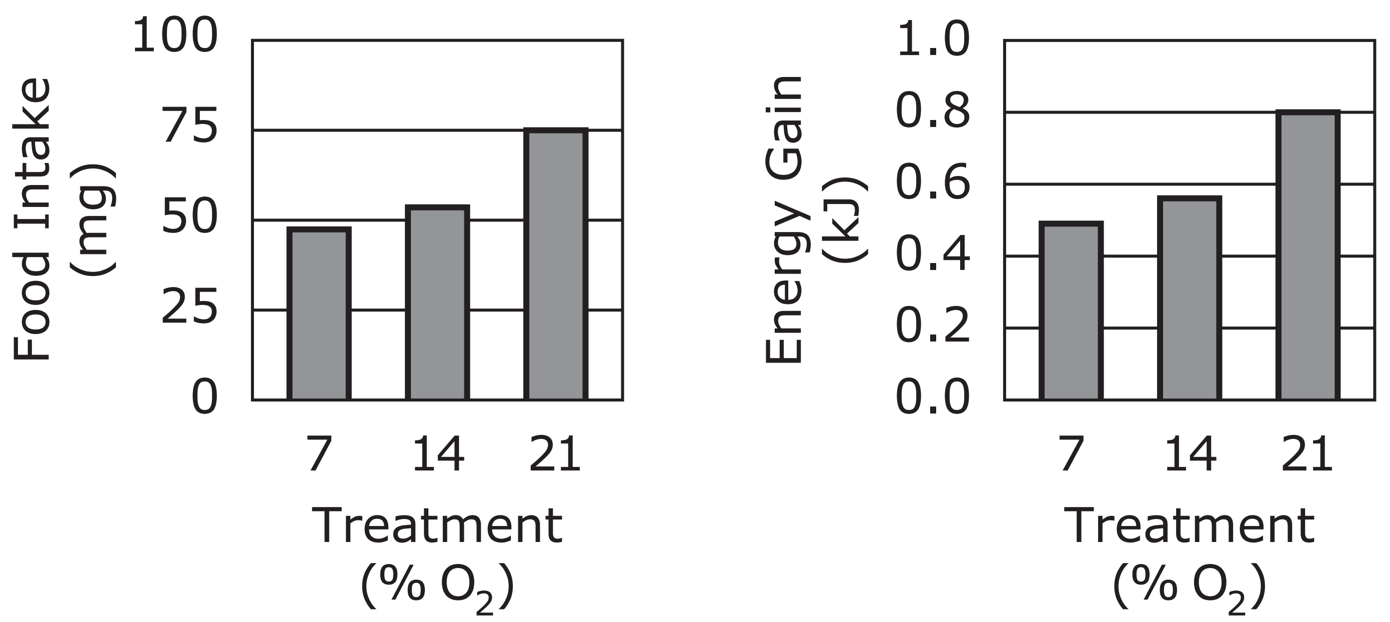
Bombardier beetles consume other organisms to obtain complex carbohydrates. The beetles break down the complex carbohydrates into glucose. The chemical reaction of the breakdown of glucose is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy. Beetles breathe through many openings, or pores, in their bodies. These pores connect to tubes, which transport gases to and from the muscle cells. The bombardier beetle controls the formation and release of the chemical spray with several groups of muscles. The beetle continues to spray a predator until the muscles relax. A partial model shows the transportation of gases.

Cellular Respiration in Beetles

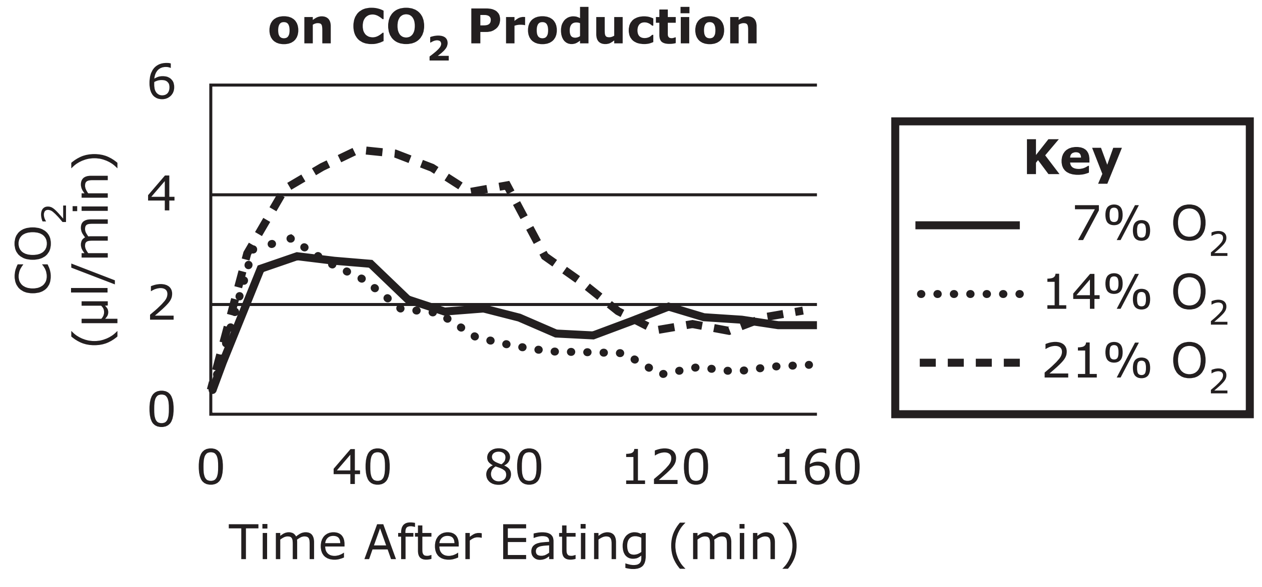


Air normally contains 21% oxygen (O_2) by volume. Bombardier beetles often experience conditions with very low oxygen such as leaf litter, soil, and burrows. Scientists wondered how low oxygen conditions affect the ability of beetles to sustain life's processes. Scientists set up three climate chambers with various levels of oxygen concentration. The scientists controlled the gases entering the chamber and recorded the level of carbon dioxide (CO_2) leaving the chamber. The CO_2 leaving the chamber was measured in microliters per minute (µl/min). During the investigation, scientists also measured the amount of food the beetles ate. The scientists used the amount of CO_2 produced and the amount of food eaten to calculate the energy gained by the beetles. The scientists measured energy in kilojoules (kJ). The graphs show the results of the investigation.

Effects of Oxygen Level on Beetles



Effect of Oxygen Level on CO_2 Production



GO ON

7 Which evidence **best** supports the claim that food ingested by the beetle drives the defense response?

A Sugar molecules are broken down and release a loud popping sound when mixed with quinones and heat.

B Sugar molecules are broken down and rearranged into new molecules needed for the defense response.

C Hydroquinones from food are broken down into water and oxygen just before the defensive spray is released.

D Hydrogen peroxide from food is broken down into enzymes just before the defensive spray is released.

GO ON

8 Use the Cellular Respiration in Beetles model to answer the questions.

Part A

Which statement **best** describes how the process provides muscles with the energy needed for the defense response?

A The process of cellular respiration stores energy when bonds are formed in carbon dioxide and water.

B The process of cellular respiration stores energy when bonds are formed in oxygen and water.

C The process of cellular respiration releases energy when bonds are formed in hydrogen peroxide and water.

D The process of cellular respiration releases energy when bonds are formed in carbon dioxide and water.

Part B

Which statement describes the energy from bonds being formed in Part A?

A It is greater than the energy required to break the bonds of carbon dioxide and oxygen.

B It is greater than the energy required to break the bonds of sugar and oxygen.

C It is less than the energy required to break the bonds of hydrogen peroxide and oxygen.

D It is less than the energy required to break the bonds of sugar and oxygen.

GO ON

9 Which relationship is supported by the evidence in the Effects of Oxygen Level on Beetles graphs?

A When oxygen is low, beetles have to eat more food to break the bonds and transfer the same amount of energy.

B The amount of food eaten affects the number of bonds broken and the amount of energy transferred.

C At normal oxygen levels, beetles break all of the bonds in food to transfer all of the available energy.

D Beetles can survive longer with normal oxygen levels, because they are most efficient at breaking down food to transfer energy.

10 Using the Cellular Respiration in Beetles model, which statement describes the molecules involved in the breaking and formation of chemical bonds during cellular respiration?

A Glucose and water in the muscles combine to form energy, CO_2, and oxygen.

B Oxygen taken in through the pores combines with glucose to form energy, CO_2, and water.

C Oxygen taken in through the pores is combined with water in the muscles to form energy, CO_2, and glucose.

D Glucose in the muscles reacts with CO_2 to form energy, water, and oxygen.

GO ON

11 Which statement is **best** supported by the Effects of Oxygen Level on Beetles graphs?

A There is less prey available in areas with low oxygen, so beetles cannot find enough food.

B There are fewer predators in low oxygen areas, so beetles produce more energy.

C The beetles cannot process as much food and produce less energy when oxygen is low.

D The amount of oxygen has only a slight impact on the amount of food beetles eat.

12 Use evidence to explain the process the bombardier beetle uses to convert food into large carbon-based molecules needed for its chemical defense spray.

Enter your answer in the space provided.

STOP

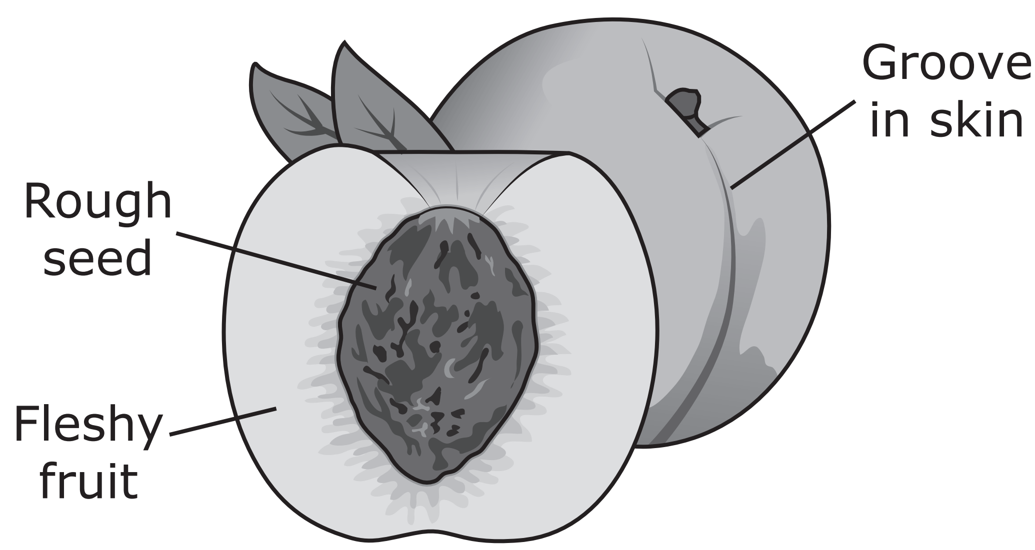
Session 2

Read the following information. Use the information to answer the questions.

Peaches and Nectarines

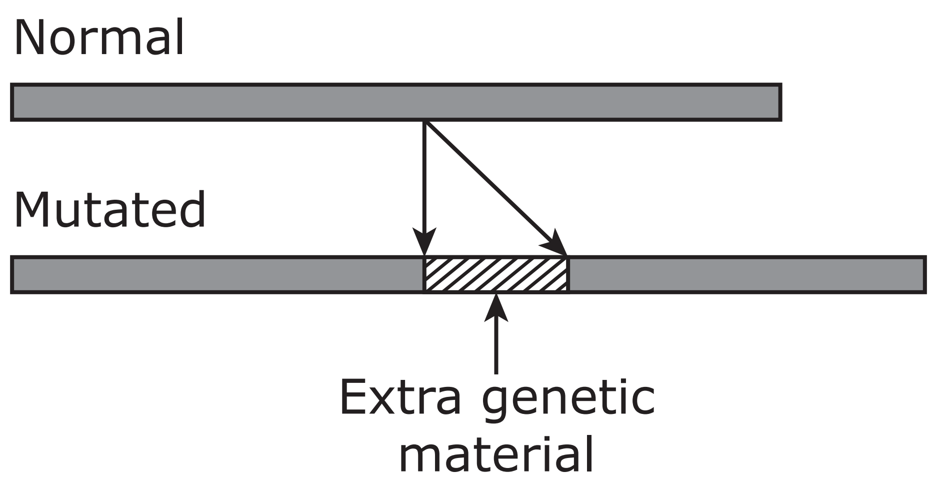
Peaches are grown in many parts of Maryland and have been studied by scientists because of a unique genetic difference between peaches and nectarines. Peaches have a fuzzy coating on the skin and nectarines have a smooth skin. Cultivated peaches originated in China about 4,000–5,000 years ago. Nectarines appeared about 2,000 years ago. The diagram shows the parts of a peach.

Peach Diagram



A mutation in a single gene, labeled *MYB25*, controls the production of the hair-like structures that create peach fuzz. The insertion of an extra segment of genetic material into *MYB25* results in the smooth skin of nectarines. The model shows the difference between the normal and mutated *MYB25* gene.

