

Bio- logy

for AP[®] Courses

Advanced Placement[®] and AP[®] are trademarks registered and/or owned by the College Board, which was not involved in the production of, and does not endorse, this product.

Table of Contents – Part 2

| | |
|---------------------------------------------------------|------------|
| 35 Ecology and the Biosphere | 733 |
| Review Questions | 733 |
| Critical Thinking Questions | 741 |
| Test Prep for AP® Courses | 751 |
| Science Practice Challenge Questions | 755 |
| 36 Population and Community Ecology..... | 758 |
| Review Questions | 758 |
| Critical Thinking Questions | 771 |
| Test Prep for AP® Courses | 787 |
| Science Practice Challenge Questions | 809 |
| 37 Ecosystems..... | 813 |
| Review Questions | 813 |
| Critical Thinking Questions | 817 |
| Test Prep for AP® Courses | 821 |
| Science Practice Challenge Questions | 828 |
| 38 Conservation Biology and Biodiversity | 829 |
| Review Questions | 829 |
| Critical Thinking Questions | 835 |
| Test Prep for AP® Courses | 841 |

35 | ECOLOGY AND THE BIOSPHERE

REVIEW QUESTIONS

- 1 C, H, O, and N are nutrients that cycle through Earth in different forms. Which level of ecology includes the study of nutrient cycling through the environment?
- A Organismal ecology
 - B Population ecology
 - C Community ecology
 - D Ecosystem ecology

Solution The solution is (D). Ecosystem ecology is the study of interactions of abiotic (nutrient cycling) and biotic factors.

- 2 What is arranged from least inclusive to most inclusive?
- A Population > ecosystem > community > biosphere
 - B Ecosystem < population < biosphere < community
 - C Biosphere < ecosystem < community < population
 - D Population < community < ecosystem < biosphere
- 3 An ecologist is studying the ways that patterns on the wings of an endangered butterfly species allow it to escape predators such as birds. This is an example of —
- A mimicry
 - B organismal ecology
 - C mutualism
 - D community ecology

Solution The solution is (B). Organismal ecology is a study of a particular type of organism, such as the butterfly in this case.

- 4 Each year, Lake Michigan beach visitors are warned of possible exposure to *E. coli*, which can cause illness. To understand how both biotic and abiotic environmental conditions affect the risk of *E. coli* abundance, which type of individual should an infectious disease specialist collaborate with?
- A An ecosystem ecologist
 - B A podiatrist
 - C A community ecologist
 - D A population ecologist

- 5 Some bacterial species can use nitrogen directly from the atmosphere. In their ecosystem, the bacteria are a(n) —
- A biotic factor
 - B abiotic factor
 - C infectious factor
 - D symbiotic partner

Solution The solution is (A). Bacterial species are living, so they are biotic factors.

- 6 Photosynthetic organisms are important to most ecosystems because they —
- A synthesize organic compounds that they obtain from decaying heterotrophs
 - B can use carbon dioxide and sunlight and synthesize their own food
 - C use wind energy to synthesize organic compounds
 - D synthesize inorganic compounds from organic compounds

- 7 What does study of population ecology focus on?
- A The number of individuals of one species in an area and how and why that number changes over time
 - B The processes driving interactions within and among different species within an area
 - C The adaptations that enable individuals to live in specific habitats
 - D Plants and animals living in an enclosed area

Solution The solution is (A). Population ecology focuses on a population, a group of interbreeding organisms living in the same area at the same time.

- 8 The study of the effect of abiotic factors such as rain and temperature on the distribution of living organisms is known as —
- A community ecology
 - B biogeography
 - C ecosystem
 - D geography
- 9 Individuals within a single species of pine tree are often found in different geographical locations in North America and Canada. Why?
- A They were not separated geographically over millions of years and did not evolve to become different species.
 - B Plant breeders carried seeds to different areas.
 - C Pollen from pine trees traveled to distant locations.
 - D Pine tree species were present widely and died out in some areas.

Solution The solution is (A). Pine trees were not separated geographically and did not evolve to be different species.

- 10** An ecologist hiking up a mountain may notice different biomes along the way due to changes in all of the following except —
- A** elevation
 - B** rainfall
 - C** latitude
 - D** temperature
- 11** Temperate forests have plants of varying sizes. In this particular environment, understory plants in a temperate forest are notable for adaptations to capture limited —
- A** water
 - B** nutrients
 - C** heat
 - D** sunlight

Solution The solution is (D). Sunlight is a limiting factor because understory plants are covered with a canopy.

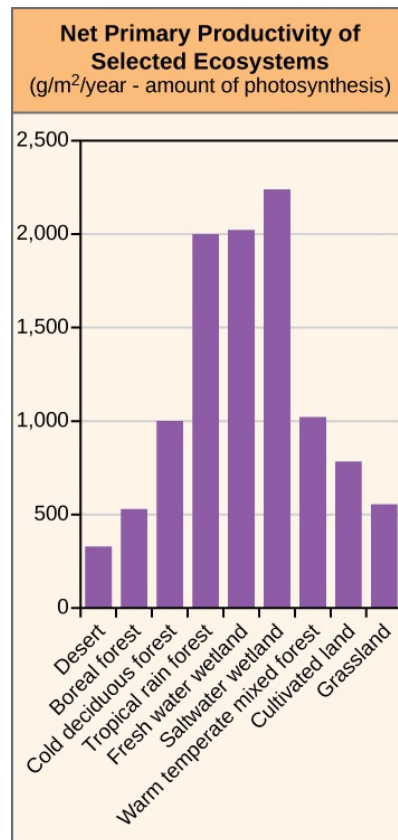
- 12** Which body of water lacks temperature stratification?
- A** Estuaries
 - B** Lakes
 - C** Seas
 - D** Oceans
- 13** Plants living in deserts have adaptations such as hair on their leaves and a thick cuticle. What purpose do these adaptations serve?
- A** To conserve water
 - B** To prevent exposure to sunlight
 - C** To increase oxygen intake
 - D** To decrease carbon dioxide intake

Solution The solution is (A). The cuticle and hair help to prevent water loss.

- 14** Which biome would have the highest net primary production?
- A** Deciduous forests
 - B** Deserts
 - C** Arctic tundra

D Savannas

- 15 When the net primary productivity was measured in the presented graph, what was included in those measurements?



- A Above and underground biomass are included in net primary productivity
- B Net primary productivity is the total amount of carbon fixed
- C Net primary productivity is the amount of carbon fixed minus the amount used during cellular respiration, including only the aboveground biomass in terrestrial biomes
- D Net primary productivity refers to the amount of total amount of carbon fixed

Solution The solution is (C). Net primary productivity is the amount of carbon fixed minus the amount used during cellular respiration and includes only the aboveground biomass in terrestrial biomes.

- 16 Biogeography is the study of the geographic distribution of living things as well as the _____ that affect their distribution.
- A Abiotic factors
- B Biotic factors
- C Biomes
- D Conspicifics

- 17** In which biome are plants unable to grow because the soil is frozen most of the year?
- A** Arctic tundra
 - B** Boreal forests
 - C** Grasslands
 - D** Chaparrals

Solution The solution is (A). Soil frozen is frozen in the Arctic tundra due to low temperatures year-round.

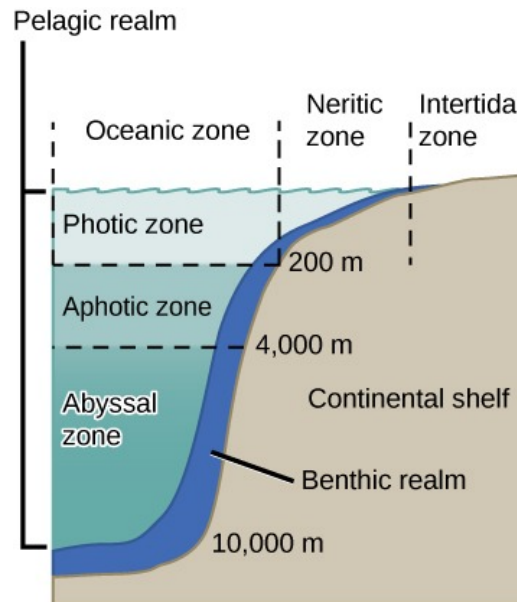
- 18** In grasslands, fires are a common occurrence. Which statement regarding grasslands is true?
- A** They have the ability to withstand fires.
 - B** They have a well-developed root system, which allows them to regrow after a fire.
 - C** Grasses are tall and only their top portions are destroyed.
 - D** Trees shield some of the grass, thus protecting it from fire.
- 19** Savannas are grasslands with scattered trees. Which statement is correct about savannas?
- A** They receive abundant rainfall.
 - B** The temperatures are cold throughout the year.
 - C** They have relatively long dry seasons.
 - D** Savannas are dominated by fluctuations in temperature.

Solution The solution is (C). Savannas have long dry seasons between rains, which do not allow trees to grow well.

- 20** The boreal forest, also known as taiga or coniferous forest, is found south of the Arctic Circle and across most of Canada, Alaska, Russia, and northern Europe. What is a characteristic of the boreal forest?
- A** High temperature
 - B** Deciduous trees
 - C** High humidity
 - D** Acidic soil
- 21** The amount of sunlight and rainfall affects the growing season of plants in different biomes. Which biome is characterized by short growing seasons?
- A** Savanna
 - B** Temperate grasslands
 - C** Arctic tundra
 - D** Tropical wet forest

Solution The solution is (C). Plants growing in the Arctic tundra have a 10- to 12-wk growing period in which they get nearly 24 h of sunlight each day.

22 The figure shows different zones present in the ocean.



Which statement about marine biomes is true?

- A The benthic zone includes the ocean's open water and shore.
 - B The pelagic realm includes all of the ocean's open water.
 - C The majority of the ocean includes the photic zone.
 - D The deepest zone of the ocean is known as the aphotic zone.
- 23** Corals have a mutualistic relationship with photosynthetic algae in the photic zones of water. What purpose does this serve?
- A Corals are able to derive their nutrition from the algae and thus survive in the nutritionally poor water.
 - B Corals are able to accumulate calcium carbonate from the algae.
 - C Corals and algae can form coral reefs because of this association.
 - D Corals provide food to the algae.

Solution The solution is (A). Corals are able to derive their nutrition from the algae and thus survive in the nutritionally poor water.

24 Which abiotic factor is most important for sustaining life in marine biomes?

- A Wind
- B Soil
- C Salt

D Warmth

25 There are several different marine zones. In which zone are organisms exposed to air and sunlight at low tide but are underwater most of the time, especially during high tide?

A Intertidal zone

B Neritic zone

C Oceanic zone

D Abyssal zone

Solution The solution is (A). It occurs in the intertidal zone, closest to the shore.

26 Which group of photosynthetic organisms is more likely to grow in a lake as opposed to a river?

A Fungi

B Phytoplankton

C Moss

D Lichens

27 Water flow can vary in wetlands. Freshwater marshes and swamps are characterized by —

A Dry soil

B Rapid water flow

C Slow water flow

D Irregular water flow

Solution The solution is (C). Freshwater swamps and marshes have slow and steady water flow.

28 Water bodies can differ in the amount of salt present. What is a characteristic of an estuary?

A A continuous body of water with high salinity

B An area where the salinity varies

C A body of water with low salinity

D A body of water with low salt entering land

29 Earth's geological past has witnessed many important events. Which period was associated with global warming?

A Permian period

B Cambrian period

C 2nd and 3rd centuries B.C.

D 20th century

Solution The solution is (A). The Permian period showed a rise in global temperature, leading to mass extinctions.

30 What is one of the indirect consequences of global warming?

A Loss of biodiversity

B Increase in temperature

C Change in water quality

D Increase in the temperature tolerance of plants

31 Which fuel was used extensively during the Industrial Revolution, leading to increases in levels of carbon dioxide?

A Coal

B Petroleum

C Natural gas

D Solar energy

Solution The solution is (A). Coal was used extensively during the Industrial Revolution and produced carbon dioxide.

32 Global warming is due to many factors. What is known to change with carbon dioxide concentration?

A Solar intensity

B Wind intensity

C Temperature

D Humidity

33 All of the following are natural factors that have led to slow increases in global temperatures except —

A volcanic eruptions

B change in solar intensity

C earthquakes

D changes in Earth's orbit

Solution The solution is (C). Earthquakes do not cause long-term changes in global climate.

34 Global temperatures have been steadily increasing since the Industrial Revolution largely as a result of —

A agricultural production

B burning fossil fuels

- C increase in the movement of people
- D use of pesticides

35 Which gas is NOT considered a significant contributor to global warming?

- A Carbon dioxide
- B Methane
- C Nitric oxide
- D Oxygen

Solution The solution is (D). Oxygen is not a greenhouse gas.

36 Carbon dioxide, methane, and nitrous oxide are considered greenhouse gases because —

- A they trap solar radiation released from the sun in its entirety as it reaches Earth's surface, similar to the glass in a greenhouse
- B they are found mostly in greenhouses
- C they are essential for plant growth in a greenhouse
- D they trap solar radiation, which is converted into thermal radiation on Earth's surface, some of which is reradiated back into the atmosphere

37 The Medieval Climate Anomaly occurred between A.D. 900 and 1300. Temperatures during this time were between 0.10 and 0.20 higher, which allowed —

- A the Vikings to colonize Greenland
- B the rapid development of new technologies
- C advances in agriculture
- D harsh winters

Solution The solution is (A). The slightly higher temperatures freed seas of ice and allowed the Vikings to sail to Greenland to colonize.

CRITICAL THINKING QUESTIONS

38 What is community ecology? Give an example.

- A It is the study of the number of individuals of one species in an area as well as how and why the number changes over time. An example would be counting the number of individual Karner blue butterflies, a federally endangered species whose population density is highly influenced by the abundance of wild lupine.
- B It is the study of the processes and consequences of interactions within and among different species within an area. An example would be the work of scientists who study the various interactions of several populations of birds, crabs, and grasses in a marsh without studying the water or air quality.

- C** It is the study of the physiological, morphological, and behavioral adaptations that enable individuals to live in specific habitats. An example would be the work of scientists who study the various interactions of several populations of birds, crabs, and grasses in a marsh without studying the water or air quality.
- D** It is the study of the processes and consequences of interactions within and among different species within an area. An example would be counting the number of Karner blue butterflies, a federally endangered species whose population density is highly influenced by the abundance of wild lupine.

39 Ecologists often collaborate with other researchers interested in ecological questions. Which levels of ecology would most easily lend to collaborative research because of the similarities in the scope of questions asked?

- A** It is easier to study community and ecosystem ecology as the effect of biotic and abiotic factors can be studied in a community or ecosystem more easily. Organismal and population ecology might be more difficult for collaboration.
- B** It is easier to study organismal and population ecology as the effect of biotic and abiotic factors can be studied in an organism or population more easily. Community and ecosystem ecology might be more difficult for collaboration.
- C** It is easier to study community and population ecology as the effect of biotic and abiotic factors can be studied in easily in a community or population more easily. Organismal and ecosystem ecology might be more difficult for collaboration.
- D** It is easier to study organismal and ecosystem ecology as the effect of biotic and abiotic factors can be studied in an organism or ecosystem more easily. Community and population ecology might be more difficult for collaboration.

Solution The solution is (A). Community and ecosystem ecology are neighboring ecological levels. Therefore, the scope of the questions asked by two researchers collaborating in these areas would be closer than any of the other pairs of levels in the answer choices.

40 How do organisms return nutrients and water to the environment?

- A** By cycling between the abiotic and biotic environment
- B** By cycling between evaporation and transpiration
- C** By cycling between the flora and fauna of the Earth
- D** By cycling between temperature and moisture

41 What are organismal, population, and community ecology? Give an example of each.

- A** Organismal ecology includes the study of the number of individuals in an area as well as how and why population size changes over time, such as a study of the drop in antelope population. Population ecology includes the study of adaptations that enable individuals to live in specific habitats, such as a study of the use of opposable thumbs. Community ecology includes the study of the processes and consequences of

interactions within and among different species in an area, such as a study of interactions between wolves and deer.

- B** Organismal ecology includes the study of the processes and consequences of interactions within and among different species in an area, such as a study of the interactions between wolves and deer. Population ecology includes the study of the number of individuals in an area as well as how and why population size changes over time, such as a study of the drop in antelope population. Community ecology includes the study of adaptations that enable individuals to live in specific habitats, such as a study of the use of opposable thumbs.
- C** Organismal ecology includes the study of adaptations that enable individuals to live in specific habitats, such as a study of the use of opposable thumbs. Population ecology includes the study of the number of individuals in an area as well as how and why population size changes over time, such as a study of the drop in antelope population. Community ecology includes studies of the processes and consequences of interactions within and among different species in an area, such as a study of the interactions between wolves and deer.
- D** Organismal ecology includes studies of the adaptations that enable individuals to live in specific habitats, such as a study of the use of opposable thumbs. Population ecology includes studies of the processes and consequences of interactions within and among different species in an area, such as a study of the interactions between wolves and deer. Community ecology includes studies of the number of individuals in an area as well as how and why population size changes over time, such as a study of the drop in antelope population.

Solution The solution is (C). Organismal ecology emphasizes the adaptations that enable individuals to live in specific habitats. These adaptations can be morphological, like opposable thumbs. Population ecology focuses on a population, a group of interbreeding organisms living in the same area at the same time. The interest lies in the number of individuals in an area as well as how and why population size changes over time. An example would be how ecologists are trying to figure out the dramatic drop in the antelope population. Community ecology focuses on the processes driving interactions within and among different species within an area. For example, a community ecologist would be interested in the interactions between wolves and deer.

- 42** Many endemic species are found in areas that are geographically isolated. Which option is a plausible scientific explanation why this is so?
- A** Geographically isolated areas are usually warmer than other areas, and high temperatures promote rapid mutation and development of unique characteristics compared with cooler temperatures. Over time, these species retain their unique characteristics because they remain separated from other species.

- B** Geographically isolated areas have provided a unique environment for certain species to evolve. Over time, these species retain their unique characteristics because they remain separated from other species.
 - C** Certain species are introduced into some geographically isolated areas that provide them unique environments. Over time, these species retain their unique characteristics because they remain separated from other species.
 - D** A unique environment is provided for certain species to evolve in vitro, and these species are introduced into geographically isolated areas. Over time, these species retain their unique characteristics because they remain separated from other species.
- 43** The American white pelican migrates from North America to Central America in the winter months. Why do these birds follow an annual migration pattern?
- A** The American white pelican follows an annual migration pattern in search of cooler climates. Cooler climates make it easier for them to maintain a constant body temperature than if they stayed somewhere warm.
 - B** The American white pelican follows an annual migration pattern in search of food, saltwater, and cooler climates. Cooler climates help these birds reproduce.
 - C** The American white pelican follows an annual migration pattern in search of food and warmer climates. Warmer climates and greater food availability make it easier to maintain a constant body temperature than if they stayed somewhere cold.
 - D** The American white pelican follows an annual migration pattern in search of food only. Warmer climates have greater food availability, and pelicans can maintain their body temperature equally easily in cold versus warm temperatures.

Solution The solution is (C). Many birds such as the American white pelican follow an annual migration pattern in search of food and warmer climates. Moving to warmer climates that also have greater food availability makes it easier for them to maintain their body temperature than if they had stayed somewhere cold.

- 44** Why is it essential for organisms to maintain a relatively constant body temperature? Describe adaptations that help the organisms cope with changes in environmental temperature.
- A** The rate of metabolic processes increases at very high or low temperatures. So, organisms have to maintain a constant body temperature. This can be achieved only by migration to avoid seasonal temperature changes.
 - B** Enzymes that carry out metabolic processes are denatured at very high temperatures and work more slowly at lower temperatures. So, organisms have to maintain a constant body temperature. This can be achieved by hibernation, aestivation, or migration.
 - C** The rate of metabolic processes increases at very high or low temperatures. So, organisms have to maintain a constant body temperature. This can be achieved by hibernation, aestivation, or migration.

- D** Enzymes that carry out metabolic processes are denatured at very high temperatures. So, organisms have to maintain a constant body temperature. This can be achieved only by migration to avoid seasonal temperature changes.
- 45** The extremely low precipitation of subtropical desert biomes might lead one to expect fire to be a major disturbance factor. However, fire is more common in the temperate grassland biome than in the subtropical desert biome. Why is this?
- A** Due to higher net primary productivity, biomass in deserts is significantly more than in temperate grassland biomes. However, it is easier for fire to spread in grasslands as biomass is abundant.
- B** Due to lower net primary productivity, biomass in deserts is significantly less than in temperate grassland biomes. It is easier for fire to spread in grasslands as biomass is abundant.
- C** Due to lower net primary productivity, biomass in deserts is significantly less than in temperate grassland biomes. It is easier for fire to spread in grasslands as they have very low precipitation and high temperatures.
- D** Due to higher net primary productivity, biomass in deserts is significantly more than in temperate grassland biomes. However, it is easier for fire to spread in grasslands as they have very low precipitation and high temperatures.

Solution The solution is (B). Even though deserts have very low precipitation and high temperatures, the biomass in deserts is significantly less than in temperate grassland biomes because of lower net primary productivity. It is easier for fire to spread in grasslands as biomass is abundant.

- 46** What are endemic species? Give an example and explain how endemic species differ from generalist species.
- A** Endemic species are found naturally in specific geographic areas that are usually restricted in size. For example, the raccoon is found only in Australia. Generalist species are found in a wide range of geographical locations. For example, the koala is native to most of North and Central America.
- B** Endemic species are defined as those that are likely to be extinct. For example, the Tasmanian tiger (a marsupial) was found only in Australia but became extinct. Generalist species are those found in a wide range of geographical locations and are less likely to become extinct. For example, the raccoon is native to most of North and Central America and is not endangered.
- C** Endemic species are found in a wide range of geographical locations. For example, the raccoon is native to most of North and Central America. Generalist species are found naturally in specific geographic areas that are usually restricted in size. For example, the koala is only found in some regions of Australia.
- D** Endemic species are found naturally in specific geographic areas that are usually restricted in size. For example, the koala (a marsupial) is found only in some regions in

Australia. Generalist species are found in a wide range of geographical locations. For example, the raccoon is native to most of North and Central America.

- 47** Deserts and subtropical deserts experience low precipitation and extremes in temperature. For plants to survive and reproduce, what adaptations should they have? Why?
- A** To survive, they need prop roots, reduced foliage, and fleshy leaves with sunken stomata to reduce transpiration. Also, they should have seeds that can remain dormant over long periods.
 - B** To survive, they need deep roots, reduced foliage, and fleshy leaves with sunken stomata to reduce transpiration. Also, they should have seeds that can remain dormant over long periods.
 - C** To survive, they need deep roots, reduced foliage, and fleshy leaves with sunken stomata to reduce transpiration. Also, these plants need to grow in clumps.
 - D** To survive, they need deep roots, increased foliage, and fleshy leaves with sunken stomata to reduce transpiration. Also, the plants need seeds that can remain dormant over long periods.

Solution The solution is (B). Plants growing in deserts have deep roots, reduced foliage to reduce transpiration, and seeds that can remain dormant over long periods. In addition, these plants should have fleshy leaves with sunken stomata to avoid transpiration.

- 48** In what ways are the subtropical desert and the Arctic tundra similar?
- A** Both are characterized by animals that are adapted to burrowing.
 - B** Both are characterized by plants that prefer to grow in clumps.
 - C** Both are characterized by low water availability and, as a result, low net primary productivity.
 - D** Both are characterized by plants that are mostly perennials.
- 49** Describe the chaparral biome. How does it differ from subtropical deserts?
- A** Shrubs dominate chaparral vegetation and are well adapted to the periodic fires in the area. Ashes left behind after fires are rich in nutrients, which promote regrowth. Subtropical deserts are characterized by their high precipitation and water-retaining plants.
 - B** Shrubs dominate chaparral vegetation and are well adapted to the periodic fires in the area. Ashes left behind after fires are rich in nutrients, which promote regrowth. Subtropical deserts are characterized by their low precipitation and water-retaining plants.
 - C** Lichens dominate chaparral vegetation and are well adapted to the periodic fires in the area. Ashes left behind after fires are rich in nutrients, which promote

regrowth. Subtropical deserts are characterized by their low precipitation and water-retaining plants.

- D** Shrubs dominate chaparral vegetation but are not well adapted to the periodic fires in the area. Ashes left behind after fires are rich in nutrients, which promote regrowth. Subtropical deserts are characterized by their low precipitation and water-retaining plants.

Solution The solution is (B). The chaparral is the shrub forest found in California, along the Mediterranean Sea, and along the southern coast of Australia. Shrubs dominate chaparral vegetation and are well adapted to the periodic fires that burn through the area. Some of the plants only produce seeds that germinate after they have been exposed to fire. The ashes that are left behind after a fire are rich in nutrients like nitrogen and serve as fertilizer to promote regrowth. Subtropical deserts are characterized by their low precipitation and water-retaining plants with seeds that are able to remain dormant between periods of rain.

- 50** What happens to aquatic life in deep lakes when water freezes during the winter months?
- A** During winters, a layer of ice forms on the water surface, as ice is less dense than water. Water is densest at 7 °C and retains its liquid form below the water surface. The aquatic life can exist in liquid water.
- B** During winters, the aquatic life exists in liquid water, which is present between layers of ice, by consuming more resources so they can survive during the harsh winter season.
- C** During winters, a layer of ice forms on the water surface, as ice is less dense than water. Water is densest at 4 °C and retains its liquid form below the water surface, where the ice layer is. In liquid water, the aquatic life can survive using the resources available.
- D** During winters, ice forms only on the surface and a few meters below the surface of water. Water is densest at 4 °C and retains its liquid form below the water surface, where the ice layer is. In liquid water, the aquatic life can exist using the resources available.
- 51** What are the challenges facing organisms living in the intertidal zone, and what are their adaptations to meet these challenges?
- A** They are subject to constant exposure to air, sunlight, periods of dryness, and pounding waves. For this reason, some species have an exoskeleton.
- B** They are subject to periodic exposure to air, sunlight, periods of dryness, and pounding waves. For this reason, some species have an exoskeleton.
- C** They are subject to periodic exposure to air, sunlight, periods of dryness, and pounding waves. For this reason, all species have an exoskeleton.

- D** They are subject to periodic exposure to air, sunlight, periods of dryness, and pounding waves. For this reason, most species have an endoskeleton.

