PA Biology STEELS Practice Questions: Module A Molecules to Organisms - Structures, Functions, and Natural Cycles

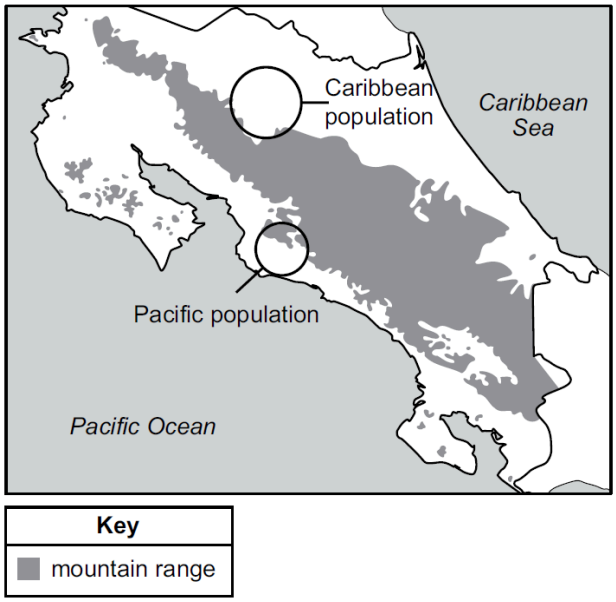
Section 1: Structure and Function

3.1.9-12.A: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

The fer-de-lance pit viper is responsible for most snakebites that occur in southern Mexico, Central America, and northern South America. These snakes can survive in a variety of habitats, including areas that have been cleared for agriculture, which puts them in contact with humans. Scientists are studying the venom of different populations to make more effective antivenom treatments.

In Costa Rica, scientists studied two fer-de-lance populations living on either side of a mountain range. The mountain range creates a geographic barrier between the populations.

Populations of Fer-de-Lance Pit Vipers in Costa Rica



Snake venom is a mixture of various proteins, peptides, and nucleotides that help break down muscle tissue in prey. A snake uses its venom to immobilize prey and to defend itself. Venom is secreted by glands in the snake's head, similar to how saliva is produced.

In Costa Rica, studies of the two populations show that the similarity of the proteins in their venom is only about 52%. When scientists investigated one particular protein, they found a single amino acid difference between the Caribbean and Pacific populations.

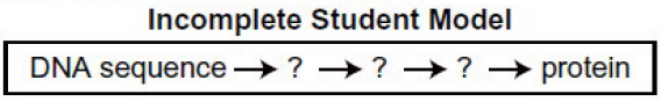
1. Which factor most directly caused the difference in the venom of the Caribbean and Pacific fer-de-lance populations?

A. the different types of prey that the juveniles and adults consume
B. the different types of producers and consumers in the populations' environments
C. the different weather conditions the populations experience in their environments
D. the different DNA sequences that provide the templates for the production of protein molecules

2. Which sequence represents the process by which snake venoms are most likely formed?

A. Protein molecules from prey are broken down and used to form sugars. Sugars form amino acids in the venom.
B. Sugar molecules from prey are broken down and used to form proteins. Proteins form amino acids in the venom.
C. Sugar molecules from prey are broken down and used to form amino acids. Amino acids form proteins in the venom.
D. Protein molecules from prey are broken down and used to form amino acids. Amino acids form sugars in the venom.

Use the model below to answer the question.



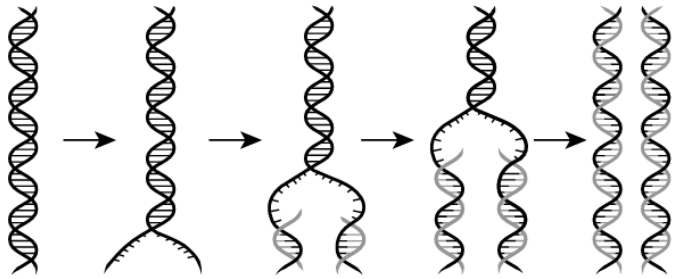
3. A student develops a model to show how DNA and proteins are related. Which sequence correctly completes the model to show the protein synthesis process?

A. amino acid sequence → tRNA sequence → mRNA sequence
B. tRNA sequence → mRNA sequence → amino acid sequence
C. mRNA sequence → tRNA sequence → amino acid sequence
D. mRNA sequence → amino acid sequence → tRNA sequence

4. PAH is a protein found in human cells. A change of one amino acid in the structure of PAH can cause PKU, a condition in which the PAH protein no longer functions. How was PKU most likely introduced into the human population?

A. A mutation occurred in the PAH gene.
B. The PAH gene moved to a different chromosome.
C. Expression of the PAH gene produced lipids instead of proteins.
D. The PAH gene was translated in the nucleus instead of in the cytoplasm.

A model of a cellular process is shown.

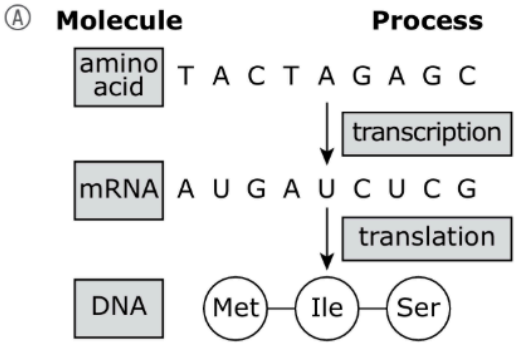


5. This process is necessary so newly divided cells can

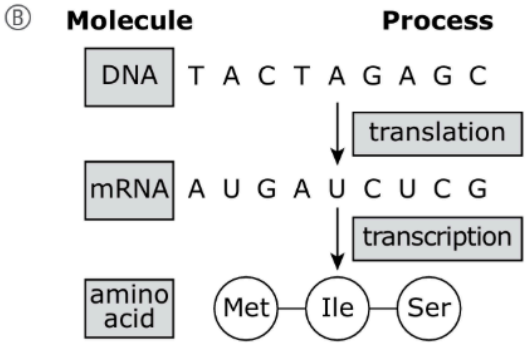
A. make more carbohydrates.
B. store more energy molecules.
C. produce lipids for cell membranes.
D. have instructions for making proteins.

6. Which of the following models of protein synthesis is labeled with the correct molecules and processes?

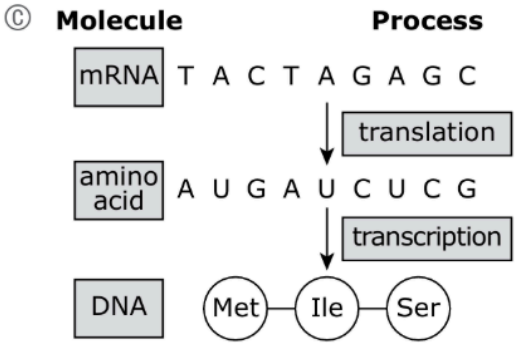
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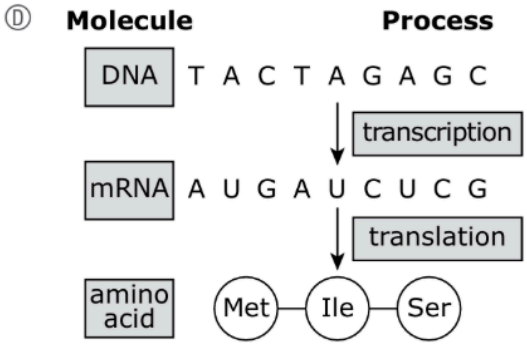
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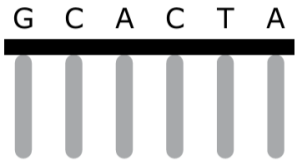
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7. A student created a model of a sequence of DNA nucleotides using craft sticks to represent nucleotides. One strand of the DNA model is shown.



What is the corresponding mRNA sequence for the DNA sequence?

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Ⓓ



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

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

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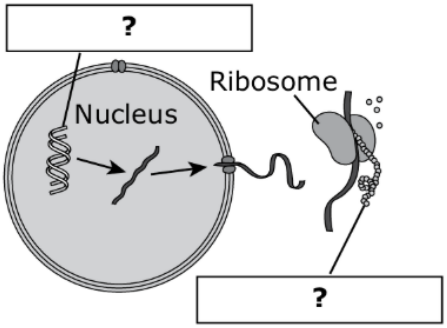
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Nucleotide Base	Percentage of DNA Molecule
adenine (A)	32
cytosine (C)	64
guanine (G)	18
thymine (T)	16

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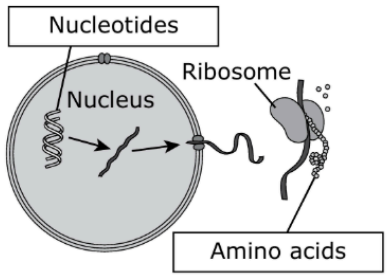
Nucleotide Base	Percentage of DNA Molecule
adenine (A)	32
cytosine (C)	18
guanine (G)	16
thymine (T)	64

9. An incomplete model of protein synthesis is shown.

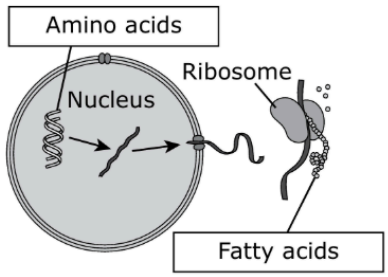


Macromolecules, which are made up of monomers, are involved in this process. Which of the following models best shows the monomers that make up the macromolecules?

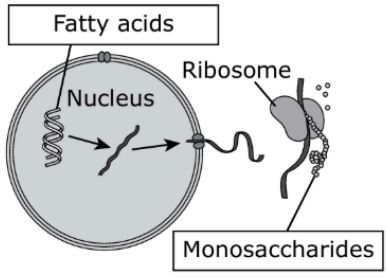
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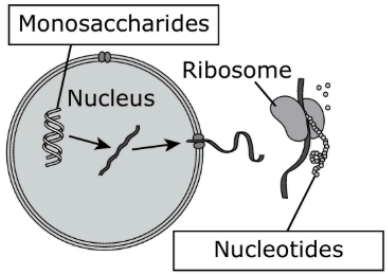
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3.1.9-12.B: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

1. Use the information below to answer the question.

Fight-or-Flight Response in a Rabbit

1. A rabbit hears a noise perceived as dangerous.
2. Neurons signal the brain that danger may be near.
3. Signals from the brain cause chemical signals to be released through blood vessels.
4. Cells in the heart receive the chemical signals.
5. The rabbit's heart rate increases.

Which model correctly identifies the organization of an organ system and explains how organ systems interact when a rabbit perceives danger?

A. nervous system → brain → nervous tissue → neurons
   The nervous system and circulatory system work together in response to danger.
B. circulatory system → heart → cardiac tissue → myocardial cells
   The nervous system and circulatory system respond independently to danger.
C. nervous system → neurons → nerve tissue → brain
   The nervous system and circulatory system respond independently to danger.
D. circulatory system → myocardial cells → cardiac tissue → heart
   The nervous system and circulatory system work together in response to danger.

2. Which characteristic is observed in both prokaryotic and eukaryotic cells?

A. presence of cytoplasm
B. reproduction by binary fission
C. presence of membrane-bound organelles
D. reproduction requires a host

3. Although the kidneys account for only 0.4% of a human's body weight, about 25% of the blood pumped out of the heart travels to the kidneys. Which of the following explains why such a large amount of blood passes through the kidneys?

A. The kidneys exchange carbon dioxide for oxygen in the blood.
B. The kidneys filter the blood to remove wastes and regulate blood volume.
C. The kidneys absorb ATP from the blood needed for cellular respiration in body cells.
D. The kidneys secrete an enzyme that digests proteins and other macromolecules found in blood.