MYB25 **Gene**



GO ON

Family Rosaceae

Peaches belong to a large family of flowering plants called Rosaceae, which contains about 3,000 different species. Rosaceae includes common fleshy fruits such as apples and peaches. The fruit is key to the evolutionary success of Rosaceae. It protects the seeds and helps seed dispersal by animals, wind, and water. The table shows the characteristics of some common species from the Rosaceae family.

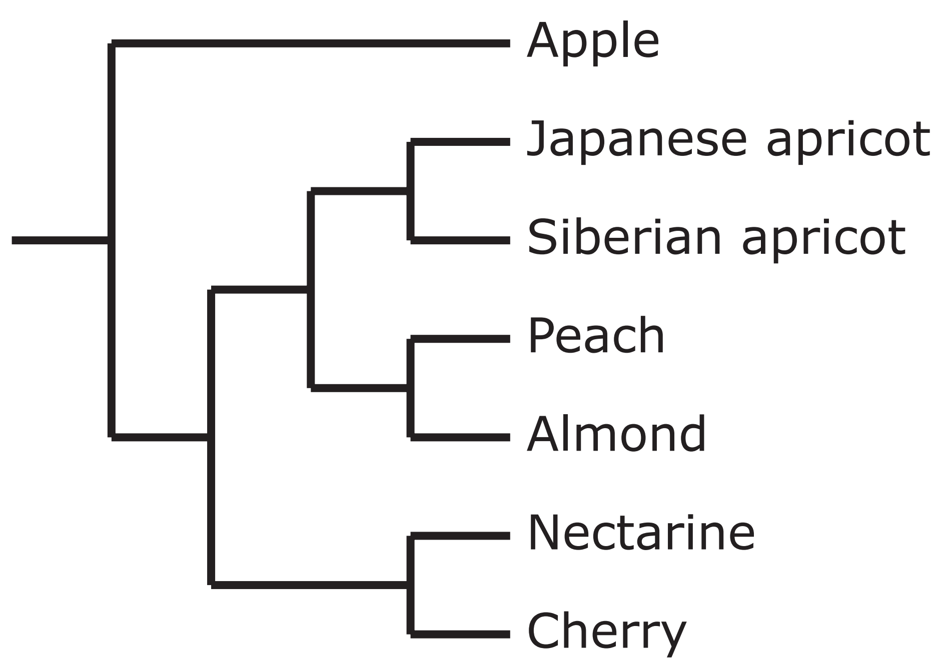
Rosaceae Characteristics

Plant	Skin	Seed	Number of Seeds/Fruit	Number of Flower Petals
Apple	smooth	smooth	5+	5
Apricot	groove	rough	1	5
Peach	groove	rough	1	5
Almond	groove	rough	1	5
Cherry	groove	smooth	1	5

GO ON

Scientists used gene sequences to determine that Rosaceae likely evolved from ancestors with dry fruits and grain-like seeds. These dry fruits have a single seed loosely attached to a stalk. The scientists concluded that the evolution of Rosaceae was likely driven by environmental factors and whole genome duplications. Whole genome duplication is an event commonly seen in land plants. An additional copy of the entire genome is created in a cell. This process provides genetic material that may result in new gene functions. The diagram shows a partial phylogenetic tree for the Rosaceae family.

Rosaceae Phylogenetic Tree



Amino Acid Sequences

Studying the evolution of specific traits often focuses on molecules that perform the same function in a wide variety of organisms. A group of scientists compared the transport molecules in the Rosaceae family to barley, which is a grass. The table shows a portion of a sequence of amino acids from several Rosaceae plants compared to barley.

Amino Acid Comparison between Rosaceae and Barley

Plant	Amino Acid Location: 47–52	Amino Acid Location: 53–58
Apple	ACNCLK	NLAGSI
Apricot	ACNCLK	QLSGSI
Peach	ACNCLK	QLSASV
Cherry	ACNCLK	QLSASV
Barley	VCNCLK	GIARGI

KEY

A- Alanine C- Cysteine N- Asparagine L- Leucine K- Lysine	Q- Glutamine G- Glycine I- Isoleucine S- Serine V- Valine

GO ON

13 The seed of the cotton plant, known as cottonseed, has long hair-like structures that are very similar to the short fuzz on a peach.

Which additional evidence **best** supports the scientists' conclusion that the *MYB25* gene controls the production of hair-like structures on peach skin?

A A cottonseed with the normal *MYB25* gene produces long hair-like structures.

B Cottonseeds with multiple versions of the *MYB25* gene produce smooth cottonseeds.

C Multiple mutations in the *MYB25* gene of a cotton plant produce short hair-like structures.

D A mutation in the *MYB25* gene of a cotton plant prevents long hair-like structures from forming on a cottonseed.

14 Which statement **best** explains the formation of the skin and seeds of an apple, as shown in the Rosaceae Characteristics table?

A Cells in each part of an apple contain different DNA sequences that code for skin and seeds.

B The DNA sequence in all apple cells is the same, but certain genes control the formation of skin and seeds.

C Some apple cells have genes that code for skin and seeds, while other cells have genes that result in the features shared by all Rosaceae plants.

D Some apple cells are missing the genes that would result in smooth skin and seeds shared by other Rosaceae plants.

GO ON

15 Which statement explains the formation of smooth skin in nectarines?

A The mutation that inserted DNA into the *MYB25* gene resulted in nectarines expressing a different protein.

B The mutation in the *MYB25* gene shows that the same mutation can result in different proteins in peaches and nectarines.

C The different characteristics of peaches and nectarines are a result of different gene sequences forming the same protein.

D The similar characteristics of peaches and nectarines are a result of identical genes forming different proteins in different plants.

16 Which statement **best** explains the reason nectarines are considered a type of peach?

A They have different genes, but the proteins produced are the same.

B They have the same DNA, but nectarines have extra amino acids that code for smooth skin.

C They have similar DNA for most traits, but the gene controlling skin texture is different.

D They have different DNA sequences, but the amino acids produced are identical.

GO ON

17 Patterns in amino acid sequences provide evidence for common ancestry and evolutionary descent.

Part A

Based on the amino acid sequence data, which amino acids in barley support common ancestry between grasses and the Rosaceae family?

A V and GI_RG

B CNCLK and A_ _I

C GIARGI

D VCNCLK

Part B

Based on the amino acid sequence data, which amino acids in peach support the divergence of peach trees from apple trees during their evolution?

A ACNCLK and _L_ _S_

B ACNCLK and QLSASV

C Q_SA_V

D _L_ _S_

18 Identify and communicate the connections between multiple lines of evidence to support the claim of common ancestry for members of the Rosaceae family.

Enter your answer in the space provided.

GO ON

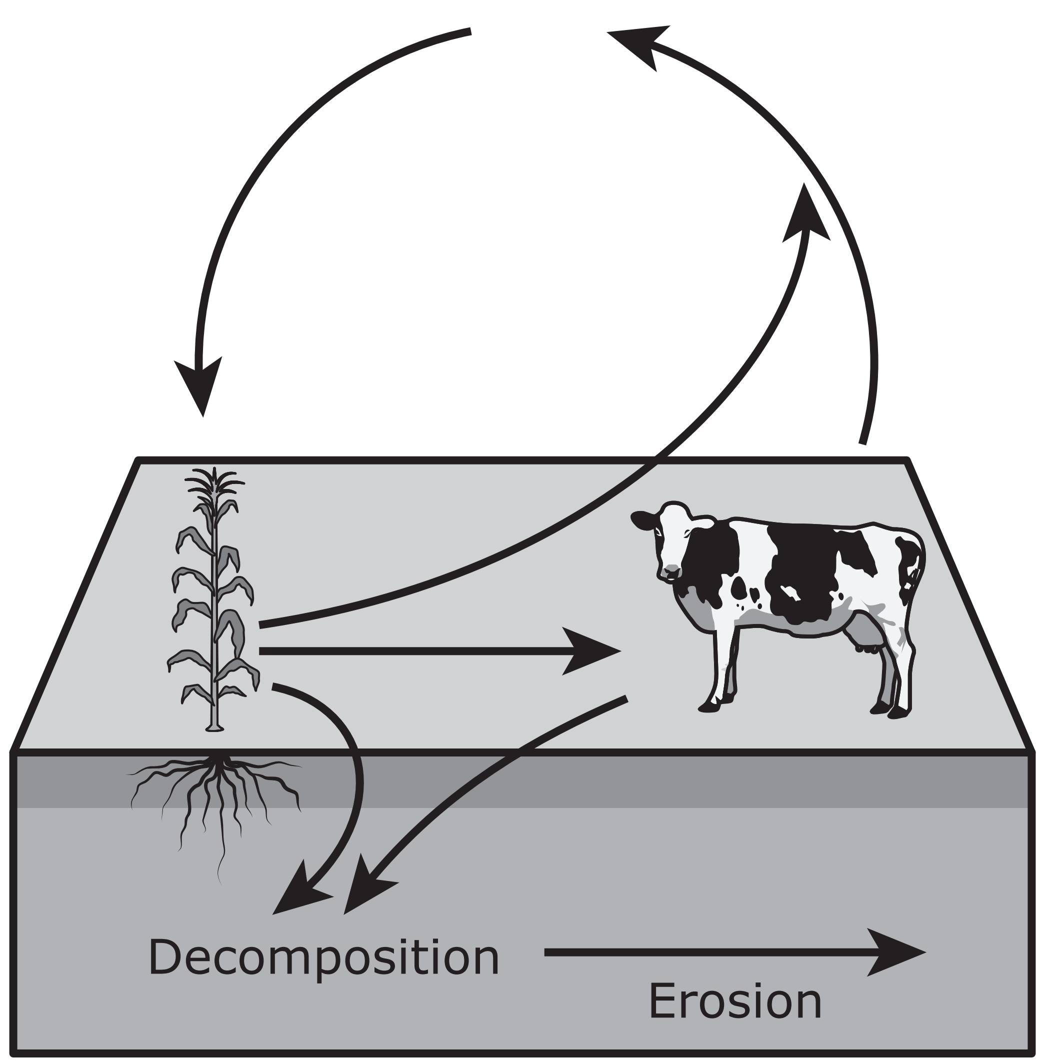
Read the following information. Use the information to answer the questions.

Crops in the Carbon Cycle

As the human population increases, there is a growing demand for resources and space. It is estimated that at least 25% more rice will be needed by 2025 to feed the growing population. Scientists are trying to increase the productivity of food crops to meet the increasing need.

The majority of plants, including rice, use the carbon-3 (C_3) photosynthesis pathway to produce food. However, a few plants use a specialized carbon-4 (C_4) photosynthesis pathway. The C_4 pathway occurs in some major crops, such as corn, sorghum, and sugar cane. C_4 plants account for the cycling of 23% of the carbon on Earth. The model shows the role of agriculture in the carbon cycle.

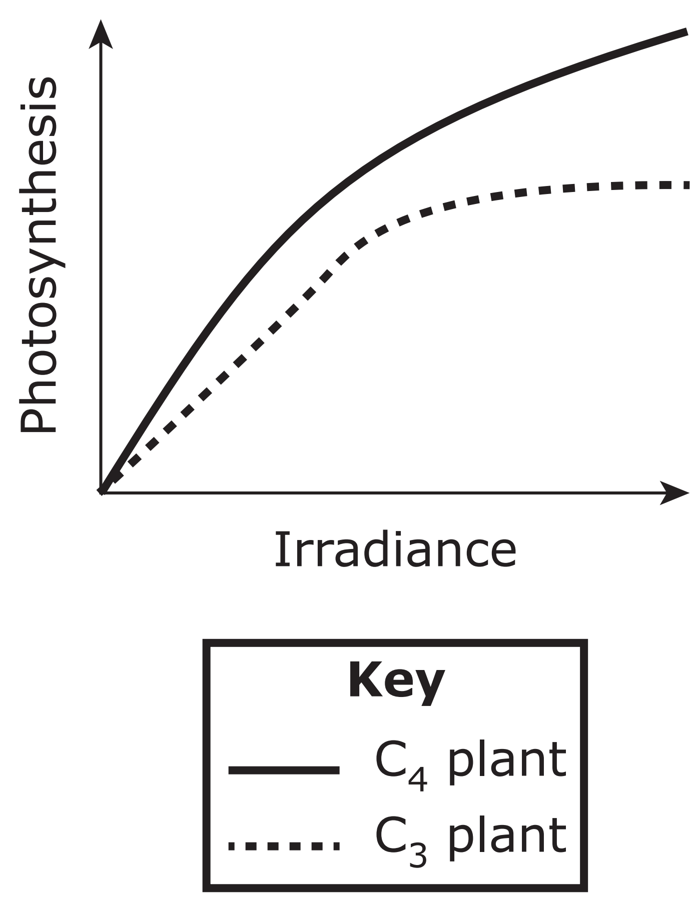
Agricultural Carbon Cycle



GO ON

Scientists compared the efficiency of the C_3 and C_4 photosynthetic pathways. C_3 plants can capture and store about 4.6% of the Sun's energy, while C_4 plants capture 6%. The graph models the rate of photosynthesis in C_3 and C_4 plants based on temperature and the Sun's irradiance, the amount of solar energy received per unit area.