Solution The solution is (B). Organisms living in the intertidal zone are subject to periodic exposure to air, sunlight, and periods of dryness. They are also exposed to the pounding waves, and some species have a protective exoskeleton.

- 52** If algae grow out of proportion as seen during algal blooms, how does this affect the ecosystem?
- A** Other photosynthetic organisms will not be able to grow. The animals and birds that live on those organisms will be affected. As the algae die, oxygen will be depleted, affecting fish and other aquatic animals. The pH of water will change, affecting metabolic processes as well.
- B** Nonphotosynthetic organisms will not be able to grow due to lack of light. The photosynthetic organisms that require them to live will be affected. As the algae die, oxygen will be depleted, affecting fish and other aquatic animals. The pH of water will change, affecting metabolic processes as well.
- C** Other photosynthetic organisms will not be able to grow. The animals and birds that live on those organisms will be affected. As the algae die, carbon dioxide will be depleted, affecting fish and other aquatic animals. The pH of water will change, affecting metabolic processes as well.
- D** Nonphotosynthetic organisms will not be able to grow. The animals and birds that live on those organisms will be affected. As the algae die, carbon dioxide will be depleted, affecting fish and other aquatic animals. The pH of water will change, affecting metabolic processes as well.
- 53** What are some abiotic factors that affect freshwater biomes? Explain.
- A** Salinity and sunlight are both abiotic factors that influence life in freshwater biomes. Because organisms living in freshwater biomes require high salt density for survival, its depletion would kill the organisms. Many organisms that serve as food for others are photosynthetic and would die if algal blooms obscured the light. Their decomposition as well as the depletion of oxygen by algae would cause organisms that require oxygen to die out as well.
- B** Salinity and sunlight are both abiotic factors that influence life in freshwater biomes. Because organisms living in freshwater biomes cannot tolerate high salt levels, these organisms would not survive if it increased. Many organisms that serve as food for others are photosynthetic and would die if algal blooms obscured the light. Their decomposition and the depletion of carbon dioxide by algae would cause organisms that require carbon dioxide to die out as well.
- C** Salinity and sunlight are both abiotic factors that influence life in freshwater biomes. Because organisms living in freshwater biomes cannot tolerate high salt levels, these organisms would not survive if it were to increase significantly. Many organisms that serve as food for others are photosynthetic and would die if algal blooms obscure

light. Their decomposition and depletion of oxygen by algae would cause organisms that require oxygen to die out as well.

- D** Salinity and temperature are both abiotic factors that influence life in freshwater biomes. Because organisms living in freshwater biomes cannot tolerate low salt concentrations, those organisms would not survive if salt concentrations fell significantly. Many organisms that serve as food for others are photosynthetic and would die if algal blooms obscured the light. Their decomposition and the depletion of oxygen by algae would cause organisms that require oxygen to die out as well.

Solution The solution is (C). Salinity and sunlight are both abiotic factors that influence life in freshwater biomes. Organisms that inhabit freshwater biomes like lakes and ponds cannot tolerate salty conditions. If salinity in those environments were to increase, the organisms would not survive the change in conditions. Sunlight greatly affects life in freshwater biomes. Many organisms that serve as food sources for others are photosynthetic, requiring exposure to sunlight. If photic zones (areas in which light can penetrate) are obstructed by, for example, algal blooms, photosynthetic and aphotic organisms will not be able to carry out their respective process and will die out. The decomposition of those organisms and the algae depletes oxygen, causing organisms that require oxygen to also die out.

- 54** Is it possible to reverse global warming? What measures may help in reducing global climate change?
- A** Because it has not yet affected ecosystems, it is possible to reverse global warming by reducing the usage of fossil fuels, using alternative fuels, using alternatives to CFCs, and using natural sources of energy.
- B** It is not possible to reverse global warming since major climate changes have already occurred and settled in the environment. Reducing fossil fuel usage, using natural sources of energy, and using alternative fuels are sufficient to slow down future global climate change.
- C** It may not be possible to reverse global warming, as we are already witnessing changes in the environment, plants, and animal behavior. However, taking multiple steps including reducing fossil fuel usage and using natural sources of energy may slow down global climate change.
- D** It is possible to reverse global warming by working on new technologies that will help in preventing temperature changes worldwide. Using wind power and high-efficiency natural gas generation will be sufficient to achieve this goal.
- 55** As global temperatures change, many flowering plants are flowering earlier. What change would most likely occur if the insect pollinators are NOT around at the same time?
- A** Insects will be deprived of their nectar, leading to decrease in numbers; but flowering plants will not be affected because other animals will pollinate them.

- B** Flowering plants will not be pollinated, resulting in a decrease in population; but insects will not be affected because they will feed on other organisms.
- C** Neither plants nor pollinators will be affected because new or different species of insects are going to pollinate the flowering plants.
- D** Both plant and pollinator numbers would decrease because insects will be deprived of nectar and plants will not be pollinated.

Solution The solution is (D). Insects will be deprived of their nectar, and flowering plants will not be pollinated, leading to a lack of seed production. Over time, both plant and pollinator numbers will be significantly affected, leading to a decrease in their numbers.

- 56** If scientists had to predict the rise in Earth's temperature in the next 100 years, what would they take into consideration?
- A** Scientists can predict the change in Earth's temperature only by analyzing previous and current data such as dimensions and locations of glaciers as well as the water levels in lakes, rivers, and oceans.
 - B** Scientists could predict a rise in Earth's temperature by analyzing previous and current data such as dimensions and locations of glaciers, water levels in lakes, rivers, and oceans, and the number of annual rings in trees.
 - C** Scientists could predict a rise in Earth's temperature by measuring the greenhouse gases present in the current atmosphere. Counting and examining the number of annual rings in trees would provide information about past temperature changes.
 - D** Scientists can predict the change in Earth's atmosphere by counting and analyzing the number of annual rings in trees. Also, analyzing ice cores for over a year would predict the rise in Earth's temperature in the next 100 years.
- 57** Many people cannot imagine a world without fossil fuels, but fossil fuels are finite resources and will eventually run out. This is why drilling had begun in the Arctic in an effort to find a new source of fossil fuels, although it is currently stopped. What are the dangers of drilling in the Arctic? What are the alternatives?
- A** Drilling as well as melting of ice in the Arctic affects organisms there and results in the release of large amounts of methane, accelerating global warming. Investing in clean energy like wind, water, and solar power, which do not release harmful gases, could be the alternative.
 - B** Drilling as well as melting of ice in the Arctic results in the release of large amounts of carbon monoxide, accelerating global warming. Investing in clean energy like wind, water, and solar power, which do not release harmful gases, could be the alternative.
 - C** Drilling as well as melting of ice in the Arctic results in the release of large amounts of carbon monoxide, which is lethal. Investing in clean energy like wind, water, and solar power, which do not release harmful gases, could be the alternative.

- D** Drilling as well as melting of ice in the Arctic results in the release of large amounts of methane, accelerating global warming. Investing in the mining of Earth minerals and metal ores could be an alternative.

Solution The solution is (A). Drilling in the Arctic poses a threat to the environment and the organisms that live in it. Though we are far removed from the Arctic, drilling there poses a threat to people, plants, and animals around the world. Global warming has already caused the melting of chunks of ice containing methane called clathrates. These clathrates release methane into the atmosphere, increasing the levels of methane, which further accelerates the rate of global warming. Drilling in the Arctic could also release large amounts of methane into the atmosphere, feeding into the positive feedback loop leading to the rapid rate of increase in global temperatures. Instead of investing in drilling for more fossil fuels, people could invest in clean energy sources such as wind, water, and solar power. These sources of energy do not release harmful gases into the atmosphere.

TEST PREP FOR AP[®] COURSES

- 58** The Karner blue butterfly has been declared an endangered species. It is dependent on wild lupine for larval development. This butterfly species, which was found abundantly in Indiana Dunes National Park, is now found farther north in Wisconsin and Michigan. Wild lupine has been destroyed in areas where it grew abundantly because of development and construction in the open grasslands where it prefers to grow.

Which biotic factors are present in the community?

- A** Karner blue butterfly
- B** Karner blue butterfly and wild lupine
- C** Karner blue butterfly, wild lupine, and fire
- D** Karner blue butterfly, wild lupine, and grasslands
- 59** In a temperate grassland system area of North America, vegetation has been destroyed by fire. What will happen to the net primary productivity and the local ecosystem when rains return in the next season?
- A** The grasses will grow back, but the herbivores that lived there will not return because they would have found new land to live on. Therefore, the net primary productivity would decrease.
- B** The grasses will not grow back; therefore, the herbivores that lived there will not return. Thus, the net primary productivity would decrease.
- C** The grasses will grow back and the herbivores that lived there will probably return. The net primary productivity should be similar to the previous season.
- D** The grasses will grow back and the herbivores that lived there will probably return. The net primary productivity would be less than the previous season.

Solution The solution is (C). Grasses have perennial buds that lie under the soil, so the grasses will grow back when favorable conditions return, and the net primary productivity should be more or less similar to the previous season. The herbivores that lived there will return when grasses grow back.

- 60** The Karner blue butterfly larva secretes a carbohydrate, which is a source of energy for ants. In turn, ants tend to the larva, increasing its likelihood to grow into an adult butterfly. What is this an example of?
- A** Predation
 - B** Competition
 - C** Mutualism
 - D** Parasitism
- 61** A lake in the Midwest experiences a sudden increase in the algae population (algal bloom) that covers the lake. This results in changes in factors that affect net primary productivity, especially —
- A** light and nutrient availability
 - B** predation by primary consumers
 - C** pollution
 - D** carbon dioxide

Solution The solution is (A). Light and nutrient availability affect primary productivity.

- 62** In bogs, paleontologists have discovered perfectly preserved bodies of humans and animals that have been there for hundreds of years. How is this possible?
- A** Bogs have high oxygen content and organic acids, which lower the pH. Low pH and high oxygen content prevent oxidation, thus slowing down decomposition.
 - B** Bogs have low oxygen content and organic acids, which increase the pH. High pH and low oxygen content prevent oxidation, thus slowing down decomposition.
 - C** Bogs have low oxygen content and organic acids, which lower the pH. Low pH and low oxygen content prevent oxidation, thus slowing down decomposition.
 - D** Bogs have low oxygen content and organic acids, which lower the pH. Low pH and low oxygen content prevent reduction, thus slowing down decomposition.
- 63** You are asked to estimate the nutrient content of a lake and its possible effect on net primary productivity. How will you determine the effect?
- A** Sample water from different parts of the lake and determine nutrient composition.
 - B** Sample the carbon content of the phytoplankton growing.
 - C** Take a sample of lake water and artificially enrich it, then see the effect of the enrichment on phytoplankton growth compared with growth in unenriched lake water.

D Wait for spring turnover to check for nutrients found in the lake floor.

Solution The solution is (C). Artificially adding nutrients to water and checking the growth of phytoplankton will give an idea of the lake water conditions.

64 The population of a certain species of deer has been reduced drastically because of indiscriminate hunting. How will you determine the impact on the local ecosystem?

A To determine the effect of indiscriminate hunting on a local ecosystem, environmental conditions should be determined. If a drastic change in environmental conditions is observed, then indiscriminate hunting of deer should be discouraged.

B The number of predators, their effect on plants they feed on, availability of nutrients in soil, and number of pests should be determined. If there is a drastic change in numbers, then indiscriminate hunting of deer should be discouraged.

C Determining the number of predators alone is sufficient to determine the impact of indiscriminate hunting on a local ecosystem. If there is a drastic change in numbers, then indiscriminate hunting of deer should be discouraged.

D Determination of the availability of nutrients in soil helps in determining the impact of indiscriminate hunting on a local ecosystem. If there is a drastic change in the availability, then indiscriminate hunting of deer should be discouraged.

65 In a forest fire, many oak trees were destroyed. After the fire, numerous taller trees replaced the oak trees. What is the most likely explanation for this event?

A The tall trees grow faster and create a canopy, which did not allow oak trees to grow.

B The burning of the trees changed the pH of the soil, which did not allow oak to grow.

C Roots of shrubs and trees proliferate, taking over the place of the oak trees.

D Oak trees succumb to pests, thus other pest-resistant trees are able to proliferate.

Solution The solution is (A). Trees that grow faster than the oak trees can create a canopy.

66 What are possible consequences if there is a big oil spill in the middle of the ocean? How will it affect the biodiversity and the net primary productivity? What are some strategies to clean up this oil spill?

A Oil spills increase the amount of light and oxygen entering the ocean. The phytoplankton may perish. The presence of oil would limit mobility of marine animals and may result in death. Some chemicals and bioremediation can help with oil clean-up.

B Oil spills increase the amount of light and oxygen entering the ocean. The phytoplankton may increase. The mobility of marine animals increases. Biodiversity and, therefore, net primary productivity increases. Some chemicals and bioremediation can help with oil clean-up.

- C** Oil spills cover the surface of the ocean, reducing the amount of light entering the ocean. The marine organisms that can survive independent of light will not be affected. Some chemicals and bioremediation can help with oil clean-up.
- D** Oil spills cover the surface of the ocean, reducing the amount of light and oxygen entering the ocean. The phytoplankton may perish. The presence of oil would limit mobility of marine animals and may result in death. Some chemicals and bioremediation can help with oil clean-up.
- 67** Global climate change has led to butterflies emerging earlier and amphibians mating earlier in the United Kingdom. What impact is climate change most likely to have on the populations of these species in the next few years?
- A** There will be no impact on the butterfly and amphibian populations.
- B** The butterfly and amphibian numbers may increase as they adapt to the new conditions.
- C** Their butterfly and amphibian numbers may decline as the plant hosts of butterflies may not flower earlier, and young amphibians may not be viable if there is a lack of water.
- D** It is hard to predict what will happen to the butterfly and amphibian populations because there are no similar studies.

Solution The solution is (C). There may be other changes that could cause their numbers to decline. For example, the plant hosts of butterflies may not flower earlier, and young amphibians may not be viable if there is a lack of water.

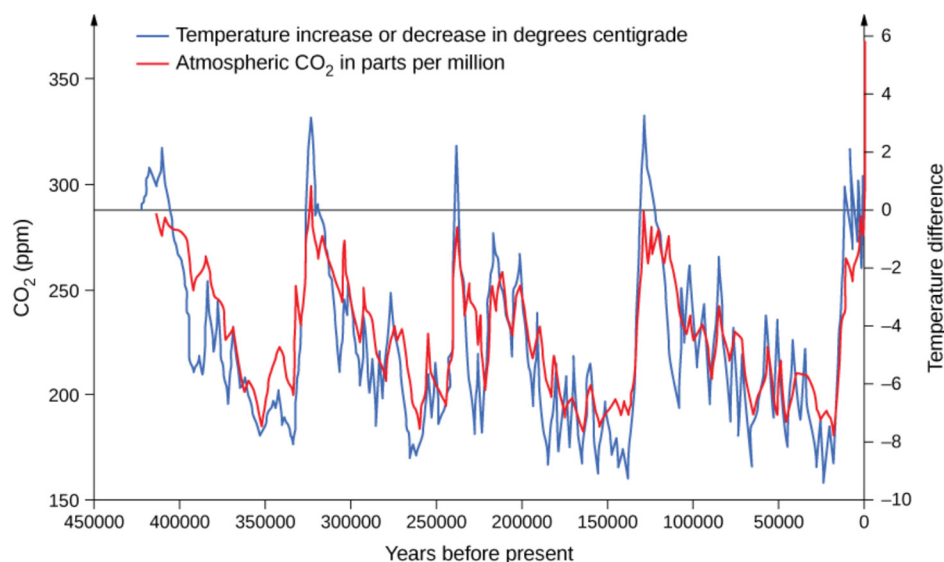
- 68** What are possible short-term and long-term effects of natural and human-induced processes on global climate change and, consequently, on ecosystems?
- A** Short-term changes include melting of glaciers and rising levels of water bodies that may cover islands close to sea level, which may destroy the local ecosystem and animals. Long-term changes could include changes in seasonal patterns, unseasonal rainfall, and changes in the life cycle of insects.
- B** Short-term changes include changes in seasonal patterns, unseasonal rainfall, and changes in the life cycle of insects and animals. Long-term changes could be changes in the flowering times of plants and rising levels of water bodies that may cover islands close to sea level, destroying the local ecosystem.
- C** Short-term changes include changes in seasonal patterns, unseasonal rainfall, and changes in the life cycle of insects and animals. Long-term changes could include the melting of glaciers and a rise in levels of water bodies, which may cover islands close to sea level, which could destroy the local ecosystem.
- D** Short-term changes include melting of glaciers, unseasonal rainfall, and changes in the life cycle of insects and animals. Long-term changes could include rising levels of water bodies that may cover islands close to sea level, destroying the local ecosystem.

SCIENCE PRACTICE CHALLENGE QUESTIONS

35.5 Climate and the Effects of Global Climate Change

69 Twenty targets for the protection of biodiversity by 2020 were established by the 2010 Convention on Biological Diversity. Midway to the target date, it is widely agreed that the goals will not be met. The *2016 Living Planet Report* from the World Wildlife Federation claims global populations of animals fell by 58 percent between 1970 and 2012 and extrapolates the loss by 2020 to 67 percent. E.O. Wilson's estimate of the current extinction rate is three species per hour. Geologic periods are defined by mass extinctions. The proposed name for the current geological period is the Anthropocene (Waters et al., *Science*, 2016).

During the current period of mass extinction, human activities are driving loss of habitat and climate change. Climate change during the past 500,000 years is a direct consequence of rising atmospheric CO₂ levels, as the graph shows. The relative abundance of O¹⁶ and O¹⁸ isotopes can be used to infer temperature because, as temperature increases, the lower mass isotope is enriched in the atmosphere (objects with a smaller mass have a higher velocity at equal molecular kinetic energy that is proportional to temperature).

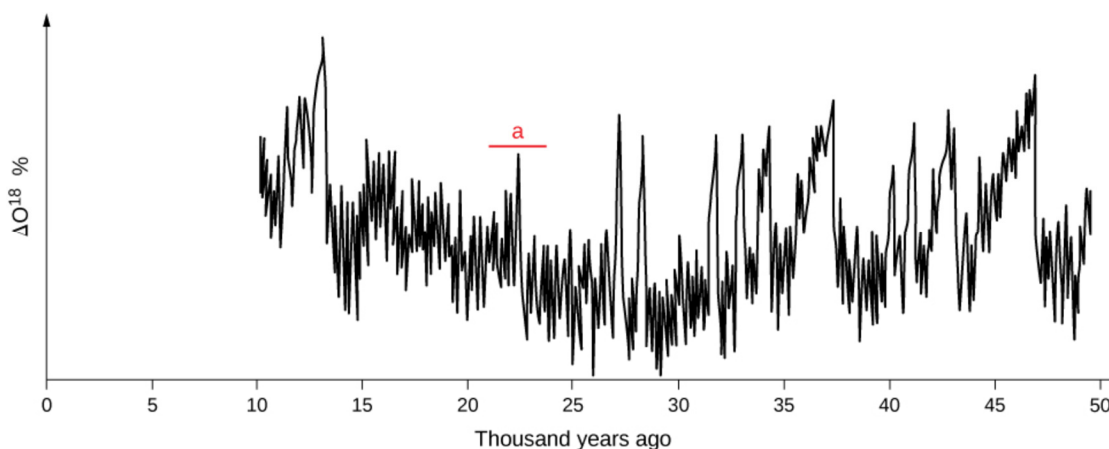


The role of humans in the last great extinction, the Holocene Extinction, during which the megafauna such as the woolly mammoth, the woolly rhinoceros, and the giant deer disappeared, has long been debated. Did we hunt these creatures to extinction? By examining all available DNA evidence, Cooper et al. (*Science*, 349, 2015) have compared time extinction intervals with these oscillations of climate as shown in the table.

| Animal | Label | Location | Beginning extinction date (thousand years ago) | Ending extinction date (thousand years ago) |
|--------|-------|----------|------------------------------------------------|---------------------------------------------|
| Bear | a | Beringia | 24 | 21 |

| Animal | Label | Location | Beginning extinction date (thousand years ago) | Ending extinction date (thousand years ago) |
|------------|-------|---------------|------------------------------------------------|---------------------------------------------|
| Bison | b | Europe | 35 | 32 |
| Rhinoceros | c | Britain | 36 | 32 |
| Rhinoceros | d | Russia | 14 | 13 |
| Horse | e | North America | 15 | 13 |
| Horse | f | Beringia | 43 | 38 |
| Mastodon | g | North America | 12 | 11 |
| Mammoth | h | Europe | 13 | 12 |
| Mammoth | i | Eurasia | 11 | 10 |
| Musk Ox | j | Eurasia | 48 | 44 |
| Deer | k | Europe | 13 | 12 |
| Cave Lion | l | Beringia | 14 | 12 |
| Cave Bear | m | Europe | 29 | 27 |

Additionally, the data shown in the graph are obtained from ice cores. The deeper the sample, the older the sample. The percent departure from the current O^{18} percentage that is graphed is a measure of temperature relative to the present temperature. The higher the isotope concentration, the higher the average temperature of the ocean.



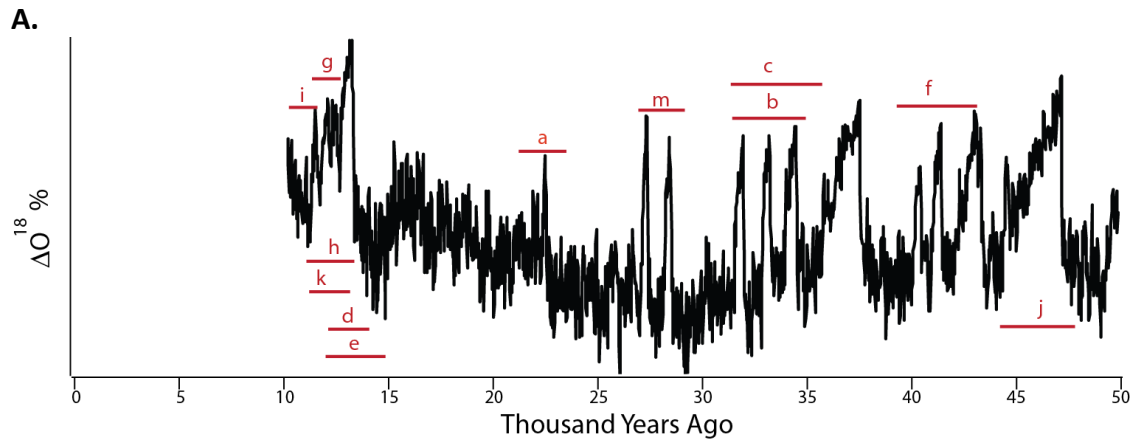
A. Refine the graph by adding the interval of time of extinction with a label drawn from the table as shown by “a.”

B. Analyze these data in terms of the clustering of extinction events.

C. Based on your analysis, explain how ecosystems have changed during the past 40,000 years and **identify** the factor that caused these changes.

D. Based on the correlation between Earth's temperature and the concentration of CO₂ in the atmosphere, predict what will happen to animal populations in the future.

Solution Sample answer:



B. The extinction events cluster where the temperature has spiked.

C. Ecosystems respond to increasing temperature by reducing biodiversity, at least of top species.

D. These results indicate that the extinction event now occurring is in part a consequence of climate change.

36 | POPULATION AND COMMUNITY ECOLOGY

REVIEW QUESTIONS

- 1 An ecologist is planning to measure both the size and density of a population. Which experimental method can best provide these data?
- A Mark and recapture
 - B Mark and release
 - C Quadrat
 - D Life table

Solution The solution is (C). A quadrat is a tool used to study the size and density of a population.

- 2 Which statement can be made about the mark and recapture method of estimating population numbers?
- A Using quadrats for counting individuals in a population increases the accuracy of the mark and recapture method.
 - B The greater the number of individuals captured during the first round of mark and recapture, the greater is the overall population size.
 - C The mark and recapture method is useful for mammals and birds, but of little use for other organisms.
 - D An underestimate of population size would tend to be observed in cases of studies involving animals that learn to seek out bait.
- 3 Which type of dispersal pattern is characterized by even spacing between individuals in the population?
- A Random
 - B Uniform
 - C Sparse
 - D Clumped

Solution The solution is (B). Uniformly dispersed individuals are equally spaced apart from one another.

- 4 Which method best shows the life expectancy of an individual within a population?
- A Mark only
 - B Mark and release

- C Quadrat
- D Life table

- 5 How would a researcher best collect data in order to calculate overall mortality rates within a population?
- A For various age groups, count the number of individuals that died and the number that survived within a defined time period.
 - B For various age groups, count the number of individuals that were born and the number that died within a defined time period.
 - C For each sex, count the number of individuals that were born and the number that survived within a defined time period.
 - D For each sex, count the number of individuals that died and the number that were born within a defined time period.

Solution The solution is (A). To calculate mortality rates, count the number of individuals that died and the number that survived in various age groups within a defined time period.

- 6 What survivorship pattern can be used to describe humans?
- A Type I survivorship curve
 - B Type II survivorship curve
 - C Type III survivorship curve
 - D Type IV survivorship curve
- 7 Different species have different survivorship curves. A Type III survivorship curve would most likely be observed for —
- A whales
 - B seals
 - C salmon
 - D polar bears

Solution The solution is (C). Salmon have a low probability of surviving to adulthood.

- 8 What is associated with long-term parental care?
- A Few offspring
 - B Many offspring
 - C Semelparity
 - D Fecundity
- 9 Which condition is inversely related with fecundity?

- A Number of offspring
- B Energy budget of parent
- C Amount of parental care
- D Age of parent

Solution The solution is (C). The amount of parental care is inversely related to the fecundity of an organism.

10 When studying a squash beetle native to the Everglades, scientists collected data to compare the squash beetle to another beetle native to the Great Lakes region. What data would be used to compare the beetles' reproductive potential?

- A Temperature
- B Population size
- C Semelparity
- D Fecundity

11 Albatrosses are birds that can live to age 60 and older. They usually do not start breeding until they reach age eight or nine, which is relatively late compared to other bird species. Based on this information, which conditions might be a risk to the survival of albatrosses?

- A Increased chance of individuals dying before reproducing
- B Slightly decreased life spans of individuals
- C Increased chance of offspring dying regardless of whether they had reproduced
- D Decreased chances of mating between unrelated individuals

Solution The solution is (A). The problem with delaying reproduction until late in life is that there is a greater chance individuals will die before they reproduce.