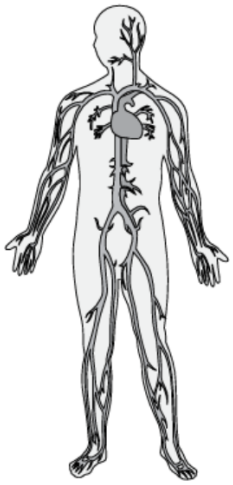
4. When a person has pneumonia, fluid accumulates in the alveoli. This fluid accumulation directly results in which of the following problems?

A. limited production of antibodies
B. decreased ability to regulate body temperature
C. slower diffusion of glucose into the bloodstream
D. reduced gas exchange between the lungs and the blood

5. As a tadpole becomes a frog, it loses its tail. Lysosomes play an important role in tail cells during this process. What is the function of lysosomes as tadpoles lose their tails?

A. Lysosomes absorb ATP, causing the tail cells to die.
B. Lysosomes cause mutations in DNA that destroy tail cells.
C. Lysosomes release enzymes that help break down tail cells.
D. Lysosomes produce hormones, causing the tail cells to differentiate.

A diagram of a body system is shown.



6. What is the primary function of this system?

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

7. A frog's skin is very thin and has many capillaries. This allows the movement of oxygen and carbon dioxide directly across the frog's skin. The frog's skin performs the same function as which of the following in the human body?

A. alveoli
B. sweat glands
C. villi

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

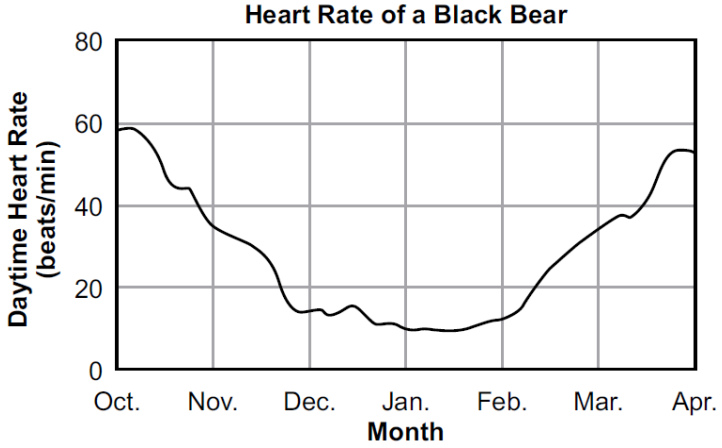
A. digestive
B. excretory
C. respiratory

9. Which of the following is a reproductive advantage that bacteria have but viruses do not?

A. Bacteria are able to reproduce by meiosis.
B. Bacteria have a nucleus to control reproduction.
C. Bacteria can replicate their DNA without a host cell.
D. Bacteria have mitochondria to supply energy for cell division.

3.1.9-12.C: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Use the graph below to answer the question.

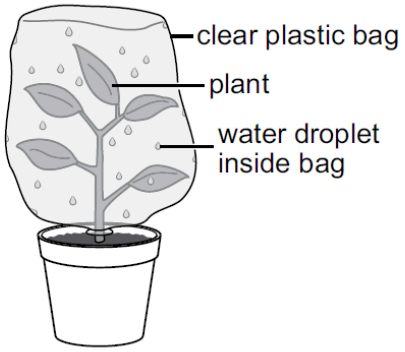


1. The graph shows data collected from studying a black bear. Which investigation would provide the best evidence that changes in a bear's heart rate are a response to temperature changes and are a mechanism that helps the bear maintain homeostasis?

A. measuring the heart rate of a grizzly bear in the same seven-month period
B. measuring the heart rate of another black bear and the average temperatures during the day for a one-month period
C. measuring the average temperatures in a polar bear's ecosystem in the same seven-month period
D. measuring the heart rates of a larger sample size of black bears and the average temperatures during the same seven-month period

2. A researcher investigated how stomata in plant leaves open and close in response to temperature changes. Four of the same plants were each given 120 milliliters (m L) of water and placed in separate rooms with different temperatures. Each room had a similar light source. The diagram shows the investigation setup, and the table shows the results of the investigation.

Investigation Setup



Investigation Results

Room Temperature (°C)	Amount of Water Collected after 24 Hours (mL)
16	5.5
21	7.3
27	9.9
37	3.8

Part A: Describe the purpose of the plastic bags that were placed over the plants.

Part B: Describe the relationship between temperature of the room and the amount of water collected.

Part C: Using the data, describe how stomata most likely help plants maintain homeostasis.

3. Blood glucose levels rise after a person eats. When blood glucose levels rise, insulin from the pancreas is released. Insulin increases the transport of glucose into cells and stimulates the liver and muscle cells to store glucose as glycogen. As a result, blood glucose levels decrease and return to a normal level. Blood glucose levels returning to a normal level is an example of

A. homeostasis.
B. osmosis.
C. reflex.
D. respiration.

4. When a person is dehydrated, a hormone called ADH is produced that increases the reabsorption of water into the bloodstream. As a result, less water leaves the body. Which organ does ADH most directly affect?

A. heart
B. kidney
C. liver
D. stomach

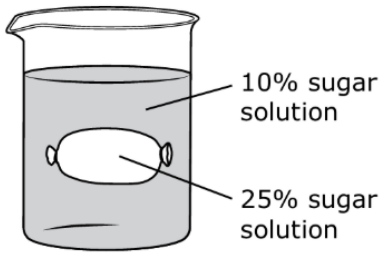
5. When the concentration of oxygen is greater outside a cell than inside the cell, oxygen will move into the cell without the assistance of proteins or additional energy. This movement of oxygen is an example of what process?

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

6. In some mammals, a decrease in body temperature causes mitochondria to become active in the cells of specialized tissue called brown adipose tissue. Instead of converting stored energy to ATP, these mitochondria convert stored energy directly to thermal energy. Why does the body respond in this way?

A. to prevent infection
B. to speed up osmosis
C. to reduce perspiration
D. to maintain homeostasis

7. A student is modeling passive transport in cells. The student places a 25% sugar solution into a semipermeable membrane and seals it. The membrane allows water molecules to pass through, but the sugar molecules are too large to cross the membrane. The membrane is placed in a beaker containing a 10% sugar solution, as shown.



Before reaching equilibrium, the volume of water inside the membrane

A. increases.
B. decreases.
C. stays the same.

8. This is because the number of water molecules that enter the membrane is

A. equal to the number of water molecules that leave the membrane.
B. less than the number of water molecules that leave the membrane.
C. greater than the number of water molecules that leave the membrane.

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

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

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

Ⓑ
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5. Brain cells detect decreasing blood pH.
6. Breathing rate increases, more carbon dioxide is exhaled, and blood pH increases.

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

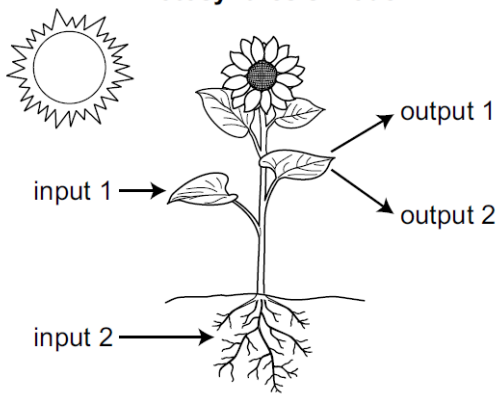
A. Carbon dioxide is removed from the body.
B. It is harmful to have a decrease in blood pH.
C. While a person is running, the brain sends signals to muscles.
D. As carbon dioxide in the blood decreases, blood pH returns to normal.

Section 2: Matter and Energy in Organisms and Ecosystems

3.1.9-12.E: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

Use the information below to answer the question.

Photosynthesis Model



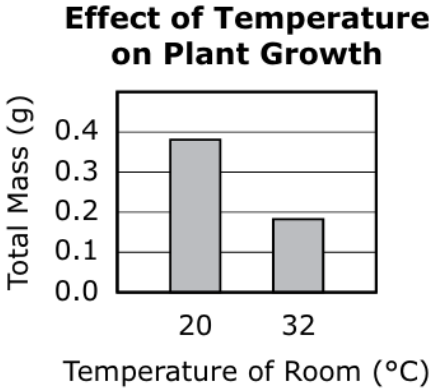
Labels for Student Photosynthesis Models

Student	Site of Process	Input 1	Input 2	Output 1	Output 2
1	mitochondrion	oxygen	water	carbon dioxide	water
2	chloroplast	carbon dioxide	water	oxygen	glucose
3	mitochondrion	oxygen	water	carbon dioxide	glucose
4	chloroplast	carbon dioxide	glucose	oxygen	water

1. Students labeled a photosynthesis model. Which student labeled the model correctly?

A. student 1
B. student 2
C. student 3
D. student 4

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



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

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

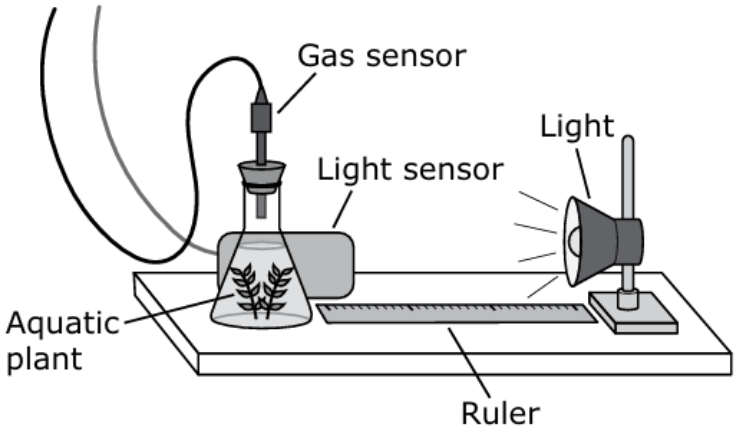
3. A student planted an oak tree that was three meters tall. The tree was exposed to sunlight, water, and air. One year later, the tree was four meters tall. Where did the tree obtain most of the carbon necessary for its growth?

A. from the air
B. from the soil
C. from sunlight
D. from fertilizers

4. Phytoplankton are microscopic aquatic organisms that perform photosynthesis. Phytoplankton support other aquatic organisms by producing

A. carbon dioxide.
B. oxygen.
C. salt.
D. water.

5. A student conducted an investigation. The setup of the investigation is shown in the diagram. A gas sensor measured the amount of a certain gas produced by an aquatic plant, and a light sensor measured the amount of light the plant received. During the investigation, the student moved the light closer and closer to the flask.



Which of the following best describes the investigation?

A. It was designed to find out how light intensity affects the rate of photosynthesis by measuring the amount of oxygen produced.
B. It was designed to find out how gas exchange affects the rate of cellular respiration by measuring the amount of oxygen produced.
C. It was designed to find out how gas exchange affects the rate of photosynthesis by measuring the amount of carbon dioxide produced.
D. It was designed to find out how light intensity affects the rate of cellular respiration by measuring the amount of carbon dioxide produced.

3.1.9-12.F: Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

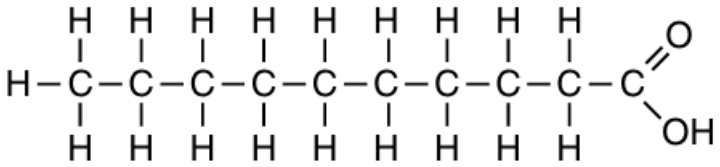
1. A student claims that sugar molecules can be converted directly to proteins by the cell since proteins contain the same elements as sugar. Which statement best evaluates this claim?

A. The claim is incorrect because proteins contain nitrogen. Cells can use the elements in sugar but will need to combine them with other elements to form proteins.
B. The claim is incorrect because all proteins are enzymes, which are used to make sugar molecules.
C. The claim is correct because proteins help form DNA, and DNA synthesis uses energy from sugar molecules.
D. The claim is correct because proteins are made from only carbon, hydrogen, and oxygen, which are all parts of a sugar molecule.

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

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

3. The chemical structure of a fatty acid is shown.



This fatty acid is a building block of which type of organic molecule?

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

3.1.9-12.G: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

Use the table below to answer the question.