Rate of Photosynthesis



GOLDEN2 Genes

One way to potentially improve crop productivity is to transfer C_4 traits into C_3 plants such as rice. Scientists studying corn, a C_4 plant, discovered a mutation in the *GOLDEN2* (*G2*) gene that regulates the development of chloroplasts. Scientists also discovered a similar non-mutated gene called *GOLDEN2-like* (*GLK1*) in corn. Similar pairs of non-mutated *GLK* genes were found in rice (*GLK1* and *GLK2*). This finding suggests that grasses such as rice and corn originated after their entire genome was duplicated. Genome duplication results in additional copies of the entire genome of an organism and can lead to the development of new features.

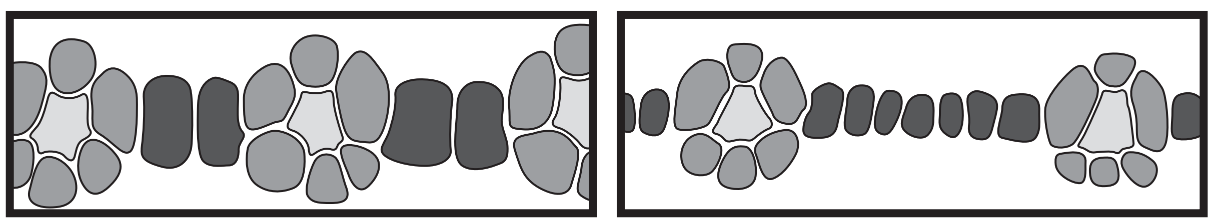
In rice, the *GLK* genes promote the development of one chloroplast type. In corn, the *GLK1* and *G2* genes promote the development of two types of chloroplasts, which have a role in the C_4 pathway.

GO ON

The table summarizes some differences in corn and rice cells involved in photosynthesis. The two main cell types include bundle sheath and mesophyll. Veins are responsible for the transportation of water and food energy in both corn and rice.

Corn vs. Rice Structure

Corn (C_4) Rice (C_3)



Key
- Mesophyll
- Bundle sheath
- Veins

Corn vs. Rice Cell Function

Corn	Rice
Bundle sheath and mesophyll cells have chloroplasts.	Only mesophyll has chloroplasts.
Bundle sheath and mesophyll chloroplasts have different functions and cooperate during photosynthesis.	Mesophyll chloroplasts have a single function.

Evolution of *GLK* Genes

Scientists used genetic analysis to better understand *GLK* genes and the evolutionary history of C_4 plants. The tables show a portion of the amino acid sequences in corn and rice. In the amino acid sequences, each letter is an abbreviation for one amino acid.

Amino Acid Sequences in Corn and Rice

Plant Gene	Amino Acids
Corn *GLK1*	ALA GKS QQD
Rice *GLK1*	ALT SKN QQD
Corn *GLK2*	SPP QGN KLA
Rice *GLK2*	PPP STT KLA

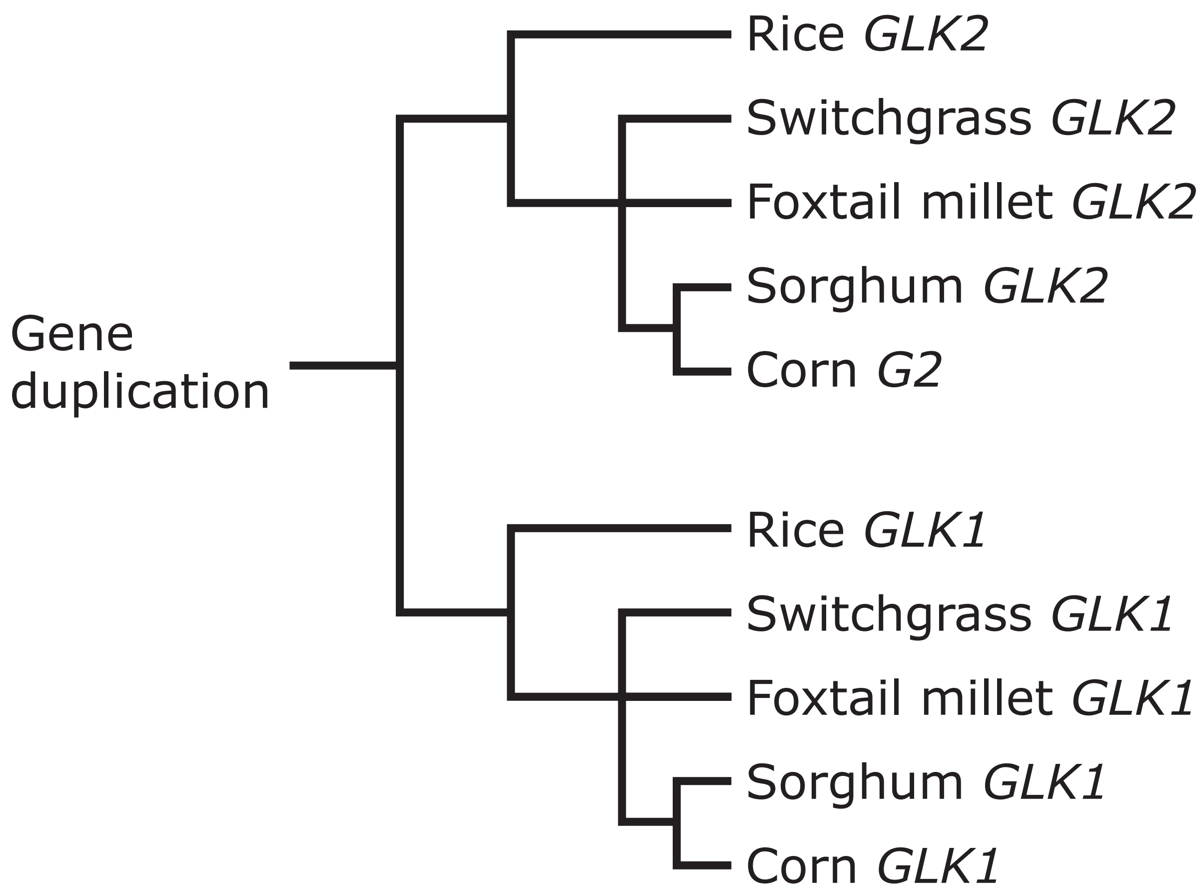
KEY

A– Alanine D– Aspartic acid G– Glycine K– Lysine L– Leucine	N– Asparagine P– Proline Q– Glutamine S– Serine T– Threonine

GO ON

The phylogenetic tree based on genetic analysis shows the history of the *GLK* gene in some grasses.

Gene Phylogenetic Tree



19 Using the Agricultural Carbon Cycle model, which statement best describes the inputs and outputs of photosynthesis performed by the plant?

A Plants take in O_2 from the atmosphere and produce CO_2 and glucose.

B Plants take in CO_2 from the atmosphere and produce O_2 and energy.

C Plants take in glucose from the geosphere and produce O_2 and energy.

D Plants take in CO_2 from the geosphere and produce CO_2 and O_2.

20 Use the Agricultural Carbon Cycle model to answer the questions.

Part A

Which statement describes how corn moves carbon through Earth's spheres during photosynthesis?

A Carbon moves from the atmosphere to the biosphere.

B Carbon moves from the biosphere to the atmosphere.

C Carbon moves from the atmosphere to the geosphere.

D Carbon moves from the geosphere to the biosphere.

Part B

Which statement describes how cows move carbon through Earth's spheres during cellular respiration?

A Carbon moves from the atmosphere to the geosphere.

B Carbon moves from the atmosphere to the biosphere.

C Carbon moves from the biosphere to the geosphere.

D Carbon moves from the biosphere to the atmosphere.

GO ON

21 Which changes can be made to the Agricultural Carbon Cycle model to better represent the actual cycling of carbon in the environment? Select the two that apply.

A Add cars to show the carbon dioxide released into the atmosphere by burning fossil fuels.

B Remove the label showing carbon in soil because decomposition moves carbon quickly into the atmosphere and hydrosphere.

C Remove the arrow from the plants to CO_2 because plants absorb carbon from the atmosphere.

D Add forests to show that trees release more carbon into the atmosphere than they store in the biosphere.

E Add a lake or pond to show that they absorb carbon dioxide from the atmosphere.

22 Which statement compares the efficiency of photosynthesis in corn and in rice plants?

A Photosynthesis is more efficient in the rice plants because the C_3 pathway is more efficient.

B Photosynthesis is more efficient in the corn plants because the C_4 pathway is more efficient.

C Photosynthesis is more efficient in the rice plants because their rate of photosynthesis increases as solar energy increases.

D Photosynthesis is equally efficient in both corn and rice plants because they both have chloroplasts.

GO ON

23 Which statement is supported by the evidence in the Gene Phylogenetic Tree?

A The *GLK* genes in corn and sorghum are most similar to each other.

B The *GLK* genes in corn and rice are most similar to each other.

C Switchgrass and foxtail millet do not share a common ancestor.

D Switchgrass is more closely related to rice than to corn.

24 Describe how various patterns in the evidence support a relationship between the biological evolution of the C_4 pathway from the C_3 pathway and the common ancestry of all grass species.

Enter your answer in the space provided.

STOP

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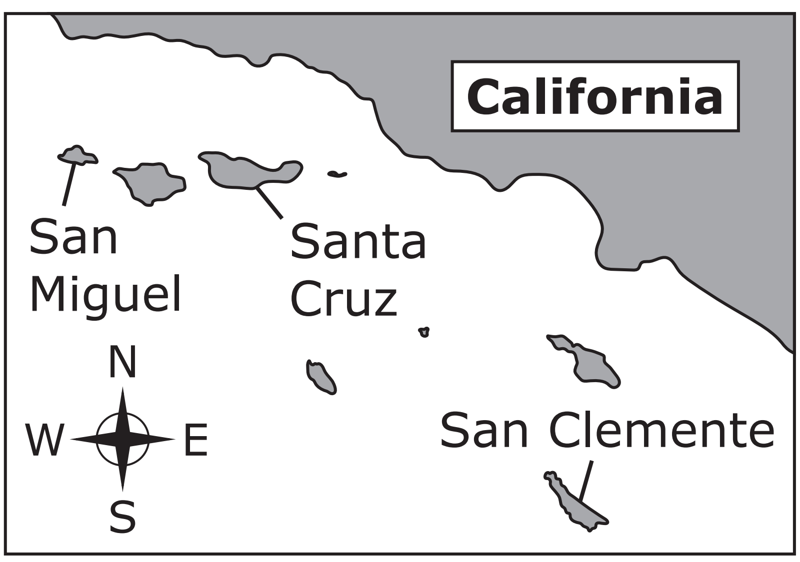
Session 3

Read the following information. Use the information to answer the questions.

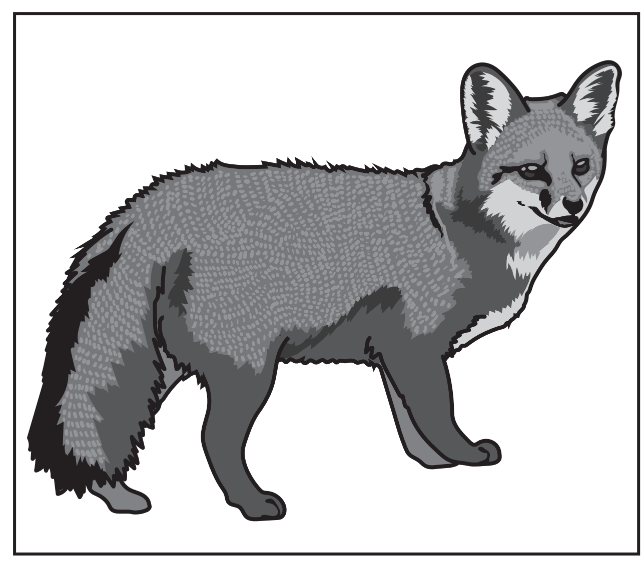
From Predator to Prey

Channel Island foxes are native to a group of small islands located off the California coast. These foxes are much smaller in size than the mainland foxes and are only found on the Channel Islands.