12 Frogs are animals with high fecundity. Based on this information, frogs are expected to have which characteristic?

- A High energy budget
- B Extensive energy storage for each individual offspring
- C Small numbers of offspring
- D Little or no parental care

13 What type of growth curve do species with limited resources usually exhibit?

- A Logistic
- B Logical
- C Experimental
- D Exponential

Solution The solution is (A). Logistic growth is observed, as the population grows exponentially and then levels off as the population approaches the carrying capacity imposed by limited resources.

- 14** What is an example of exponential population growth?
- A** Salamanders adapting to fungal infections
 - B** Polar bears living in a warming habitat
 - C** Bacteria growing in an enriched medium in a lab
 - D** Feral cats being trapped and neutered in a suburb
- 15** If the major food source of seals declines due to pollution or overfishing, how would the seal population be affected?
- A** The carrying capacity of seals would decrease, as would the seal population.
 - B** The carrying capacity of seals would decrease, but the seal population would remain the same.
 - C** The number of seal deaths would increase but the number of births would also increase, so the population size would remain the same.
 - D** The carrying capacity of seals would remain the same, but the population of seals would decrease.

Solution The solution is (A). The declining food source would decrease the carrying capacity, and the seal population would decrease in response.

- 16** What is the carrying capacity of a population, and does it change or remain fixed for a population?
- A** Carrying capacity is the amount of land needed to support a population, and it is fixed for each population.
 - B** Carrying capacity is the amount of water and food resources required to support a population, and it is fixed for each population.
 - C** Carrying capacity is the maximum size of a population that can survive using the available resources, and it can vary up or down.
 - D** Carrying capacity is the time needed for a population to reach its maximum size, and it can vary up or down.
- 17** Suppose a pesticide used by farmers wipes out the insect population that feeds a population of bats. What effect will this change have on the bat population?
- A** The carrying capacity of the population will increase.
 - B** The carrying capacity of the population will decrease.
 - C** The carrying capacity of the population will not change.
 - D** The carrying capacity of the population cannot be predicted.

Solution The solution is (B). The carrying capacity of the bat population will decrease because the food resources for the bats have decreased.

- 18** Which explanation best defines density-dependent growth regulation?
- A** A factor that affects population density but not population size
 - B** A factor that affects population size but not population density
 - C** A factor that affects population size regardless of population density
 - D** A factor that affects population size in ways related to population density

19 A forest fire is an example of which type of regulation?

- A** Density-dependent
- B** Density-independent
- C** r-selected
- D** K-selected

Solution The solution is (B). Forest fires are density-independent because they affect populations of organisms regardless of their density.

20 Species that have many offspring at one time are usually —

- A** r-selected
- B** K-selected
- C** both r- and K-selected
- D** not selected

21 The following statements compare r-selected and K-selected species. Which statement draws an accurate comparison of the two species?

- A** r-selected and K-selected species both have limitations in the amount of energy they can invest in reproduction, so they both use similar strategies.
- B** r-selected and K-selected species both have limitations in the amount of energy they can invest in reproduction, but they use completely different strategies.
- C** r-selected and K-selected species use similar reproductive strategies, but r-selected species require less energy to reproduce than K-selected species.
- D** r-selected and K-selected species use different reproductive strategies, because r-selected species require less energy to reproduce than K-selected species.

Solution The solution is (B). Species that are r-selected and K-selected both have limitations in the amount of energy they can invest in reproduction, but they use completely different strategies.

22 If a population moves to a new environment rich in resources, what type of growth curve will it exhibit in the short term?

- A Logistic
- B Logical
- C Experimental
- D Exponential

23 Humans have altered environmental factors that have allowed the human population to grow exponentially. What is an example of such a factor?

- A Interspecific competition
- B Age structure
- C Carrying capacity
- D Reproductive strategies

Solution The solution is (C). Human population has increased exponentially as we have increased the carrying capacity by increasing available resources.

24 Humans have altered their own carrying capacity. How have humans changed their carrying capacity, and what are the consequences of this change?

- A By limiting their own carrying capacity, humans have enabled their population to grow rapidly.
- B By decreasing their own carrying capacity, humans have enabled their population to grow slowly.
- C By stabilizing their own carrying capacity, humans have enabled their population to grow steadily.
- D By increasing their own carrying capacity, humans have enabled their population to grow exponentially.

25 Humans have influenced their own carrying capacity in several ways. Some human activities increase carrying capacity while others decrease it. Which human activity has decreased the human carrying capacity of the environment?

- A Agriculture
- B Using large amounts of natural resources
- C Domestication of animals
- D Use of language

Solution The solution is (B). By using large amounts of natural resources, humans have decreased their carrying capacity because fewer resources will be available for future generations to use.

26 Humans began developing oil as an energy source in the early part of the 20th century. Which statement describes the relationship between oil development and Earth's human carrying capacity?

Advanced Placement Biology Student's Solution Manual

- A** Drilling for oil enabled humans to increase food production through the use of machinery, which increased Earth's human carrying capacity.
- B** Oil production allowed new transportation methods faster than methods using animals, which decreased Earth's human carrying capacity.
- C** Accessing oil as an energy source created increased greenhouse gas emissions, which increased Earth's human carrying capacity.
- D** Oil as an energy source enabled humans to enjoy more recreational activities, which decreased Earth's human carrying capacity.

27 Populations with the greatest proportion of young individuals can be found in —

- A** economically developed countries
- B** economically underdeveloped countries
- C** countries with zero population growth
- D** countries in Europe

Solution The solution is (B). Economically underdeveloped countries have high reproductive rates and shorter life expectancies and therefore a greater proportion of young individuals.

28 Which statement explains the correlation between age structure and the level of economic development observed in many countries?

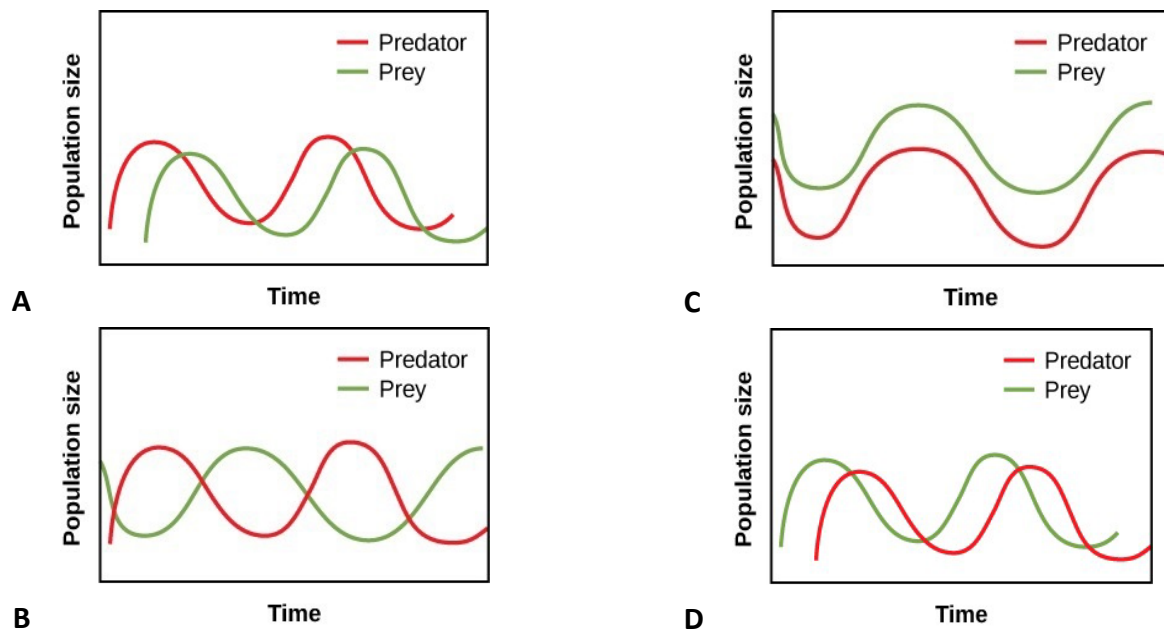
- A** There is no correlation between the characteristics of age structures and the level of economic development.
- B** Countries that are more economically developed tend to have fewer middle-aged individuals and more young individuals than undeveloped countries.
- C** A larger ratio of very young individuals to very old individuals characterizes the age structures of countries with the highest economic development.
- D** Age structures of economically undeveloped countries show greater proportions of children and fewer proportions of elderly people.

29 Which environmental characteristic is likely to increase if the human population continues growing unchecked?

- A** Wilderness areas
- B** Fresh water supplies
- C** Fossil fuel reserves
- D** Atmospheric carbon dioxide

Solution The solution is (D). Atmospheric carbon dioxide increases through human actions such as deforestation and burning of fossil fuels. As human population increases, atmospheric carbon dioxide will increase as well.

- 30** How would you predict and explain the effects of the human population on biodiversity many years in the future?
- A** Biodiversity will decline as the human population increases because of habitat loss, increased pollution, and climate change.
 - B** Biodiversity will decline as the human population increases because of enhanced food supplies, medical advances, and development of renewable energy sources.
 - C** Biodiversity will increase as the human population increases because of habitat loss, increased pollution, and climate change.
 - D** Biodiversity will increase as the human population increases because of enhanced food supplies, medical advances, and development of renewable energy sources.
- 31** Which predator-prey graph correctly depicts a predator-prey cycle?



Solution The solution is (D). The population size of predators fluctuates with the prey population, but lags slightly behind as it responds to the changes in prey population.

- 32** Which statement describes a predator-prey cycle?
- A** Prey increase in numbers, causing an increase in the predator population, which causes a downturn in prey numbers, which leads to a downturn in predator numbers, and then the cycle repeats.
 - B** The number of prey is directly related to the number of predators so that the two populations remain at the same ratio even though the total population numbers fluctuate.
 - C** Increasing prey numbers trigger decreases in predator numbers, which eventually causes a decrease in prey numbers as predators become too sparse, and then the cycle repeats.

D A prey population undergoes a cyclic increasing and decreasing fluctuation in size as its predator population undergoes the same cycle but in a mirror image relationship.

- 33** In a region in Texas, biologists observed that two highly venomous snakes with similar markings deter owl predators. Upon closer inspection, the snakes were determined to belong to different genera and species.

How would these biologists describe the mimicry in this case?

- A** Batesian mimicry because it involves nontoxic species that resembles a toxic species
- B** Emsleyan/Mertensian mimicry because an extremely toxic species resembles a less toxic species
- C** Batesian mimicry because it involves an extremely toxic species that resembles a less toxic species
- D** Müllerian mimicry because it involves different species that both produce toxins and display similar warning coloration

Solution The solution is (D). Müllerian mimicry involves many different species that produce toxins and also display similar warning coloration in defense against the same predators.

- 34** What would happen to an animal species classified as a Batesian mimic if it did NOT have its mimicry attributes?

- A** The animal species would suffer increased loss through predation because its predators would not learn to avoid eating it.
- B** The animal species would suffer decreased loss through predation because it still produces harmful toxins that would kill its predators.
- C** The animal species would suffer no long-term loss through predation because it still produces foul-tasting compounds that its predators would learn to avoid.
- D** The animal species would suffer increased loss through predation because predators would not be deterred by its appearance and would find it to be tasty.

- 35** According to the competitive exclusion principle, how can two different species coexist in the same habitat?

- A** Two species can coexist in the same habitat as long as they do not share the same trophic level.
- B** Two species can coexist in the same habitat as long as they do not share the same mates.
- C** Two species can coexist in the same habitat as long as they do not share the same resources.
- D** Two species can coexist in the same habitat as long as they do not share the same life span.

Solution The solution is (C). Two species can coexist in the same habitat as long as they do not share identical resources. The competitive exclusion principle dictates that if two species share the same resources, one of the populations will either go extinct locally, or the populations will adapt to utilize different resources.

36 What would happen if the competitive exclusion principle were violated?

- A** One species will prey on another species and drive it to extinction.
- B** One species will adapt to another species invading its habitat.
- C** One species will block another species' access to a critical resource.
- D** One species will contend with another species for the same resources.

37 Which statement explains the symbiotic relationship of mutualism?

- A** One species benefits and the other derives no benefit or harm from the relationship.
- B** One species benefits and the other is harmed by the relationship.
- C** Both species benefit from the relationship.
- D** Neither species benefits or is harmed.

Solution The solution is (C). In a mutualistic symbiotic relationship, both species benefit from the relationship.

38 Which statement describes the symbiotic relationships of mutualism, commensalism, and parasitism?

- A** These symbiotic relationships always benefit both species involved.
- B** These symbiotic relationships never harm either of the species involved.
- C** These symbiotic relationships always benefit at least one of the species involved.
- D** These symbiotic relationships always harm at least one of the species involved.

39 Which statement best describes a pioneer species?

- A** A pioneer species is a species that is transported deliberately out of its native habitat into a nonnative habitat, where there are few or no natural predators to keep the population in check.
- B** A pioneer species is a species that maintains the community structure in an ecosystem, and whose loss causes the ecosystem to fail.
- C** A pioneer species is a species that has the greatest influence over the ecosystem usually by bringing most of the energy into the system.
- D** A pioneer species is a species that can colonize new landscapes and begin the process of succession.

Solution The solution is (D). A pioneer species is one of the first to begin the process of succession. Pioneer species can colonize areas devoid of organic material.

- 40** What happens to a forest community after a forest fire?
- A** The same community is quickly reestablished just as it existed before the disturbance.
 - B** Another mature community with different species grows quickly in place of the original community.
 - C** Groups of species grow and then are replaced by other groups through a sequential series of changes as the community matures over time.
 - D** The landscape remains barren for many years until trees grow large enough to provide the shade needed for smaller plants to grow.

41 What is innate behavior?

- A** Innate behavior results from practice and conditioning.
- B** Innate behavior occurs spontaneously without any learning component.
- C** Innate behavior results from thought processes.
- D** Innate behavior results from interactions within a social group.

Solution The solution is (B). Innate behavior does not need to be taught. It occurs spontaneously without any learning component.

42 What is the difference between innate and learned behaviors?

- A** Innate behaviors can change based on previous experiences, whereas learned behaviors remain the same throughout an organism's life.
- B** Innate behaviors are controlled by genes, whereas genes play no role in learned behaviors.
- C** Innate behaviors allow an organism to adapt to new situations by applying previous experiences, whereas learned behaviors allow an organism to respond quickly.
- D** Innate behaviors are involuntary responses to stimuli, whereas learned behaviors change based on an organism's experiences.

43 Which statement best describes phototaxis?

- A** Phototaxis is the directed movement of an organism in response to gravity.
- B** Phototaxis is the long-range movement of an organism in response to a change in season.
- C** Phototaxis is the movement of an organism in search of food.
- D** Phototaxis is the directed movement of an organism in response to light.

Solution The solution is (D). Phototaxis occurs as an organism directs its movement in response to light.

44 Monarch butterflies in the eastern regions of North America migrate thousands of miles to an area in Mexico in the fall and then back to northern regions in the spring. How did this migration behavior come to be established in this species?

- A** Each new generation learned the migration behavior by observing older generations and mimicking their behavior patterns.
- B** In very early generations of this species, a few individuals found that migration improved their chances for survival and taught their young to carry on the behavior.
- C** Individuals that migrated survived through the winter, whereas individuals that did not migrate died, leading to selection for migration in later generations.
- D** When this butterfly emerged as a new species, by chance it inherited the genetic material that underlies long-distance migration behavior from its ancestor.

45 Pheromones are used in communication between some organisms. What is a pheromone?

- A** A pheromone is a type of chemical compound.
- B** A pheromone is a type of display.
- C** A pheromone is a type of language.
- D** A pheromone is a type of song.

Solution The solution is (A). A pheromone is a type of chemical compound that communicates a message, such as a warning or the location of a food trail, from one individual to another individual of the same species.

46 Which statement describes the type of signal used by birds to communicate the presence of a predator to other birds?

- A** Birds release chemical compounds into the air that other birds rapidly recognize as signals of the presence of a predator.
- B** Birds flash visual signals such as wing flapping to communicate warnings to other birds whenever a predator is present.
- C** Birds physically touch other birds using tactile signals when they observe a predator entering their location.
- D** Birds make aural signals such as calls that other birds can hear and learn about a predator that has been observed in the area.

47 The sacrifice of the life of an individual so that the genes of relatives may be passed on is an example of —

- A** operant conditioning
- B** kin selection
- C** kinesis
- D** imprinting

Solution The solution is (B). Individuals may sacrifice their lives in order to promote their genes being passed on through their close relatives, which is an example of kin selection.

- 48** Which example describes how an animal expends energy in finding, selecting, or winning a mate?
- A** Female swallows engage in aggressive harassment of a hawk during breeding season.
 - B** Male cardinals harass and peck at other male cardinals in their territory.
 - C** Both male and female squirrels build nests out of leaves, twigs, and other plant material.
 - D** Female black widow spiders eat males following copulation.
- 49** The polyandrous mating system term *polyandry* comes from the Greek words for *many* and *man*. Based on these word origins, which best describes a polyandrous mating system?
- A** One male mates with many females.
 - B** One female mates with one male.
 - C** One female mates with many males.
 - D** Many females mate with one male.

Solution The solution is (C). In a polyandrous mating system, one female mates with many males.

- 50** Which option describes an advantage of a monogamous relationship?
- A** Having many males around to provide assistance with protecting and feeding offspring ensures that offspring have the best chance of surviving.
 - B** When very few males are available in a population, this mating system makes sure that each male has a mating partner.
 - C** In populations where very few females are available, this mating system ensures that no eggs are wasted.
 - D** The constant presence of one male throughout the offspring rearing process makes it more likely that offspring will survive and be healthier.
- 51** The ability of rats to learn how to run a maze is an example of cognitive learning. What happens during cognitive learning?
- A** Cognitive learning is a type of learning that occurs early in an animal's development when it learns to bond to an object or animal.
 - B** Cognitive learning occurs when an animal learns to associate a stimulus with a behavior not normally associated with that stimulus.
 - C** Cognitive learning occurs when an animal learns a behavior in response to a positive stimulus or negative stimulus.

- D** Cognitive learning is the most complex type of learning that involves multiple types of brain processes to carry out.

Solution The solution is (D). Cognitive learning is the most complex type of learning that involves multiple types of brain processes to carry out. The rat learning to run the maze requires multiple brain processes.

52 Which statement best explains how classical conditioning and operant conditioning differ?

- A** In operant conditioning, the animal learns to associate a voluntary behavior with its consequences, whereas the animal learns to associate a nonvoluntary behavior with an unusual stimulus in classical conditioning.
- B** In operant conditioning, the animal does not learn a new behavior in response to a stimulus, whereas the animal learns to associate a nonvoluntary behavior with an unusual stimulus in classical conditioning.
- C** In operant conditioning, the animal learns to associate a voluntary behavior with its consequences, whereas the animal does not learn a new behavior in response to a stimulus in classical conditioning.
- D** In operant conditioning, the animal learns to associate a nonvoluntary behavior with an unusual stimulus, whereas the animal learns to associate a voluntary behavior with its consequences in classical conditioning.

CRITICAL THINKING QUESTIONS

53 How could a researcher determine the population size and density of a bird population on one of the Hawaiian Islands?

- A** Population size can be determined by life tables. The area of the islands in square kilometers is divided by the population size to determine the density of the bird population.
- B** Population size can be determined by the mark and recapture method. The population size is divided by the area of the islands in square kilometers to determine the density of the bird population.
- C** Population size can be determined by life tables. The population size is divided by the area of the islands in square kilometers to determine the density of the bird population.
- D** Population size can be determined by the mark and recapture method. The area of the islands in square kilometers is divided by the population size to determine the density of the bird population.

Solution The solution is (B). The researcher could use the mark and recapture method to determine the total number of birds on the islands, which gives the population size.

Then, the researcher could divide the total number of birds by the area of the islands in square kilometers to give the density of the bird population.

- 54** Which is an example of how two different populations of organisms might have the same population density, but different dispersal patterns?
- A** Two populations could occupy the same range with the same number of individuals, giving different dispersal patterns. However, both the populations may be dispersed randomly throughout the range, giving identical population densities.
 - B** Two populations could occupy the different range with the different number of individuals, giving different dispersal patterns. However, both the populations may move over this range in a herd, giving identical population densities.
 - C** Two populations could occupy the same range with the different number of individuals, giving identical population densities. However, one population may move over this range in a herd while the other population may be dispersed randomly throughout the range.
 - D** Two populations could occupy the same range with the same number of individuals, giving identical population densities. However, one population may move over this range in a herd while the other population may be dispersed randomly throughout the range.
- 55** A population is observed to have very large numbers of very young individuals, but very low numbers of sexually mature individuals. What hypothesis might a researcher propose about mortality patterns in this population, and how would that researcher follow up to test her hypothesis?
- A** The researcher might propose that the mortality rate of this species is very high during the developmental period after sexual maturity is reached. She can test this hypothesis by constructing a life table and calculating mortality rates at different age intervals.
 - B** The researcher might propose that the mortality rate of this species is very high during the developmental period before sexual maturity is reached. She can test this hypothesis by using the mark and recapture method and calculating population densities.
 - C** The researcher might propose that the mortality rate of this species is very high during the developmental period before sexual maturity is reached. She can test this hypothesis by constructing a life table and calculating mortality rates at different age intervals.
 - D** The researcher might propose that the mortality rate of this species is very low during the developmental period before sexual maturity is reached. She can test this hypothesis by constructing a quadrat and calculating mortality rates at different age intervals.

Solution The solution is (C). A researcher might propose the mortality rate of this species is very high during the developmental period before sexual maturity is reached. To test this hypothesis, the researcher would follow a group of individuals within the population from birth to death, recording the age at which they died. From the data, the researcher could construct a life table and calculate mortality rates at different age intervals.

- 56** An organism, such as an elephant, that invests in long-term care of its offspring faces risks to its survival as a result of this investment. Which statement best explains those risks?
- A** Organisms that invest in long-term parental care have many offspring. Having many offspring means there is greater risk of rapid increase in population.
 - B** Organisms that invest in long-term parental care have few offspring. Having a limited number of offspring means there is greater risk to the survival of the species when a single offspring dies.
 - C** Organisms that invest in long-term parental care have many offspring. Having many offspring means there is greater risk to the survival of the species when a single offspring dies.
 - D** Organisms that invest in long-term parental care have few offspring. Having a limited number of offspring means there is greater risk of rapid increase in population.
- 57** A honeybee colony contains one queen, hundreds of drones, and many thousands of worker bees. The queen produces eggs, the drones produce sperm, and the workers are sterile. How does the reproductive strategy of honeybees benefit the survival of the species? (credit: Food and Agriculture Organization of the United States)
- A** The fertile queen and drones produce many offspring while sterile worker bees do not benefit the survival of the species.
 - B** Worker bees produce many offspring while the sterile queen and drones do not benefit the survival of the species.
 - C** The sterile queen and drones use the energy taken in by them for their own growth, growth and maintenance of the hive, and protection and nurturing of offspring.
 - D** Sterile worker bees use the energy they take in for their own growth, growth and maintenance of the hive, and protection and nurturing of offspring.

Solution The solution is (D). Because most of the individuals are sterile, energy needed for reproduction can be concentrated in just a small percentage of the population. This allows all of the energy taken in by a worker to go toward its own growth, growth and maintenance of the hive, and protection and nurturing of offspring.

- 58** Two different plant species expend approximately the same amount of energy on reproduction, yet one produces many seeds in a season and the other produces very few. What is likely to be true of the seeds of these two species?

- A** In the plant species that produces many seeds, most of the energy is used to produce seeds, of which only a few will germinate and produce another plant. In the species that produces few seeds, most of the energy is used to increase the chances of seeds produced will germinate and grow into an adult plant.
- B** In a plant species that produces many seeds, most of the energy is used to produce seeds, most of which will germinate and produce another plant. In a species that produces few seeds, most of the energy is used to increase the chances of seeds produced will germinate and grow into an adult plant.
- C** In a plant species that produces many seeds, most of the energy is used to produce seeds, of which only a few will germinate and produce another plant. In a species that produces few seeds, most of the energy is used to reduce the chances of seeds produced germinating and growing into adult plants.
- D** In a plant species that produces many seeds, most of the energy is used to increase the chances that seeds produced germinate and grow into an adult plant. In a species that produces few seeds, most of the energy is used to produce those seeds, which will germinate and produce another plant.
- 59** How would r_{\max} be expected to differ for an elephant and a flea, and how does that change the time scale over which populations of these two animals would be studied?
- A** The r_{\max} would be greater for an elephant as elephants reproduce at a faster rate than fleas. A shorter time scale would be used to study changes over several elephant generations.
- B** The r_{\max} would be greater for a flea as fleas reproduce at a faster rate than elephants. A shorter time scale would be used to study changes over several flea generations than over several elephant generations.
- C** The r_{\max} would be greater for a flea as fleas reproduce at a faster rate than elephants. A longer time scale would be used to study changes over several flea generations than over several elephant generations.
- D** The r_{\max} would be greater for an elephant as the elephants grow at an exponential rate so the population growth rate is greatly increased. A shorter time scale would be used to study changes over several elephant generations.

Solution The solution is (B). The r_{\max} would be expected to be much greater for a flea than an elephant because a flea reproduces at a faster rate than an elephant. This means anyone studying a flea population would use a much shorter time scale to study the changes over several flea generations than another person studying changes over several elephant generations.

- 60** These data were collected on a population of beetles in Florida.

| Date | <i>N</i> |
|---------|----------|
| 5/1/12 | 56 |
| 6/1/12 | 98 |
| 7/2/12 | 203 |
| 8/10/12 | 421 |

Based on the data, which option best describes the population growth in this case and predicts the growth of this population in the future?

- A** The population shows logistic growth, as the number of individuals approximately doubles every month and will likely continue to grow logistically until its resources become depleted. At that point, the population growth rate will slow down and level off to zero.
 - B** The population shows exponential growth, as the number of individuals approximately doubles every month and will likely grow logistically in the future until its resources become limited. At that point, the population growth rate will slow down and level off to zero.
 - C** The population shows exponential growth, as the number of individuals approximately doubles every month and will likely continue to grow exponentially until its resources become limited. At that point, the growth will become logistic; the population growth rate will slow down and level off to zero.
 - D** The population shows logistic growth and is likely to grow exponentially as the resources increase. The population growth rate will increase in the future as well.
- 61** How might climate change lead to a decrease in one population's carrying capacity and an increase in a different population's carrying capacity?
- A** Plant species that are drought-resistant would decline in warm temperatures whereas other species would thrive in number in such a climate.
 - B** Plant species that are pest-resistant would thrive in warm temperatures whereas other species would decline in number in such a climate.
 - C** Plant species that are drought-resistant would decline in cold temperatures whereas other species would thrive in number in such a climate.
 - D** Plant species that are drought-resistant would thrive in warm temperatures whereas other species would decline in number in such a climate.