Effects of Exercise on Carbon Dioxide and Oxygen Levels

Exercise Intensity	Carbon Dioxide Production (L/min)	Oxygen Consumption (mL/kg/min)
Low (e.g., washing dishes)	0.3	40
Moderate (e.g., walking)	0.7	60
High (e.g., dancing)	1.3	80

1. Which statement correctly identifies the relationship between cellular respiration and energy requirements?

A. More intense exercise causes cellular respiration to decrease, resulting in a reduced output of oxygen.
B. The intensity of exercise does not change the rate of cellular respiration, so the carbon dioxide input remains unchanged.
C. As exercise intensity increases, the rate of cellular respiration increases. This requires more oxygen and produces more carbon dioxide.
D. As exercise intensity decreases, the rate of cellular respiration decreases. This requires less carbon dioxide and produces less oxygen.

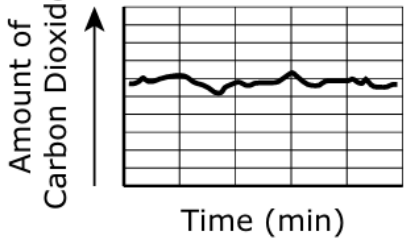
2. Emperor penguins can dive underwater for over 20 minutes. While underwater, the penguins use oxygen that is stored in their bodies.

Part A: Which of the following best describes the importance of oxygen in the penguins' body systems?

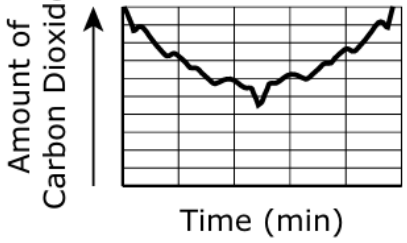
A. Oxygen allows the lungs to grow underwater.
B. Oxygen diffuses from the muscles to other body parts.
C. Oxygen is converted into other gases in the bloodstream.
D. Oxygen is used to produce energy for muscle movement.

Part B: Which of the following graphs shows the amount of carbon dioxide produced over time in a penguin's body as it swims underwater?

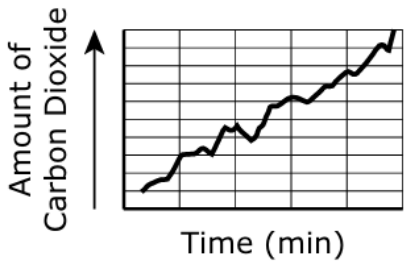
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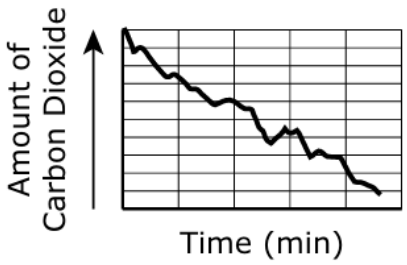
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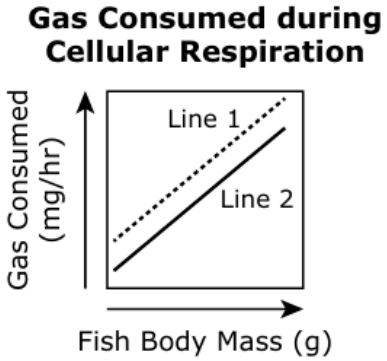
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3. A scientist measured the cellular respiration rates of zebrafish while at rest and while actively swimming. The incomplete graph shows the data collected by the scientist.

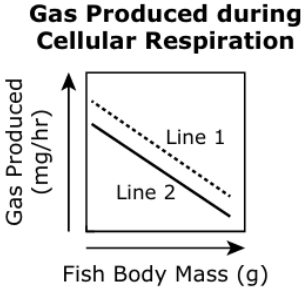


A. Identify the gas consumed by the fish, represented by the y-axis of the graph.

B. Identify the line that most likely shows the data from actively swimming zebrafish. Explain your reasoning.

C. The scientist repeats the experiment, but instead of measuring the gas consumed by the fish, the scientist measures the gas produced by the fish. Identify the gas that is produced by the fish while at rest and while actively swimming.

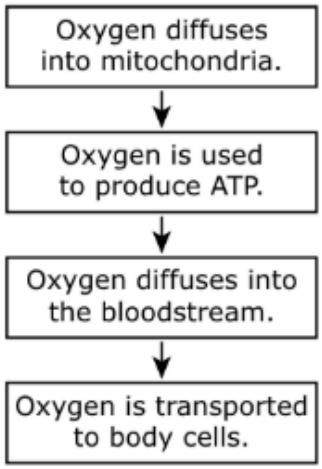
D. A student predicts that a graph showing the gas produced during cellular respiration will look like the graph shown. Is the student's prediction correct? Explain your reasoning.



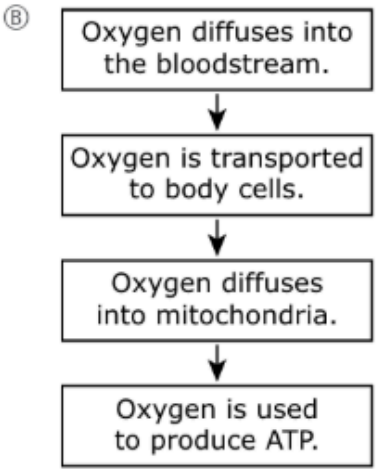
4. Zebrafish take in oxygen as water moves through their gills.

Part A: Which of the following models best shows the steps that occur when oxygen is used by the zebrafish?

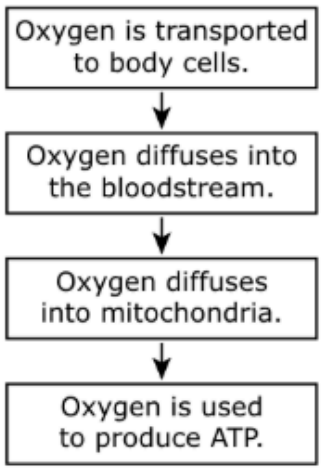
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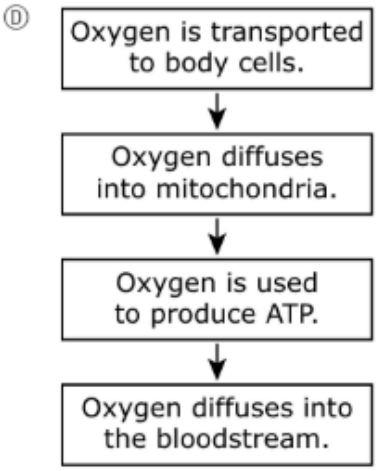
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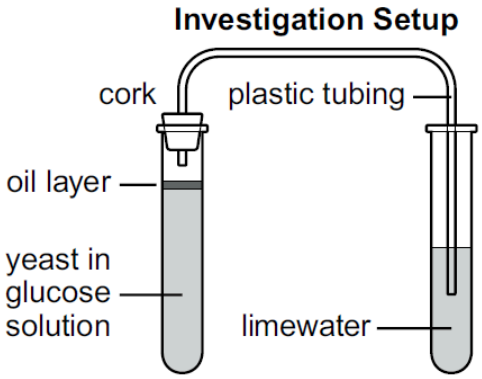


Part B: Which of the following best describes how oxygen is used by the zebrafish?

A. Zebrafish use oxygen and water to perform transcription.
B. Zebrafish use oxygen and glucose to perform transcription.
C. Zebrafish use oxygen and water to perform cellular respiration.
D. Zebrafish use oxygen and glucose to perform cellular respiration.

3.1.9-12.J: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Use the diagram and list below to answer the question.



- The oil layer allows gas to bubble upward through the oil.
- The oil layer does not allow gas to move downward through the oil.
- Yeast consume glucose as a food source.
- Limewater turns from clear to cloudy when carbon dioxide is added to it.

1. Students constructed the setup shown in the diagram and noticed that the limewater changed from clear to cloudy. Which phrase best describes the student investigation?

A. evidence of aerobic respiration
B. evidence of anaerobic respiration
C. evidence of photosynthetic oxygen release
D. evidence of photosynthetic carbon dioxide release

3.1.9-12.H: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

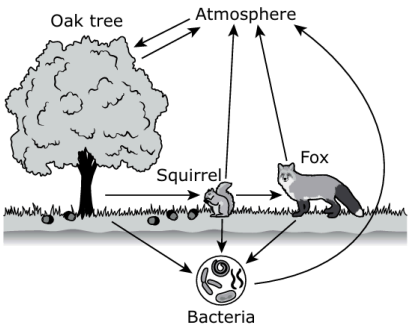
1. Energy pyramids represent the flow of energy through organisms at different trophic levels in the same ecosystem. If the producers in a desert ecosystem receive 90,000 kilocalories (kcal) of energy from the Sun, about how much energy would be available to secondary consumers in this ecosystem?

A. 90 kcal
B. 900 kcal
C. 9,000 kcal
D. 900,000 kcal

2. Which of the following best describes how carbon is cycled from the atmosphere to living organisms?

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

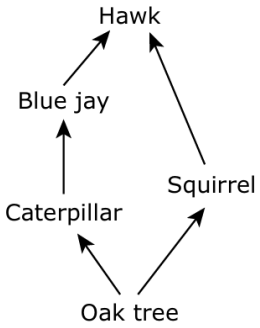
3. The model shows how carbon moves through an ecosystem.



Select all the actions in which carbon storage occurs.

A. Oak trees produce sugar.
B. Foxes use energy to hunt.
C. Squirrels eat acorns to build up fat.
D. Bacteria decompose dead oak trees.

A food web for a forest ecosystem is shown.



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

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

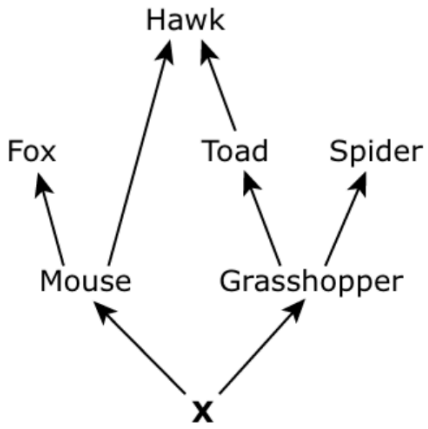
5. What is the role of the caterpillar in the ecosystem?

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

6. What is the role of the squirrel in the ecosystem?

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

7. A part of a food web for an ecosystem is shown. One of the organisms is labeled X



A. Identify whether the organism labeled X in the food web is a decomposer, primary consumer, producer, or secondary consumer.

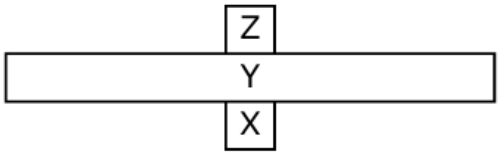
B. Identify the organism in the food web whose population size would likely decrease the most if the mouse population became extinct. Explain your reasoning.