Channel Islands



Island Fox



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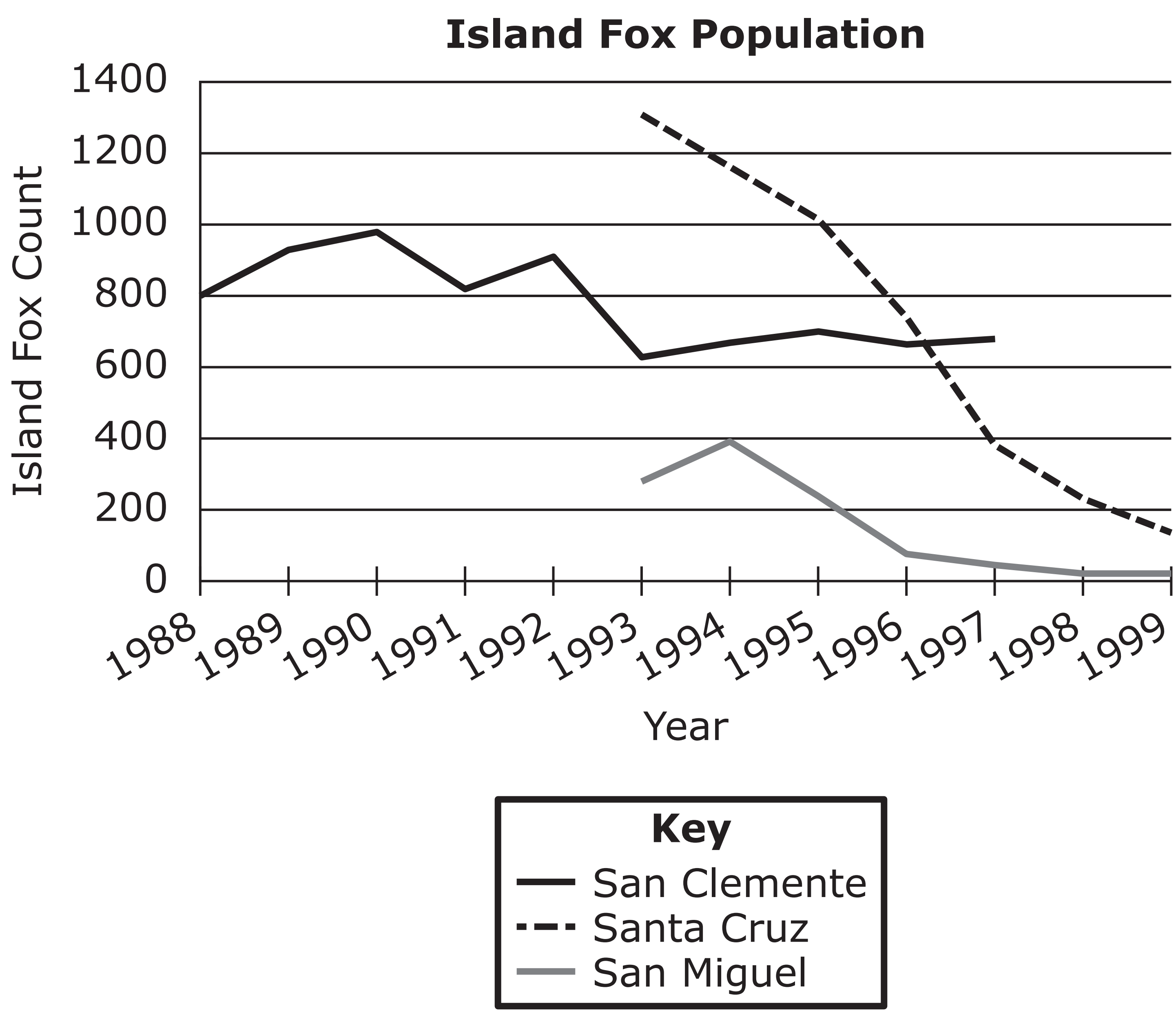
Each island has its own subspecies of foxes. The graph shows the population of island foxes on three of the islands.



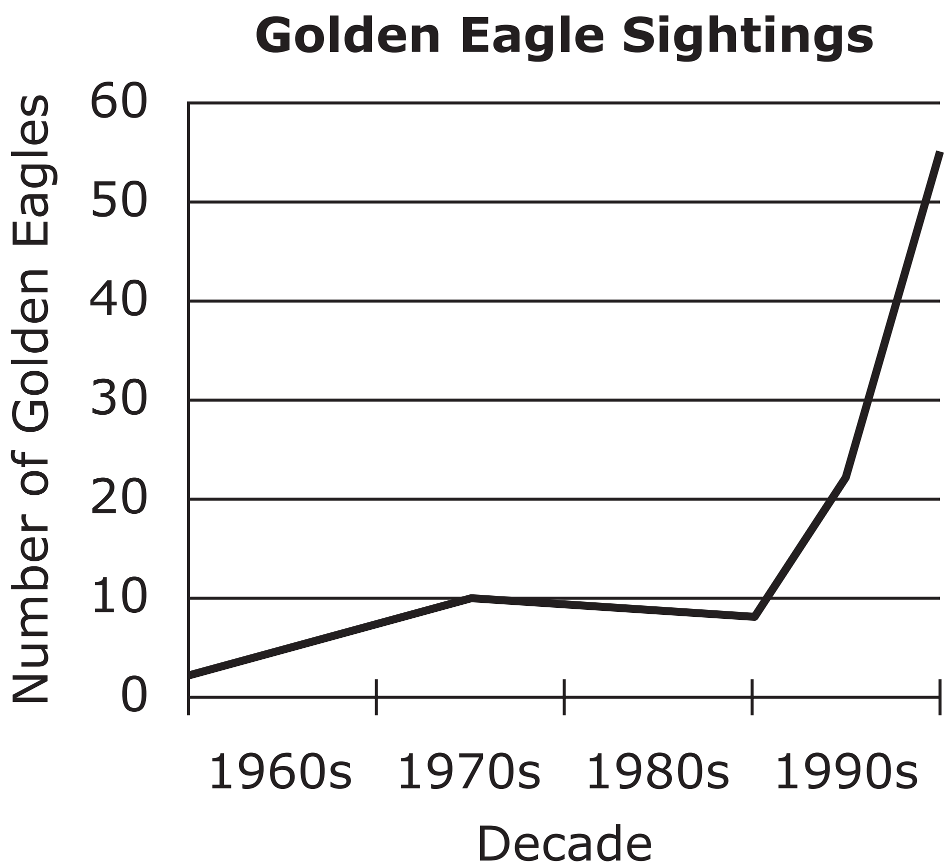
The island fox did not have any natural predators. They were also the largest predator on the island. Over time, other predators were introduced to the island. The table lists several species in the Channel Island ecosystem.

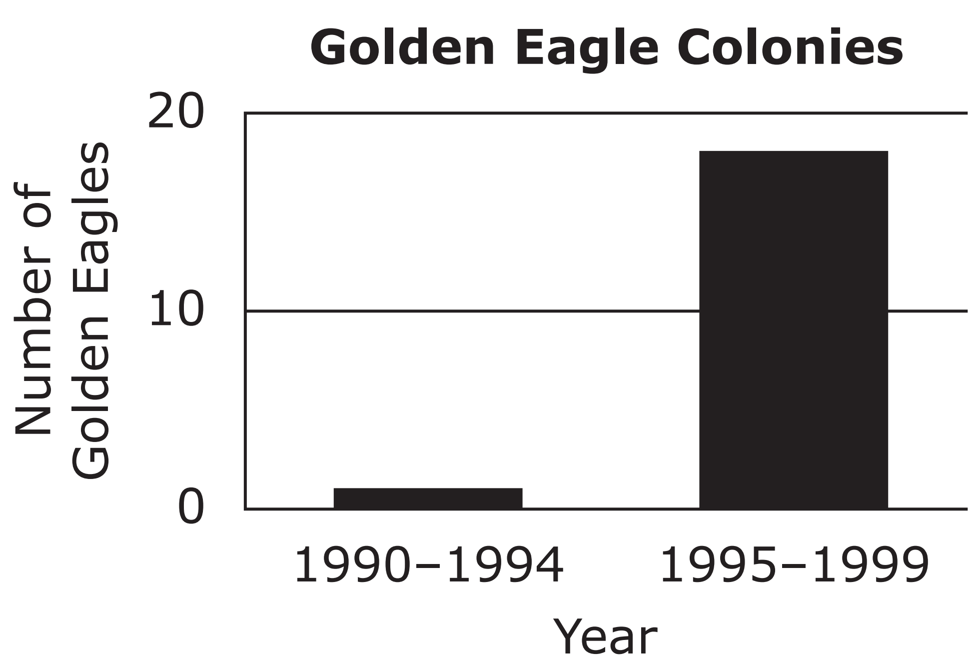
Channel Islands Ecosystem

Species	Ecosystem Dynamics/Functions
Wild pig	• First appeared in the ecosystem in the 1850s • High reproductive rate; large litters • Causes significant destruction of vegetation
Island skunk	• Competes for food sources with island fox • Feeds during the night
Island fox	• Produces one small litter in the spring • Competes for food sources with island skunk • Feeds during the day
Bald eagle	• Territorial; kept other eagle species from nesting on the islands • Feeds during the day; eats mostly fish • Disappeared from islands around 1960
Golden eagle	• First appeared in the ecosystem around 1960 • Feeds during the day • Eats pigs and foxes

GO ON

The golden eagle did not reproduce on the islands until the 1990s. After they started nesting on the islands, they became the top predator of foxes. The graphs show the golden eagle population and colony size on the islands over time.





GO ON

Restoring Balance

In the early 1990s, the National Park Service (NPS) began monitoring the Channel Island foxes and size of the fox populations. In 1999, the NPS started an ecosystem recovery program. Approximately 2.5 million dollars was spent on monitoring, restoring, and managing the ecosystem of the islands.

The ecosystem recovery program focused on different aspects to help the Channel Islands recover, as shown in the table.

Ecosystem Recovery Program

Recovery Program Component	Bald Eagle	Island Fox	Wild Pig	Golden Eagle	Native Plants
Captive breeding—Species captured and bred in captivity under close monitoring		X			
Reintroduction of species to ecosystem after captive breeding (2007–2008)		X			
Reestablishment of species into ecosystem (2001–2002)	X				
Removal/relocation of a species			X	X	
Restoration of shrubs, wildflowers, and other vegetation					X

GO ON

The table shows the Channel Island fox population after the recovery program began in 1999.

Recovery of the Channel Island Fox Population

Year	San Miguel	Santa Rosa	Santa Cruz
1999	0	0	100
2005	0	0	100
2011	450	250	1000
2014	500	750	2500

GO ON

25 Which sequence of events **best** describes the conditions that changed the Channel Island ecosystem before the recovery program?

A Disappearance of bald eagles → Increase in golden eagles → Decrease in wild pigs

B Increase in wild pigs → Disappearance of bald eagles → Increase in golden eagles

C Decrease in native plants → Increase in wild pigs → Decrease in skunks

D Increase in golden eagles → Disappearance of bald eagles → Increase in wild pigs

26 Which statement **best** describes the island fox population after the golden eagles were introduced into the Channel Island ecosystem?

A The presence of five times more golden eagles led to the extinction of the island fox population.

B Between 1960 and 1990, golden eagles and island fox populations were stable with no change.

C The fox population decreased between 1990 and 1999, when the largest increase in the golden eagle population occurred.

D Island fox populations decreased 60–80% once the golden eagles were introduced.

GO ON

27 Scientists claim that the interactions between species on the Channel Islands can be beneficial or harmful to the ecosystem.

Which statements support the claim about the interactions between species in the Channel Island ecosystem? Select the two that apply.

A Bald eagles and wild pigs have a beneficial interaction.

B Bald eagles and wild pigs have a harmful interaction.

C Channel Island foxes and bald eagles have a beneficial interaction.

D Channel Island foxes and bald eagles have a harmful interaction.

E Channel Island foxes and golden eagles have a beneficial interaction.

F Channel Island foxes and golden eagles have a harmful interaction.

28 One solution to the ecosystem disruption on the Channel Islands was to relocate the golden eagle.

Which tradeoffs did scientists consider when proposing this solution? Select the two that apply.

A The number of bald eagles may decrease.

B The number of island skunks may increase.

C The amount of native plants may decrease.

D The number of wild pigs may increase.

E The predation on island foxes may decrease.

GO ON

29 Which statement **best** evaluates the recovery program in the Channel Island ecosystem?

A There were so many different approaches that it was difficult to tell which recovery program worked best.

B The national park service spent too much money since all they needed to do was remove the golden eagle.

C The combination of multiple approaches was successful in restoring the Channel Island fox population.

D The recovery program was not successful because Channel Island fox populations decreased on San Miguel Island.

30 Describe a criteria to be used to refine the Channel Islands recovery program.

Enter your answer in the space provided.

GO ON

Read the following information. Use the information to answer the questions.

Bee Populations

California supplies over 80% of the world's almonds. Each spring millions of honeybees are shipped to California. Almond growers need the honeybees to pollinate their trees. Almond trees rely on honeybee pollination. The almond growers look for hives that can be rented for the pollination season. The table summarizes the large number of honeybees needed.