Solution The solution is (D). Climate change may bring warmer temperatures, and sometimes drier conditions, to a region. Plant species that thrive in warm temperatures will soar in population numbers, especially if they tend to be drought-resistant. Other plant

species will be harmed by warm temperatures and loss of water availability, and those populations will decline in numbers.

- 62** How would you compare and contrast density-dependent growth regulation with density-independent growth regulation? Give an example of each as they might affect a caterpillar population.
- A** Both are environmental conditions that result in changes in population numbers. Density-independent factors have different effects on population densities whereas density-dependent factors all have the same effect at different densities. An example of the former is a caterpillar population being kept low by a pesticide because it kills them regardless of their numbers. An example of the latter is a large caterpillar population leading to a decrease in food availability, causing the caterpillar population to decline.
 - B** Both are environmental conditions that result in changes in population numbers. Density-independent factors have the same effect at all population densities whereas density-dependent factors have different effects at different densities. An example of the former is a caterpillar population being kept low by a pesticide because it kills them regardless of their numbers. An example of the latter is a large caterpillar population leading to a decrease in food availability, causing the caterpillar population to decline.
 - C** Both are environmental conditions that result in changes in population numbers. Density-independent factors have the same effect at all population densities whereas density-dependent factors have different effects at different densities. An example of the former is of a caterpillar population being kept low by a pesticide because it kills them only when their numbers are low. In the case of the latter, a large caterpillar population leads to a decrease in food availability, which will cause the caterpillar population to decline.
 - D** Both are environmental conditions that result in changes in population numbers. Density-independent factors have the same effect at all population densities whereas density-dependent factors have different effects at different densities. An example of the former is of a caterpillar population being kept low by a pesticide because it kills them regardless of their numbers. An example of the latter is a large caterpillar population leading to a decrease in food availability, causing the caterpillar population to increase.
- 63** Why doesn't a frog, which is an r-selected species, care for its offspring in the way a wolf, which is a K-selected species, cares for its offspring?
- A** Frogs have been selected by stable, predictable environments; therefore, they do not feel the need to care for their offspring like wolves.
 - B** Frogs use very little energy to produce large numbers of offspring; therefore, they do not have enough remaining to nurture them.

- C Smaller animals like frogs do not care for their offspring, whereas larger animals like wolves do.
- D Frogs expend a lot of energy to produce large numbers of offspring, leaving less energy for nurturing them.

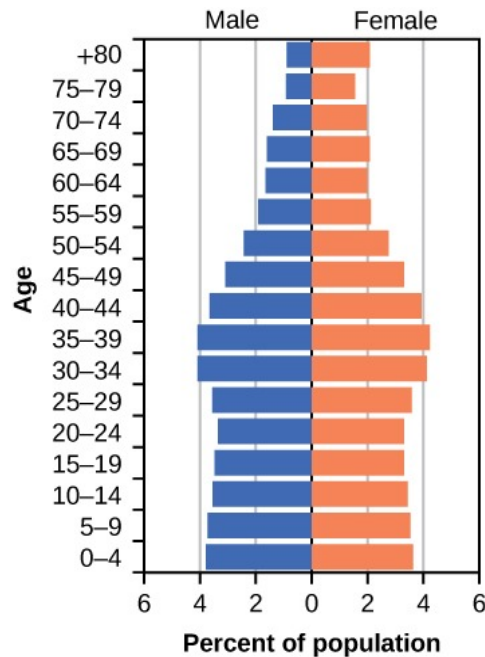
Solution The solution is (D). Both animals only have so much energy to devote to reproduction. The frog uses its energy to produce a large number of offspring, which it then leaves to develop on their own. The frog expends so much energy to produce these large numbers of offspring that it does not have enough to also nurture them. But by producing so many, there is a chance that a few of them will survive long enough to grow to maturity. In this way, the frog has developed a life history consistent with using its available energy to ensure a few of its offspring will survive to carry on the lineage.

- 64** Which features of a logistic growth curve are the same for every population exhibiting logistic growth, and which features might vary from one population to another?
- A The overall S-shape would be the same for all populations. The actual x- and y-values on the graphs, population numbers corresponding to starting populations, and the ending carrying capacities could differ.
 - B The overall carrying capacities would be the same for all populations. The actual x- and y-values on the graph and population numbers corresponding to the starting populations could differ.
 - C The overall S-shape would be the same for all populations showing logistic growth. The only factor that could differ is the actual x- and y-values on the graphs indicating the time frames for the growth curves.
 - D The x- and y-values on the graphs indicating the time frames for the growth curves would be the same. Overall S-shape and population numbers corresponding to the starting populations could differ.
- 65** Why is the concept of carrying capacity important when discussing human population growth?
- A Humans can decrease the carrying capacity of their environment by developing food production methods and engineering high-quality shelters, enabling more people to live than would otherwise be possible.
 - B Humans have been able to change the carrying capacity of their environment, which enables more people to survive. By decreasing their own carrying capacity, humans are responsible for their population boom.
 - C Humans have been able to change the carrying capacity of their environment, enabling more people to live. By increasing their own carrying capacity, humans are responsible for their population boom.

- D** Humans can increase the carrying capacity of their environment by developing food production methods and engineering high-quality shelters, which enables fewer people to live than would otherwise be possible. This would result in population collapse.

Solution The solution is (C). The concept of carrying capacity is key to understanding why the human population is able to grow exponentially. Humans have been able to change the carrying capacity of their environment by developing food production methods and engineering high-quality shelters, which enables more people to live than would otherwise be possible. By increasing their own carrying capacity, humans are responsible for their population boom.

- 66** The Industrial Revolution began with the invention of the steam engine. At about the same time, human population began increasing exponentially. How are these two events linked to the idea that humans are able to change the carrying capacity of their environment?
- A** The invention of the steam engine enabled people to use machines to carry out farming activities. The amount of available resources needed to sustain human life increased with the invention of machines. This increase in resources spurred exponential population growth.
- B** The invention of the steam engine enabled people to develop pest-resistant crop varieties. The amount of available resources needed to sustain human life increased with the invention of machines. This increase in resources spurred exponential population growth.
- C** The amount of available resources needed to sustain human life decreased with the invention of machines, but the carrying capacity increased. This increase in carrying capacity spurred exponential population growth.
- D** The invention of the steam engine enabled the environment to be changed according to the needs of the people. This regulation of environmental conditions spurred exponential population growth.
- 67** The diagram shows the age structure for a country. Analyze the age structure.



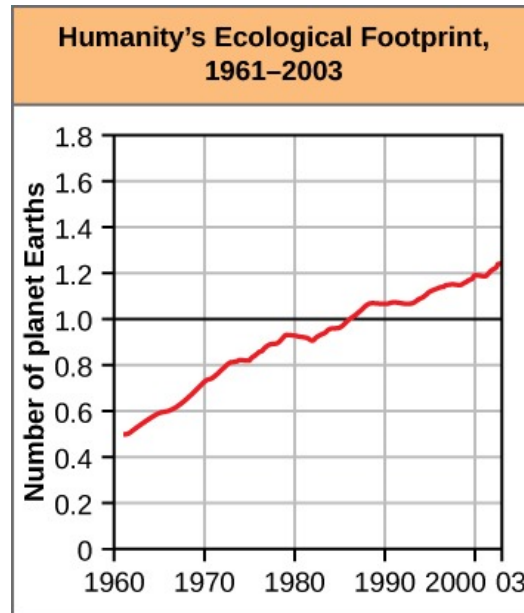
(credit: Quia)

Which statement best predicts the economic status of this country?

- A** This country is likely to be an economically developing country because it has a fairly even distribution of individuals in all age groups.
- B** This country is likely to be an economically developed country because it has many more very young people and very few old people.
- C** This country is likely to be an economically developed country because it has a fairly even distribution of individuals in all age groups.
- D** This country is likely to be an economically undeveloped country because it has many more very young people and very few old people.

Solution The solution is (C). This country is likely an economically developed country because it has a fairly even distribution of individuals in all age groups. Compared to undeveloped countries, in which there are many more very young people and very few old people, this country has lower birth rates, lower child mortality rates, and longer life spans. As a result, the distribution of people tends to be more equally spread throughout the various age groups.

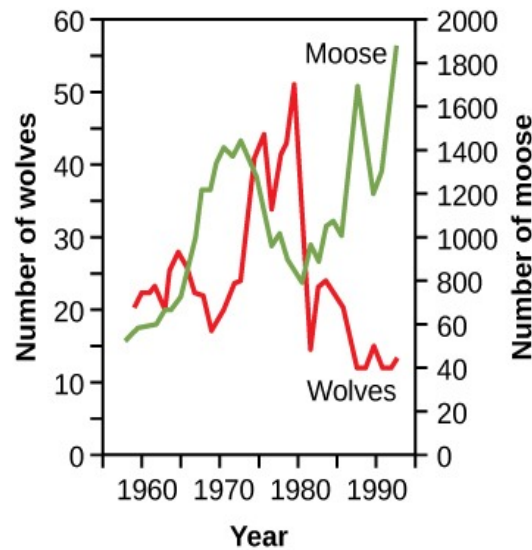
- 68** The global ecological footprint is defined as the total land area needed to supply all of the resources consumed by all humans. This graph shows the relationship between time and the global human footprint measured in number of planet Earths. Analyze the graph.



(credit: EPA Victoria)

What has been the consequence of human population change so far, and what are the consequences of continued population change in the future?

- A** The human population has exceeded Earth's water resources. If the human population keeps increasing, the ecological footprint of humans will increase far beyond the ability of Earth to support human population and our population could crash.
 - B** The human population has exceeded Earth's land area. If the human population keeps increasing, the ecological footprint of humans will increase far beyond the ability of Earth to support human population and our population could crash.
 - C** The human population has exceeded Earth's land area present to supply our resources of many types. If the human population keeps increasing, the birth and death rates will decrease and our population could crash.
 - D** The human population has exceeded Earth's water resources. If the human population keeps increasing, the birth and death rates will decrease and our population could crash.
- 69** This graph shows a predator-prey cycle for wolves and moose.



The graphs do not resemble the idealized graphs used as models of the predator-prey cycle. Why?

- A This graph reflects all of the influences on both populations in addition to the predator-prey influences.
- B This graph reflects all of the influences on both populations, but not the predator-prey influences.
- C This graph reflects just the influence of predator-prey interactions on both populations.
- D This graph reflects some of the influences on both populations other than the predator-prey influences.

Solution The solution is (A). This graph represents actual population data collected on two real populations. There are many more factors influencing population numbers in addition to predator-prey interactions. Therefore, this graph reflects all of the influences on both populations in addition to the predator-prey influences. As a result, the curves do not follow the idealized up and down cycling seen in the model graphs.

- 70** Suppose a population of lizards becomes divided into two groups on two different islands after a devastating tsunami. No predators of the lizard are present on one island, and on the other island is a fierce predator that uses the lizard as its primary source of food. Assume both populations encounter similar environments in every other way, and both survive and grow over the next 100 years.

How do you predict any of the characteristics of the two lizard populations to differ at the end of that time?

- A The lizards on the island with no predators will likely evolve adaptations such as camouflaged coloration, sharp spines, or toxins to defend against this predator. These

adaptations will likely be absent in the other population because they are adapted to other predators.

- B** The lizards that survive the fierce predator will likely evolve adaptations such as camouflaged coloration, sharp spines, or toxins to defend against this predator. These adaptations will likely be absent in the other population because they are adapted to other predators.
 - C** The lizards that survive the fierce predator will likely evolve adaptations such as camouflaged coloration, sharp spines, or toxins to defend against this predator. These adaptations will likely be absent in the other population because this predator is not a factor in their survival.
 - D** The lizards on the island with no predators will likely evolve adaptations such as camouflaged coloration, sharp spines, or toxins to defend against this predator. These adaptations will likely be absent in the other population because they have survived this predator.
- 71** The downy woodpecker and the hairy woodpecker are two species that live in the same habitats. The downy woodpecker is slightly smaller and has a smaller beak than the hairy woodpecker. The downy woodpecker uses its bill to search for food on small twigs and branches while the hairy woodpecker is most often observed searching for food on tree trunks.

How does the competitive exclusion principle relate to this example?

- A** Both woodpeckers have identical bill structure, but do not access their food from the same places in the habitat. They do not directly compete with one another for food and thus, can coexist in the same habitat.
- B** Both live in the same habitat and have some similarities, but access their food from the same places in the habitat. In this way, the two species can coexist in the same habitat.
- C** Both woodpeckers share similarities in their bill structures. So, they directly compete with one another for food. This directly relates to the competitive exclusion principle.
- D** Both live in the same habitat and have some similarities, but do not access their food from the same places in the habitat. In this way, the two species can coexist in the same habitat.

Solution The solution is (D). The competitive exclusion principle states no two species can occupy the same niche in a habitat. These two woodpeckers demonstrate this principle because both live in the same habitat and have some similarities, but do not access their food from the same places in the habitat. They have evolved different bill structures to allow them each to search for food in different parts of the same trees. Because they do not overlap in this area, they do not directly compete with one another for food. In this way, the two species can coexist in the same habitat.

- 72** Honeybees are pollinators. Which statement explains the type of symbiotic relationship that exists between honeybees and flowering plants? Explain your reasoning.
- A** This is commensalism because bees help plants pollinate and, in turn, obtain nectar from the plants.
 - B** This is a mutualistic relationship, because bees obtain nectar from the plants, but do not provide any benefits to the plants.
 - C** This is commensalism, because bees obtain nectar from the plants, but do not provide any benefits to the plants.
 - D** This is a mutualistic relationship, because bees help plants pollinate and, in turn, obtain nectar from the plants.
- 73** Prairie dogs are considered a keystone species in the western United States because of their extensive burrowing activities and their role as a prey animal. Why would these characteristics result in the keystone role of prairie dogs in their ecosystem?
- A** Prairie dogs provide protection and shelter for small animals and harm predator animals in the ecosystem.
 - B** Without the prairie dogs, the ecosystem might collapse due to lack of protection and shelter for small animals and lack of prey to sustain large predator animals.
 - C** Prairie dogs dig underground burrows, reducing aeration in the soil and preventing excessive growth of plants aboveground.
 - D** The burrows that prairie dogs dig underground provide shelter for other species of animals as well as protection from predators, but prevent growth of plants aboveground.

Solution The solution is (B). A keystone species is one that ecosystem balance depends on. If the keystone species is lost, the whole ecosystem becomes in danger of collapsing. In the case of prairie dogs, the burrows they dig underground could provide needed shelter for other species of animals as well as protection from predators. The burrowing activity could also aerate soil and allow for better growth of plants above ground. Their role as a prey animal is to sustain predator animals that also keep other prey animal populations in check in the ecosystem. Without the prairie dogs, these ecosystems might collapse due to lack of protection and shelter for small animals and lack of prey to sustain large predator animals.

- 74** Mating pairs of two different species of parrots sometimes lay their eggs in the same nest. When this happens, only one mating pair ends up parenting the chicks even though chicks of both species may be present. The chicks in such mixed nesting groups displayed some interesting behaviors summarized in the table.

| Raised by parents of species A | Contact calls made to other members of the flock | Alarm calls made in response to predator sighting |
|--------------------------------|--------------------------------------------------|---------------------------------------------------|
| Species A chicks | Species A call | Species A call |
| Species B chicks | Species A call | Species B call |

Classify these behaviors as innate or learned. How do they compare?

- A** The alarm call is an innate behavior and a contact call is a learned behavior. Innate behavior comes out automatically in response to a stimulus whereas learned behavior develops over time after observing other birds carrying out the behavior.
- B** The alarm call is a learned behavior and contact call is an innate behavior. Learned behavior develops over time after observing birds carrying out the behavior whereas innate behavior comes out automatically in response to a certain stimulus.
- C** The alarm call is an innate behavior and contact call is a learned behavior. Innate behavior develops over time in response to stimulus after continuous exposure. Learned behavior develops over time after observing other birds carrying out their behavior.
- D** The alarm call is a learned behavior and contact call is an innate behavior. Learned behavior comes out automatically whereas innate behavior develops over time in response to stimulus after continuous exposure.
- 75** Mammals such as humans show a behavior known as the fight-or-flight response. How was natural selection likely involved in the development of this behavior that can be observed in humans today?
- A** Individuals showing fight-or-flight behavior were more likely to survive than individuals lacking the trait. This trait was randomly selected by natural selection, and thus became preferentially incorporated into the human lineage.
- B** Individuals showing fight-or-flight behavior were more likely to survive than individuals lacking the trait. Sudden, inheritable changes were naturally selected for, which included the fight-or-flight behavior, even though individuals with the trait were less likely to reproduce. Thus, this response was incorporated into the human lineage.
- C** Individuals showing fight-or-flight behavior were more likely to survive than individuals lacking this trait. Therefore, surviving individuals passed on their trait to offspring while nonsurviving individuals do not. Thus, this response became incorporated into human lineage.

- D** Individuals showing fight-or-flight behavior were not more fit than individuals lacking this trait. However, the trait was selected by natural selection due to a random chance event in the gene frequency of individuals showing fight-or-flight behavior.

Solution The solution is (C). Human ancestors and early humans were constantly exposed to natural dangers such as predators they had to defend against in order to survive. Those individuals with the genetic material allowing them to respond quickly by running away from danger or standing their ground and fighting were more likely to survive than individuals who lacked these traits. The surviving individuals passed on the fight-or-flight traits to their offspring, while the nonsurviving individuals passed on none of their traits. Thus, the fight-or-flight response became preferentially incorporated into the human lineage.

- 76** A researcher studying minnows, a type of fish, kept two groups of 20 fish in separate containers. The containers were linked by a pair of small tubes outfitted with a pump that constantly circulated water between both tanks. The researcher observed both groups of fish after placing a larger fish known to be a predator of minnows into one of the tanks. Fish in both tanks demonstrated alarm behavior.

How can you explain these observations?

- A** Fish in the tank that received the predator released alarm signals in chemical form. These compounds circulated and reached the other tank, eliciting an alarm response from the fish there nonetheless.
- B** Fish in the tank that received the predator released alarm signals in the form of electrical signals. These compounds circulated and reached the other tank, eliciting an alarm response from the fish there nonetheless.
- C** The predator introduced in one tank of fish released alarm signals in chemical form. These compounds circulated and reached the other tank, eliciting an alarm response from the fish there nonetheless.
- D** Fish in the tank that did not receive the predator released alarm signals in the chemical form. These compounds circulated and reached the other tank and elicited an alarm response from the fish.
- 77** In some species, males expend a great deal of energy in courtship rituals, whereas males of other species expend much less energy using other ways of attracting mates such as producing colorful plumage. What does this mean for any energy that leftover males of these species might have to devote to care for offspring?
- A** Males of species carrying out courtship rituals are more likely to assist in parental care whereas males that use colorful plumage to attract mates are less likely to assist with the parental care.
- B** Males of species carrying out courtship rituals are more likely to assist in parental care whereas males that use colorful plumage to attract mates are more likely to assist with parental care because they have more energy available.

- C** Males of species carrying out courtship rituals as well as species of males that use colorful plumage to attract mates both are likely to assist with parental care.
- D** Males of species carrying out courtship rituals as well as species of males that use colorful plumage to attract mates are both unlikely to assist in parental care as the females would be involved.

Solution The solution is (B). In the species of males that carry out courtship rituals, there would be less energy available for caring for young. These species probably use most of their reproductive energy to mate with females, rather than assisting with parental care. In the species of males that use colorful plumage to attract mates, there would be more energy available in the male's reproductive energy budget to assist with parental care.

- 78** Female spotted sandpipers fight each other for resource-rich territories on their beach breeding grounds. Based on this, which mating type would most likely be operating in this species?
- A** Polyandrous mating is most likely operating as the females establish territories apart from other females. The females will then attract males to the resources they control, resulting in many males attracted to few females with the richest territories.
 - B** Polygynous mating is most likely operating as the females establish territories apart from other females. The females from all territories would attract males to the resources they control, resulting in few males attracted to many females in each territory.
 - C** Polyandrous mating is most likely operating as the females establish territories apart from other females. The females from all territories would attract males to the resources they control, resulting in few males attracted to many females in each territory.
 - D** Polygynous mating is most likely operating as the females establish territories apart from other females. The females will then attract males to the resources they control, resulting in many males attracted to few females with the richest territories.
- 79** Which option describes Pavlov's dog experiments as an example of classical conditioning?
- A** Pavlov demonstrated classical conditioning through a maze running experiment with the dog. The motivation for the dog to work its way through the maze was a piece of food at the end of the maze. The dog ran in one trial per day and had food available at the end of the run.
 - B** Pavlov hung a chicken piece in a cage too high for the dog to reach and several boxes were placed randomly on the floor. Eventually the dog was able to stack the boxes and climb on top to get the chicken piece through classical conditioning.
 - C** Pavlov put a dog in a large box that contained a lever that would dispense food to the dog when pressed. While initially the dog would push the lever a few times by

accident, it eventually associated pushing the lever with getting the food through classical conditioning.

- D** Pavlov sounded a bell whenever food was presented to a dog, which produced saliva in response to the sight or smell of the food. Through classical conditioning, the dog started responding to the bell ringing with salivation as the dog came to associate the bell sound with the arrival of food.

Solution The solution is (D). Pavlov sounded a bell whenever food was presented to a dog. The dog had the involuntary reaction of producing saliva in response to the sight or smell of the food. But through classical conditioning, the dog also responded involuntarily by salivating whenever it heard the bell ringing because the dog came to associate the bell sound with the arrival of food.

TEST PREP FOR AP[®] COURSES

- 80** A researcher has been tracking a population of turtles. The researcher marked 200 young turtles just after hatching. A year later, collection data reveal that about 80 percent survived. A year after that, collection data revealed that about 60 percent of the original group was still living. After a third year, about 40 percent could be found alive.

What do these data say about the survivorship curve that would best describe this population? Explain your reasoning

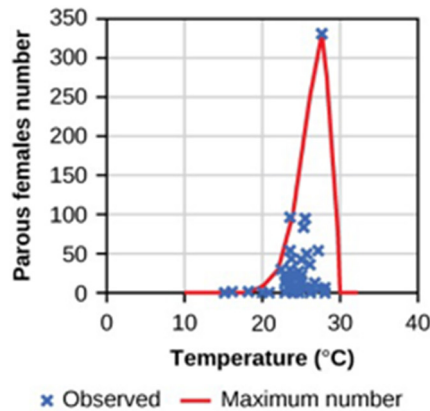
- A** Type II survivorship curve because the number of survivors decreases by the same value (20 percent) every year
- B** Type I survivorship curve because the number of survivors decreases by the same value (20 percent) every year
- C** Type II survivorship curve because the number of survivors increases by the same value (20 percent) every year
- D** Type IV survivorship curve because the number of survivors decreases by the same value (20 percent) every year
- 81** After discovering a new species of salamander in a forest ecosystem, a researcher set traps at many different locations within the forest and collects data from his traps. The researcher's goal was to determine which types of environments within the forest the salamander is most likely to be found.

What is another scientific question the researcher can answer using the data he has already collected to further refine his study of this species?

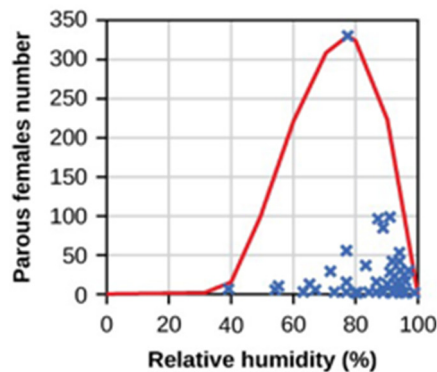
- A** What is the population distribution of this salamander species in this ecosystem?
- B** What is the rate of population growth of this salamander species in this ecosystem?
- C** Which animal species prey on this salamander species in this ecosystem?
- D** What abiotic resources are essential for the survival of this salamander species in this ecosystem?

Solution The solution is (A). The researcher can use the data to determine population density throughout the forest, and determine distribution through the ecosystem. Additional data would be needed in order to determine growth rate, predators, and abiotic resources needed.

- 82** These graphs summarize data collected in an area of Brazil between 2005 and 2006. Researchers captured mosquitos and counted the number of parous females. Parous females are females that produced viable offspring.



(a)



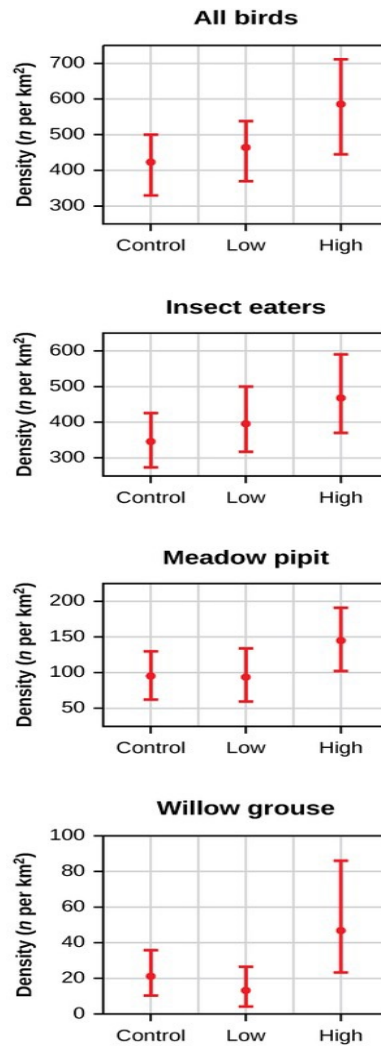
(b)

(credit: Revista da Sociedade Brasileira de Medicina Tropical)

Based on the information given, how would mosquito populations change in Brazil if the climate shifted to very hot (above 30 °C) and very dry (below 60 percent humidity) conditions for an extended period of time? Explain your reasoning.