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

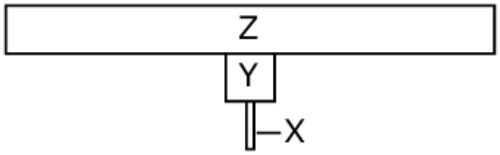
Trophic Level	Organisms
X	berry bush, tree
Y	small bird, mouse
Z	fox, owl

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

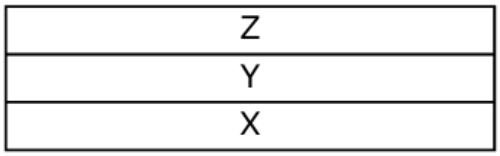
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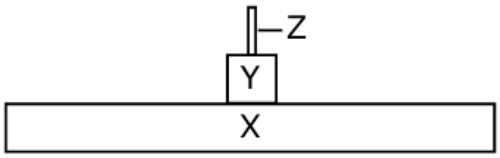
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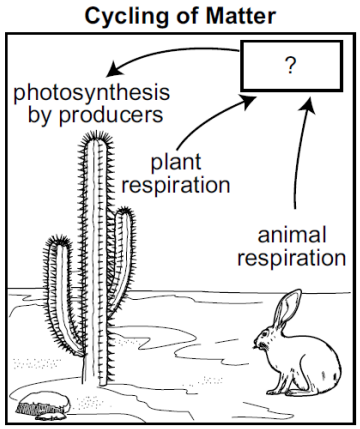


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3.1.9-12.K: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

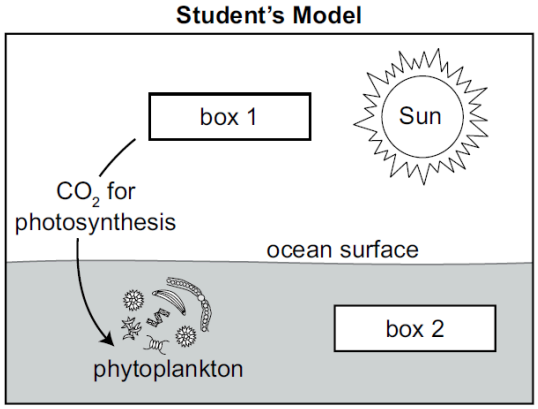
Use the model below to answer the question.



1. The model shows some ways that matter moves between the biosphere and the atmosphere as a result of different processes. Which label correctly identifies the question mark in the model?

A. carbon dioxide gas
B. hydrogen gas
C. nitrogen gas
D. oxygen gas

Use the diagram below to answer the question.



2. A student draws a model of the carbon cycle in an ecosystem that includes phytoplankton. The model is missing the final labels for box 1 and box 2. Which set of labels should the student use to complete the model?

A. box 1: geosphere box 2: biosphere
B. box 1: hydrosphere box 2: geosphere
C. box 1: biosphere box 2: atmosphere
D. box 1: atmosphere box 2: hydrosphere

Section 3: Interdependent Relationships in Ecosystems

3.1.9-12.I: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

Use the table below to answer the question.

1. A scientist studied a population of deer in a forest ecosystem over several years. The table shows the population size and the availability of food resources.

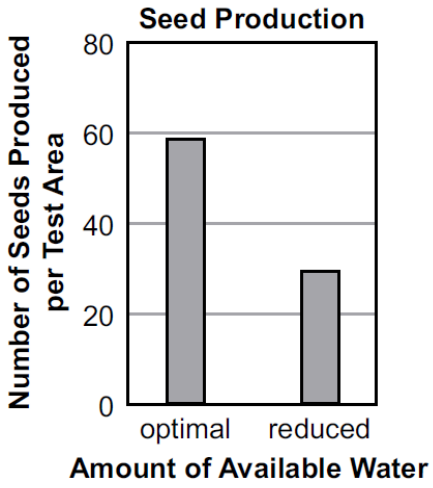
Year	Deer Population	Available Food (kg per yea
1	120	12,000
2	180	12,500
3	260	12,800
4	310	12,900
5	305	12,700

Which statement best explains how the data support the concept of carrying capacity in this ecosystem?

A. The deer population continues to increase because food resources increase at the same rate as population size.
B. The deer population stabilizes because limiting factors, such as food availability, prevent further population growth.
C. The deer population decreases because predators increase as food availability increases.
D. The deer population fluctuates randomly and is not affected by environmental factors.

3.1.9-12.L: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

1. A researcher observed that water resources in an area had become limited. The researcher investigated how the role of pollinators, organisms that fertilize flowering plants, is affected by reduced water availability. The graph summarizes the data collected during the investigation.



Part A: Identify the abiotic limiting factor the researcher studied.

Part B: Predict how the number of seeds produced by flowering plants would most likely be affected by access to unlimited resources.

Part C: Describe the effect of water availability on the abundance of species in the area.

2. Fragments are areas of a habitat that are separated from other areas of the same habitat. Corridors connect two or more fragments and allow individuals of a population to move between different fragments. Which statement best describes the relationship between a fragment and a population?

A. A larger fragment with few corridors supports fewer individuals, increasing its population.
B. A smaller fragment with few corridors supports more individuals, increasing its population.
C. A larger fragment with many corridors supports more individuals, increasing its population.
D. A smaller fragment with many corridors supports fewer individuals, increasing its population.

The following section focuses on island foxes. Read the information below and use it to answer the selected-response questions and the constructed-response question that follow.

The island fox is a small fox that lives on Santa Cruz Island off the coast of California. It is a descendant of the gray fox that is found on the mainland in California. From 1994 to 2000, the island fox population on Santa Cruz Island declined from 1,465 to only 62 individuals.

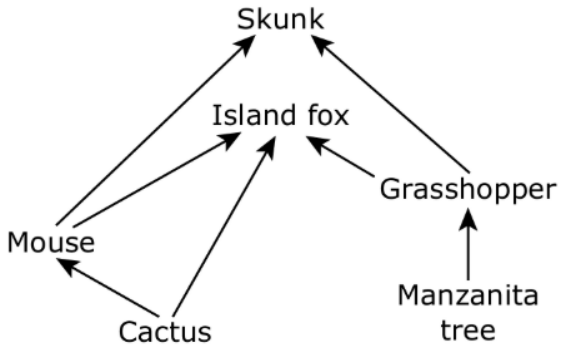
Several events on Santa Cruz Island caused the island fox population to decrease. In the 1800s, people introduced non-native plants and farm animals, including pigs, to the island. Some of the pigs escaped and reproduced in the wild, eventually producing a large population of feral (wild) pigs. The feral pigs dug up and ate native plants, including cactus plants and manzanita trees.

Young, small feral pigs on the island became a food source for visiting golden eagles. However, golden eagles were unable to nest on the island because the bald eagles living there chased them away. The bald eagles hunted fish from the ocean, but they did not eat feral pigs or island foxes. Other small mammals that lived on the island included mice and skunks. The sizes of these animal populations were not directly affected by the visiting golden eagles.

From 1950 to 1980, the bald eagle population on the island was greatly reduced as a result of the use of the chemical DDT. By 1994, there were no longer any bald eagles on the island. Golden eagles then began nesting on the island and hunting island foxes as well as the young feral pigs.

Since 2000, humans have helped restore the island fox population on Santa Cruz Island by removing feral pigs and golden eagles from the island and reintroducing bald eagles.

A food web after the island fox population was restored on the island is shown.



3. One type of plant that was introduced to Santa Cruz Island was fennel. The fennel spread and began growing in the wild. Fennel seeds are spread by wind, and fennel plants can grow up to two meters tall. Which of the following best explains how fennel most likely affected smaller native plants when it began to grow in the wild?

A. Fennel decreased the amount of sunlight that was available to native plants.
B. Fennel increased the number of native plant seeds that were spread by wind.
C. Fennel decreased the likelihood that native plants would be eaten by bald eagles.
D. Fennel increased the amount of energy that native plants used during cellular respiration.

4. After the golden eagles started nesting on the island, the skunk population began to increase. Which of the following best explains why the skunk population increased as the island fox population decreased?

A. The skunk preyed on the island fox.
B. The skunk competed with the island fox.
C. The skunk and the island fox had a parasitic relationship.
D. The skunk and the island fox had a mutualistic relationship.

5. Which of the following describes the genetic diversity in the island fox population from 1994 to 2000?

A. Genetic diversity increased as the foxes ate more mice.
B. Genetic diversity remained unchanged as the foxes stayed on the island.
C. Genetic diversity decreased as the foxes were preyed upon by golden eagles.
D. Genetic diversity remained unchanged as the number of mutations in the foxes stayed the same.

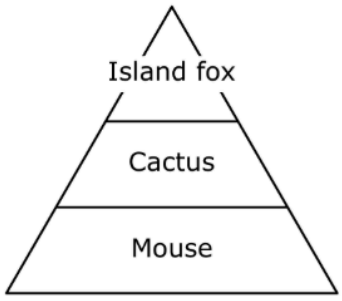
6. Island foxes play a role in the transfer of energy in the Santa Cruz Island ecosystem.

Part A: Which of the following best shows an energy pyramid for the Santa Cruz Island ecosystem?

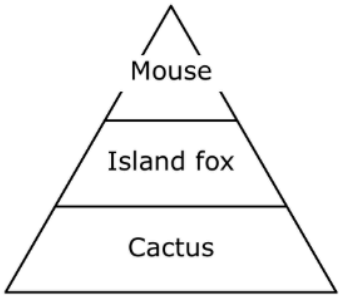
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Part B: What percentage of energy from producers is stored in the trophic level of the island fox?

A. 100%
B. 10%
C. 1%
D. 0.1%

7. Humans helped increase the island fox population on Santa Cruz Island by removing feral pigs and golden eagles from the island and by reintroducing bald eagles.

A. Explain how reintroducing bald eagles helped to increase the island fox population.

B. Describe one way the island ecosystem benefited from the removal of feral pigs. Explain how removing feral pigs helped to increase the island fox population.

C. Other than reintroducing bald eagles and removing feral pigs, describe another action that humans could take to increase the island fox population. Explain how this action would increase the size of the island fox population.

3.1.9-12.M: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Forests cover about 60% of the land in Pennsylvania. These ecosystems protect drinking water, provide recreational opportunities, and are a source of lumber, which provides many jobs. Forest managers make decisions about when and how trees are cut, whether new trees are planted, and other actions that can have significant effects on the environment and on people's lives.

Another function of forest ecosystems is carbon storage. As trees grow, they remove carbon from the air and store it in their tissues. However, about 40% of the carbon stored in a forest is contained in the upper layers of soil, and about 23% is stored in the layer of plant litter that lies on top of the soil. The remaining 37% is stored in the trees themselves. This type of carbon storage, called sequestration, can offset some of the carbon released into the atmosphere by human activities.

There are many factors that affect how much carbon a forest sequesters (stores). Large mature trees store large amounts of carbon and provide habitat for wildlife; young trees absorb more carbon as they grow. A product made from wood continues to store carbon until it is burned or begins to decompose, so the ways that harvested trees are used can also affect the carbon cycle.

Through the choices they make, Pennsylvania's forest managers affect not only carbon sequestration but also forest ecosystem health and the benefits that forests provide to residents and visitors.

1. Wild pigs are invasive animals that consume a wide variety of plants and small animals. What is the most likely result of recent increases in wild pig populations living in forests?

A. a decrease of carbon storage due to increased health of the forests' trees
B. decreased populations of native species due to consumption of their food sources
C. an increase of carbon storage due to increased health of the forests' trees
D. increased populations of native species due to consumption of their food sources

2. A forest manager proposes cutting down specific areas of an old-growth forest and planting young trees. The forest manager's goal is to reduce the total amount of carbon in the atmosphere. Which method of disposing of the old-growth trees will best help the forest manager meet this goal?

A. transforming the wood into paper products
B. allowing the wood to decompose for use as compost
C. using the wood to build furniture or other durable products
D. grinding up the wood into chips used for gardening and landscaping

3. The upland sandpiper is a type of bird that is endangered in Massachusetts. Scientists are studying factors affecting death rates and birth rates in upland sandpiper populations.

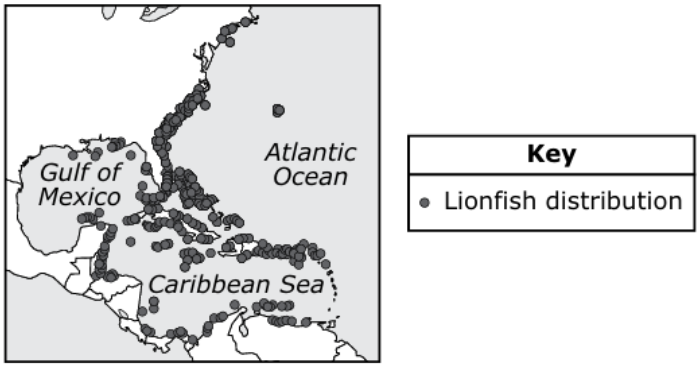
A. Assume immigration and emigration rates are equal in an upland sandpiper population. Describe how the birth rate must compare with the death rate for the size of this population to increase.