California Hives

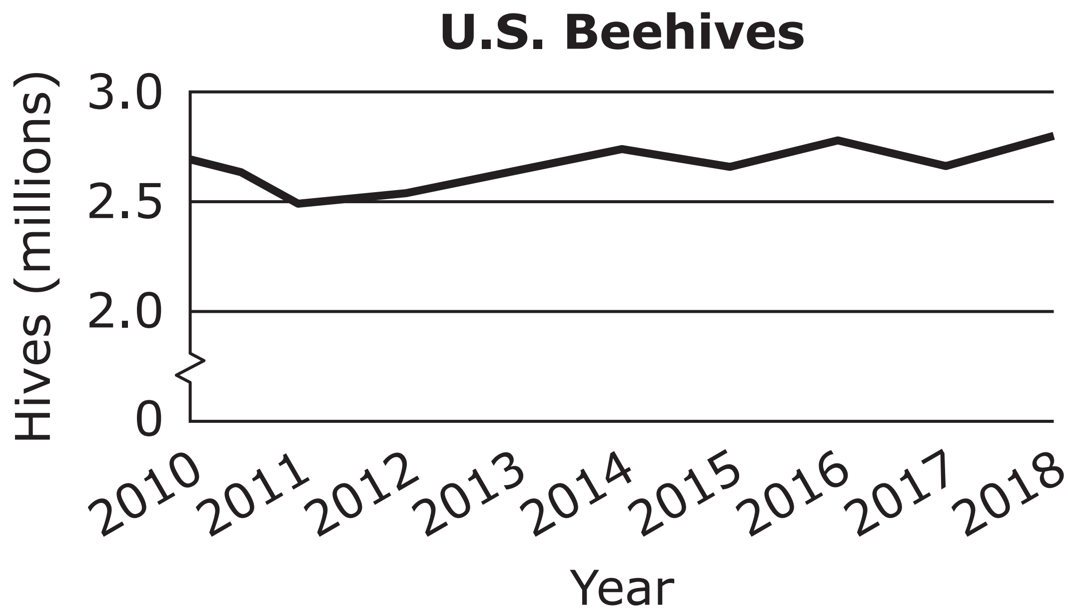
Hives in California	Hives Needed to Pollinate California Orchards
~500,000	~2,000,000

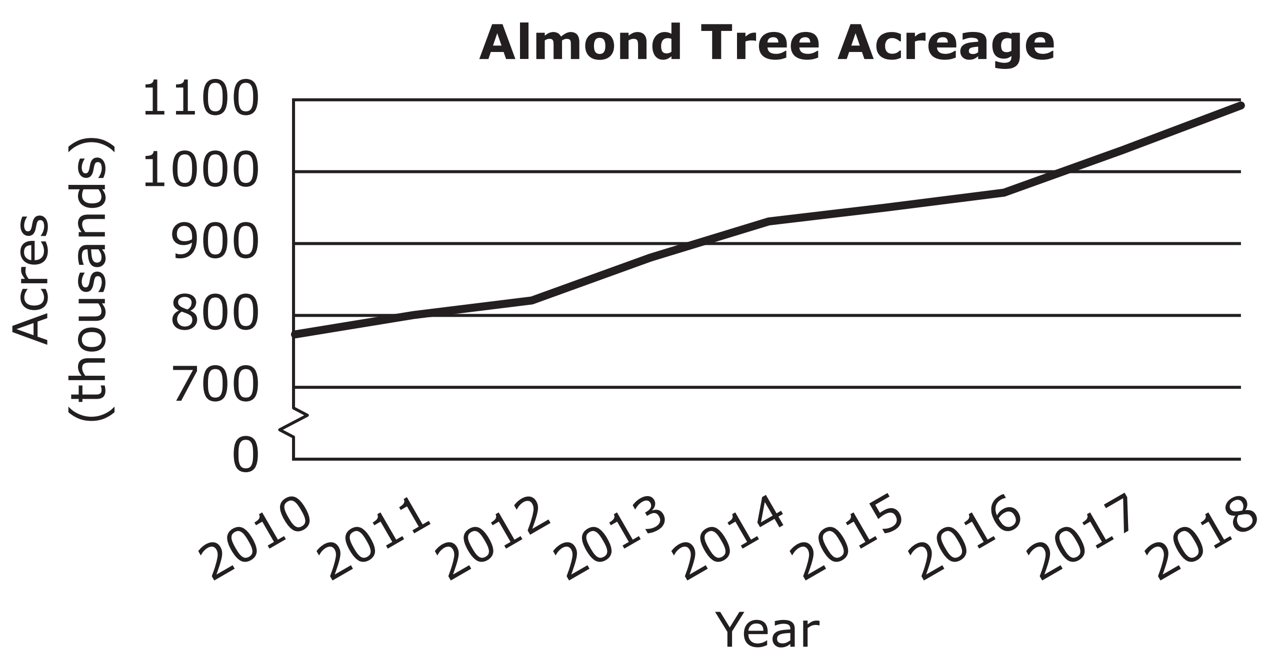
Honeybees live in a structure called a hive. A hive consists of

- one queen bee that lays all the eggs for the hive,
- hundreds of male drones whose only job is to mate with the queen,
- and 20,000–80,000 worker bees who are responsible for pollination.

GO ON

Two or more hives are needed per acre to pollinate the almond trees. The graphs show the number of hives and the almond tree acreage over a nine-year period.





GO ON

Changing Conditions

During the winter, almond trees remain dormant, existing on stored water and nutrients. In early spring, almond trees begin blooming. The honeybees are released to begin four weeks of work moving from tree to tree pollinating each bloom.

Other insects add competition for the honeybees. The competition causes honeybees to pollinate at a higher rate. All these honeybees together from so many different places could potentially spread viruses and diseases. This could result in a loss of honeybees and, ultimately, almonds. The table summarizes several key factors in bee losses.

Bee Losses

Reason for Hive Loss	Possible Causes	Average % of Yearly Loss
colony collapse disorder	• stress of traveling • habitat change • poor nutrition • lack of hibernation period – no rest	~17–20%
pesticide usage	• insecticides and fungicides	~40% and up
harsh winters	• lack of honey • longer, colder days/ nights	~30%

GO ON

Almond pollination gives honeybees their first food of the year and provides the protein and amino acids their diet requires. Honeybee hives need more than one type of food to remain healthy. A healthy ecosystem is dependent on the honeybee population. The table shows how honeybees affect the rest of the ecosystem they support.

Honeybee Importance

Function	Effect
food source	Bees produce honey for other organisms as well as being a food source for birds and spiders.
plant growth	Wild plants depend on pollination to create seeds.
biodiversity	Bees support the growth of other plants and flowers that are habitats and food sources for others.
wildlife habitats	Honeybees build elaborate hives for themselves, but also help build suitable ecosystems for sustaining other species.

31 Which statement **best** explains the relationship between almond tree reproduction and honeybees?

A As the honeybee population size increases, so does the almond tree reproductive rate.

B As the almond tree reproductive rate increases, so does the honeybee population size.

C As the honeybee population size decreases, the almond tree reproductive rate stays the same.

D As the almond tree reproductive rate decreases, so does the honeybee population size.

32 Which statement explains the impact of other insects on the California almond ecosystem?

A Honeybees perform less pollination in the almond orchards.

B Other insects cause increased pollination of almond trees and other plants by honeybees.

C Other insects distract the honeybees from performing pollination in the almond orchards.

D Honeybees can only pollinate one type of tree in the almond orchards.

GO ON

33 Use the events to show how a decline in honeybees has an effect throughout the ecosystem.

1. Honeybees produce less honey.
2. The amount of food resources available for other organisms decreases.
3. Fewer honeybee hives are available for pollination.
4. Almond tree pollination decreases.

Part A

Which sequence of events shows the first two steps of the effect throughout the ecosystem?

A 2 → 4

B 4 → 1

C 3 → 4

D 1 → 3

Part B

Which sequence of events shows the last two steps of the effect throughout the ecosystem?

A 3 → 1

B 2 → 3

C 4 → 2

D 1 → 2

GO ON

34 Which statement **best** describes how honeybees with poor nutrition and no rest likely affect the honeybee ecosystem?

A Almond trees will all die off and eventually go extinct, as there will be no pollination.

B The ecosystem would become more stable, as there will be less competition for other organisms.

C The ecosystem would become less stable, as there would be less food sources for other organisms.

D Almond trees will increase, as other pollinators will have the ability to cross-pollinate the orchards.

35 Which statement describes how honeybees experiencing harsh winters impacts the almond orchard ecosystem?

A There will be more honeybees, which would increase the number of honeybees surviving after the almond bloom.

B There will be fewer honeybees, which would cause a decrease in pollination.

C There will be fewer almond trees, which would decrease the food needed for honeybees.

D There will be more almond trees, which would increase the food needed for honeybees.

36 Use reasoning to explain the effect on biodiversity in the ecosystem if a large decrease in the honeybee population occurred in the United States.

Enter your answer in the space provided.

STOP

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Session 4

Read the following information. Use the information to answer the questions.

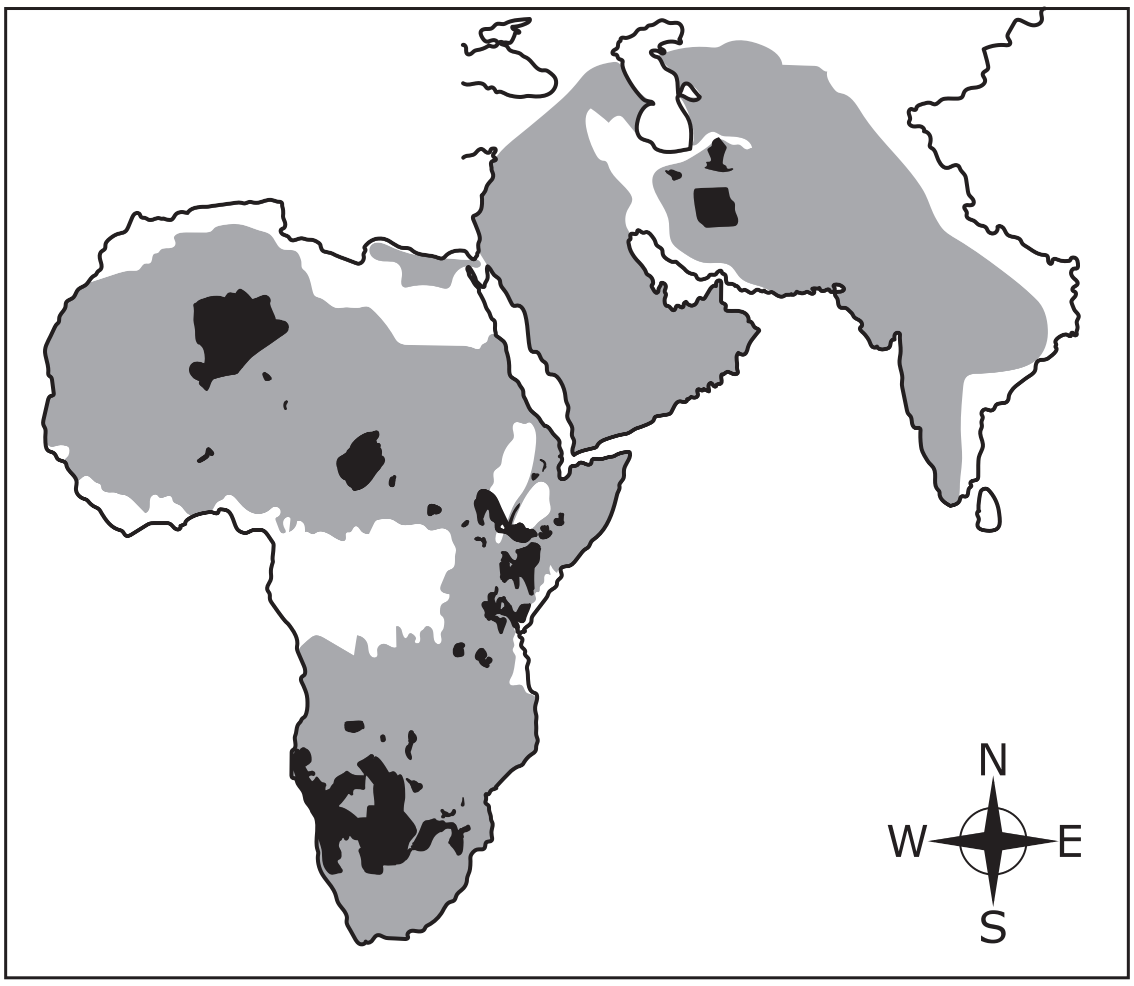
Cheetah Population and Habitat

Cheetahs are the fastest land animal. In 1900, there were about 100,000 cheetahs and today there are fewer than 7,100. Habitat loss and hunting by humans continue to decrease cheetah populations.

Protected areas (PAs) have been created to reduce habitat loss and protect cheetahs from hunters. Cheetahs prevent prey species from becoming overpopulated in the PAs. These PAs also protect other large predators that compete with cheetahs for resources. Large predators can also prey on the young cheetahs.

Cheetahs currently inhabit less than 10% of their historic range, and about 77% of their current range is outside of PAs. The map shows the change in cheetah range. The table shows cheetah population sizes in Africa and Asia.