- A** The mosquito populations would decrease at temperatures above 30 °C, as this is the upper limit for parous females, leading to a drop in offspring production. Not much change would be seen in the population of mosquitoes if the humidity dipped below 60 percent without a temperature change.
- B** The mosquito populations would decrease, possibly reaching zero. As temperatures above 30 °C are the upper limit for parous females, offspring production would drop. Drier conditions would have the same effect.

- C** The mosquito populations would stay the same because temperature above 30 °C and humidity below 60 percent is close to the favorable conditions of offspring production by parous females.
- D** The mosquito populations would stay the same at temperatures above 30 °C as higher temperatures will not affect the production of viable offspring by parous females. Drier conditions, below 60 percent humidity, would cause a drop in the population as it is the lower limit for offspring production.
- 83** Researchers were interested in answering the question, “How does sheep grazing affect the population densities of wild mountain birds?” To answer this question, the researchers counted population numbers of various birds in areas of low intensity sheep grazing and in areas of high intensity sheep grazing. A third set of data was collected from control areas in which no sheep grazing occurred. The results of this study are shown in these graphs.



(credit: The Royal Society Publishing: Biology Letters)

All of the bird species eat insects as their primary source of nutrition. The group labeled *insect eaters* combines many species because the numbers for individual species were too small to show separately as shown for the meadow pipit and willow grouse, which are both highly abundant. Because all of the birds are insect eaters, which scientific question related to this fact could the researchers ask to refine their study even further?. Explain your reasoning.

- A** Does sheep grazing make insects more available to birds? This question refines the question about how sheep grazing affects bird populations because it asks more specifically how sheep grazing changes the food availability for the birds.
- B** How does sheep grazing make insects more available to birds? This question refines the question about how sheep grazing affects insect populations because it asks more specifically how sheep grazing changes the food availability for the insects.
- C** Does sheep grazing make insects more available to birds? This question refines the question about how sheep grazing affects bird populations because it asks more specifically how sheep grazing changes the food availability for the insects.
- D** How does sheep grazing make insects more available to birds? This question refines the question about how sheep grazing affects bird populations because it asks more specifically how sheep grazing changes the food availability for the insects.

Solution The solution is (A). The researchers could ask the question, “Does sheep grazing make insects more available to birds?” This question refines the question of how sheep grazing affects bird populations because it asks more specifically how sheep grazing changes the food availability for the birds, which has an effect on the bird populations.

- 84** A pond ecosystem in an open field begins to be shaded by the growth of trees around its perimeter. Which statement predicts changes in this pond after the trees grow large enough to completely shade the pond?
- A** The population sizes of all organisms will decrease in response to lower energy flowing into the pond.
 - B** The population densities of all organisms will increase in response to lower temperatures in the pond.
 - C** The population distributions of large organisms will shift from clumped to random in response to lower energy flowing into the pond.
 - D** The population distributions of small organisms will shift from uniform to clumped in response to lower temperatures in the pond.
- 85** A researcher has been studying a wildflower population growing in a large meadow. The researcher counts individual plants and mapped their locations. Analysis of the data reveals that the wildflower has a uniform population distribution. This result prompts the researcher to ask a new scientific question to further refine his understanding of the ecology of this plant species.

What is a scientific question the researcher might ask that is directly prompted by his first set of findings?

- A When does this plant species flower and how does it attract pollinators?
- B Does this wildflower species have any adaptations that function to defend the plant against herbivores?
- C Which species of insects and/or birds are pollinators for this wildflower species?
- D Does this wildflower species secrete any chemical compounds that inhibit growth of others of its species?

Solution The solution is (D). Does this wildflower species secrete any chemical compounds that inhibit growth of others of its species? This would be a likely cause for their uniform population distribution because each individual would kill plants immediately around it.

- 86** Fruit flies are found in many different areas in the world. Fruit flies that are resistant to cold temperatures tend to have decreased fecundity at early ages compared to flies that are not capable of surviving the cold.

Which statement explains a likely reason for why this set of traits is observed? (credit: Anthony Zera Publications)

- A Fruit flies having traits that traded early reproductive energy for greater storage of energy in their bodies were favored via natural selection because they survived the cold better than flies that did not have these traits.
 - B In cold conditions, fruit flies have less need for reproduction than in warm conditions and so energy normally used for reproduction is diverted to other survival functions.
 - C Fruit flies respond to weather conditions to shift their energy resources to either storage in their bodies in the cold or to reproduction when conditions become warm again.
 - D All fruit flies have the same genetic makeup, but express different patterns of genes under different conditions, which results in expression of certain genes for cold conditions and others for warm conditions.
- 87** Female parasitoid wasps lay their eggs inside the bodies of caterpillars. The caterpillars die when the eggs hatch, and the young wasps feed on the body of the caterpillar. Egg-laying females of two species of parasitoid wasps were studied in special growth chambers in which a food source was either provided or omitted. This table summarizes some of the data collected.

| | % Females laying eggs in host | % Viability of young | Longevity of female parent (days) |
|-----------------------------------|-------------------------------------------|-------------------------------|-----------------------------------------------|
| Species A | | | |
| Mated females without food | 23.5 | 92.5 | 2.6 |
| Mated females with food | 83.5 | 95.2 | 7.8 |
| Species B | | | |
| Mated females without food | 0.0 | – | 2.0 |
| Mated females with food | 68.9 | 95.3 | 6.9 |

(credit: Brazilian Archives of Biology and Technology)

Which statement is most consistent with these data?

- A** When energy availability is low, females put more energy than normal into producing offspring.
- B** When energy availability is high, females produce offspring with higher viability.
- C** When energy availability is low, females shift energy away from reproduction and toward their own survival.
- D** When energy availability is high, females cannot both produce viable offspring and maintain their own survival.

Solution The solution is (C). When energy availability is low, females shift energy away from reproduction and toward their own survival. The percentage of mated females in the environment without food, and energy is not available, is low or absent in both species.

- 88** During breeding season, many female elk mate with males, but not all mated females become pregnant. Female elk having body fat less than 6 percent were found to have greatly reduced chances of becoming pregnant than female elk having body fat above 10 percent. How was natural selection likely involved in establishing this trait in elk?
(credit: USGS Northern Prairie Wildlife Research Center)

- A** Through natural selection, female elk that did not have the energy reserves to carry a pregnancy to term and did not become pregnant died whereas those elk that became pregnant anyway were favored.
- B** Natural selection favored the selection of traits preventing pregnancies in female elk with low fat reserves, so this trait has become predominant in natural elk herds observed today.
- C** Natural selection randomly changes the frequency of genes allowing traits preventing pregnancies in female elk with low fat reserves to be favored.
- D** Natural selection leads to a sudden inheritable change in the genome of the female elk, ensuring female elk with very high fat reserves can effectively carry out pregnancy.

- 89** Research on elk in Yellowstone National Park was conducted to determine how body condition affects survival of the elk over the winter months. It was found that the probability of survival of female elk is greater when they have accumulated 15 percent or more body fat by the end of fall. Female elk with body fat less than 10 percent in late fall were found to be at high risk of not surviving the winter.

Why is this pattern likely to be observed? (credit: USGS Northern Prairie Wildlife Research Center)

- A** In winter, the availability of food decreases. So, there needs to be a certain threshold level of energy their bodies store in the form of fat to ensure their survival.
- B** In winter, the availability of food increases. So, there should be a certain threshold level of energy in their bodies stored in the form of fat to ensure their survival.
- C** In winter, elk's requirement for food increases due to increase in metabolic activities even though availability of food increases. So, there should be a certain threshold level of energy in their bodies stored in the form of fat to ensure their survival.
- D** In winter, elk release more energy. So, there should be a certain threshold level of energy in their bodies stored in the form of fat to ensure their survival.

Solution The solution is (A). In winter, the availability of food decreases as many plants do not survive the cold and plants that do survive are covered by heavy snow. This means elk cannot take in as much energy on a daily basis during winter as they do during the warmer months. Their bodies must rely on energy reserves stored in the form of fat to sustain survival during the winter. If an elk does not have a certain threshold level of fat to sustain itself, then it dies in winter because it will not find enough food to make up for the difference needed for survival.

- 90** The table contains birth rates and death rates for populations of several species living in the same ecosystem. Analyze the data.

| Species | Birth rate (N/year) | Death rate (N/year) |
|---------|---------------------|---------------------|
| A | 1845 | 1467 |
| B | 43 | 79 |
| C | 2800 | 2115 |
| D | 16 | 16 |
| E | 933 | 1351 |

Which populations(s) experience a negative change in population size?

- A Species A only
 - B Species A and species C
 - C Species B and species D
 - D Species B and species E
- 91 The data in the table were collected on the population size of a species of plant growing in a region during the years after a flood destroyed the area.

| Year after flood | Number of individuals |
|------------------|-----------------------|
| 1 | 5 |
| 2 | 10 |
| 3 | 16 |
| 4 | 25 |
| 5 | 36 |
| 6 | 58 |
| 7 | 82 |
| 8 | 99 |
| 9 | 110 |
| 10 | 116 |
| 11 | 120 |
| 12 | 122 |
| 13 | 121 |
| 14 | 122 |

What do the data indicate about this population?

- A** The plant population grew exponentially throughout the years as the numbers of individuals increased at an exponential rate. The population eventually became stable after reaching a maximum number of around 120 individuals, which could be the carrying capacity of the environment.
- B** The population grew exponentially in the first few years and later became logistic as the rate slowed down. The population eventually became stable after reaching a maximum number of around 120 individuals, which could be the carrying capacity of the local environment.
- C** The plant population grew logistically throughout the years as the growth rate of the population slowed down. The population eventually became stable after reaching a maximum number of around 120 individuals, which could be the carrying capacity of the environment.
- D** The population grew exponentially in the first few years and later became logistic as the rate slowed down. The population eventually became stable after reaching a number of around 116 individuals, which could be the carrying capacity of the environment.

Solution The solution is (B). The data show the plant population grew exponentially in the first few years after the flood, but the rate slowed down and growth became logistic. The population eventually became stable after reaching a maximum number of around 120 individuals. This number could reflect the carrying capacity of the local environment for the plant.

- 92** It has been suggested a population of a flowering plant is being jeopardized by population declines in a butterfly species thought to be the primary pollinator of the plant. Which data could best be used to either justify or refute this suggestion?
- A** Nectar energy provided to the butterfly species per visit to a flower of the plant species in a field
 - B** Number of fruits produced per flower of plants in a section of a field screened off from access by the butterfly species
 - C** Number of butterfly visits per flower per day in various fields throughout the growing range of the plant
 - D** Species of flowers visited by individual butterflies in a field and frequency of visits to each flower species
- 93** A conservation group has claimed that the introduction of logging into a forest ecosystem will decrease the carrying capacity of trout living in a stream within the ecosystem. Which data could be used to either justify or refute this claim?
- A** Growth rate of trout in the stream before and after logging
 - B** Death rate of trout in the stream after the introduction of logging
 - C** Number of trout in the stream after the introduction of logging

D Number of trout in the stream before and after logging

Solution The solution is (D). These data will directly compare how the population changes as a result of introducing logging into the ecosystem, which will give an indication as to whether the claim is justified.

- 94** Which statement predicts how human population change in the next 50 years is likely to affect marine ecosystems?
- A** Humans will decrease their own carrying capacity, which will also decrease the carrying capacities of marine ecosystems.
 - B** Decreased fishing can be expected, which will lead to rebounds in fish populations and healthier marine ecosystems.
 - C** Increases in greenhouse gas emissions are likely, with increases in ocean temperatures that trigger shifts in marine populations.
 - D** Biodiversity of marine ecosystems will increase as humans use engineering to increase food production in the oceans.
- 95** How can the quantity of waste from human activities be expected to change in the next 50 years? Why? Explain how that change could impact a specific ecosystem.
- A** The amount of waste generated by human activities will increase exponentially as the human population continues to increase exponentially. Removal of waste would require a decrease in habitats, which will lead to a decrease in populations of species dependent on those habitats.
 - B** The amount of waste generated by human activities will increase exponentially as the human population continues to increase exponentially. Removal of waste will require an increase in habitats, which will lead to an exponential increase in populations of species dependent on those habitats.
 - C** The amount of waste generated by human activities will decrease exponentially as the human population continues to increase exponentially. Removal of waste would require an increase in habitats, which will lead to exponential increase in populations of species dependent on those habitats.
 - D** The amount of waste generated by human activities will decrease exponentially as the human population continues to increase exponentially. Removal of waste will require a decrease in habitats, which will lead to decrease in populations of species dependent on those habitats.

Solution The solution is (A). The amount of waste generated by human activities will increase exponentially as the human population continues to increase exponentially. Humans will want to remove this waste from the areas where they live and work and so it will be transported into natural areas such as forests that are transformed into landfills. By transforming forests into landfills, humans will cause decreases in habitats, which will lead to decreases in populations of species dependent on those habitats.

- 96** A company wants to establish suspended cultures of mussels in a natural estuary from which they can farm mussels in a sustainable enterprise. The suspended cultures would keep the mussels contained for easy capture, but would allow free flow of estuary waters in and out of the cultures. The company wants to know the maximum number of mussels they can farm each month and maintain a sustainable system. A biologist has suggested that the limiting factor for mussels in this specific environment is the amount of phytoplankton that the mussels feed on.

Which data could best be used to either justify or refute this suggestion?

- A** Rates of growth of newly established mussel cultures in a lab under different phytoplankton concentrations
 - B** Phytoplankton population changes in the estuary as a function of intensity and duration of sunlight exposure
 - C** Biomasses of natural mussel populations and phytoplankton populations in the estuary determined at many different times
 - D** Lab measurements of phytoplankton biomass in response to added mussel population numbers
- 97** A nonvenomous species of snake has a wide geographical range. In one region, the species has dull coloration. In another region, the species exhibits bright coloration that resembles a local venomous species of snake. A hypothesis has been proposed that the bright coloration is an adaptation to defend against predation, an example of Batesian mimicry. Which statement describes an experimental design that could be used to most directly test this hypothesis?
- A** Run field tests in which dull individuals and brightly colored individuals are captured and switched into the other's territory to see how many of each survive.
 - B** Run field tests in which video cameras are set up to record predators capturing dull individuals and brightly colored individuals in their native territories.
 - C** Run laboratory tests in which predators familiar with the venomous snake are offered dull individuals and brightly colored individuals to see if the predators show a preference.
 - D** Run laboratory tests in which predators familiar with the dull colored nonvenomous snake are offered venomous brightly colored individuals and nonvenomous brightly colored individuals to see if the predators show a preference.

Solution The solution is (C). The proposed hypothesis would predict that the predators familiar with the venomous snake coloration would avoid all snakes with that coloration, regardless of the actual ability of the snake to use venom.

- 98** Frogs are amphibians and most species spend time both on land and in water. Female frogs are vulnerable to predation by fish when they enter the water to lay eggs. A hypothesis has been proposed that frogs rely on chemical detection of predators in

addition to visual detection. In other words, frogs detect the presence of predator fish by chemicals released by fish into the water.

What best describes a design for an experiment to test this hypothesis?

- A** Arrange containers of water in which water can be freely shared between two compartments. Fish are contained within one compartment and frogs in another such that the frogs on one side cannot see or hear fish on the other side. Observe and compare the egg-laying behavior of female frogs in the presence and absence of predator fish in the fish tank.
- B** Arrange containers of water in which water can be freely shared between two compartments. Fish and frogs are contained within one compartment such that frogs cannot see or hear fish. Observe and compare the egg-laying behavior of female frogs in the presence and absence of predator fish.
- C** Arrange containers of water in which water can be freely shared between two compartments. Fish and frogs are contained within one compartment such that frogs can see or hear fish. Observe and compare the egg-laying behavior of female frogs in the presence and absence of predator fish in the fish tank.
- D** Arrange containers of water in which water can be freely shared between two compartments. Fish are contained within one compartment and frogs in another such that frogs on one side can see or hear fish on the other side. Observe and compare the egg-laying behavior of female frogs in the presence and absence of predator fish in the fish tank.
- 99** A biologist studied two populations of the same species of a small fish living in different locations in the same tropical stream. He noticed that adult male fish were either spotted or unspotted and made careful counts of the two variants in the two stream locations in 1998. He repeated his population studies 10 years later. The table summarizes the data.

| | Unspotted males | Spotted males |
|------------|-----------------|---------------|
| 1998 | | |
| Upstream | 244 | 742 |
| Downstream | 368 | 1165 |
| 2008 | | |
| Upstream | 298 | 791 |
| Downstream | 1086 | 205 |

Which hypothesis accounts for these data?

- A** A new prey species of the fish established itself only in the downstream portion of the stream between 1998 and 2008.
- B** A new prey species of the fish established itself only in the upstream portion of the stream between 1998 and 2008.

- C** A new predator of the fish established itself only in the downstream portion of the stream between 1998 and 2008.
- D** A new predator of the fish established itself in both the upstream and downstream portions of the stream between 1998 and 2008.

Solution The solution is (C). A new predator of the fish established itself only in the downstream portion of the stream between 1998 and 2008. This predator is more likely to consume spotted males, which caused the downstream population of spotted males to be much smaller in size in 2008.

- 100** A species of marine snail is found in shallow waters near coastlines. This snail feeds on detritus on the ocean bottom. Researchers noticed that snails in one area had a mottled appearance, while snails in another area were solid in color. The researchers set up areas in each region for study and then released both mottled and solid snails into the solid snail region and released both mottled and solid snails into the mottled snail region. The survival rate of each variant was measured. Results are summarized in this table.

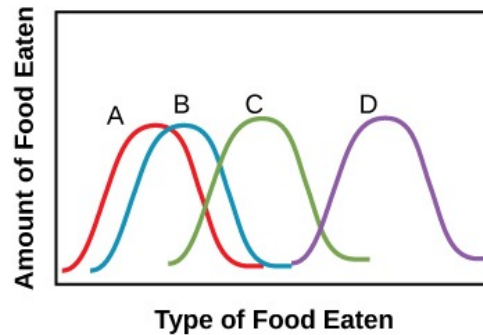
| | Survival Rate | |
|----------------|------------------------------------|----------------------------------|
| | Released into mottled snail region | Released into solid snail region |
| Mottled snails | 95% | 5% |
| Solid snails | 22% | 93% |

Which hypothesis accounts for these data?

- A** A possible hypothesis is that the coloration of the snail is dependent on environmental conditions. Camouflage in both mottled and solid snails is best during optimum environmental conditions and does not change according to the region in which they are placed.
- B** A possible hypothesis is that the coloration of the snail is an adaptation in the form of camouflage to protect the snail from predators in the region it is invading. Mottled snails are best camouflaged in the solid snail region and stand out to predators and suffer greater predation when placed in their native region.
- C** A possible hypothesis is that the coloration of the snail is an adaptation in the form of camouflage to protect the snail from predators in its native region. Mottled snails are best camouflaged in their native region and stand out to predators and suffer greater predation when placed in the region normally occupied by solid snails.
- D** A possible hypothesis is that the coloration of the snail is an adaptation in the form of camouflage to protect the snail from predators in its native region. Solid snails are best camouflaged in mottled snail region and are more obvious to predators when placed in their native region.

Advanced Placement Biology Student's Solution Manual

- 101** The graph summarizes data concerning four different species of lizards that inhabit tropical habitats.



Which statement predicts how these species will be able to coexist if they inhabit the same region of a tropical habitat?

- A** All species will coexist with one another because they consume the same amounts of food.
- B** Species A, B, and C will best coexist because of their similarities in amount and type of food eaten.
- C** Species A and B will best coexist because they have the most overlap in diet.
- D** Species D will best coexist with any one of the other species because this species eats completely different types of food.

Solution The solution is (D). Species D will best coexist with any one of the other species because this species eats completely different types of food. The graph shows a distribution for species D that does not overlap with species A, B, or C.

- 102** Warblers are a group of small songbirds consisting of many species. The table summarizes data collected on the diets of two species of warblers. In addition, both species A and B use the same types of nesting materials and sites for building nests.

| | Insects | Nectar | Worms |
|-----------|---------|--------|-------|
| Species A | 95% | 5% | 0% |
| Species B | 92% | 3% | 5% |

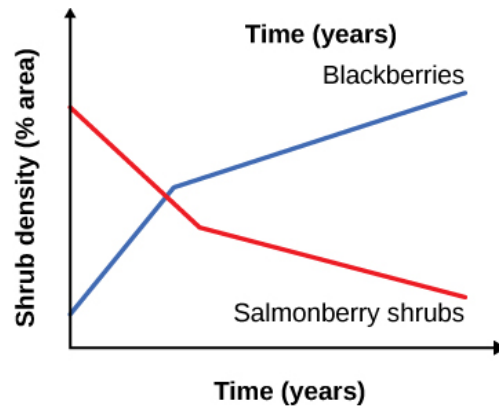
A biologist observes that species A and species B primarily inhabit different regions of a forest in western Canada. During a forest fire that wiped out the region it inhabited, species B fled to the region inhabited by species A.

What is likely to happen to these two species in the future?

- A** Both the species will survive because of difference in needs for food.
- B** Species A will increase in population whereas species B will remain same due to the overlapping needs for food.

- C** Unless the species can modify their diets, it is likely that only one of these species will survive in this region due to the difference in needs for food. The species that loses will either die off or migrate to another region.
- D** Unless the species can modify their It is likely that only one of these species will survive in this region due to the overlapping needs for food. The species that loses will either die off or migrate to another region.

- 103** Himalayan blackberries are an invasive species that has spread in the forest of the Pacific Northwest. The plants develop thick tangles of cane covered with thorns that cover ground with a tight mat. Ecologists hypothesized that Himalayan blackberries displace native species of shrubs by reproducing faster and reducing areas available for growth. They recorded the density of blackberries and native salmonberries, a native shrub, along a creek for several years. The percentage areas of ground covered by blackberries and native shrubs were plotted over time, as shown in the graph.



Based on the graph, what statement best explain the role of blackberries on the ecosystem studied?

- A** Blackberries promote the growth of salmonberry shrubs.
- B** Blackberries and salmonberry shrubs do not interfere with each other's growth.
- C** Salmonberry shrubs prevent the growth of blackberries.
- D** Blackberries displace salmonberry shrubs.

Solution The solution is (D). Blackberries are an invasive species that outcompete native shrubs. As blackberries spread, the density of native shrubs decreases.

- 104** Which statement best predicts how ecosystems in the northernmost land regions will be affected by human population change in the next 50 years?
- A** Biodiversity of these northernmost regions will remain constant as humans will find other more habitable locations to house their growing numbers.
- B** The populations of organisms presently inhabiting these regions will shift as global warming causes many species to decline and new species to move in.

- C The carrying capacity of these regions for humans will decrease as the human population increases exponentially.
- D Ecosystems can be expected to remain untouched by humans as new technologies are developed to sustain a growing population.

105 A researcher is interested in investigating whether the croaking pattern produced by males in a frog species is a learned behavior or an innate behavior. What would best help the researcher answer this question?

- A Genetic analyses of adult male frogs raised in isolation and in multigenerational frog communities
- B Field observations of adult frogs in their native habitat during mating season
- C Video recordings of individual frogs raised in large multigenerational frog communities
- D Audio recordings of individual frogs at sexual maturity after being raised in total isolation

Solution The solution is (D). Comparison of audio recordings of individual frogs at sexual maturity after being raised in total isolation with frogs raised in normal conditions would indicate the role of learned behavior in the development of the croaking pattern.

106 A biologist hypothesizes birds of various species recognize the predator warning calls of other bird species. The biologist has established several feeders in a forest where birds come to feed regularly. They are spread out over a wide area, making it difficult to observe all of the boxes at the same time.

How can the biologist use this site to collect data to test his hypothesis?

- A The biologist can use video cameras to record the behavior of birds coming to the feeders.
- B The biologist can leave an audio recorder near the feeders.
- C The biologist can record the behavior of birds by comparing them with other birds using video cameras.
- D The biologist could observe the birds continually for 1 month.

107 Yellow buntings are birds that feed on butterflies, including *Aglaisurticae*, a species of butterfly that has bright circular coloring on its wing called an eyespot. Biologists have hypothesized that eyespots mimic owl eyes. Owls are predators of yellow buntings.

In laboratory experiments using yellow buntings captured from the wild and held in captivity, individual birds were observed during sessions in which they were given butterflies that had either not been treated or had been treated to remove their eyespots. Yellow buntings were scored according to whether they showed fleeing behavior when they encountered butterflies of both types. The data were compiled in this table.

| | Yellow bunting encountered and fled | Yellow bunting encountered and attacked | Total encounters |
|-----------------------------|-------------------------------------|-----------------------------------------|------------------|
| Butterflies with eyespot | 9 | 19 | 28 |
| Butterflies without eyespot | 0 | 18 | 18 |

How do these data support the claim that one species' response to information can affect natural selection in another species?

- A** Comparison of the total number of encounters shows that more birds responded to the eyespot, a trait that will likely be selected against in natural populations of the butterfly.
- B** Comparison of the number of birds attacking butterflies with and without eyespots suggests that the presence of an eyespot makes butterflies more visible to predators resulting in selection against the trait.
- C** Comparison of the number of birds fleeing from butterflies with and without eyespots indicates that the eyespot trait has been disfavored because this trait makes the butterflies stand out to predators.
- D** Comparison of the number of birds fleeing from butterflies with and without eyespots suggests that selection has occurred in butterflies in favor of the eyespot trait, which mimics a predator of the bird.

Solution The solution is (D). Comparison of the number of birds fleeing from butterflies with and without eyespots suggests that selection has occurred in butterflies in favor of the eyespot trait, which mimics a predator of the bird. A higher percentage of birds fled from butterflies with eyespots that mimic the predator of the bird.

- 108** Biologists analyzed the sound frequencies of different calls made by a small bird species that serve as prey for a much larger predator bird species. The small bird makes three different kinds of calls: a mobbing call that a group of adults make when mobbing a single predator bird in defense of their nests, a scolding call that a single bird makes to scold a predator bird perched nearby, and a warning call that a single bird makes to warn other birds when a predator bird flies into the vicinity. A table was created to summarize the data from this analysis and also show the range of sound frequencies audible to the prey and predator species.

| Calls made by small bird | Call sound frequency | Small bird hearing range (1–10 kHz) | Large bird hearing range (1–4 kHz) |
|--------------------------|----------------------|-------------------------------------|------------------------------------|
| Mobbing call | 4.5 kHz | Yes | Yes |
| Scolding call | 4 kHz | Yes | Yes |
| Warning call | 7–8 kHz | Yes | No |

(credit: Behavioral Ecology and Sociobiology)

How do these data support the claim that communication of information affects natural selection in the small bird species?