B. Identify two environmental factors that could affect the death rate in an upland sandpiper population.

C. Determine whether each factor you identified in Part B would increase or decrease the death rate in the upland sandpiper population. Explain your reasoning for each factor.

D. Identify one environmental factor, other than the factors you identified in Part B, that could affect the birth rate in the upland sandpiper population. Describe how this factor affects the birth rate and explain your reasoning.

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



4. Part A: Which of the following best explains what most likely happened in the areas where lionfish invaded?

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

5. Part B: Which of the following best explains the change in the number of lionfish from 1990 to 2010?

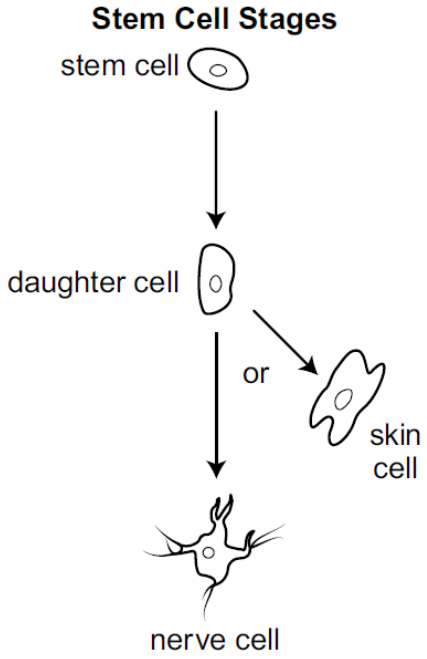
A. Lionfish took many years to reproduce.
B. Lionfish were mainly active at night.
C. Lionfish had little genetic diversity.
D. Lionfish had no natural predators.

PA Biology STEELS Practice Questions: Module B Continuity and Unit of Life - Biodiversity, Genetics, and Changes Over Time

Section 1: Inheritance and Variation of Traits

3.1.9-12.D: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

Use the model below to answer the question.

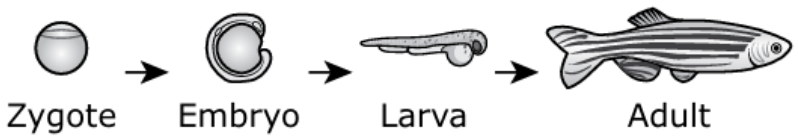


1. The model represents processes a stem cell goes through to become different types of specialized cells within an organism. Which processes demonstrated by the model allow a single cell to produce skin cells and nerve cells that all contain the same DNA?

A. mitosis and mutation
B. mitosis and differentiation
C. meiosis and mutation
D. meiosis and differentiation

The following section focuses on zebrafish research. Read the information below and use it to answer the selected-response questions and constructed-response question that follow.

Zebrafish are small freshwater fish that are often used in scientific research. Zebrafish develop from a zygote into an adult in only three months. A model of zebrafish development is shown.



A group of scientists identified some mutations that affect how the organs of the digestive system develop in zebrafish larvae. The table describes four mutations, W, X, Y, and Z, in zebrafish.

Mutation	Effect on Digestive System Development
W	small intestine wall is thin and lacks villi
X	pancreas does not develop
Y	esophagus* does not fully develop
Z	liver does not fully develop

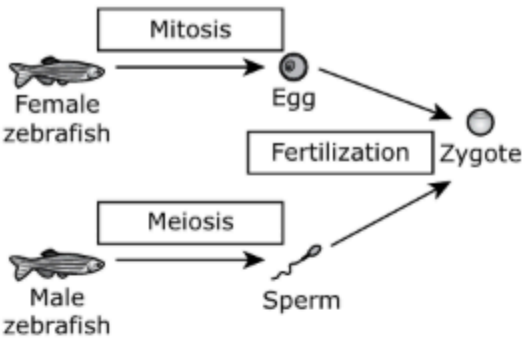
*esophagus—a tube that connects the mouth to the stomach

2. Zebrafish larvae with the mutation have a change in the
   A. DNA in the nuclei of their cells.
   B. mRNA in the nuclei of their cells.

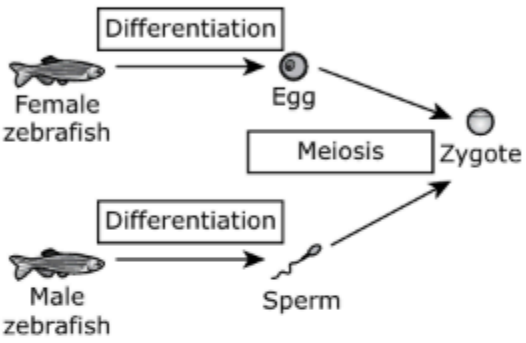
3. During transcription, the mutation causes a change in the
   A. DNA and results in a nonfunctioning lipid.
   B. DNA and results in a nonfunctioning protein.
   C. mRNA and results in a nonfunctioning lipid.
   D. mRNA and results in a nonfunctioning protein.

4. Which of the following models best shows how a zebrafish zygote forms?

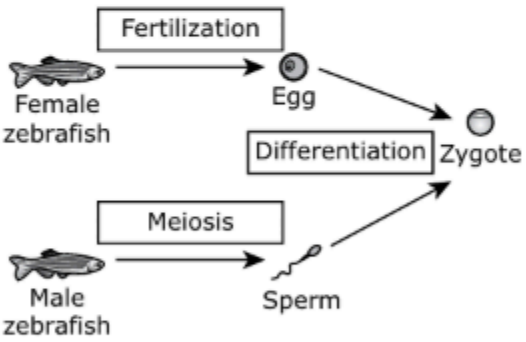
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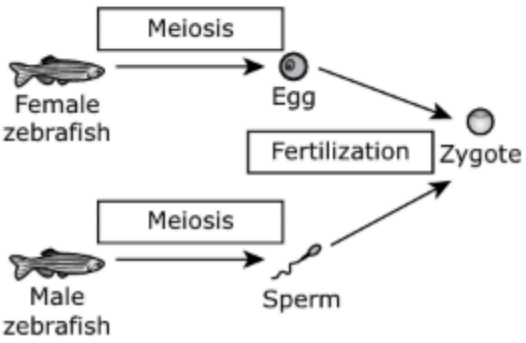
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5. Scientists collected small intestine cells from zebrafish with and without mutation W. The percentage of cells in each sample that had replicated DNA is shown in the table.

Type of Zebrafish	Percentage of Cells with Replicated DNA
with mutation W	20%
without mutation W	35%

Which of the following best compares the small intestine cells with mutation W to those without the mutation?

A. The small intestine cells with mutation W produced more proteins.
B. The small intestine cells with mutation W had more chromosomes.
C. The small intestine cells with mutation W spent less time in meiosis.
D. The small intestine cells with mutation W underwent less cell division.

6. Spiders grow until they reach adulthood. Which processes lead directly to growth by increasing the number of cells the spiders have?

A. mitosis and cytokinesis
B. osmosis and active transport
C. photosynthesis and transpiration
D. aerobic and anaerobic respiration

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

Part A: What process replaces the damaged cells of the female anglerfish?

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

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

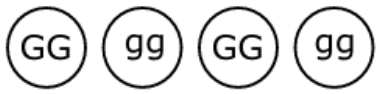
A. They are genetically identical to their parent cells.
B. They are genetically different from their parent cells.
C. They have a mix of genetic material from both parent cells.
D. They have one-half the chromosome number of their parent cells.

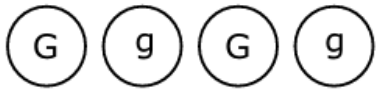
3.1.9-12.P: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

1. Some cats have a striped fur pattern. Scientists discovered that striped patterns in cat fur correspond to areas of thick and thin skin on the developing embryo. Which question could a student use to best discover how DNA coding affects this pattern?

A. Do cats with striped fur have smaller cells in areas of thin skin?
B. Does a striped cat's behavior have an effect on the thickness of its skin?
C. Do cats with striped fur have an allele that is absent from cats with solid fur patterns?
D. Does a striped cat have more genetic material in its cells than either of its parents do?

2. Which of the following best represents the gametes produced from a diploid cell with genotype Gg?

Ⓐ 

Ⓑ 

Ⓒ 

Ⓓ 

3. Pine trees are pollinated when the wind carries pollen grains from male pinecones to female pinecones. The female pinecones contain egg cells. Which statement describes what happens in a female pinecone during fertilization?

A. A diploid sperm cell and a diploid egg cell fuse together to form a zygote.
B. A haploid sperm cell and a haploid egg cell fuse together to form a zygote.
C. A diploid sperm cell and a diploid egg cell undergo rapid meiosis to form an embryo.
D. A haploid sperm cell and a haploid egg cell undergo rapid meiosis to form an embryo.

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

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

A. rr only
B. RR only
C. rr or Rr
D. RR or Rr

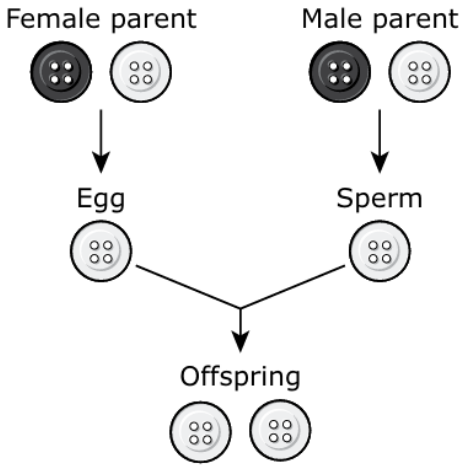
5. The mass of DNA in a human body cell is approximately 6.5 picograms (pg). What is the approximate mass of DNA in a human gamete?

A. 3.2 pg
B. 6.5 pg
C. 9.7 pg
D. 13 pg

6. An unfertilized egg from the European frog *Rana esculenta* has 13 chromosomes. A zygote of this species has 26 chromosomes. What causes the increase in chromosome number?

A. The unfertilized egg undergoes meiosis.
B. Cell division occurs in the unfertilized egg.
C. DNA replication occurs in the unfertilized egg.
D. The unfertilized egg joins with a male gamete.

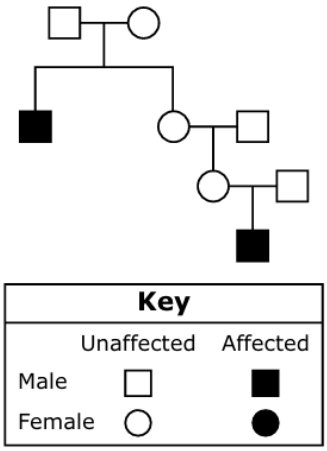
7. Students use buttons to model the inheritance of a genetic trait. Black and white buttons represent alleles of a single gene. The diagram shows part of the students' model.



Which of the following is best illustrated by this model?

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

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



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

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

9. Fence lizards can be light or dark in color. The color of fence lizards is determined by a single gene with two alleles. The allele for light color (R) is dominant to the allele for dark color (r).

A. Identify the two possible genotypes for fence lizards that are light in color.

B. A fence lizard that is heterozygous for light color is crossed with a fence lizard that is dark in color. Using the allele symbols R and r, complete the Punnett square to show this cross. Identify the percentage of the offspring from this cross that are expected to be light in color.

C. Owls and hawks eat fence lizards. Identify whether the allele for light color in fence lizards is expected to be more common in areas with dark soil or in areas with light soil. Explain your answer using your knowledge of natural selection.

10. A certain genetic condition is caused by a mutation in an animal. Answering which of the following questions would best determine whether the condition would be passed on to the animal's offspring?

A. In what type of cell did the mutation occur?
B. Did the mutation change the appearance of the animal?
C. How many female offspring were produced by the animal?
D. Can the mutation travel through the body in the circulatory system?