Historic and Current Cheetah Range in Africa and Asia



Key
- Historic range
- Current range

Cheetah Populations in Africa and Asia

Region	Population
South Africa	4297
East Africa	2290
West, Central, & North Africa	457
Asia	43

GO ON

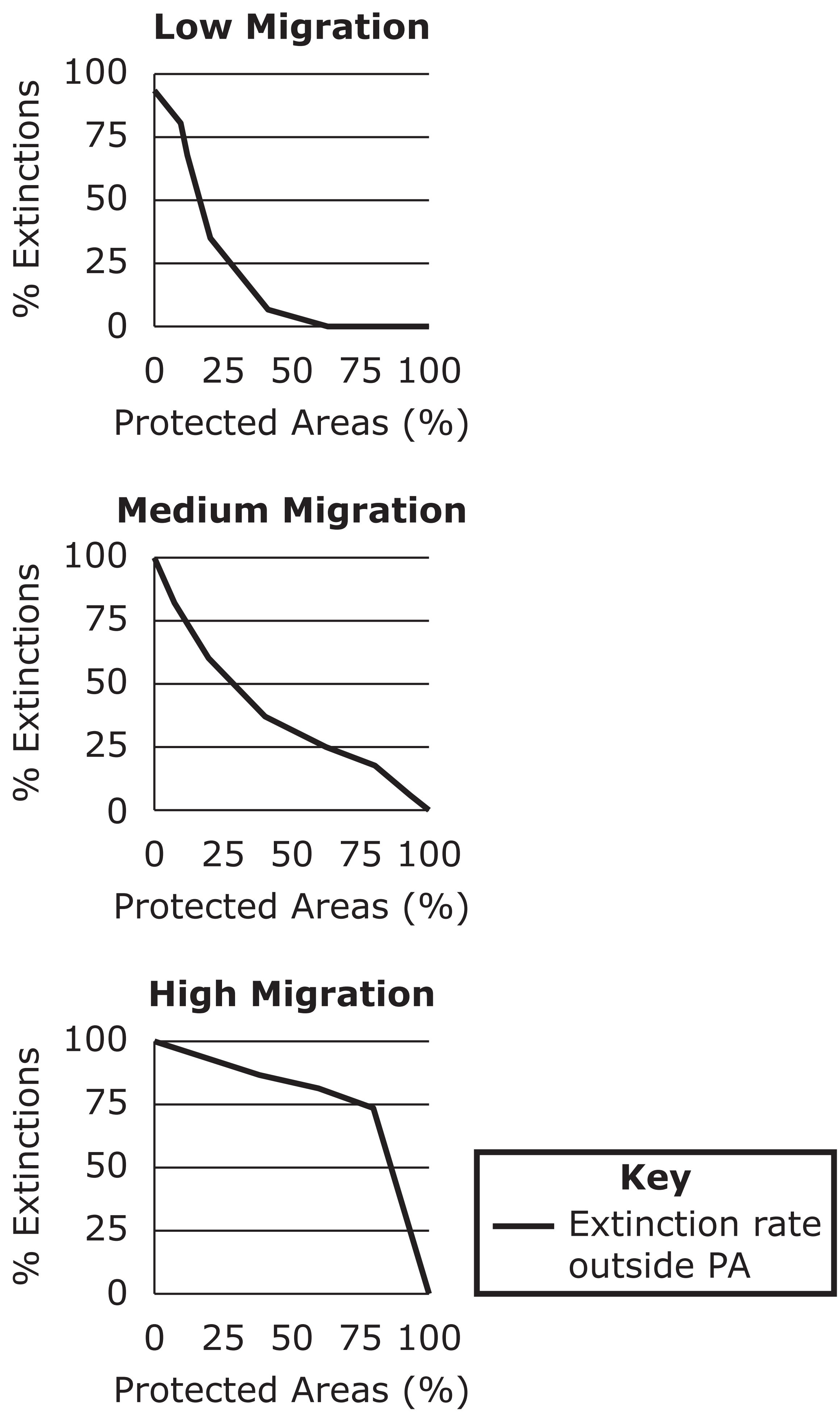
Session 4

Wildlife monitoring can be difficult, so researchers often use models to predict population changes. The graphs model the predicted rate of extinction for cheetah populations based on the following:

- the amount of protected land available within the cheetah's range
- the growth rate of cheetah populations outside of protected areas
- the migration rate of cheetahs from protected to unprotected areas

GO ON

Cheetah Population Extinction Models



GO ON

Session 4

Genetic Variation in Cheetah Populations

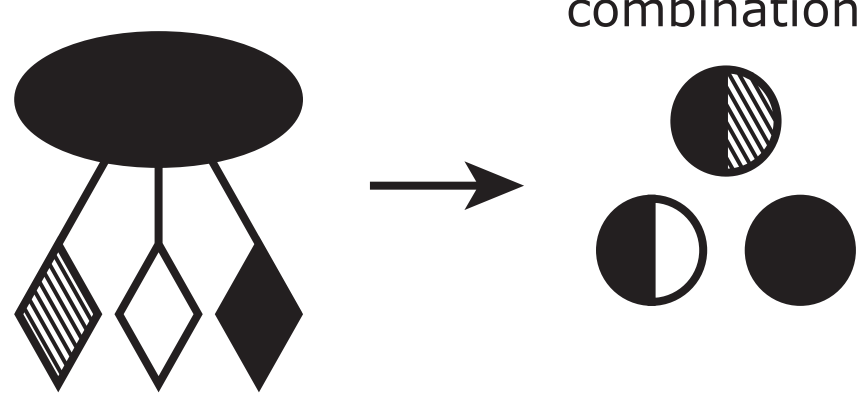
Scientists believe cheetahs went through a genetic bottleneck when the genetic pool got very small about 10,000 years ago. DNA samples show that all modern cheetahs share 95–99% of the same genes. Scientists believe this lack of genetic diversity is a leading cause of the rapid decline of the species. Up to 40% of cubs die within the first 3 months of life.

Cheetahs can start reproducing around the age of 20–24 months. Females can breed at any time of year and usually mate with more than one male during a reproductive cycle. As a result, females can give birth to 3–4 cubs, each from a different father, within a single litter. Females travel long distances, mating with males across a wide range, and may not return to mate with the same males from year to year. The practice of mating with a variety of males helps improve genetic diversity in a population and could save the species. The diagram compares the outcomes of a female that mates with three males and a female that mates with only one male.

Scenario 1:

1 female mates with 3 males

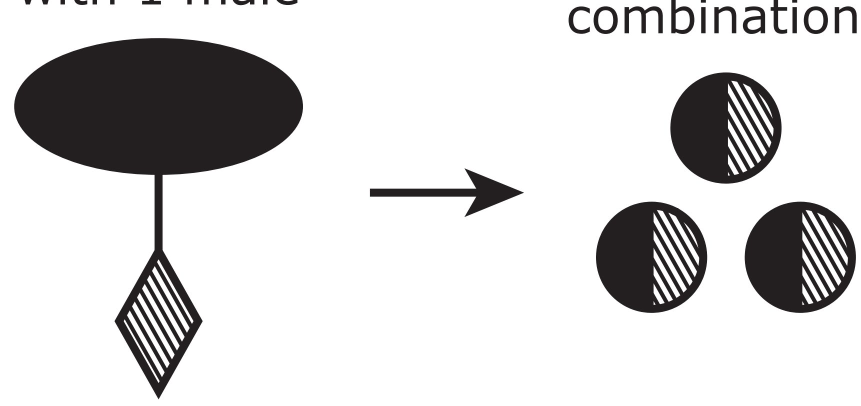
3 cubs are produced with different genetic combinations



Scenario 2:

1 female mates with 1 male

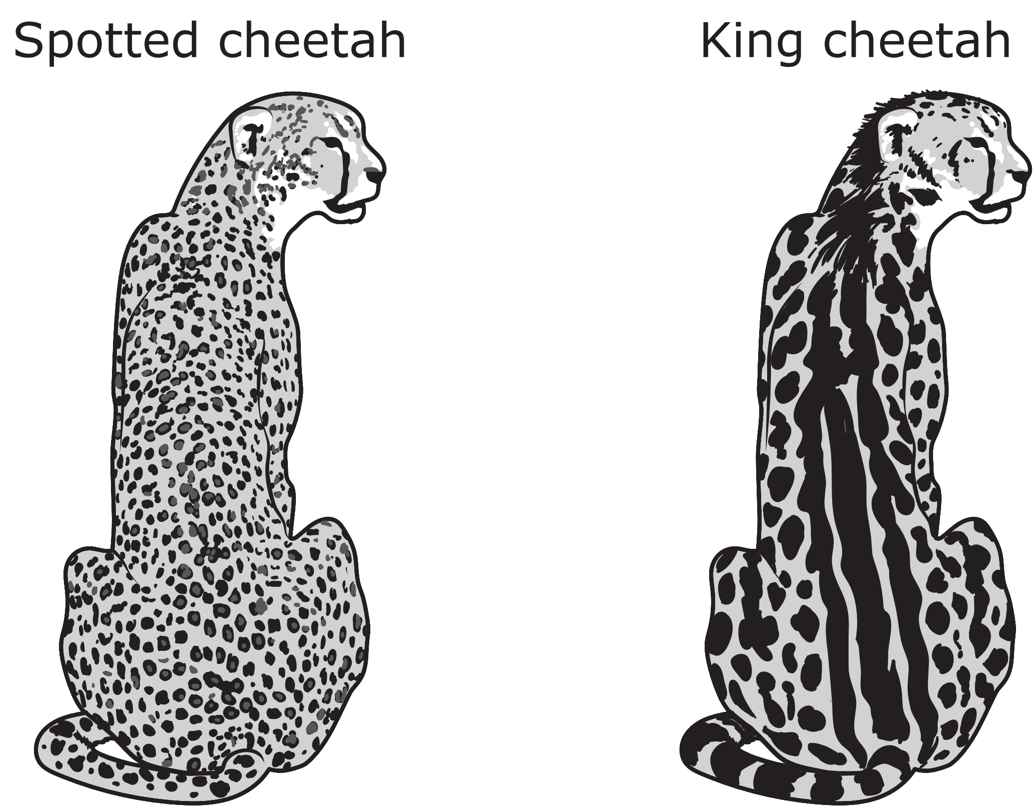
3 cubs are produced with the same genetic combinations



GO ON

Low genetic diversity increases the occurrence of diseases. It also results in inbreeding, in which closely related cheetahs mate and produce offspring with increased mutations. One common inbreeding mutation causes the spots on a cheetah's fur to look smeared. This mutated gene also creates long black stripes down a cheetah's back. Scientists compared DNA sequences from domestic cats and cheetahs and found that a mutation in the *Taqpep* gene caused spots to become stripes in both cheetahs and cats.

The diagram shows the fur pattern and DNA sequences for a spotted cheetah with a normal *Taqpep* gene and for a "king" cheetah with a mutated *Taqpep* gene.



***Taqpep* Gene**

Cheetah Type	DNA Sequence
Spotted	GGA AAC AAA AAG CTC
King	GGA AAC CAA AAA GTC

GO ON

Session 4

37 Which statement is **best** supported by the Historic and Current Cheetah Range in Africa and Asia map and the Cheetah Populations in Africa and Asia table?

A Cheetah populations are too small to recover even with proper protections and space.

B Cheetah populations can survive in a variety of ecosystems when they have enough space, food, and protection.

C Cheetah populations are too different from one another to increase the total population size through normal reproduction.

D Cheetah populations can safely travel far enough to breed with individuals living in different regions.

38 Cheetah populations are most successful in areas where there are a large number of prey species available to hunt.

Which order shows the regions where cheetah populations are found arranged from the region with the greatest prey abundance to the region with the least prey abundance?

A West, Central & North Africa → Asia → East Africa → South Africa

B East Africa → South Africa → West, Central & North Africa → Asia

C South Africa → East Africa → West, Central & North Africa → Asia

D Asia → West, Central & North Africa → East Africa → South Africa

GO ON

39 Which statement about the survival of cheetah populations is **best** supported by the Cheetah Population Extinction Models?

A A high migration rate and the ability to live outside PA boundaries are both important factors that increase survival.

B The amount of protected land for cheetahs and the rate of migration to find resources are both important factors that affect survival.

C The amount of protected land is a more important factor for survival than the rate of migration to find resources.

D The ability to live inside PA boundaries is a more important factor for survival than the percent of land protected within the cheetah's range.

40 Based on the Cheetah Population Extinction Models, which factor **most likely** impacts the survival of cheetahs in a population?

A the size of a cheetah population in a region

B the number of PAs located in the historic range of cheetahs

C the proportion of the cheetah population living in protected areas

D the ability of cheetahs to migrate between countries to find food

GO ON

41 Which statement **best** explains why cheetahs are beneficial to an ecosystem?

A Prey populations fluctuate more when there is increased predation.

B Prey populations remain more stable when cheetahs are present to prevent them from overpopulating.

C Other predator populations fluctuate more when there is increased competition for prey.

D Other predator populations remain more stable when cheetahs are present to prevent them from overhunting.

42 Use evidence to predict how errors during replication and environmental mutations could contribute to inheritable genetic variation in the cheetah population.

Enter your answer in the space provided.