- A** A scolding call made by small birds can be heard by large predator birds, which is required to scold away the birds; therefore, this trait is favorable and has been naturally selected.
 - B** The mobbing call made by small birds can be heard by large predator birds; therefore, small birds cannot defend their nests without the predators knowing. This unfavorable trait is thus naturally selected.
 - C** The warning call made by small birds cannot be heard by large predator birds, giving the small birds an advanced warning. This is an unfavorable trait that gives birds a survival disadvantage.
 - D** The warning call made by small birds cannot be heard by large predator birds, giving the small birds an advanced warning. This is a favorable trait that gives birds a survival advantage.
- 109** Which statement most directly supports the claim that monarch butterfly migration is a regulated event?
- A** Monarch butterflies fly up to 3,000 mi from their summer habitat in North America to their winter habitat in Mexico.
 - B** Because the life span of a monarch butterfly is so short, not every generation of monarch migrates.
 - C** Monarch caterpillars feed on milkweed while adult butterflies feed on flower nectar.
 - D** Changes in day length trigger hormonal and nervous system changes in monarchs that result in behavioral changes.

Solution The solution is (B). Triggers such as changes in day length lead to hormonal and nervous system changes in monarchs that result in behavioral changes, including migration.

- 110** What evidence supports the claim that the timing of entry into hibernation by grizzly bears is regulated?
- A** Grizzly bears go into hibernation at the end of winters. This observation provides evidence that there is some environmental cue that triggers physiological changes in bears.
 - B** Grizzly bears do not go into hibernation at the beginning of autumn. This observation provides evidence that there is some environmental cue that triggers physiological changes in bears.
 - C** Grizzly bears go into hibernation at random times during the year. This observation provides evidence that there is some environmental cue that triggers physiological changes in bears.
 - D** Grizzly bears do not go into hibernation at random times during the year. This observation provides evidence that there is some environmental cue that triggers physiological changes in bears.
- 111** Some animal behaviors can be modified by experience. What accurately predicts how an experiential factor is likely to affect an animal's behavior?
- A** A species of salmon will migrate up the same river regardless of increases in predators that visit these waterways from one year to the next.
 - B** Female elk that had difficult deliveries of calves will continue to mate with males in succeeding mating seasons.
 - C** Bears that receive food from humans are later more likely to break into human habitations than bears that are not approached by humans.
 - D** A bird raised from an egg isolated in a lab environment will give the same alarm call as birds of the same species raised in the wild.

Solution The solution is (C). Bears that receive food from humans are later more likely to break into human habitations than bears that are not approached by humans. The feeding of the bears provides them with experience that modifies their normal behavior.

- 112** Estivation is a type of dormancy that some animals enter during hot, dry periods. Typically, the metabolisms of these animals slow down, their bodies retain water, and they may shift to altered nitrogen metabolism. How would the behavior of an animal such as a lizard change in response to environmental factors that trigger the lizard into entering estivation?
- A** The lizard would sit on a rock to remain protected from predation and water loss. The breathing and heart rate would slow as it begins estivating. Then it would only do critical activities needed to sustain its living state.

- B** The lizard would live in a shaded spot to remain protected from predation and water loss. The breathing and heart rate would slow as it begins estivating. This way a lizard can perform all activities.
- C** The lizard would stay in a shaded spot to remain protected from predation and water loss. Its breathing and heart rate would slow as it begins estivating. Then it would only do critical activities needed to sustain its living state.
- D** The lizard would live in a shaded spot to remain protected from predation and water loss. The breathing and heart rate would increase as it begins estivating. Then it would only do critical activities needed to sustain its living state.
- 113** Many animals produce chemical compounds that function as alarm cues. Researchers interested in determining whether salamanders fall into this group performed the following experiment. Long-toed salamanders were captured from the wild. A few were injured and tissue from their injuries was collected and ground up with water. This solution was used to moisten a paper towel. Others were not injured and placed on moistened paper towels for 48 hours. The moistened paper towels were placed at one end of a rectangular box (stimulus end) and a paper towel moistened with water was placed at the other end (control end). In each test, a salamander was placed in the center and the researchers observed the direction in which the salamander moved. Multiple trials were performed using paper towels moistened with chemicals from injured and noninjured salamanders and the data were compiled into a table.

| Treatment of paper towels | Number of trials where test animals spent the majority of time | | |
|---------------------------|----------------------------------------------------------------|---------|----------|
| | Stimulus | Control | <i>P</i> |
| Non-injured | 12 | 8 | 0.504 |
| Injured | 3 | 17 | 0.002 |

Which statement is an accurate analysis of the data?

- A** This salamander releases chemical compounds during injury that elicit avoidance behavior in members of its own species.
- B** Chemical compounds released from this salamander species during injury elicit attractant behavior in members of its own species.
- C** Both injured and noninjured salamanders produce chemical compounds that elicit avoidance behavior in noninjured salamanders.
- D** There was a statistically significant difference between stimulus and control results from treatment involving noninjured salamanders.
- Solution** The solution is (A). This salamander releases chemical compounds during injury that elicit avoidance behavior in members of its own species. The presence of those

compounds causes a decrease in salamanders in the area of the paper towels treated with the injured salamanders.

- 114** Biologists have observed some animal species making predator warning calls when no predator is in the area. In one species of bird, for example, individuals appeared to perform this behavior as a means for deceiving other birds into fleeing from a food source that the bird making the call was then better able to access.

In investigating the possibility that this bird species uses false alarm calls to improve its access to food, the following experiment was conducted. Researchers set up a bird feeding table in a protected area to attract two species of birds, species A and B. They either clumped food in one concentrated pile on the table, allowing a few birds to feed simultaneously, or dispersed the food in a much wider area under and around the table so that it was available to large numbers of birds. They then observed the number of times an individual in species A gave a predator warning call and whether species B was present at the feeding table. The data collected by the researchers are shown in the table.

| Food dispersion | Presence of species B | Number of species A giving alarm calls | Number of species A not giving alarm calls |
|-----------------|-----------------------|----------------------------------------|--------------------------------------------|
| Concentrated | Present | 10 | 2 |
| Concentrated | Absent | 1 | 11 |
| Dispersed | Present | 2 | 10 |
| Dispersed | Absent | 0 | 12 |

(credit: Ethology)

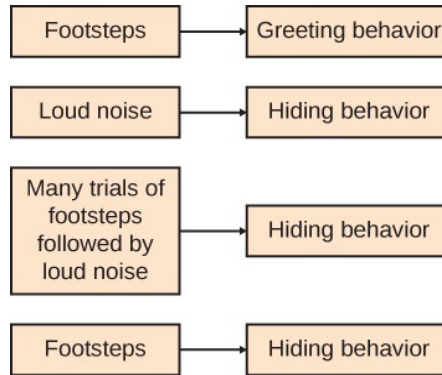
What do the data suggest about the use of deception by species A?

- A** Species A may sometimes use deception in cases when food is plentiful, but concentrated in a way that access is limited to a small group of birds. A bird that had restricted access to the food has open access because of the alarm. The bird only carries out this deceptive behavior in cases where it's necessary.
- B** Species A may sometimes use deception in cases when food is plentiful, but concentrated in a way that access is available to a large group of birds. A bird that had restricted access to the food has open access because of the alarm. The bird only carries out this deceptive behavior in cases where it's necessary.
- C** Species A may sometimes use deception in cases when food is plentiful, but dispersed in a way that access is limited to a small group of birds. A bird that had restricted access to the food has open access because of the alarm. The bird only carries out this deceptive behavior in cases where it's necessary.

Advanced Placement Biology Student's Solution Manual

- D** Species A may sometimes use deception in cases when food is plentiful, but concentrated in a way that access is available to a small group of birds. A bird that had unrestricted access to the food has open access because of the alarm. Deceptive behavior is carried out regardless of whether it is needed or not.

- 115** This representation was created to describe how the behavior of a cat was affected as it was exposed to different stimuli.



Which term describes the process represented by the exposure to footsteps followed by loud noise in this diagram?

- A** Innate behavior
- B** Classical conditioning
- C** Operant conditioning
- D** Cognitive learning

Solution The solution is (B). The cat is exhibiting innate behaviors triggered by external stimuli. This is classical conditioning.

- 116** Elk migrate from summer feeding grounds in high mountain meadows down into lower valleys during winter. What is the order of events that occur to bring about this migration?
- A** Seasonal changes, physiological changes, migration, and behavioral changes, respectively
 - B** Physiological changes, seasonal changes, behavioral changes, and migration, respectively
 - C** Seasonal changes, behavioral changes, physiological changes, and migration, respectively
 - D** Seasonal changes, physiological changes, behavioral changes, and migration, respectively
- 117** Some fish swim in schools, which can respond rapidly by moving quickly away from predator threats. In schools, fish swim in a coordinated pattern without moving chaotically and bumping into one another. Which type of communication between

individuals accounts for the precisely coordinated movements of all of the fish in a school in response to a threat?

- A Aural signals
- B Pheromone signals
- C Tactile signals
- D Visual signals

Solution The solution is (C). Tactile signals are used to communicate swimming patterns.

- 118** In which situation do animals of the same species exchange information in response to an approaching predator? How does information flow between individuals?
- A Herring gulls have a brightly colored bill. When a predator approaches, the parent gull stands over its chick and taps the bill on the ground in front of it, which elicits a begging response from a hungry chick.
 - B Prairie dogs live in underground burrows. If a lookout observes an approaching predator, it gives an aural alarm cry communicating the information to the foraging individuals who then run back to safety.
 - C Herring gulls have a brightly colored bill. When a predator approaches, the parent gull stands over its nest and taps the bill on the ground to elicit a begging response from its chick and therefore warning other gulls.
 - D Prairie dogs live inside the bark of trees. If a lookout observes an approaching predator, it gives an aural alarm cry communicating the information to the foraging individuals who then run back to safety.

SCIENCE PRACTICE CHALLENGE QUESTIONS

36.1 Population Demography

- 119** A flask of nutrient broth, buffered to maintain pH, is inoculated with a strain of *E. coli*. The flask is placed in a constant temperature environment where it is aerated by shaking.
- A. **Predict** the effect of a change in energy availability over time.
 - B. **Represent** the change graphically in terms of the number of cells as a function of time.
 - C. In your graph as time progresses there is a change in the growth rate of the population. Add annotation to your graph to **describe** the time interval during which the growth rate is increasing linearly in proportion to the number of cells. Add annotation to your graph to **describe** another time interval during which the growth rate is decreasing in proportion to the square of the number of cells. Add a third annotation to **describe** an interval of time where the rate of growth is zero.
 - D. **Select and justify** two measurements of the *E. coli* population that could be made at two different points in time during growth that would be sufficient to answer questions predicting the population size at any time.

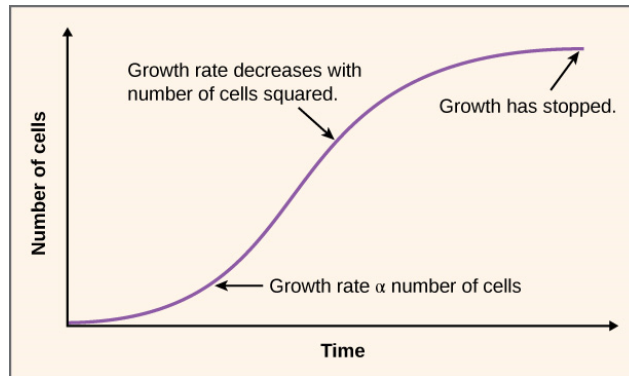
Advanced Placement Biology Student's Solution Manual

E. Describe the population of *E. coli* if the environment was continuously supplemented by additional nutrient broth.

Solution Sample answer:

A. Initially growth is not limited by energy availability. As growth increases, the availability of energy decreases. Eventually growth ceases during to energy limitations.

B. and C.



D. There are only two parameters in the logistic model

- The rate of growth in the low density limit; this can be obtained from measurement of the growth rate very soon after inoculation.
- The limiting population size; this can be obtained from measurement of the density at large times where the growth has ceased.

E. With a continuous addition of new energy resources, the population will grow exponentially for all time.

36.2 Life Histories and Natural Selection

120 The following problem extends the Hardy-Weinberg model of population dynamics that was covered in Chapter 19. It applies mathematics that would be appropriate after a second course in Algebra. While the concepts applied in this problem are within the scope of the Exam, the mathematical representations are not and the item is provided to allow students who are able to take another look at the concepts.

The Hardy-Weinberg model of population dynamics is an algebraic representation of the relationships among genotype frequencies (F), the probability of the dominant allele A (p), and the probability of the recessive allele a (q). The Hardy-Weinberg model of population dynamics is based on several assumptions. One of these assumptions is “random mating.” If all genes in a population are equally able to reproduce, this means that all genes are equally fit and equally fertile. Consequently, the population does not evolve while in Hardy-Weinberg equilibrium.

However, populations do evolve and the Hardy-Weinberg model can be modified slightly to allow evolution to occur. Suppose that there is an initial population at generation zero

and the probability of the dominant allele at that time is p_0 . Later, at population k , the probability is different. If the frequencies of the three different combinations of alleles are known, then the probabilities p_k and q_k can be calculated at generation k .

$$p_k = F_k(AA) + \frac{1}{2}F_k(Aa)$$

$$q_k = F_k(aa) + \frac{1}{2}F_k(Aa)$$

Because p and q are probabilities for a case where only two alleles exist $p + q = 1$.

Additionally, $(p + q)^2 = 1$, leading to the Hardy-Weinberg equation

$$p_k^2 + 2p_kq_k + q_k^2 = 1$$

The gene distribution never changes and $p_k = p_0$.

The equations of the Hardy-Weinberg model were modified (Haldane, 1924) to create a model in which evolution occurs.

$$F_k(AA) = p_k^2 w_{AA} / W$$

$$F_k(Aa) = 2p_kq_k w_{Aa} / W$$

$$F_k(aa) = q_k^2 w_{aa} / W$$

$$W = p_k^2 w_{AA} + 2p_kq_k w_{Aa} + q_k^2 w_{aa}$$

Haldane divides by the factor $W = F_k(AA) + F_k(Aa) + F_k(aa)$ so that the probabilities that are still calculated with

$$p_k = F_k(AA) + \frac{1}{2}F_k(Aa)$$

$$q_k = F_k(aa) + \frac{1}{2}F_k(Aa)$$

to continue to satisfy the condition for p and q to represent probabilities $(p + q)^2 = 1$.

A. Justify Haldane's model in terms of what the factors w_{AA} , w_{Aa} , and w_{aa} mean.

B. Suppose that $w_{AA} = w_{Aa} = 1$, but that $w_{aa} = 0.8$. Predict what will happen to the population over time.

Fitness is determined by the environment. Moree (*The American Naturalist*, 86, 1952) measured the relative fitness in *Drosophila melanogaster* of a recessive allele that imparts black eye color as population density increases. A varying number of flies with an equal number of males and females were placed in a pint jar and progeny counted. In each experiment the population was initially heterozygous.

| Number of females \times Number of males | w_{aa} |
|--------------------------------------------|----------|
| 1 \times 1 | 0 |
| 10 \times 10 | 0.06 |
| 50 \times 50 | 0.11 |
| 150 \times 150 | 0.46 |

C. Apply Haldane's approach to **calculate** the probability p in the first generation after mating 150 female and 150 male flies that are heterozygous using $w_{AA} = w_{Aa} = 1$.

Rendel (*Evolution*, 5, 1951) conducted an investigation of the dependence of fecundity (fertility) on light in ebony-eyed *D. melanogaster*. A summary of some of the data that he reported is shown in the table.

| Phenotype of Male | Fraction of Females Inseminated Light Condition | Fraction of Females Inseminated Dark Condition |
|-------------------|-------------------------------------------------|------------------------------------------------|
| Ebony | 0.215 | 0.607 |
| Wild type | 0.494 | 0.466 |

D. Pose two scientific questions concerning the behavioral response indicated by the data that can be tested experimentally.

37 | ECOSYSTEMS

REVIEW QUESTIONS

- 1 What type of ecosystem is the rarest on Earth, among both terrestrial and aquatic ecosystems?
- A Ocean
 - B Freshwater
 - C Grasslands
 - D Tundra

Solution The solution is (B). Freshwater only composes about 1.8 percent of Earth's surface.

- 2 If an ecosystem is considered to be highly resilient, what can be inferred about that ecosystem?
- A The ecosystem is in a steady state.
 - B The ecosystem has the ability to remain in equilibrium despite disturbance.
 - C The ecosystem recovers quickly from disturbance.
 - D The ecosystem is exposed to disturbances.
- 3 What is a recreated ecosystem in a laboratory environment known as?
- E Mesocosm
 - F Simulation
 - G Microcosm
 - H Duplication

Solution The solution is (C). A microcosm can be developed to analyze ecosystem dynamics in a controlled setting.

- 4 A scientist wants to analyze how grazing by deer alters plant species composition in a forest and sections off a portion of the forest for observation and analysis. What type of system is the scientist using?
- A Mesocosm
 - B Simulation
 - C Microcosm
 - D Duplication
- 5 What term describes the use of mathematical equations in the modeling of linear aspects of ecosystems?

- A Analytical modeling
- B Simulation modeling
- C Conceptual modeling
- D Microcosm modeling

Solution The solution is (A). Analytical modeling employs mathematical models to predict potential changes in ecosystems.

- 6 If a scientist constructs a flow chart to depict the interactions among species in an estuary, what kind of model is she creating?
- A Analytical modeling
 - B Simulation modeling
 - C Conceptual modeling
 - D Microcosm modeling

- 7 What are usually the primary producers in an ocean grazing food web?

- A Plants
- B Animals
- C Fungi
- D Phytoplankton

Solution The solution is (D). Phytoplankton are able to undergo photosynthesis and are abundant in oceans.

- 8 Which statement is true of trophic levels in an ecosystem?
- A Food chains are accurate representations of dynamics in an ecosystem.
 - B In terrestrial ecosystems, primary producers commonly eat plants.
 - C Food webs are easier to interpret than food chains.
 - D The least amount of energy is available at the top of a food chain.

- 9 Where are coral reefs found?

- A Shallow ocean water
- B Deep ocean water
- C Intertidal areas
- D Shallow freshwater

Solution The solution is (A). Coral reefs are found in shallow ocean water as the photosynthetic algae of coral reefs require sunlight.

- 10 What is the weight of living organisms in an ecosystem at a particular point in time known as?

- A Energy
- B Productivity
- C Entropy
- D Biomass

11 If you wanted to measure gross primary productivity in a terrestrial ecosystem, what would you measure?

- A Rate of energy incorporation by plants
- B Energy available after a plant incorporates energy for its own biological functions
- C Amount of energy from plants entering the trophic level of deer
- D Total mass of plants and animals in an area at a given point in time

Solution The solution is (A). Gross primary productivity refers to the rate by which energy is incorporated by primary producers such as plants.

12 What law of chemistry determines how much energy can be transferred when it is converted from one form to another because energy is lost with each transformation?

- A First law of thermodynamics
- B Second law of thermodynamics
- C Conservation of matter
- D Conservation of energy

13 What is the primary factor that limits the length of food chains in ecosystems?

- A Low energy transfer efficiency between trophic levels
- B Too much net primary productivity
- C Excess assimilation
- D Low gross primary productivity

Solution The solution is (A). After a few trophic levels there is a negligible amount of energy that can be transferred.

14 What type of pyramid is considered the most representative of ecosystem structure?

- A Biomass
- B Energy
- C Number of organisms
- D Number of species

15 Why are the numbers of primary producers smaller than the number of primary consumers in the English Channel ecosystem?

- A The apex consumers have a high turnover rate.
- B The primary producers have a low turnover rate.
- C The apex consumers have a low turnover rate.
- D The primary producers have a high turnover rate.

Solution The solution is (B). This would indicate that they reproduce slowly, but have enough biomass to sustain many herbivores.

16 What forms of life use inorganic molecules as an energy source and are found in areas where sunlight is unavailable?

- A Photoautotrophs
- B Chemoautotrophs
- C Primary consumers
- D Secondary consumers

17 What is the process whereby nitrogen is brought into organic molecules?

- A Nitrification
- B Denitrification
- C Nitrogen fixation
- D Nitrogen cycling

Solution The solution is (C). Bacteria process nitrogen into organic molecules by nitrogen fixation.

18 What is a mechanism by which phosphorus is released into the environment?

- A Rock weathering
- B Decomposition of organic molecules
- C Volcanic activity
- D Geothermal vent activity

19 What is produced by eutrophication via excess nitrogen where a hydrologic reservoir lacks normal flora and fauna?

- A Fixation
- B Acid rain
- C Dead zones
- D Nitrification

Solution The solution is (C). In dead zones, oxygen is depleted by excess microorganism growth and thus other organisms can also die.

20 What is a potential consequence of excess phosphorus and nitrogen in an ecosystem?

- A These elements could result in increased global temperatures.
- B Subduction can be promoted.
- C These elements might be fixed in excess.
- D A dead zone could be produced from depleted oxygen.

21 What is the term for freshwater that flows from rain or melting ice in the hydrologic cycle?

- A Residence time
- B Surface runoff
- C Evaporation
- D Sublimation

Solution The solution is (B). Surface runoff flow can make its way into other areas such as rivers and oceans.

22 What most strongly influences how much carbon is present in a given location?

- A Number of bacteria
- B Runoff from the land into bodies of water
- C Eutrophication of bodies of water
- D Exchange of carbon between the atmosphere and water

CRITICAL THINKING QUESTIONS

23 Why does grouping terrestrial organisms into biomes obscure diversity?

- A Biomes group terrestrial organisms only on the basis of similar habitat conditions.
- B Organisms belonging to a similar biome have dissimilarities in their makeup.
- C There is variation within different types of biomes that biome categorization does not capture.
- D Terrestrial biomes are defined based only on the growth form of the dominant vegetation.

Solution The solution is (C). There is variation within different types of biomes that biome categorization does not capture. For example, the Sonoran Desert is very diverse but the desert of Boa Vista is relatively depauperate.

24 Why are mesocosm and microcosm experiments NOT considered to represent the true nature of ecosystems?

- A The ecosystem is either recreated or partitioned in both types of experiments, which may alter the dynamics of the ecosystem the experiments are aiming to analyze.

- B** In both types of experiments, dynamics of the ecosystem may get altered due to differences in species numbers and diversity even though there are no alterations in the environment.
- C** In both types of experiments, the ecosystem is recreated which may alter the dynamics of the ecosystem the experiments are aiming to analyze.
- D** Altering a natural ecosystem through partitioning, which occurs in both types of experiments, may change its dynamics due to differences in species numbers and diversity.

25 If scientists wanted to monitor a desert food chain, what type of model might they develop and why?

- A** An analytical model would be ideal because they can address simple, linear ecosystem components that are mathematically complex.
- B** A simulation model would be ideal because they can address simple, linear systems that are mathematically complex.
- C** An analytical model would be ideal as they are considered ecologically more realistic than any other model.
- D** A simulation model would be ideal because it uses numerical techniques to solve problems and visualize the complex relationships that exist in the ecosystem.

Solution The solution is (A). An analytical model would be ideal because they can address simple, linear ecosystem components, such as food chains, that are still mathematically complex.

26 Compare and contrast food chains and food webs. What are the strengths of each concept in describing ecosystems?

- A** Both food chains and food webs follow a single path as energy is transferred in an ecosystem. Food chains are easier to follow and experiment with but less accurate, whereas food webs are more holistic and complex.
- B** Both food webs and food chains describe energy transfer dynamics in an ecosystem. Food chains are nonlinear systems that are easier to follow and experiment with, whereas food webs are linear, holistic, and can be directly used as input for simulation models.
- C** Both food chains and food webs follow a single path as energy is transferred in an ecosystem. Food chains are linear systems, easier to follow, and used directly as input for simulation models, whereas food webs are nonlinear, accurate, holistic, and flexible for analytical modeling.
- D** Both food webs and food chains describe energy transfer dynamics in an ecosystem. Food chains are linear systems that are relatively easy to follow and use for experiments, whereas food webs are nonlinear, accurate, holistic, and can be directly used as input for simulation models.

- 27** Name one natural and one human-related disturbance. Why are they of concern to conservationists?
- A** Lightning is a type of natural disturbance whereas pollution is a human-related disturbance. Both are of concern to conservationists because they can cause changes to some individual species, but not to entire ecosystems.
 - B** Fire is a type of natural disturbance whereas agriculture is a human-related disturbance. Both types are of concern to conservationists because ecosystems cannot bounce back from a disturbance.
 - C** Pollution is a type of natural disturbance whereas lightning is a human-related disturbance. Both are of concern to conservationists because they alter ecosystems.
 - D** Lightning is a type of natural disturbance whereas pollution is a human-related disturbance. Both are of concern to conservationists because they alter ecosystems.

Solution The solution is (D). Natural disturbances include events such as lightning and rainfall, and human-related disturbances include agriculture and pollution. Both types are of concern to conservationists because they alter ecosystems.

- 28** Compare grazing and detrital food webs. Why would they both be present in the same ecosystem?
- A** The primary producers of detrital food webs are decomposers whereas those of grazing food webs are non-photosynthetic. Both primary producers support different components of the ecosystem.
 - B** The primary producers of detrital food webs are photosynthetic whereas those of grazing food webs are decomposers. Both primary producers support different components of the ecosystem.
 - C** The primary producers of detrital food webs are decomposers whereas those of grazing food webs are photosynthetic. Both primary producers support different components of the ecosystem.
 - D** The primary producers of detrital food webs are chemoautotrophs whereas those of grazing food webs are photosynthetic. Both primary producers support different components of the ecosystem.
- 29** How does the amount of food that endotherms and ectotherms consume compare with their net production efficiency (NPE)?
- A** The amount of food eaten by an animal does not affect its NPE.
 - B** Endotherms use more energy compared to ectotherms due to energy loss from heat production.
 - C** Both endotherms and ectotherms use the same energy from food.

- D** Ectotherms use more energy compared to endotherms due to energy loss from heat production.

Solution The solution is (B). Endotherms use more energy compared with ectotherms because much energy is lost for respiration and heat production.