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

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

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

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

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

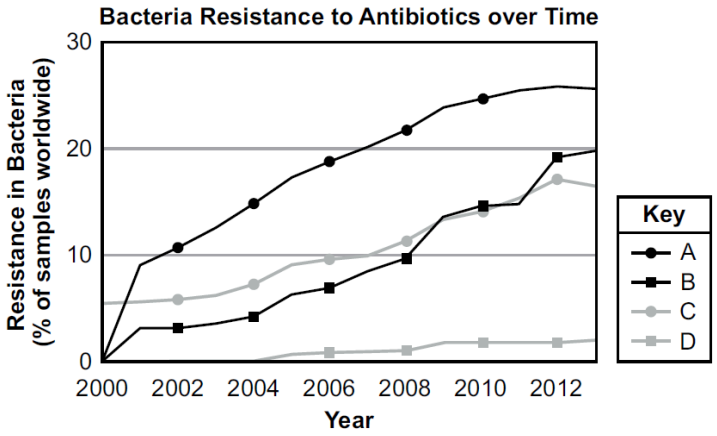
A. genetics.
B. the environment.

3.1.9-12.Q: Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

1. An offspring with a genetic mutation had a lower amount of muscle mass than expected. The offspring's parents did not have the allele for the mutation. Which of the following is the most likely cause of the offspring's mutation?

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

2. Resistance to antibiotics is a trait that is developing in several types of bacteria. The graph shows four types of antibiotics and the percentage of bacteria that have become resistant to each type of antibiotic over time.



Part A: Using evidence from the graph, identify the type of antibiotic to which the bacteria have developed the most resistance.

Part B: Describe how changes in bacterial DNA enable bacteria populations to develop resistance to a type of antibiotic.

Part C: Identify the antibiotic that scientists should investigate to understand how effectively treat bacterial infections. Explain your answer using the data provided.

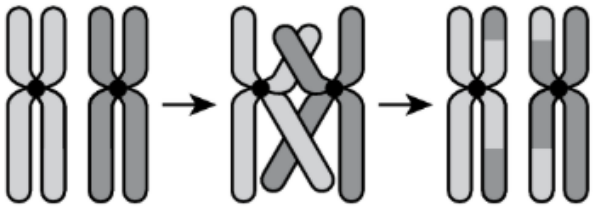
3. Familial hypercholesterolemia (FH) is a genetic condition that can cause high levels of cholesterol in the blood to develop at an early age. The symptoms of FH can be reduced or delayed if a person follows a special course of treatment that includes a low-fat diet and exercise. Which of the following best explains why a person who inherits FH can benefit from a special course of treatment?

A. Some genetic conditions are found only in certain populations.
B. The symptoms of some genetic conditions only cause problems in old age.
C. Some genetic conditions are caused by bacteria that can be controlled with antibiotics.
D. The risk of developing some genetic conditions can be influenced by environmental factors.

4. Plants watered with treated wastewater often have high levels of caffeine in their cells. Caffeine can interfere with the cellular process of crossing over that occurs between homologous chromosomes. Based on the information, which of the following cellular processes would be most directly affected by caffeine?

A. interphase
B. meiosis
C. replication
D. transcription

The model shows a pair of homologous chromosomes going through a cellular process.



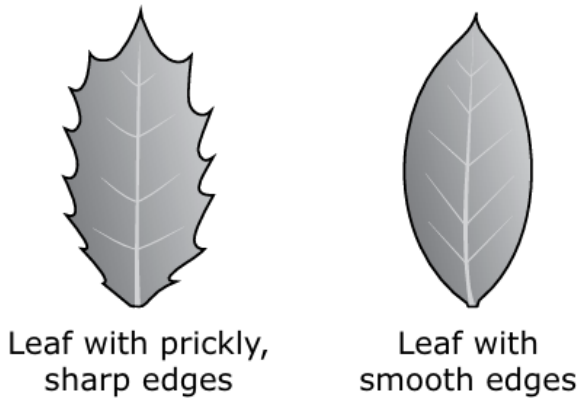
5. The process shown in the model occurs during

A. fertilization.
B. mitosis.
C. meiosis.

6. This process is a source of

A. dominant alleles.
B. genetic variation.
C. harmful mutations.

7. Holly trees can have a mix of leaves with prickly, sharp edges and leaves with smooth edges. The diagram shows both types of leaves.



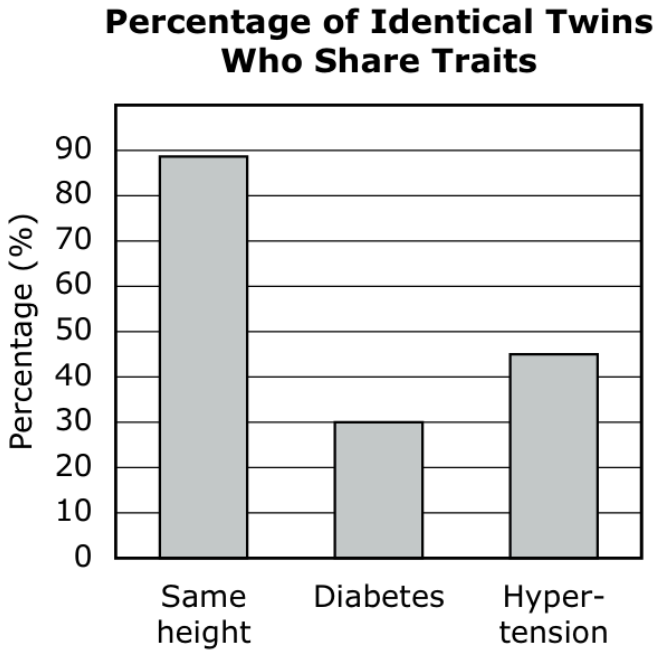
Deer prefer to eat holly tree leaves with smooth edges, which leads to the growth of more holly tree leaves with prickly, sharp edges. Scientists hypothesize that deer affect gene expression in holly tree leaves. Which of the following comparisons should be made to determine whether the scientists' hypothesis is correct?

A. Compare the gene expression in holly tree roots in an area with deer to the gene expression in holly tree leaves in the same area.
B. Compare the gene expression in one holly tree in an area with deer to the gene expression in another holly tree in the same area.
C. Compare the gene expression in holly tree leaves in an area with deer to the gene expression in holly tree leaves in an area with no deer.
D. Compare the gene expression in holly tree leaves in an area with deer to the gene expression in leaves of another tree species in an area with no deer.

8. A human gamete typically contains 23 chromosomes. Two human gametes combine to produce a zygote. Which of the following is the best evidence that an error occurred during the formation of one of these gametes?

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

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



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

A. same height
B. diabetes
C. hypertension

Part B: Scientists also collected data for certain traits in fraternal twins. Unlike identical twins, each fraternal twin develops from a different fertilized egg. The data indicate that approximately 60% of the time, one fraternal twin is the same height as the other fraternal twin. Which of the following best explains why the percentage of fraternal twins that are the same height is different from the percentage of identical twins that are the same height?

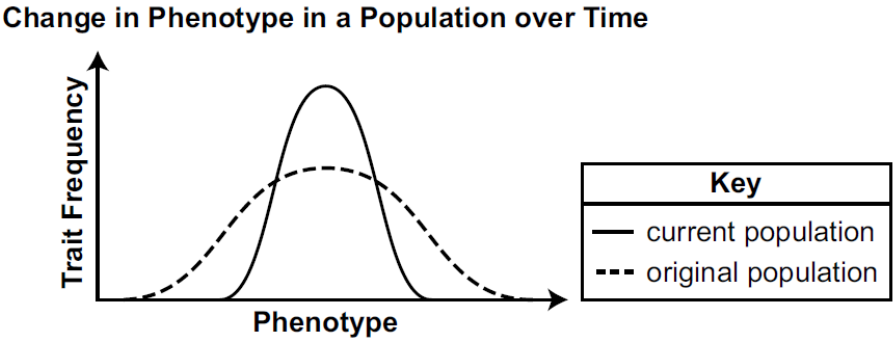
A. Fraternal twins have access to fewer foods than identical twins.
B. Fraternal twins are exposed to more infections than identical twins.
C. Fraternal twins share fewer genes with each other than identical twins do.
D. Fraternal twins share more genes influenced by the environment than identical twins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

3.1.9-12.R: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

1. In rabbits, the allele for brown fur is dominant and the allele for white fur is recessive. A rabbit that is homozygous dominant for brown fur mates with a rabbit that is heterozygous. What is the probability that any one offspring will have white fur?

A. 0 percent
B. 25 percent
C. 50 percent
D. 75 percent

Use the graph below to answer the question.



2. The graph represents a change in phenotype distribution for a population in an ecosystem over time. Which statement is supported by the graph?

A. A larger population is more stable than a smaller population is.
B. An increase in favorable conditions allows the population size to increase.
C. The ecosystem favors extreme versions of the phenotype of the organism.
D. Individuals with extreme phenotypes are less likely to survive and reproduce in the ecosystem.

3. In humans, eye color can be separated into five different color categories. The table shows how two genes, each with two alleles, code for eye color in humans.

Eye Color		Genotype
	light blue	aabb
	deep blue or green	Aabb, aaBb
	light brown	AaBb, AAbb, aaBB
	medium brown	AABb, AaBB
	dark brown or black	AABB

Part A: What is the inheritance pattern for eye color in humans?

A. polygenic
B. sex-lined
C. codominant

Part B: The Punnett square represents a cross between two individuals who are heterozygous for both genes (AaBb × AaBb).

	AB	**Ab**	**aB**	**ab**
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Based on the Punnett square, what fraction of offspring are expected to have medium brown eyes?

A. 1/16
B. 4/16
C. 6/16
D. 9/16

4. In rabbits, the allele for black fur (B) is dominant to the allele for brown fur (b). Two rabbits that have the heterozygous genotype (Bb) for fur color mate and produce a litter of offspring. What percentage of these offspring are expected to have at least one copy of the allele for black fur (B)?

A. 25%
B. 50%
C. 75%
D. 100%

The following section focuses on rock pocket mice.

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

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

Most of the habitat for rock pocket mice consists of light-colored rock called granite. However, there are several areas where the mice live that are made up of dark-colored rock called basalt. Basalt rock formed when lava

flowed over granite rock and cooled. Owls and other predators use their sense of sight to hunt rock pocket mice.

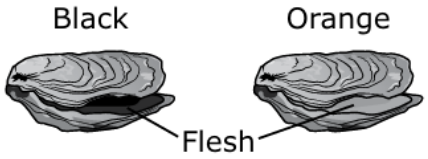
5. Fur color in rock pocket mice is primarily controlled by the Mc1r gene.

A. Two mice that are heterozygous for the Mc1r gene mate and produce offspring. Using the allele symbols D and d, create the Punnett Square for this cross.

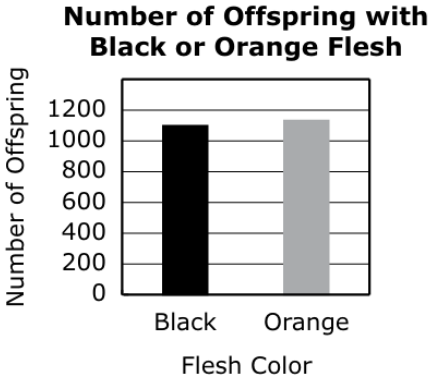
B. Based on the Punnett square, determine the percentage of offspring from this cross that are expected to have light-colored fur. Explain your answer.

C. A student claims that having genotype DD or Dd would increase the fitness of a mouse living on granite rock. Explain why this student's claim is not supported by the information provided.

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



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



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

A. Bb × bb
B. Bb × Bb
C. BB × bb
D. BB × Bb

Section 2: Interdependent Relationships in Ecosystems

3.19-12.N: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Use the drawing below to answer the question.

Kudzu Covering a Tree



without kudzu with kudzu

1. Kudzu was planted in the southeastern United States in the 1930s to reduce soil erosion. Since then, the fast-growing vine has covered plants and structures across the region. Two solutions have been suggested to control further kudzu growth.