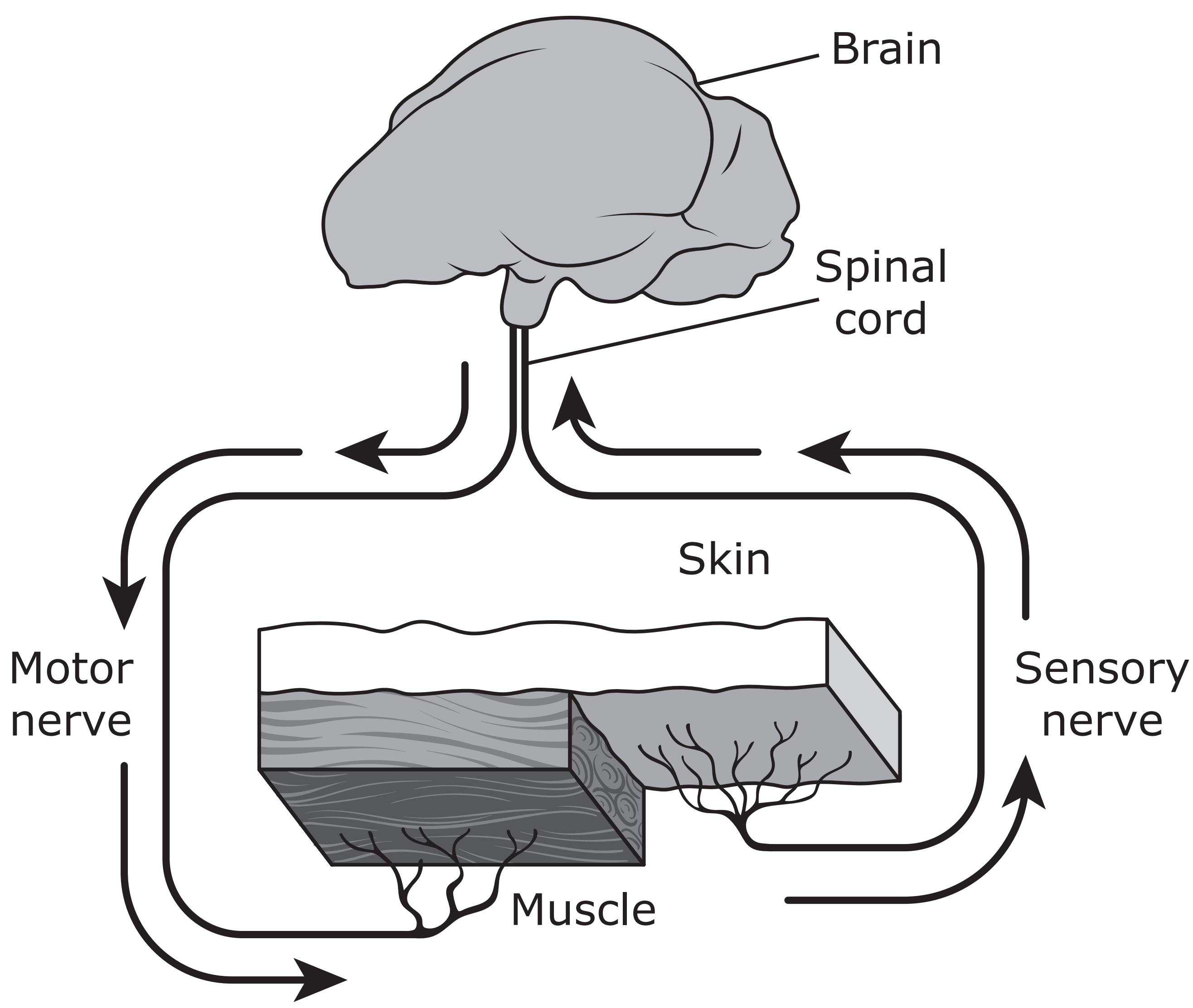
GO ON

Read the following information. Use the information to answer the questions.

Winter's Tiny Survivors

Unlike many Maryland birds, chickadees do not migrate to warmer climates during the winter. These small songbirds have adaptations that allow them to survive very cold temperatures. Chickadees grow a thicker coat of feathers and increase fat levels. The body also uses muscle energy to create heat by shivering, as shown in the model.

Shivering Model



GO ON

Session 4

Chickadees use a large amount of energy during shivering. In the winter, they eat foods like seeds to increase the fat content in their bodies. Chickadees must eat an additional 35 percent or more of their body weight each day. They can also lower their internal body temperature at night.

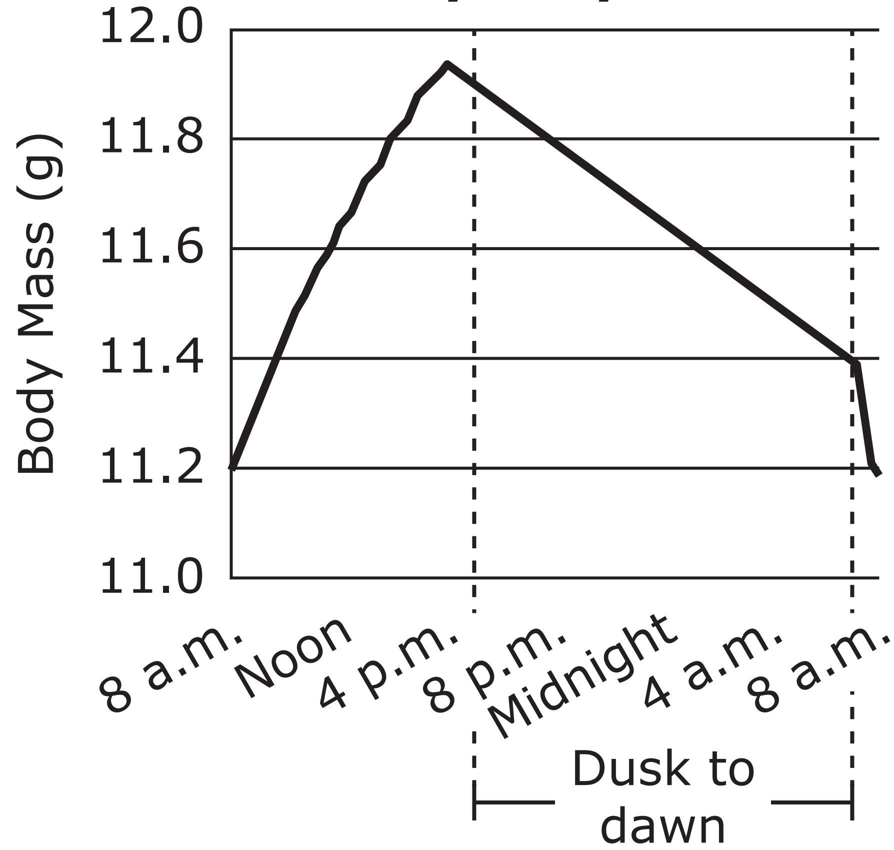
The table lists adaptations that help them survive cold temperatures. The graphs show daily changes in chickadee body mass and body temperature during the winter.

Chickadee Winter Adaptations

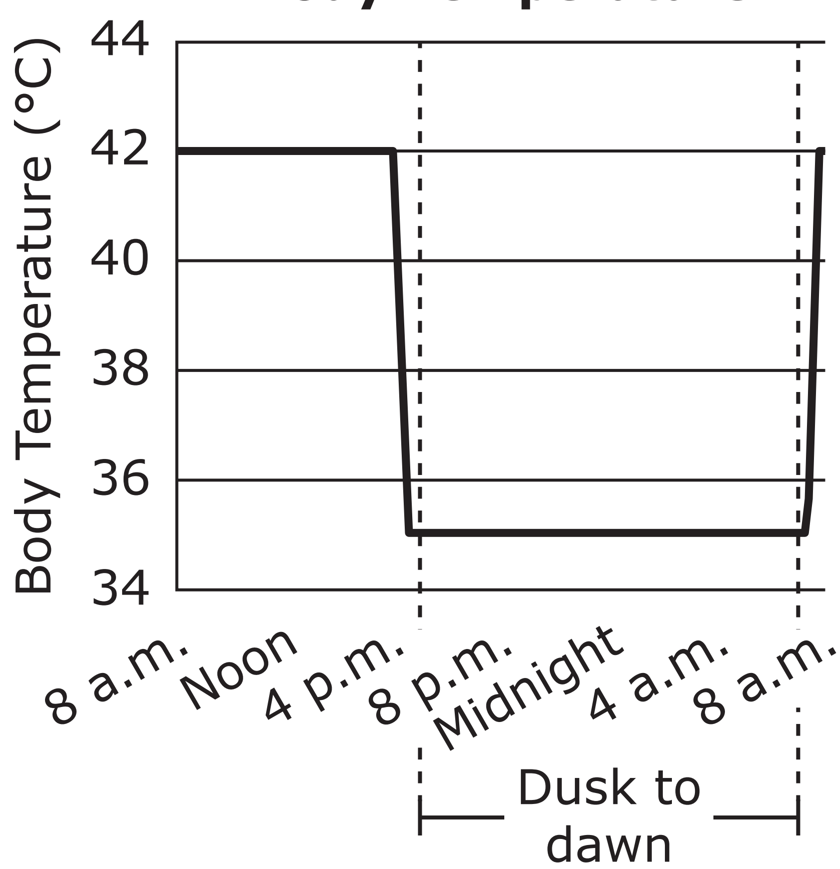
Type	Adaptation
External	• thicker feathers • fluff up feathers • tuck head into body while sleeping
Internal	• consumes 35% of mass daily • gain 10% of mass in fat daily • increase metabolism • lower internal temperature at night
Behavioral	• nest in hollow tree • huddle with others • eat food with more fat in winter