30 Compare the three types of ecosystem pyramids and how well they describe ecosystem structure. Which ones can be inverted? For each, what is a specific example of an inverted pyramid?

- A** The three types of ecosystem pyramids are pyramids of energy, number, and biomass out of which number and energy pyramids can be inverted. Examples of inverted pyramids of number and energy are temperate forests in summer and phytoplankton in the English Channel, respectively.
- B** The three types of ecosystem pyramids are pyramids of energy, number, and biomass out of which number and biomass pyramids can be inverted. Examples of inverted pyramids of number and biomass are temperate forests in summer and phytoplankton in the English Channel, respectively.
- C** The three types of ecosystem pyramids are pyramids of energy, number, and biomass out of which number and biomass pyramids can be inverted. Examples of inverted pyramids of number and biomass are temperate forests in summer and Silver Springs ecosystem in Florida, respectively.
- D** The three types of ecosystem pyramids are pyramids of energy, number, and biomass out of which number and biomass pyramids can be inverted. Examples of inverted pyramids of number and biomass are grasslands in summer and phytoplankton in the English Channel, respectively.

31 Why do scientists more commonly analyze net primary productivity compared with gross primary productivity?

- A** Net primary productivity incorporates features like production at present and next trophic levels, whereas gross primary productivity does not.
- B** Net primary productivity is the rate at which photosynthetic primary producers incorporate energy from the sun.
- C** Net primary productivity is the energy content available to the organisms of the next trophic level.
- D** As respiration and heat loss uses energy of primary producers, net primary productivity is what is actually available to primary consumers.

Solution The solution is (D). Net primary productivity is what is available to primary consumers, as some energy is used for respiration and heat loss of the primary producer.

32 What is nitrogen fixation, and why it is important to agriculture?

- A** The process of nitrate formation from ammonia is called nitrogen fixation. It improves agricultural production as nitrogen is required by plants for nucleotide and protein formation.
 - B** The process of nitrogen being incorporated into organic molecules is called nitrogen fixation. It improves the crop yield by allowing the plants to compete with weeds.
 - C** The reduction of nitrates back to nitrogen gas is called nitrogen fixation. It improves agricultural production as nitrogen is required by plants for nucleotide and protein formation.
 - D** The process of nitrogen being incorporated into organic molecules is called nitrogen fixation. It improves agricultural production as nitrogen is required by plants for nucleotide and protein formation.
- 33** How do agricultural animals such as cattle raise atmospheric carbon levels? What is a side effect?
- A** Cattle produce carbon monoxide, which when inhaled, even small quantities, can cause death.
 - B** Cattle produce carbon monoxide, which is a major contributor to global warming.
 - C** Agricultural animals increase the amount of greenhouse gases by producing carbon dioxide and methane, so they contribute to global warming.
 - D** Agricultural animals increase the amount of greenhouse gases by producing ozone, which contributes to global warming.

Solution The solution is (C). Respiration and methane production from animals such as cattle increase the amount of greenhouse gases released into the atmosphere, which can contribute to the warming of the globe.

- 34** What form of sulfur is found in the atmosphere, and how does it leave the atmosphere?
- A** Hydrogen sulfide, which leaves the atmosphere as weak sulfur dioxide rain
 - B** Sulfur dioxide, which leaves the atmosphere as weak sulfur dioxide rain
 - C** Hydrogen sulfide, which leaves the atmosphere as weak sulfuric acid rain
 - D** Sulfur dioxide, which leaves the atmosphere as weak sulfuric acid rain

TEST PREP FOR AP[®] COURSES

- 35** Producers and consumers are necessary for ecosystem function and for energy to pass through an ecosystem. What might happen in an aquatic system with excess producers relative to consumers?
- A** Oxygen depletion would result in die-off.
 - B** There would be no basal energy source.
 - C** Carbon cannot be sequestered.

D There would be more indigestible animal parts.

Solution The solution is (A). Excess growth of microorganisms can result in oxygen depletion, which kills other organisms in the ecosystem.

36 Energy is a fundamental component in an ecosystem and is contributed by the primary producers. How can light energy, in turn, support the consumers of an ecosystem?

A Light energy is converted to chemical energy by primary producers and primary consumers. Consumers belonging to higher trophic levels feed on them to gain energy.

B Primary producers can only obtain energy from sunlight by photosynthesis and gain energy by feeding on them or other consumers which have consumed these producers.

C Primary producers convert light energy to chemical energy using photosynthesis and consumers gain energy by feeding on them or on other consumers that have consumed these producers.

D Primary producers convert light energy through chemosynthesis and consumers gain energy by feeding on them or other consumers which have consumed these producers.

37 In a microcosm experiment using fish tanks to mimic a lake environment, an increase in the number of stickleback species would increase the dissolved organic carbon particle size. How could this affect primary producers in the ecosystem?

A Enhance growth rate.

B Increase abundance.

C Decrease abundance

D Maintain growth rate.

Solution The solution is (C). Sunlight would be blocked, which would prevent algal photosynthesis and decrease the abundance of the primary producers.

38 Studies on stickleback fish revealed that the presence of two species of stickleback reduced the amount of algal blooms relative to the presence of one species of stickleback in a microcosm experiment. How does this occur?

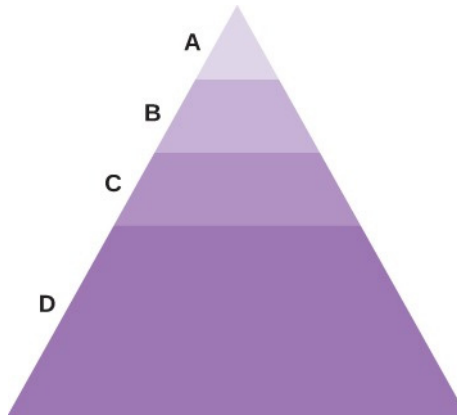
A This occurred as the presence of two species caused an increase in dissolved organic carbon molecule size, which blocked the penetration of light in water and prevented algal photosynthesis.

B This occurred because two stickleback species consumed all the nutrients which prevented algae from being able to grow.

C This occurred because dissolved organic carbon molecule size increased in the presence of one fish species which increased the amount of algal blooms.

D This occurred as algae are consumed in greater amounts in the presence of two stickleback species.

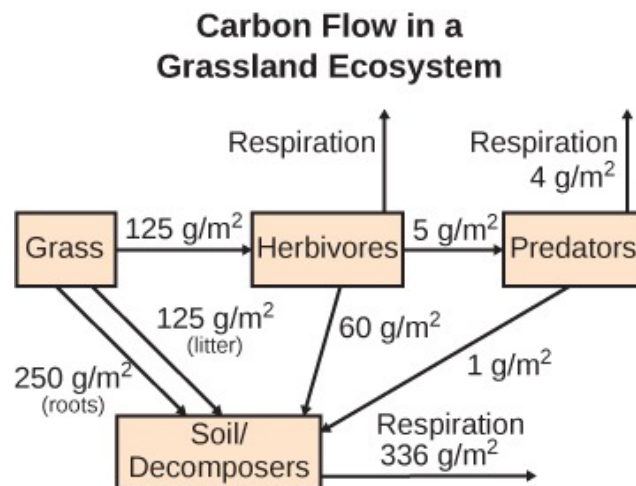
39 This figure depicts energy exchange through trophic levels. Which level represents the primary producers?



- A** Level A
- B** Level B
- C** Level C
- D** Level D

Solution The solution is (D). Primary producers provide the most energy to the ecosystem.

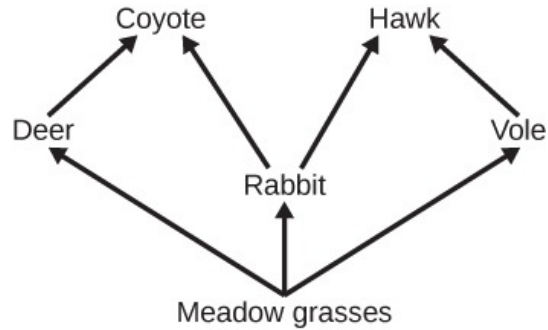
40 Using the flow chart showing carbon flow in a grassland ecosystem, how much carbon, in grams per meter squared, is released into the atmosphere as a result of the metabolic activity of herbivores? Give your answer to the nearest whole number.



- A** 125 g/m²
- B** 65 g/m²

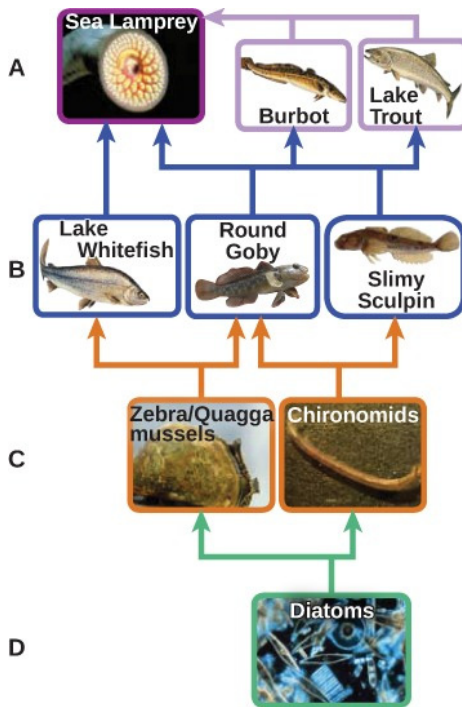
- C 60 g/m²
- D 5 g/m²

- 41 The food web for a meadow habitat occupies 25.6 km². The primary producers' biomass is uniformly distributed throughout the habitat and totals 1,500 kg/km².



Developers have approved a project that will permanently reduce the primary producers' biomass by 50 percent and remove all rabbits and deer. What is the most likely result at the completion of the project?

- A The biomass of coyotes will be 6 kg, and the biomass of hawks will be 0.5 kg.
 - B The biomass of coyotes will be dramatically reduced.
 - C The coyotes will switch prey preferences and outcompete the hawks.
 - D There will be 50 percent fewer voles and 90 percent fewer hawks.
- Solution** The solution is (B). The biomass of coyotes will be dramatically reduced because they will lose their prey sources.
- 42 This figure shows a food web of an ecosystem.



What would happen to the food web if all of the species of the entire row B was wiped out by a natural disaster such as an oil spill? Why?

- A The producers may die out, causing the food web to collapse.
 - B The food web would not be affected as the secondary and tertiary consumers would become primary and secondary consumers, respectively.
 - C The tertiary consumers would die out due to lack of food and this could potentially lead to collapse of the entire food web.
 - D The food web might suffer from loss of primary producers for a while which would then recover quickly, thus, reviving the ecosystem.
- 43** Humans are very active in modifying ecosystems worldwide. If a new set of buildings on the edge of a forest blocks sunlight from reaching the majority of one part of the forest, what might happen to that part of the forest?
- A Herbivores would occur in high abundance.
 - B Plants would occur in high abundance.
 - C Everything would remain the same.
 - D Herbivores would occur in low abundance.

Solution The solution is (D). Herbivores would occur in low abundance.

- 44** If you examined predator-prey relationships within an ecosystem and noticed that the removal of predators also resulted in the die-off of herbivores, what would you suspect occurred?

- A Removal of predators would directly lower the number of herbivores.
 - B The lack of predators could mean that too much primary production occurred.
 - C Herbivores from another region may have entered the ecosystem and consumed the primary producers, causing death of the original herbivore species.
 - D Overeating by herbivores could have caused depletion of the primary producers, leaving the herbivores without enough food.
- 45** Although producers are essential for energy to flow into an ecosystem, consumers also have important roles. What might happen in an aquatic system with excess consumers relative to producers?
- A Oxygen depletion would result in die-off.
 - B There would be an excess of the basal energy source.
 - C Consumers would deplete the abundance of producers.
 - D There would be more indigestible animal parts.

Solution The solution is (C). Consumers would deplete the abundance of producers.

- 46** The following equation is for trophic level transfer efficiency:

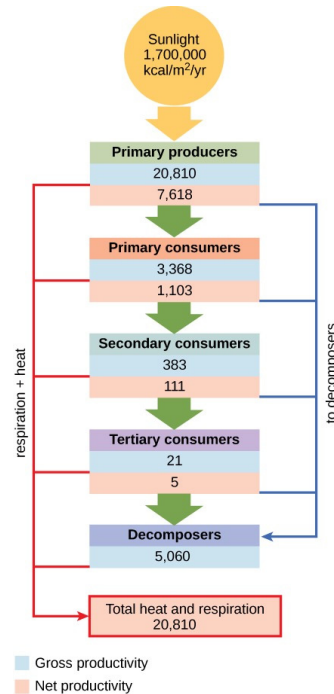
$$\left(\frac{\text{production at present trophic level}}{\text{production at past trophic level}}\right) \times 100$$

If primary producers produce 1,600 kcal/m² and primary consumers have 800 kcal/m², what is the trophic level transfer efficiency?

- A 50
 - B 200
 - C 800
 - D 1,600
- 47** There are four trophic levels in a food chain, and the amount of energy at the trophic level of the primary producer is 33,000 kcal/m². What most likely represents the amount of energy of the tertiary consumer?
- A 75 kcal/m²
 - B 500 kcal/m²
 - C 11,000 kcal/m²
 - D 33,000 kcal/m²

Solution The solution is (A). If the amount of energy of the primary producer is 33,000 kcal/m², the amount of energy of the tertiary consumer is 75 kcal/m².

- 48 Why does this figure show a higher value of gross productivity for the decomposers than the tertiary consumers?



- A Because there are differences in the conversion efficiencies of decomposers and tertiary consumers
- B Because large animals are tertiary consumers whereas small microorganisms are decomposers
- C Because tertiary consumers only consume secondary consumers whereas decomposers consume dead components of each trophic level
- D Because tertiary consumers only consume primary consumers whereas decomposers consume dead components of each trophic level
- 49 One of the key concerns about global climate change is excess amounts of carbon being released into the atmosphere. There are, however, some ways in which carbon can be sequestered from the atmosphere.

Which natural process promotes carbon sequestration?

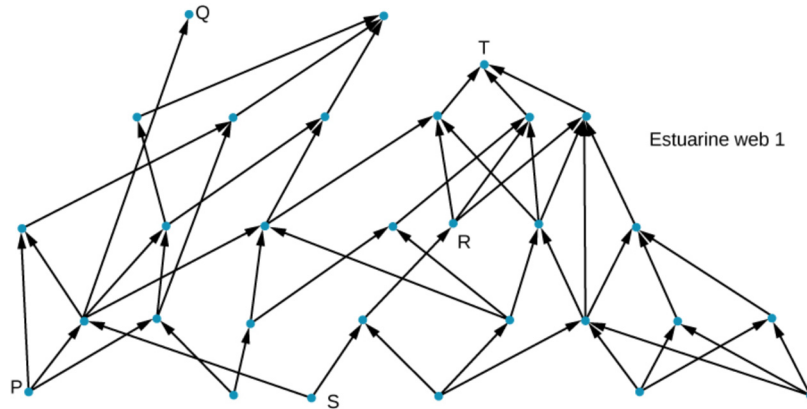
- A Burning fossil fuels
- B Methane from cattle
- C Photosynthesis by plants
- D Volcanic eruption

Solution The solution is (C). Photosynthesis by plants can act as a carbon sink.

SCIENCE PRACTICE CHALLENGE QUESTIONS

37.1 Ecology of Ecosystems

- 50** The food web utilizes an arrow pointing from a species that feeds on another to indicate the trophic structure of a simplified estuarine ecosystem at the boundary between the ocean and the shore.



- A. Analyze** the interactions among species and indicate primary producers by circling the node in the food web. **Identify** the primary producers by circling the nodes in the food web.
- B. Predict** quantitatively how free energy availability for a top species such as the one designated as T in the web changes if it feeds directly on S, assuming the abundance of species S is limited only by radiant energy input.
- C.** Consider the consequences of the dietary shift described in B if the abundance of species becomes depleted due to consumption by species T. Under those circumstances, **refine** your analysis of the food web to describe the potential effect on species Q and R.
- D.** Based on the preceding analyses, **construct a claim** regarding the effect of the structure, in terms of biodiversity and number of interactions among species, on ecosystem stability.

38 | CONSERVATION BIOLOGY AND BIODIVERSITY

REVIEW QUESTIONS

- 1 In an effort to enter all identified species on Earth into a digital catalog, scientists are preparing a unique tag for each species. Algorithms have been generated to create unique tags. Which algorithm is best suited for the task?
- A An algorithm that creates 15,000 to 20,000 unique tags
 - B An algorithm that creates 150,000 to 200,000 unique tags
 - C An algorithm that creates 1.5 million to 2 million unique tags
 - D An algorithm that creates 10 million to 20 million unique tags

Solution The solution is (C). An algorithm that creates 1.5 million to 2 million unique tags is the current estimate for the number of species on Earth.

- 2 Two genera of birds exist side-by-side on an island. Genus A is characterized by a few species of similar genetic material. Genus B contains different species of birds with a wide variety of genetic traits. After a volcanic explosion changes the ecosystem, which genus has the highest probability of surviving the disaster?
- A Genus A, which contains well-adapted species
 - B Genus B, which has greater genetic diversity and is more likely to have traits that confer an advantage in the new environment
 - C Genus A, which can serve as ancestors for the new species
 - D Genus B, because these species likely evolved from genus A species in the past
- 3 A report describes the biodiversity of an island in a remote archipelago in the Pacific Ocean having a larger number of species of birds than neighboring islands. The biologists that investigated the ecosystem of the island described it as an example of adaptive radiation. Their conclusion is based on the fact that they observed what?
- A A burst of speciation
 - B The presence of invasive species
 - C A hypothesized cause of a mass extinction
 - D Evidence of an apex predator

Solution The solution is (A). An increase in the number of species indicates adaptive radiation.

- 4 Findings from layers dating to the Cambrian geological period show an appearance of many new organisms in addition to older forms of life. The Cambrian explosion corresponds to a time where —
- A new species radiated from existing species
 - B new species appeared due to spontaneous mutations
 - C ancient species were replaced by newly evolved species
 - D a massive die-out freed ecosystems for new species
- 5 Paleontologists are analyzing fossils from a newly excavated site with layers dating from several geological periods. They established that a particular layer probably correlates to a mass extinction. What is the most likely reason for their conclusion?
- A Over 95 percent of species present in older layers have disappeared in this particular layer.
 - B An asteroid impact altered the geological terrain significantly.
 - C All of the fossils observed were of larger sized organisms.
 - D A loss of over 50 percent of species was observed.

Solution The solution is (D). Scientists define a mass extinction as the disappearance of over 50 percent of existing species in a relatively short period of time.

- 6 What is a likely reason that small animals survived the cataclysmic impact of a large meteorite that caused the massive extinction at the Cretaceous-Paleocene?
- A Small animals stopped being hunted by dinosaurs.
 - B Small animals did not depend on plants for food.
 - C Small animals needed less food for survival and reproduced rapidly.
 - D Small animals fed on the dead dinosaurs.
- 7 Scientists are evaluating an island ecosystem to be upgraded to a hot spot of biodiversity. They conduct field research on the species that populate the area. Their final assessment on the biodiversity of the ecosystem will be based on which estimate?
- A The total number of species in an ecosystem
 - B The total number of organisms in an ecosystem
 - C The total number of species divided by the area of the ecosystem
 - D The total number of endangered species in an ecosystem

Solution The solution is (A). This is the measure of biodiversity according to the current definition.

- 8 A secondary plant compound might be used for which purpose?
- A A new crop variety

- B A new drug
- C A soil nutrient
- D A new species

9 A component of snake venom kills the prey by preventing blood from clotting. What is the most likely medical application for the active component?

- A Promoting scab formation
- B Speeding healing of wounds
- C Relaxing muscle pain
- D A blood thinner

Solution The solution is (D). Blood thinners are used to reduce the risk of clotting.

10 Different varieties of potatoes are known to thrive at different altitudes. What could be the related benefit of maintaining the diversity of potato plants?

- A Diverse types of pollinators can be involved.
- B The range of usable land is extended.
- C The taste of potatoes when fried is improved.
- D Resistance to pests can be introduced if necessary.

11 Which agricultural crop is most likely to survive a catastrophic event?

- A Monoculture of a crop on a large surface
- B Diverse varieties of a crop surrounded by a diverse ecosystem
- C Single crop surrounded by a diverse ecosystem
- D Diverse varieties of a crop in a simple ecosystem

Solution The solution is (B). A diverse ecosystem was shown to support all components and is more able to withstand a catastrophic event.

12 Which factor is present in an ecosystem that performs the same role as a pesticide?

- A Pollination
- B Plant resistance to chemicals
- C Asexual reproduction
- D Presence of insect predators

13 Urban designers included wetlands and lagoons connected to a water treatment plant to a new subdivision of homes. The designers would have most likely applied which principle of conservation to their plans?

- A Ecosystem service

- B Habitat degradation
- C Habitat restoration
- D Chemical diversity

Solution The solution is (A). The inclusion of wetlands and lagoons is an example of ecosystem service.

14 What are most antibiotics in use today prepared or derived from?

- A Secondary compounds from microorganisms
- B Secondary compounds from viruses
- C Fully synthetic chemical compounds
- D Compounds synthesized by plants

15 Loss of biodiversity and accelerations of extinction rates have several causes. Which situation causes direct loss of biodiversity owing to loss of habitat?

- A Fishing cod at a rate that is greater than natural replacement
- B Converting a prairie to a farm field
- C Introduction of an invasive ornamental plant in a new ecosystem
- D Emission of greenhouse gases increasing the average temperatures of an area

Solution The solution is (B). Converting a prairie to a farm field decreases the amount of habitat available for local species, which can cause a loss of biodiversity.

16 Which activity will result in major habitat loss?

- A Picking wild flowers in a meadow
- B Cutting a tree in one's backyard
- C A farmer switching from wheat to soy crop
- D Building a dam that will flood a large plain

17 Exotic predator species are especially threatening to what kind of ecosystem?

- A Deserts
- B Marine ecosystems
- C Islands
- D Tropical forests

Solution The solution is (C). Many species on an island do not have protection against predators and are endemic.

18 Backpackers returning from a long trip abroad are stopped by customs and asked whether they brought back plants, flowers, or fruit from their trip location. Their fruit bought at a local market is confiscated.

What is the most likely reason why the fruit was confiscated?

- A The hikers are supposed to pay duty on imported fruit.
- B The fruit can be processed to produce illicit drugs.
- C The fruit seeds could be planted and would eliminate all local species.
- D The fruit may introduce new exotic pests that threaten local plants.

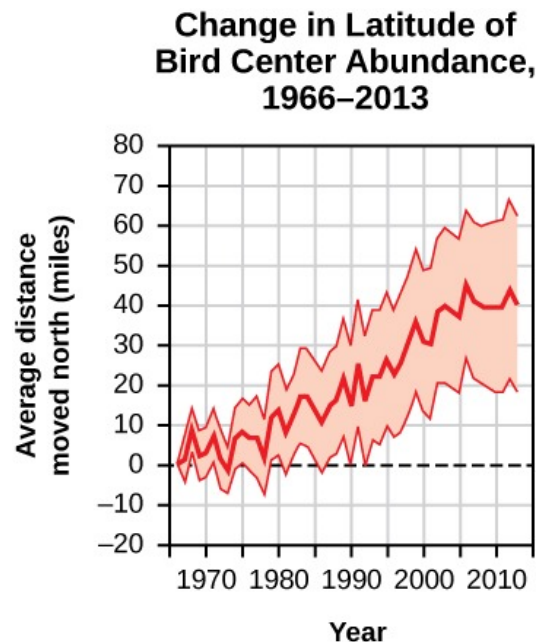
- 19 Grizzly bears and black bears have a varied diet and hunting grounds. On the other hand, polar bears feed mostly on seals. They walk on the sea ice and wait by breathing holes for seals to emerge from the water for fresh air.

Which animal would be most affected by the melting of sea ice in Alaska?

- A Grizzly bears
- B Polar bears
- C Sun bears
- D Black bears

Solution The solution is (B). Polar bears hunt on the sea ice and depend on seals, a sea animal, as their prey.

- 20 This graph shows the movement northward of wintering grounds of North American bird species. The trend closely mirrors the increase in average winter temperatures.



What problem could develop from birds using farther north areas?

- A Birds that arrive too early may be killed by the occasional abrupt cold spell.
- B Movement northward leads to overcrowding of reproductive grounds.

C Food competition increases with birds that do not migrate.

- 21** The method of DNA barcoding allows cataloguing of an organism using rapid sequencing methods. The choice of which gene to use for barcoding is guided by its rate of evolution.

Which genes are most useful for barcoding eukaryotes with the exception of plants?

- A Nuclear genes
- B Chloroplast genes
- C Plasmids
- D Mitochondrial

Solution The solution is (D). Scientists have observed that mitochondrial genes evolve faster than nuclear genes.

- 22** What does the choice of using mitochondrial genes for barcoding of genes depend on?

- A The fact that suitable primers for sequencing are not available for nuclear genes
- B Whether any gene can be used
- C The rate of evolution in mitochondrial genes
- D That there is less variability between individuals of a same species than between individuals of different species

- 23** While planning an ecological preserve, conservationists plan for an area limited in size with highly diversified niches to protect as many species as possible in the available area. With these constraints in mind, which ecosystem is especially useful to study for designing the preserve?

- A Desert
- B Island
- C Tropical rain forest
- D Temperate rain forest

Solution The solution is (B). It is especially useful to study biodiversity on islands to make predictions about biodiversity in preserves of similar size.

- 24** A marine preserve is designed off the coast of the northwest United States. The coast is dotted by several Native American reservations where the traditional occupation is catching and processing fish.

Which parties must be involved in the design of the preserve?

- A Marine biologists only
- B Marine biologists and oceanographers only
- C Marine biologists, oceanographers, and policy makers only
- D Marine biologists, oceanographers, policy makers, and representatives of the tribes

- 25** Loss of wetlands has a great impact both on the biotic and abiotic parts of an ecosystem. Wetlands provide rich habitats and act as a filter for pollution. Some loss of wetland is due to silt and invasive species clogging water flow. To restore these wetlands, it is often enough to —
- A** open new waterways
 - B** restore the water supply
 - C** reintroduce endangered animals
 - D** introduce water adapted plants

Solution The solution is (B). Restoring the water supply is often enough to restore wetlands.