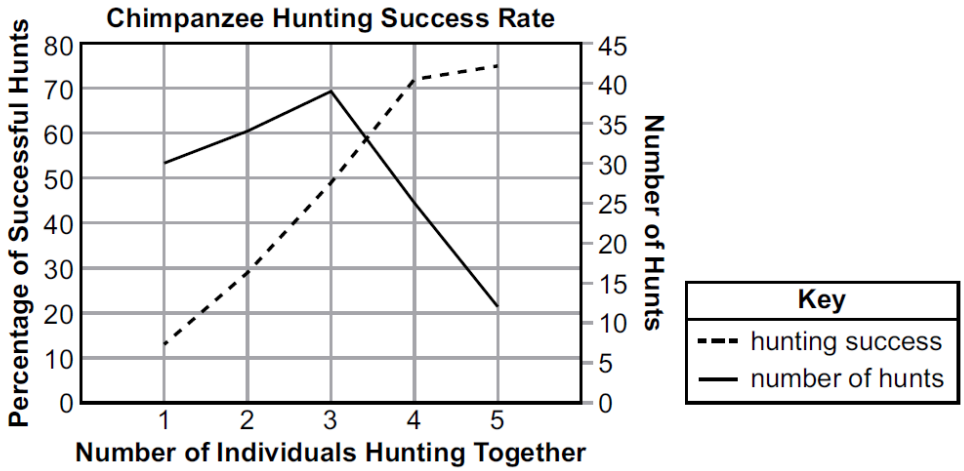
Solution 1: Cut existing kudzu vines that cover power lines and buildings. **Solution 2:** Plant other types of vines that will compete with kudzu.

Which statement best evaluates the solutions?

A. Solution 1 is limited to areas with human-made structures. Solution 2 could lead to a new type of invasive species.
B. Solution 1 is a helpful plan with no expected problems. Solution 2 could lead to a new type of invasive species.
C. Solution 1 could lead to a new type of invasive species. Solution 2 is a helpful plan with no expected problems.
D. Both are good solutions because there are no expected problems.

3.1.9-12.O: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Use the graph below to answer the question.



1. Scientists studied hunting in a population of wild chimpanzees. The data they collected are shown. Which statement is supported by the data?

A. An individual chimpanzee gains no advantage from hunting in a group.
B. A group of three hunters is the ideal number of hunters for the greatest success.
C. The larger the group of hunters, the greater the number of hunts needed to be successful.
D. Larger groups of hunters have greater success in their hunts than an individual hunter does.

2. Anglerfish may have difficulty finding a mate because the anglerfish's environment is dark, and the number of individuals in a population is relatively small. An anglerfish is a type of fish that can live in the ocean at depths of more than 1,000 meters, where there is no sunlight.

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

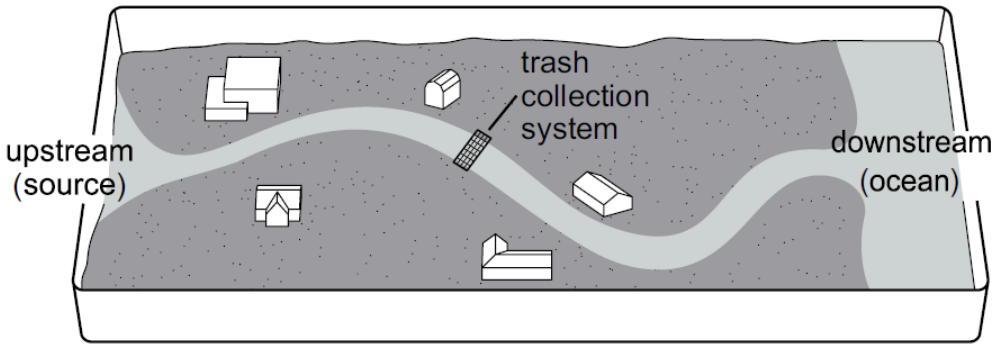
A. Explain why a male anglerfish's sense of smell is important to the male's survival in this environment.

B. Describe the evolutionary advantage of multiple males fertilizing the eggs of a female anglerfish. Explain your reasoning.

3.1.9-12.V: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Use the diagram below to answer the question.

Stream Table Model



1. Two students are designing a solution to reduce the amount of trash in local waterways. Their goal is to design a solution with the least impact on the local ecosystem. They use a stream table to create a model of their solution.

Which set of questions would best help the students evaluate the effectiveness of their solution in the actual environment?

A. A.What will the system cost to operate?
   How well can the solution allow organisms to pass through it?

B. What types of trash will the system collect?
   How much trash from the ocean will enter the stream?

C. What will the system cost to operate?
   How many pounds of trash will the system collect per minute?

D. What types of trash will the system collect?
   How well can the solution allow organisms to pass through it?

2. The blue-tailed skink is a small lizard. It was listed as extinct in the wild after its populations on a remote island experienced massive declines. The reasons for the population declines were unknown, but they were suspected to be related to an invasive predator species (a centipede) that was introduced to the island by humans. The centipedes are still present on the island.

Scientists developed a breeding program to keep the skink from extinction. Before introducing the blue-tailed skinks back into the wild, scientists conducted a simulation with small numbers of the organisms. The tables summarize the conditions tested and the results of the simulation.

Results of Small-Group Simulation

Condition Tested	Skink Survival after 3 Months
no centipedes	93%
low density of centipedes	63%
high density of centipedes	49%

Average Skink Overall Health at Start and End of Simulation

Condition Tested	0 Months	12 Months
no centipedes	healthy	healthy
low density of centipedes	healthy	unhealthy
high density of centipedes	healthy	unhealthy

Part A: Identify a likely reason why the scientists first conducted a small-scale simulation instead of directly introducing the blue-tailed skink into the wild.

Part B: Predict the likely outcome for reintroducing blue-tailed skinks to their native island. Support your answer with evidence from the simulation.

Part C: Describe the long-term genetic benefit to introducing blue-tailed skinks from a zoo population to a habitat with wild blue-tailed skinks.

Section 3: Natural Selection and Evolution

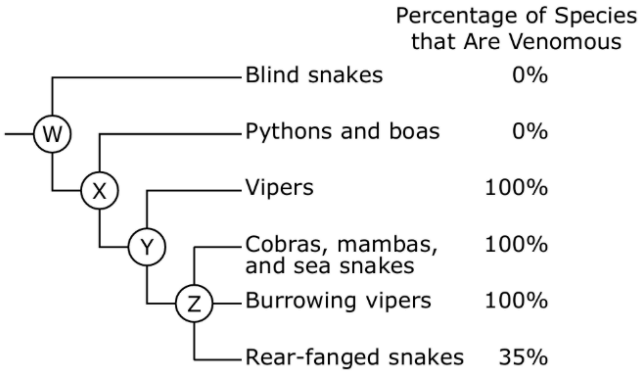
3.1.9-12.S: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

1. Rabbits, hares, and pikas are known to be related species, but their exact relatedness has been debated by scientists. Scientists have used molecular DNA evidence to propose two different cladograms that show the relationships between the species.

Which additional characteristic should be compared so scientists can better understand the common ancestry of these species?

A. their skull shapes
B. their fur colors
C. their habitats
D. their diets

Some species of snakes can produce a toxin known as venom. Scientists have identified specific genes responsible for producing venom. The cladogram shows groups of snakes and the percentage of venomous species in each group.



2. Which of the following locations on the cladogram shows where the ability to produce venom most likely originated?

A. location W
B. location X
C. location Y
D. location Z

3. Which of the following will best help a scientist determine if a sample of soil contains the remains of organisms?

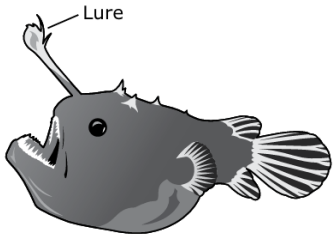
A. the amount of water in the soil sample
B. the ages of the rocks in the soil sample
C. the types of elements in the soil sample
D. the number of minerals in the soil sample

4. A diverse group of organisms, including insects and mammals, have proteins with almost identical amino acid sequences. These proteins are involved in eye development. Which of the following conclusions is best supported by this information?

A. The organisms in the group have eyes that are the same size.
B. The organisms in the group have similar numbers of chromosomes.
C. The organisms in the group are descended from a common ancestor.
D. The organisms in the group interpret sensory information in the same way.

The following section focuses on deep-sea anglerfish. Read the information below and use it to answer the selected-response questions and constructed-response question that follow.

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

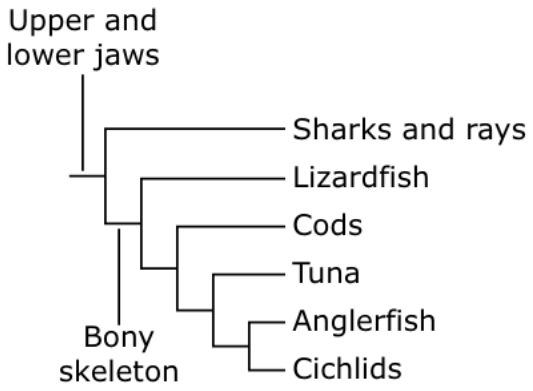


A female anglerfish uses the light from the lure to attract prey and mates. Bacteria in the lure generate the light. To speed up the chemical reaction that produces the light, the bacteria produce an organic molecule called luciferase. Male anglerfish are much smaller than females.

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

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

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



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

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

7. Which of the following provides the best evidence that the female anglerfish and the bacteria in its lure have a mutualistic relationship?

A. The anglerfish consumes the bacteria for nutrients.
B. The bacteria and the anglerfish use the same resources for nutrients.
C. The bacteria use nutrients from the anglerfish, but the anglerfish does not benefit from the bacteria.
D. The anglerfish provides nutrients to the bacteria, and the bacteria produce light needed by the anglerfish.

3.1.9-12.T: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

1. Scientists estimated how quickly a species of bacteria could adapt to an environmental change. Select the **two** pieces of information about the species of bacteria that most helped the scientists estimate how quickly the bacteria could adapt.

A. mutation rate
B. size of ribosome
C. immigration rate
D. structure of DNA
E. speed of reproduction

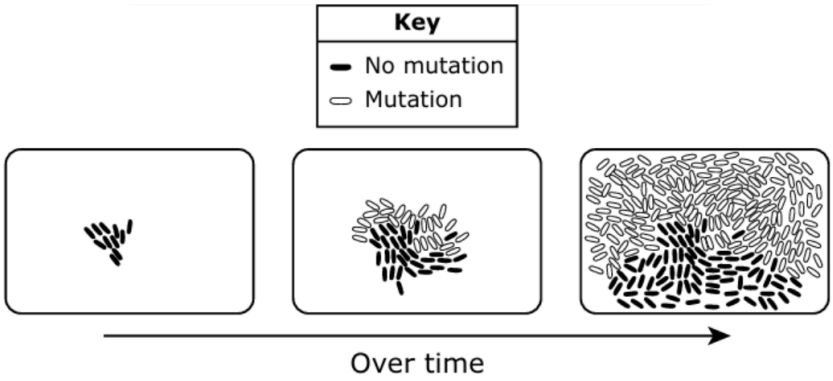
2. Two species of birds, the pied flycatcher and the collared flycatcher, are found in eastern and central Europe. In areas where the birds are geographically isolated from each other, the two species have similar color patterns. In areas where the birds' ranges overlap, each species has a different color pattern. In the overlapping areas, the birds usually mate with birds of their own species. Occasionally the two species mate with each other, but these offspring are usually not fertile. Which of the following best explains why natural selection would favor different color patterns in areas where the two flycatcher species overlap?

A. The different color patterns help the birds avoid predators.
B. The different color patterns help the birds eat a healthy, varied diet.
C. The different color patterns help increase the amount of heat the birds absorb.
D. The different color patterns help increase the reproductive success of the birds.

3. DDT is an insecticide, a chemical that kills insects. When DDT was first introduced, it killed most of the mosquitoes that transmit the disease malaria. However, DDT is no longer effective against most mosquitoes. Which of the following best explains why DDT is no longer effective against most mosquitoes?