GO ON

Chickadee Daily Body Mass

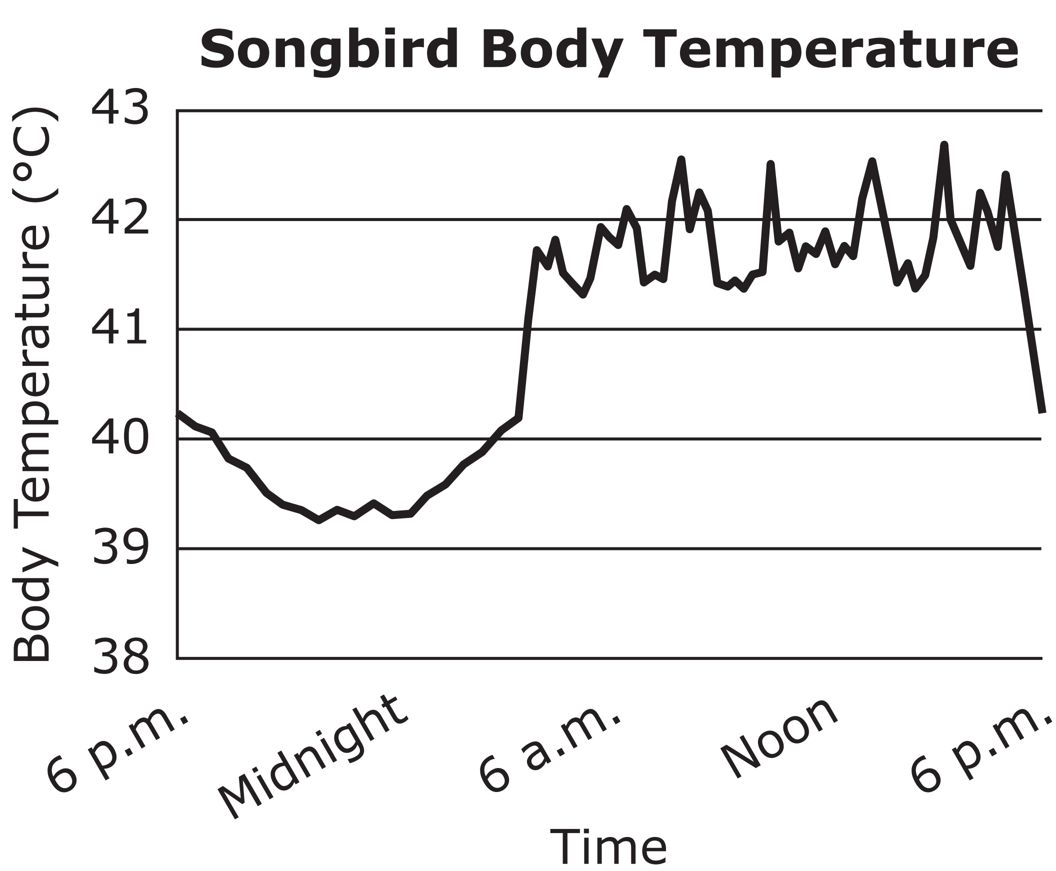


Chickadee Daily Body Temperature

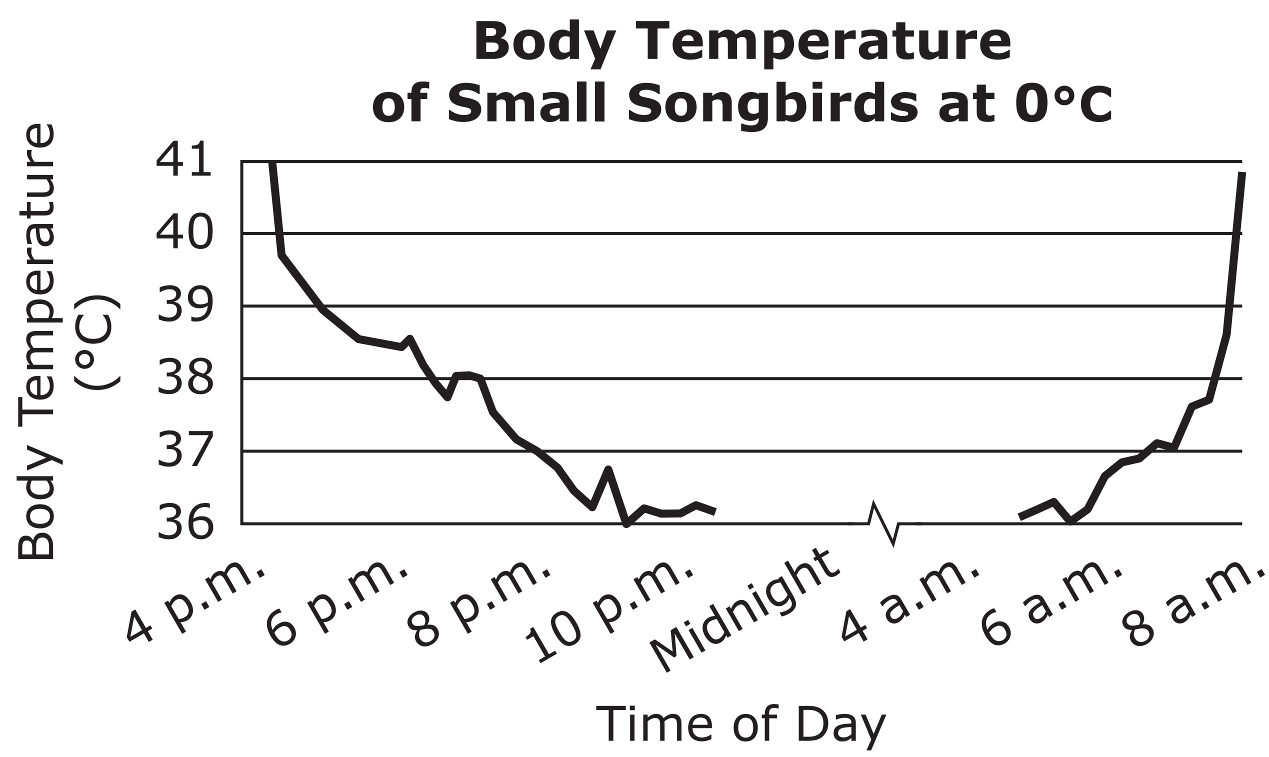


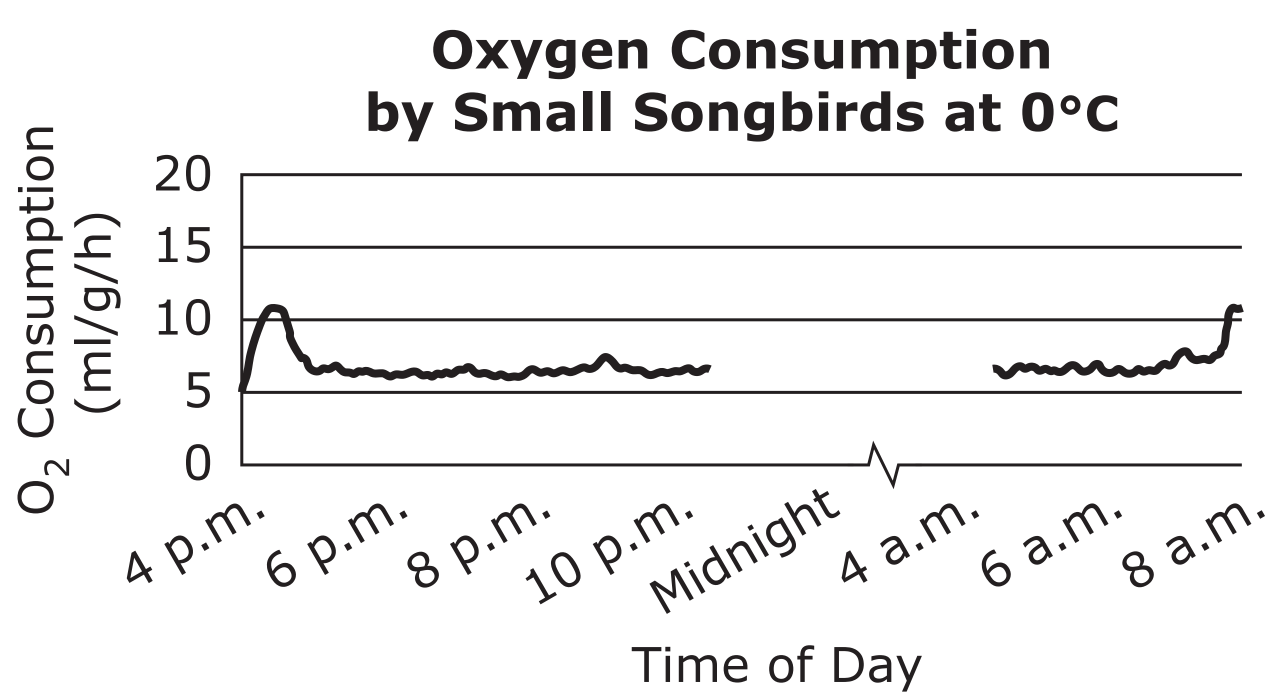
Temperature Regulation in Small Birds

Scientists studied temperature regulation in chickadees and other small songbirds. The scientists caught wild songbirds and placed them into four groups. Each group was kept at the average temperature of one season (spring, summer, fall, and winter) for a week. At the end of the week, scientists recorded the bird's body temperatures for 24 hours. The scientists found that the data were the same for all seasons. The graph shows the results of the investigation.



Scientists completed a second investigation. The birds were kept at 0°C. The scientists recorded the bird's body temperature and oxygen consumption. Oxygen consumption indicates how fast the body is converting food to energy. Scientists did not collect data between 11 p.m. and 5 a.m. The graphs show the results.



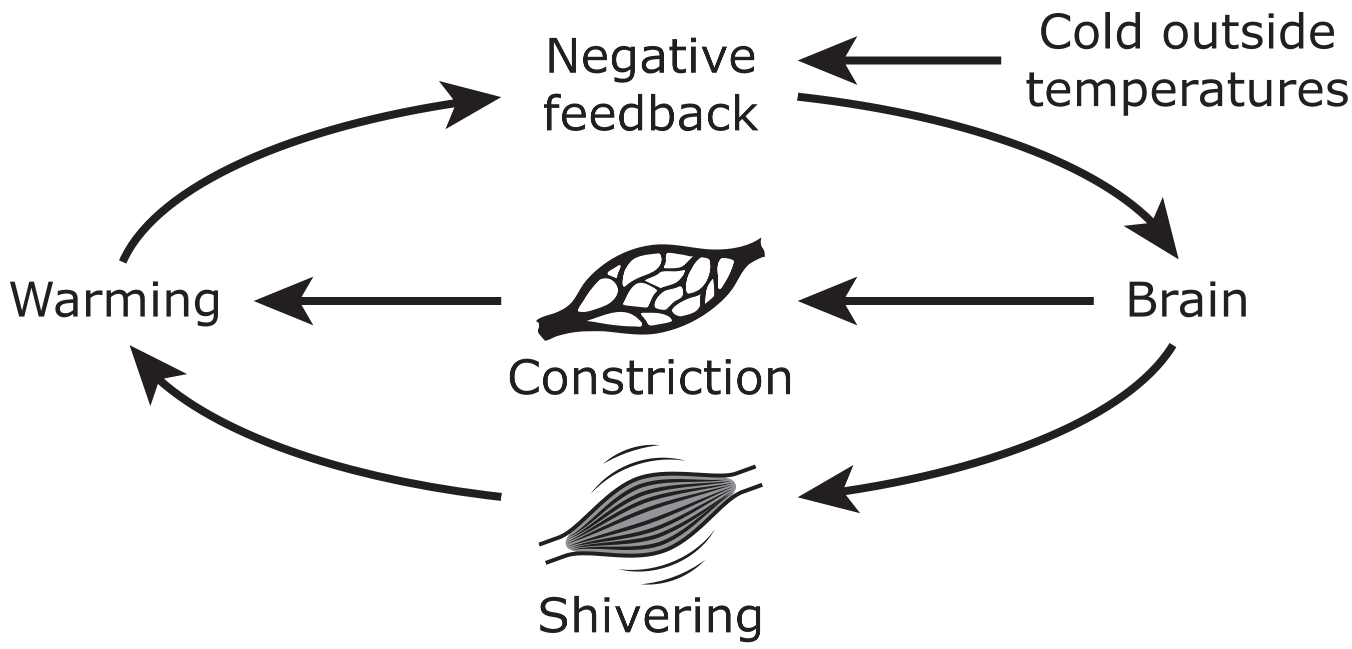


GO ON

Homeostasis

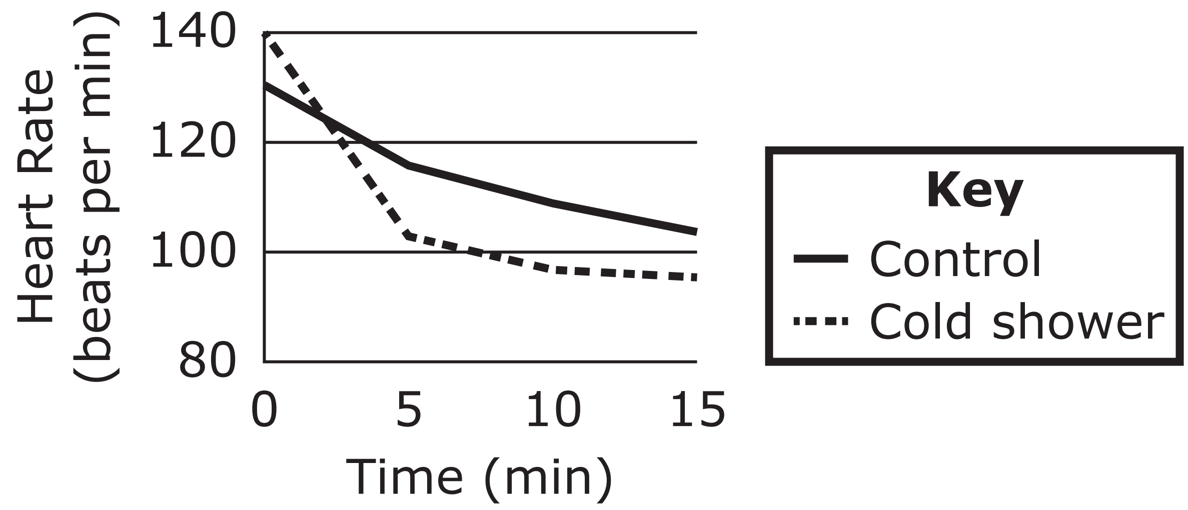
Scientists studying chickadees found multiple feedback mechanisms. The diagram shows how homeostasis is maintained when outside temperatures are cold.

Maintaining Homeostasis



Scientists also studied the effects of temperature on heart rate in humans to better understand homeostasis. Scientists divided seventeen healthy participants into an experimental group and a control group. The participants exercised and then were exposed to a cold shower or were seated for 15 minutes. Scientists measured the participants' heart rate every five minutes after exercising. The graph shows the results from the study.

Change in Heart Rate



43 Based on the Shivering Model, which statement **best** explains how chickadee body systems carry out the function of shivering?

A The skin senses the outside temperature and the brain and spinal cord respond by shivering.

B The nervous system senses the outside temperature and the muscular system responds with muscles contracting.

C The muscular system senses the outside temperature and the skin responds by shivering.

D The brain senses the outside temperature and the muscular system responds with muscles contracting.

44 Which organ systems are **most** important to the chickadee increasing its body mass each day in the winter? Select the two that apply.

A the excretory system

B the digestive system

C the respiratory system

D the skeletal system

E the nervous system

GO ON

45 The Body Temperature and Oxygen Consumption at 0°C graphs show data collected during the same time period. Different events that occur after temperatures drop to 0°C are shown.

1. Body temperature and oxygen consumption increase.
2. Energy is released more quickly.
3. Oxygen consumption stabilizes.
4. Body temperature decreases.

Which sequence of events shows how these data can be used to describe how songbirds respond to temperature changes?

A 1→3→4→2

B 2→1→4→3

C 4→2→3→1

D 4→1→2→3

GO ON

Session 4

46 Scientists set up an investigation to study temperature regulation during different seasons as shown in the Songbird Body Temperature graph.

Part A

Which statement **best** describes a limitation of the scientists' investigation?

A The temperature in the laboratory was kept constant.

B Songbirds from the wild were brought indoors into a laboratory.

C The same set of birds were studied throughout the length of the experiment.

D The skin temperature was measured at different time points during the day.

Part B

Which statement describes a modification that would provide better evidence about how songbirds respond to temperature changes?

A Keep each group at the average temperature for two weeks instead of one.

B Vary the temperatures within each season instead of using the average.

C Record the body temperature for 48 hours instead of 24.

D Record the air temperature in addition to body temperature for 24 hours.

GO ON

47 Use the Maintaining Homeostasis model to describe how chickadees respond to cold temperatures.

Part A

Which statement describes the interaction of body systems in chickadees when shivering occurs?

A The nervous system of chickadees is stimulated, and then the skeletal system causes shivering, which warms the body.

B The nervous system of chickadees is stimulated, and then the muscular system causes shivering, which warms the body.

C The circulatory system of chickadees is stimulated, and then the nervous system causes shivering, which warms the body.

D The respiratory system of chickadees is stimulated, and then the muscular system causes shivering, which warms the body.

Part B

Which statement describes another interaction of body systems in the chickadee when external temperatures drop?

A The respiratory system responds by increasing heart rate due to increasing metabolism.

B The circulatory system responds by increasing heart rate due to increasing metabolism.

C The nervous system responds by increasing metabolism through the respiratory and digestive systems.

D The circulatory system responds by increasing metabolism through the respiratory and digestive systems.

GO ON

48 Chickadees increase their body mass daily to carry out life functions in the winter.

Describe the data that once collected, would provide evidence that an increase in mass helps these birds maintain homeostasis.

Enter your answer in the space provided.

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