- 26** Acid mining pollutes nearby streams by acidifying water and discharging highly toxic by-products. Bacteria have been used to neutralize the pH and detoxify chemical compounds making the stream suitable for animals and plants. What is this approach to restoration of habitat an example of?
- A** Keystone species introduction
 - B** Bioremediation
 - C** Ecosystem preservation
 - D** Biological control
- 27** What was the name of the first international agreement on climate change?
- A** Red List
 - B** Montreal Protocol
 - C** International Union for the Conservation of Nature (IUCN)
 - D** Kyoto Protocol

Solution The solution is (D). The Kyoto Protocol, named for the location of the summit in Kyoto, Japan, was the first international agreement on climate change.

CRITICAL THINKING QUESTIONS

- 28** Which factor explains why, in general, temperate and polar regions have less biodiversity than tropical regions?
- A** The tropical regions are subjected to extreme changes of season.
 - B** The polar regions were populated earliest in the history of Earth.
 - C** The polar regions receive more intense solar energy.
 - D** The tropical regions contain more micro-ecosystems.
- 29** One method used to calculate contemporary extinction rates is based on the recorded extinction of species in the last 500 years. A second method is a calculation based on the

rate of habitat destruction. The construction of a new dam is being planned. A team of conservation biologists is preparing a report on the environmental impact of the dam.

Which method should be adopted to estimate the effect of the construction on the extinction rate in the area? What are the advantages and disadvantages of each method?

- A** The extinction rates calculation method should be adopted. It uses species-area curves that overestimate rates of extinction. The rate of habitat destruction calculation method uses large numbers of measurements, but overestimates the rate of extinction as well.
- B** The rate of habitat calculation method should be adopted. It is based on a large number of observations and measurements, but overestimates rates of extinction. The extinction rates calculation method uses species-area curves, but underestimates the rate of extinction.
- C** The extinction rates calculation method should be adopted. It is based on a large number of observations and measurements but overestimates rates of extinction. The rate of habitat destruction calculation method uses species-area curves, but underestimates the rate of extinction.
- D** The rate of habitat destruction calculation should be adopted. It uses species-area curves, but overestimates the rate of extinction. The extinction rates calculation method is based on a large number of observations and measurements, but underestimates rates of extinction.

Solution The solution is (D). In the extinction rates calculation method, extinction rates are calculated based on the recorded extinction of species in the past 500 years using data from a large number of observations and measurements. They do not take into account unobserved extinctions and undiscovered species. In this way, this method underestimates rates of extinction. The second method based on the amount of habitat destruction and species-area curves is more adapted to this situation although it is not based on existing data and is likely to overestimate the rate of extinction. This is preferable to underestimating the rate of extinction when planning new development.

- 30** What evidence do scientists provide for the cause of the Cretaceous-Paleogene mass extinction?
- A** The unusual abundance of iridium in the Cretaceous-Paleogene layers, the disappearance of so many species at its transition, volcanic activity that led to global warming, and the crater found in the Yucatan peninsula.
 - B** The unusual abundance of iridium in the Cretaceous-Paleogene layers, gamma-ray burst caused by a nearby supernova, rocks found in the clay layer at its boundary, and the crater found in the Yucatan peninsula.
 - C** The unusual abundance of iridium in the Cretaceous-Paleogene layers, the disappearance of so many species at its transition, rocks found in the clay layer at its boundary, asteroid impact, and volcanic eruptions at large.

D The unusual abundance of iridium in the Cretaceous-Paleogene layers, the disappearance of so many species at its transition, rocks found in the clay layer at its boundary, and the crater found in the Yucatan peninsula.

- 31** The island of Madagascar is located in the tropics 300 miles east of the coast of Africa, from which it separated 165 million years ago. It is characterized by a large number of endemic species.

What are the main reasons that Madagascar is a hotspot of endemic biodiversity?

- A** Madagascar has a climate that is more conducive to evolution than the larger African continent.
- B** Madagascar is close to the tropics of Africa and consequently has a large number of species.
- C** Madagascar shows species diversity of both temperate and tropical regions.
- D** Madagascar has been isolated geographically and species evolved there without interaction with outside influences.

Solution The solution is (D). Madagascar is isolated geographically, it is in a tropical area, and has separated from the mainland 165 million years ago.

- 32** Consider the following examples. The toxicity in the venom from a Brazilian viper (*Bothrops jararaca*) is due to a sudden, massive drop in blood pressure, which slows down the reaction of a bitten prey. Solutions made from the opium poppy have been used in the past to dull the sensation of pain and induce a sense of well-being.

How can the effects of these natural compounds be applied to the development of medical treatments?

- A** Compounds similar to the snake's active toxin are used routinely as antivirals. Opioids are used as immunomodulators, which modify an immune response.
- B** Compounds similar to the snake's active toxin are used routinely as painkillers. Opioids help in the lowering of blood pressure.
- C** Compounds similar to the snake's active toxin are used to treat inflammations. Opioids are used to prevent muscle spasms.
- D** Compounds similar to the snake's active toxin are used to lower blood pressure. Opioids are used routinely as painkillers.

- 33** Phylloxera, a pest related to aphids, destroyed many vineyards in France at the end of the 19th century. The vineyards were restored by grafting old vines on American root stocks, which were resistant to the pest.

Using this situation, how can biodiversity loss impact crop diversity?

- A** Loss of wild species would result in inbreeding depression, as crop varieties must be bred with wild species to remain viable.

- B** Loss of biodiversity reduces large-scale monocultures but reinforces genetic homogeneity contributing in the loss of crop diversity.
- C** Loss of wild species would result in an increase of intraspecific diversity within the different crop varieties, but decrease in interspecific crop diversity.
- D** Loss of wild species would reduce the genetic variations as genes from wild relatives are brought into crop varieties to add valued characteristics to crops.

Solution The solution is (D). Crop plants are derived from wild plants, and genes from wild relatives are frequently brought into crop varieties by plant breeders to add valued characteristics to the crops. If the wild species are lost, then this genetic variation would no longer be available.

- 34** What would be the consequences of the bee colony collapse disorder in a state such as California, which is a large supplier of produce?
- A** Only pharmaceutical manufacturing and industries involved in honey production would be affected.
 - B** Other pollinators would replace the bees in the ecosystem, and there would probably not be a major impact on the production of produce.
 - C** Lack of pollinators would affect the honey industry but not the fruit harvest industry, because other pollinators would be present to carry out pollination.
 - D** The lack of pollinators would affect the fruit harvest directly, and it indirectly would affect industries linked to it, such as the honey and jam preparation industries
- 35** Many chemical pesticides can be found in the bark and leaves of tropical plants. What is a difference in tropical plants that makes it especially beneficial to produce compounds that kill insects throughout the year?
- A** Because plants have to protect themselves year-round, as cold spells in winter do not kill pests as they do in temperate areas
 - B** Because the plants must protect themselves from insects as repellants and toxins sprayed by humans do not work in tropical areas
 - C** Because the compounds produced to kill insects also enhances the ability of the plant to recover from damage caused by various phenomena
 - D** Because compounds produced to kill insects also influence the behavior and growth of tropical plants

Solution The solution is (A). In tropical areas, there are no distinct seasons with cold temperatures. The plants must protect themselves year-round from insects, as cold spells in winter do not kill pests as they do in temperate climates.

- 36** Explain how the increase in human population and resource use causes increased extinction rates by altering ecosystems.

- A** Human population growth leads to unsustainable resource use, habitat destruction, and the unsustainable fishing and hunting of wild animal populations. All these incidences result in a slow evolutionary rate of formation of new species.
- B** Human population growth leads to unsustainable resource use, habitat destruction, and the unsustainable fishing and hunting of wild animal populations. Climate change also occurs due to excessive use of fossil fuels.
- C** Human population growth leads to unsustainable resource use, habitat destruction, and unsustainable fishing and hunting of wild animal populations. Excessive use of fossil fuels is leading to reduced populations of fish species.
- D** Human population growth leads to unsustainable resource use, habitat destruction, and unsustainable fishing and hunting of wild animal populations. Larger human populations are also leading to decreased value of products obtained from species.
- 37** As a conservationist, you are preparing a report on a frog population living on a mountainside in Costa Rica. In your report, which potential threats to the survival of the species will you predict taking into account environmental abiotic conditions and human activities, even if others also may be present as well?
- A** The frog is at risk from climate change, habitat destruction, and aggressive predators.
- B** The frog is at risk from climate change, exotic species, and possible habitat destruction.
- C** The frog is at risk from climate change, habitat destruction, and sparse availability of food.
- D** The frog is at risk from climate change, exotic species, and overhunting in its habitat.
- Solution** The solution is (B). The frog is at risk because climate change may shift its preferred habitat up the mountain. In addition, it will be at risk from exotic species, either as a new predator or through the impact of transmitted diseases such as chytridiomycosis. It is also possible habitat destruction will threaten the species.
- 38** Epidemiologists are predicting that diseases such as West Nile virus infection, dengue fever, and even malaria may expand their range. If the pathogens are viruses or protists, how could they most rapidly expand their range over a large geographic area?
- A** Through the air
- B** Through contaminated food and water
- C** Through direct human contact from increased presence in wilderness areas
- D** Through vectors such as mosquitoes
- 39** Why does the hunting of large, top predators, such as sharks or wolves, endanger the entire ecosystems in which they live?
- A** The disappearance of top predators results in excessive multiplication of producers. Producers will overgraze primary consumers.

- B** If a top predator disappears, the primary consumers will multiply without restriction, but producers will not be affected.
- C** If a top predator disappears, producers will multiply without restriction.
- D** The disappearance of top predators results in excessive multiplication of primary consumers. Primary consumers will overgraze producers.

Solution The solution is (D). The food web is balanced. If a top predator disappears (foxes, wolves, the primary consumers (caribous, hares) multiply without restriction, overgraze the producers (lichens, grass), and must migrate to avoid starvation. Some top consumers cull the herds of the weakest members or clean the environment by scavenging dead remains.

- 40** The Convention on International Trade in Endangered Species (CITES) passed a resolution to protect rhinoceroses in the wild. Rhinoceroses have been hunted to the brink of extinction because their horns, which are made of simple keratin, are considered an aphrodisiac and a powerful drug in some cultures.

Why does the protection of rhinoceroses require an international agreement?

- A** The rhinoceroses are hunted in their native countries, but the trade crosses borders.
 - B** The use of rhinoceros horns as an aphrodisiac has shown various negative effects internationally.
 - C** The hunters from different countries travel to the native country to hunt for rhinoceroses.
 - D** The demand for rhinoceroses is greater in foreign countries as compared to their native countries.
- 41** A preserve design is proposed for a densely populated suburban area. Which overall design plan would be best for preservation of local ecosystems?
- A** Set up many small, protected areas.
 - B** Select one small area that is isolated from residences.
 - C** Plan buffer zones around all backyard spaces.
 - D** Set up several larger areas to be set aside for natural ecosystems.

Solution The solution is (D). Fewer, larger areas are more successful for preservation than many small, protected areas.

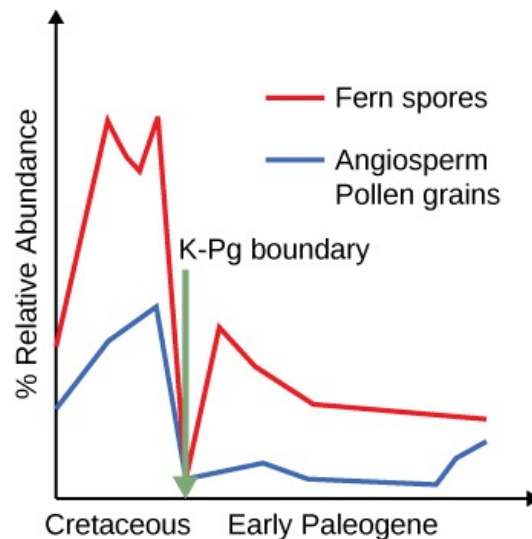
- 42** Wolves are a keystone species in the Yellowstone National Park. What would happen if they were hunted to extinction?
- A** Many species would increase and the elk population would disappear.
 - B** Many species would disappear and the elk population would initially increase.
 - C** Many species along with elk population would initially increase.
 - D** Many species, along with the elk population, would disappear rapidly.

- 43** Why have international treaties been rarely enforced so far?
- A** Signatory nations follow through with their good intentions. No governing body enforces international environmental protection.
 - B** Signatory nations do not follow through with their good intentions. A governing body enforces international environmental protection.
 - C** Signatory nations do not follow through with their good intentions. No governing body enforces international environmental protection.
 - D** Signatory nations follow through with their good intentions. A governing body enforces international environmental protection, but neither is effective.

Solution The solution is (C). Signatory nations do not follow through with their good intentions. No governing body—for example, the United Nations—enforces international environmental protection.

TEST PREP FOR AP® COURSES

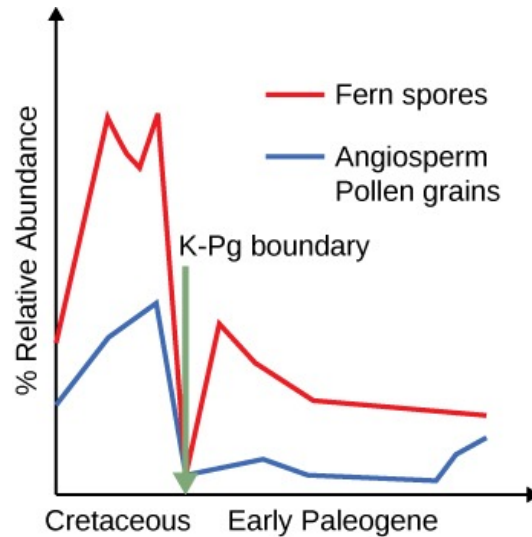
- 44** Students analyze pollen grains and fern spores recovered from sediments taken below and above the Cretaceous-Paleogene boundary. Their results are summarized in the graph.



Which conclusion can be drawn from the graph regarding the impact of the mass extinction that took place at the K-Pg boundary on plants?

- A** The mass extinction event reduced only the angiosperms.
- B** Based on their reduced pollen counts found in the samples, the mass extinction event clearly reduced the number of ferns and angiosperms.
- C** The mass extinction affected only the ferns.
- D** Ferns were more abundant after the Cretaceous-Paleogene (K-Pg) mass extinction than before.

45 Analyze the graph.



What are the reasons for the fern spike seen in the early Paleogene, considering ferns were the first plants seen on the ground after the volcanic eruption of Krakatoa and Mt. St. Helens? Propose reasons for the observed increase in fern spores following the mass extinction.

- A Ferns are considered early colonizers as they grow fast on poor soil and reproduce rapidly. Also, mass extinction gave an opportunity for the surviving species to expand and radiate to occupy vacated niches.
- B Ferns, having a selective advantage of being early colonizers, grew fast on poor soil and reproduced rapidly, thus permanently replacing angiosperms in the landscape.
- C Ferns are considered early colonizers as they grow fast on poor soil and reproduce rapidly. The mass extinction barely lowered their numbers due to their resilience.
- D Most of the fern varieties became extinct, only a single species survived; therefore, the remaining fern spores had many vacated niches to occupy, which led to an increase in fern numbers.

Solution The solution is (A). Ferns are considered early colonizers as they grow fast on poor soil and reproduce rapidly. Notice the ferns were also reduced in abundance. Although they recovered, they did not go back to the previous numbers. Mass extinctions open a window of opportunity for surviving species to expand, radiate as they occupy vacated niches.

- 46 A group of students summarized information on five great extinction events. The students are sampling a site in search of fossils from the Devonian period. Based on the chart, what would be the most reasonable plan for the students to follow?

| Mass Extinction | Time of Extinction (millions of years ago) | Organisms Greatly Reduced or Made Extinct |
|------------------------------|--------------------------------------------|------------------------------------------------------------------------|
| End of the Ordovician period | 443 | Trilobites Brachiopods Echinoderms Corals |
| End of the Devonian period | 354 | Marine families on tropical reefs Corals Brachiopods Bivalves |
| End of the Permian period | 248 | Trilobites Mollusks Brachiopods Many vertebrates |
| End of the Triassic period | 206 | Mollusks Sponges Marine vertebrates Large amphibians |
| End of the Cretaceous period | 65 | Ammonites Dinosaurs Brachiopods Bivalves Echinoderms |

- A** Searching horizontally rock layers in any class of rock and trying to find those that contain the greatest number of fossils
- B** Collecting fossils from rock layers deposited prior to the Permian period that contain some early vertebrate bones
- C** Looking in sedimentary layers next to bodies of water in order to find marine fossils of bivalves and trilobites
- D** Using relative dating techniques to determine the geological ages of the fossils so they can calculate the rate of speciation of early organisms
- 47** Students are sorting fossils of angiosperm pollen grains, some recovered from layers below the Cretaceous-Paleogene boundary and some from layers above the Cretaceous-Paleogene boundaries. The pollen grains are sorted by morphology. The results are summarized in a table.

| | Average Number of Grains/m ² | Morphology |
|----------------------------|-----------------------------------------|-----------------------|
| Below Cretaceous-Paleogene | 102 | Many different shapes |
| Above Cretaceous-Paleogene | 30 | A few common shapes |

Can you explain the results?

- A** The mass extinction that took place at the Cretaceous-Paleogene boundaries reduced the total number of organisms, shown by the presence of fewer shapes of pollen grains, and led to a loss of diversity, shown by the lower number of grains.
- B** The mass extinction that took place at the Cretaceous-Paleogene boundaries reduced the total number of organisms, shown by the presence of fewer pollen grains, and led to a loss of diversity, as shown by the presence of fewer shapes.
- C** The mass extinction that took place at the Cretaceous-Paleogene boundaries reduced the total number of organisms, shown by the lower number of pollen grains, but did not affect diversity
- D** The mass extinction that took place at the Cretaceous-Paleogene boundaries led to a loss of diversity, shown by the presence of fewer shapes of pollen grains, but did not affect the total number of organisms.

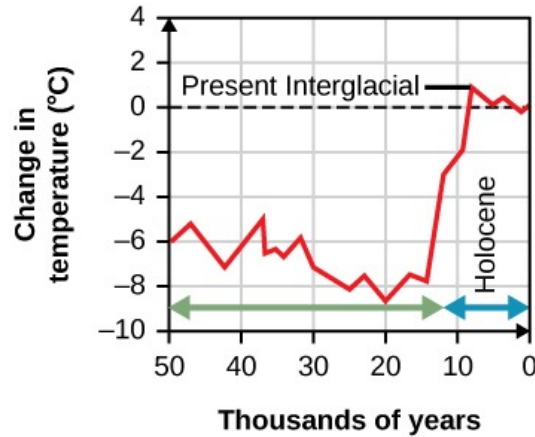
Solution The solution is (B). The mass extinction that took place at the Cretaceous-Paleogene boundaries reduced the total number of organisms and led to the disappearance of many species of angiosperms. Fewer pollen grains point to the decrease in population and fewer shapes indicate a loss of diversity.

- 48** A dig in a farmland soil rich in calcium carbonate reveals numerous shells of bivalves, chips of corals, the partial imprint of a trilobite, and a few vertebrae dated to 250 million years ago. The table of extinction summarizes information on the five major extinction events.

| Mass Extinction | Time of Extinction (millions of years ago) | Organisms Greatly Reduced or Made Extinct |
|------------------------------|--------------------------------------------|------------------------------------------------------------------------|
| End of the Ordovician period | 443 | Trilobites Brachiopods Echinoderms Corals |
| End of the Devonian period | 354 | Marine families on tropical reefs Corals Brachiopods Bivalves |
| End of the Permian period | 248 | Trilobites Mollusks Brachiopods Many vertebrates |
| End of the Triassic period | 206 | Mollusks Sponges Marine vertebrates Large amphibians |
| End of the Cretaceous period | 65 | Ammonites Dinosaurs Brachiopods Bivalves Echinoderms |

According to the table of extinction, which conclusion about the fossils is most reasonable?

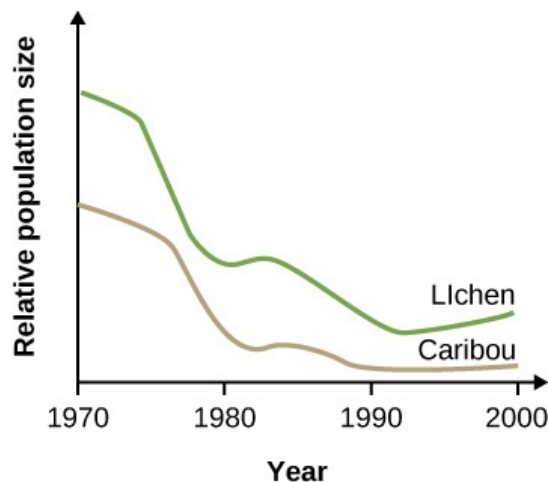
- A** The trilobites were the first animals to conquer land.
 - B** The rocks can be dated to the end of the Cretaceous period.
 - C** The farmland was probably part of the seafloor in the Permian period.
 - D** The fossils can be dated to the Ordovician period.
- 49** The average temperatures varied during the Pleistocene as glaciation periods were followed by warm intervals. Using the graph and your existing knowledge, what happened to woolly mammoths and other cold-adapted megafauna 10,000 years ago to cause their extinction?



- A Habitat destruction due to varying temperatures and over-hunting by humans led to their extinction.
- B Sudden increase in temperature and over-hunting by humans led to their extinction.
- C Gradual increase in temperature and over-hunting by humans led to their extinction.
- D Sudden increase in temperature and in predation by larger mammals led to their extinction.

Solution The solution is (B). The probable cause of mammoths' extinction is the sudden increase in temperature that took place about 10,000 years ago. A second proposed hypothesis is the humans over hunted mammoths to extinction because the appearance of humans coincides with the disappearance of the megafauna.

- 50 In winter, lichens are the only food for the caribou herds that roam the tundra. As the average temperatures increase with climate change, the lichens are gradually being replaced by shrubs and trees in the southern parts of the tundra. The graph illustrates the changes in abundance of lichens and caribou over time in a regional forest of Canada.



Which statement best explains the changes in the caribou population between 1975 and 1980?

- A The caribou population expanded after the population of lichens dropped.

- B** The decline of the caribou population and the lichen population are not related.
- C** The population of caribou decreased following the drop in lichen availability.
- D** The caribou population was eliminated once the lichens decreased.

51 A chain within the food web in the Arctic Ocean is shown.

phytoplankton → zooplankton → arctic char/cod → ringed seal → polar bear

A chain within the arctic food web on land is shown.

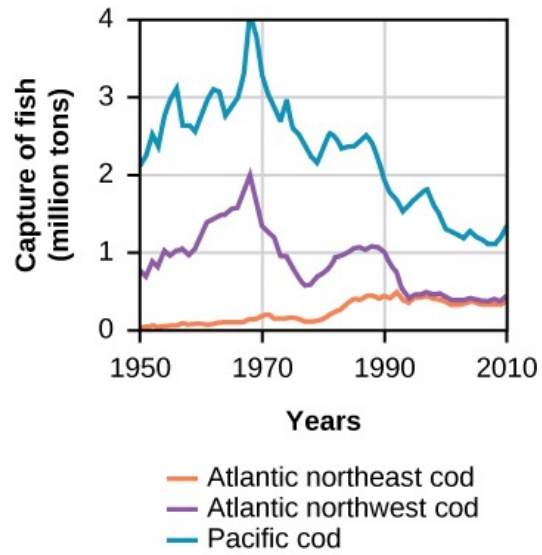
lichen/shrub → caribou/hare/small rodent → fox/lynx/bird of prey

If polar bears move to land to hunt due to loss of sea ice, what will happen to the balance of the food web?

- A** Polar bears, being top predators, will edge out the other consumers without gaining enough calories themselves.
- B** Polar bears, being secondary consumers, will edge out the other consumers without gaining enough calories themselves.
- C** Polar bears, being top predators, will edge out the producers without gaining enough calories themselves.
- D** Polar bears, being secondary consumers, will edge out the producers without gaining enough calories themselves.

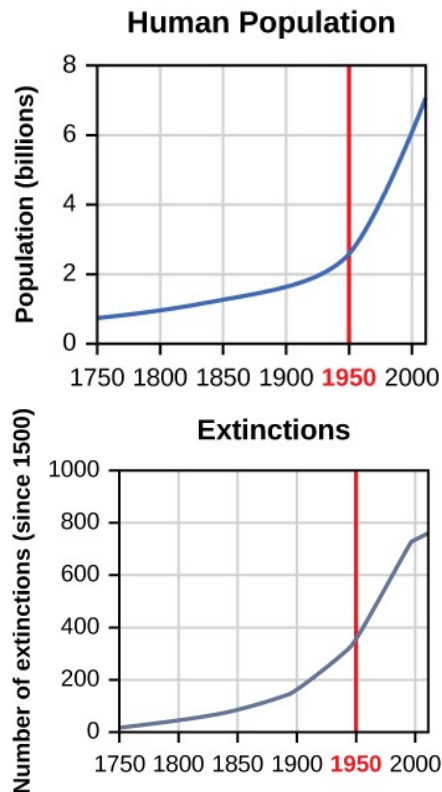
Solution The solution is (A). The secondary consumers are crowded out and compete for food with the polar bears. As the polar bears are the top predators, they have no enemies besides humans and will edge out the other consumers without gaining enough calories themselves.

52 Historically, the Atlantic Ocean off Canada and the Northeast United States has been some of the richest and most popular fishing grounds. Huge factory ships developed in the 1960s converged on the region from all over the world attracted by the rich catches. The graph represents the population of cod in recent years.



Based on the graph, what is the likely explanation for the collapse of the northwest cod?

- A A tropical disease decimated the populations of cod.
 - B Overfishing led to the collapse of the cod population.
 - C The cod population migrated somewhere else.
 - D The cod population is going through its cycle of rise and fall.
- 53 The graphs show the changes in the human population and the rate of extinction.



Which statement most likely explains how the increase in human population could lead to a decrease in biodiversity?

- A** Every human added to the planet replaces a different species of organism.
- B** The more people inhabiting the planet, the more the average temperature increases, causing loss of other species.
- C** With the increase in population the demands for land, water, food, and energy increase, leading to the destruction of habitat.
- D** Increases in human population reduce the amount of land available for use by all species.

Solution The solution is (C). More than 7 billion people inhabit the planet. Their demands for land, water, food, and energy are leading to destruction of habitat, pollution, over exploitation of resources, and accelerated increase of average temperatures.