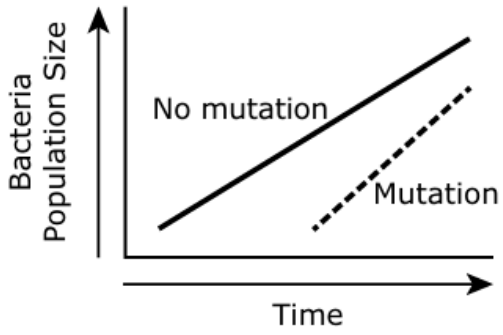
A. Genetic mutations caused by DDT gave all exposed mosquitoes resistance.
B. Climate change increased the population of mosquitoes that transmit malaria.
C. Crossing over produced a new species of mosquito with a different number of chromosomes.
D. Natural selection increased the frequency of the allele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

4. The diagrams show a change in a population of bacteria over time. A mutation is introduced into the population. The key shows bacteria with and without the mutation. Natural selection is occurring in the population.

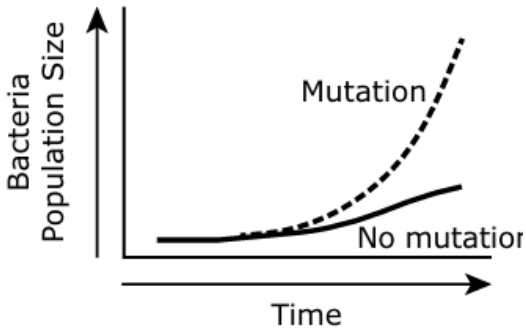


Part A: Which of the following graphs best represents the change in the population of bacteria from the beginning to the end of the diagrams?

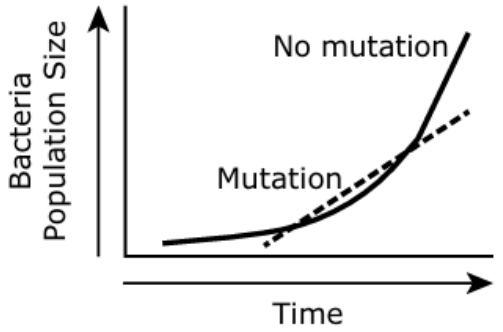
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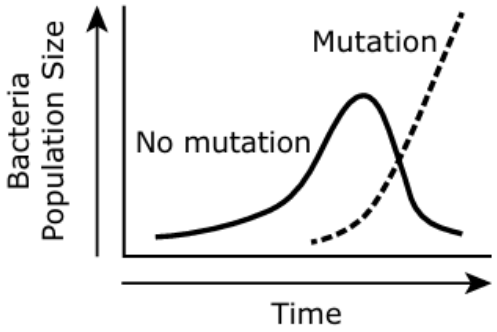
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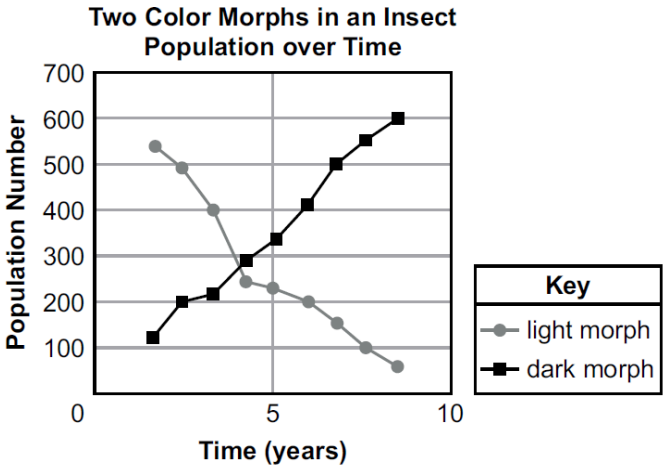


Part B: Which of the following best explains the difference in the numbers of bacteria with and without the mutation in the last diagram?

A. The bacteria with the mutation move faster than the bacteria without the mutation.
B. The bacteria with the mutation infect host cells more rapidly than the bacteria without the mutation.
C. The bacteria with the mutation have a reproductive advantage over the bacteria without the mutation.
D. The bacteria with the mutation have double the number of genes as the bacteria without the mutation.

3.1.9-12.U: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

Use the graph below to answer the question.



1. A certain type of insect can be either a light morph or a dark morph. The graph shows the numbers of light-morph insects and dark-morph insects in a population for an area over time. Which explanation is best supported by the graph?

A. The light morph was a harmful trait, so the light-morph insects changed over time to become the dark-morph insects.
B. The environmental conditions initially favored the light morph, but over time the dark morph was a more advantageous trait.
C. The dark morph did not provide individual insects with an advantage, so that trait was less likely to be passed on to offspring.
D. The dark-morph insects were eaten by predators more often than the light-morph insects, so the light morph became more common in the population.

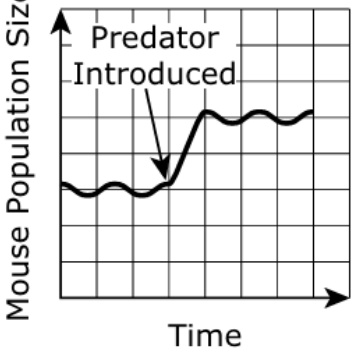
2. Predation of rock pocket mice plays a role in their population sizes.

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

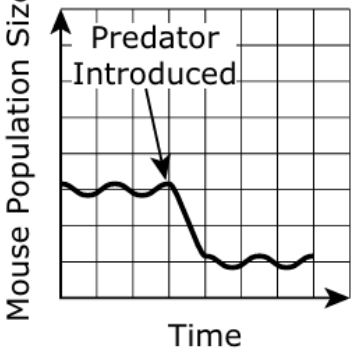
A. Mice with dark-colored fur have fewer offspring on basalt rock.
B. Mice with dark-colored fur have decreased fitness on basalt rock.
C. Mice with light-colored fur are more likely to survive and reproduce on granite rock.
D. Mice with light-colored fur are more likely to mate with mice with dark-colored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

Part B: A new predator that hunts rock pocket mice moves into site 3. Which of the following graphs shows what will most likely happen to the rock pocket mouse population size at site 3 after 40 generations?

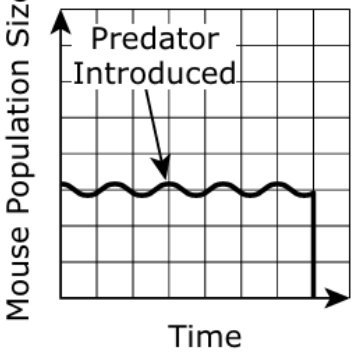
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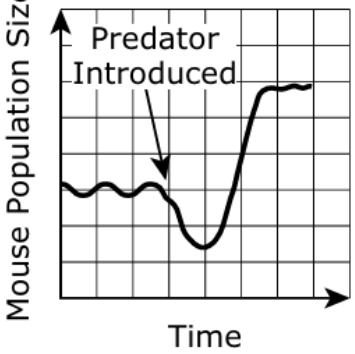
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3.1.9-12.W: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

1. Many species of fish and other aquatic animals have darker coloration on their top side and lighter coloration on their underside. This phenomenon is called countershading, and it occurs in oceans and bodies of fresh water. Which statement best explains this phenomenon?

A. The common ancestor of all fish had this color pattern.
B. Sediment tends to fall onto the tops of aquatic animals, making them darker on top.
C. This color pattern provides camouflage and is favored by natural selection in many species.
D. The tops of aquatic animals receive more sunlight than the undersides do, so the tops become darker.

2. Yarrow plants are flowering plants that grow in the Sierra Nevada Mountains in California. The average height of the yarrow plant decreases as the elevation increases.

A. Identify two environmental factors that vary by location on a mountain and could result in yarrow plants having different heights.

B. Scientists conducted an investigation to determine if the height of yarrow plants is genetically determined. The scientists collected five sets of seeds from yarrow plant populations living at different elevations and planted the seeds in a garden at an elevation of 100 m. The plants received the same amount of water and sunlight. After several weeks, the scientists measured the plants and calculated the average height of the plants in each set. The data are shown in the table.

Seed Set	Elevation Where Seeds Were Collected (m)	Average Height of Plants in Garden (cm)
1	1,100	80
2	1,800	55
3	2,200	40
4	2,700	25
5	3,200	20

Does genetics play a role in determining the height of the yarrow plants in the garden? Describe evidence from the investigation to support your answer.

C. Identify the process that resulted in yarrow plant populations adapting to different elevations.

D. Describe an investigation scientists can perform to determine whether two populations of yarrow plants growing at different elevations are the same species.

3.1.9-12.X: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

1. Scientists studied a plant species growing in two types of soil: soil polluted by heavy metals and unpolluted soil. They found some genetic variations that were more common in the plants living in polluted soil. Which statement best explains how the pollution impacted the genetic diversity within the plant species?

A. The pollution caused all individual plants to have the same genes.
B. The pollution affected which individual plants survive and successfully reproduce.
C. The pollution was absorbed by an individual plant's roots and transferred to its cells.
D. The pollution caused individual plants to choose a stronger gene variation to increase survival.

2. Which of the following events most likely led to speciation as a result of geographic isolation?

A. Several primates dispersed from a mainland population to an island off the coast.
B. A species of beetle expanded its habitat range as the range of its host tree increased.
C. A species of fox living in a woodland habitat evolved a variety of fur colors over time.
D. Several birds migrated south for the winter and then flew north for the summer.

The following section focuses on rock pocket mice.

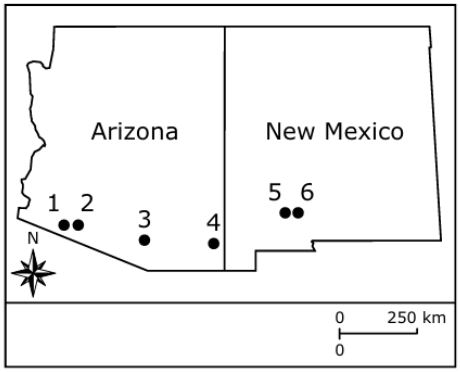
Read the information below and use it to answer the selected-response questions and constructed-response question that follow.

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

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

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

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



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

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

3. The pigment eumelanin contains the elements hydrogen and oxygen. What other two elements make up eumelanin?

A. iron and nitrogen
B. carbon and nickel
C. carbon and nitrogen
D. calcium and potassium

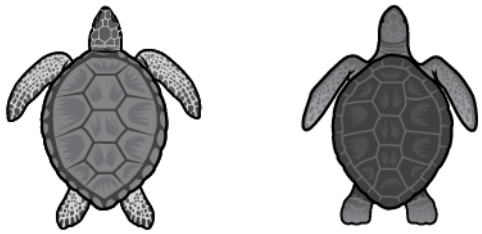
4. Researchers want to determine whether the mice at site 5 have become a different species from the mice at site 6. An investigation designed to answer which of the following questions would best help researchers determine whether the mice at these two sites have become different species?

A. Do the mice at sites 5 and 6 eat the same types of food?
B. Do the mice at sites 5 and 6 have similar population sizes?
C. Do the mice at sites 5 and 6 interbreed and produce fertile offspring?
D. Do the mice at sites 5 and 6 spend more time underground or above ground?

5. Scientists think that fur color in mice evolved through natural selection. Which of the following would have been necessary for natural selection to occur?

A. variation in the alleles for fur color in mice
B. migration of mice with different fur colors
C. identical genetic sequences in mice
D. small populations of mice

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



Green sea turtle Black sea turtle

A. A scientist wonders whether the black color in this sea turtle population is a result of natural selection. Write a testable question that scientists could answer to determine whether natural selection plays a role in the black sea turtle's color.

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

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

D. Other scientists think that green sea turtles and black sea turtles may become separate species because they are geographically isolated from each other. Explain how geographically isolating a small group of turtles from a larger population of turtles can lead to the two populations becoming separate species.