

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

LIVING ENVIRONMENT

Wednesday, June 14, 2023 — 1:15 to 4:15 p.m., only

Student Name _____

School Name _____

The possession or use of any communications device is strictly prohibited when taking this examination. If you have or use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

Print your name and the name of your school on the lines above.

A separate answer sheet for multiple-choice questions in Parts A, B–1, B–2, and D has been provided to you. Follow the instructions from the proctor for completing the student information on your answer sheet.

You are to answer all questions in all parts of this examination. Record your answers for all multiple-choice questions, including those in Parts B–2 and D, on the separate answer sheet. Record your answers for all open-ended questions directly in this examination booklet. All answers in this examination booklet should be written in pen, except for graphs and drawings, which should be done in pencil. You may use scrap paper to work out the answers to the questions, but be sure to record all your answers on the answer sheet or in this examination booklet as directed.

When you have completed the examination, you must sign the declaration printed on your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet cannot be accepted if you fail to sign this declaration.

Notice ...

A four-function or scientific calculator must be available for you to use while taking this examination.

DO NOT START THIS EXAMINATION UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part. [30]

Directions (1–30): For *each* statement or question, record on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

- 1 Which two body systems provide humans with the raw materials necessary for their cells to release energy?
 - (1) muscular and skeletal
 - (2) endocrine and nervous
 - (3) digestive and respiratory
 - (4) reproductive and circulatory
- 2 An example of an activity that best contributes to maintaining homeostasis in an organism is a
 - (1) bear eating fish from a polluted stream
 - (2) deer losing its fur at the start of winter
 - (3) person not sweating on a 100°F day
 - (4) response to a chickenpox vaccination
- 3 Equine cloning can be used to produce performance horses. Although the horses are clones of each other, they may still exhibit slight differences in appearance.

Horse Clones



Source: <http://vetmed.tamu.edu/images/site/labs/eel/5-cloned-foals.jpg>

- The differences in the physical characteristics of the cloned horses are most likely the result of
- (1) environmental influences
 - (2) natural selection
 - (3) sexual reproduction
 - (4) changes in gametes

4 Which situation is an example of an organism responding to an abiotic factor?

- (1) Plants in a forest grow toward areas where there is more sunlight available.
- (2) Rabbits attract mates by performing a mating dance.
- (3) Woodpeckers peck holes in the trunks of trees to find insects for food.
- (4) Deer eat tree bark in winter when other food is scarce.

5 CRISPR/Cas9 is a powerful system that bacteria use to cut and remove DNA from invading viruses. Using CRISPR/Cas9, researchers have successfully corrected a disease-causing mutation for muscular dystrophy in laboratory mice. Correcting the harmful mutation using CRISPR/Cas9 is an example of

- (1) biological evolution
- (2) cloning techniques
- (3) genetic engineering
- (4) selective breeding

6 Many animal populations living in a particular area would most likely

- (1) occupy the same niche
- (2) have similar physical requirements
- (3) eat the same food
- (4) require an input of solar energy

7 Cells possess structures that perform specific jobs. Which statement correctly pairs a cell structure with a function it performs in the cells?

- (1) The cell membrane synthesizes proteins for cell processes.
- (2) The mitochondria provide energy for cell processes.
- (3) Ribosomes regulate which materials enter and leave the cell.
- (4) Vacuoles transfer genetic information from one cell to another.

8 The endangered Everglade snail kite is a predatory bird which usually feeds on small snails. Conservationists feared the snail kite would face a greater decline when the Everglades was invaded by a species of larger snail that the birds had historically struggled to eat. But the snail kite population increased over several years, and the snail kites now have larger beaks and bodies.



Source: <https://www.nytimes.com/2017/11/28>

This change in the snail kite can best be explained by

- (1) selective breeding with larger kites
- (2) natural selection after an environmental change
- (3) genetic engineering to modify specific genes
- (4) ecological succession due to random mutation

9 Scientists turned a specialized stomach cell from a mouse into a skin cell by activating a specific gene responsible for the production of skin cells. Which claim can be made, based on this evidence?

- (1) Stomach cells have the genetic information to form other types of cells.
- (2) Skin and stomach cells produce identical proteins.
- (3) Stomach cells receive half their genetic information from each parent.
- (4) Skin and stomach cells have completely different genes.

- 10 New York State is home to animals such as the Eastern chipmunk. Individuals within this species are not genetically identical.



Source: J. Bartsch

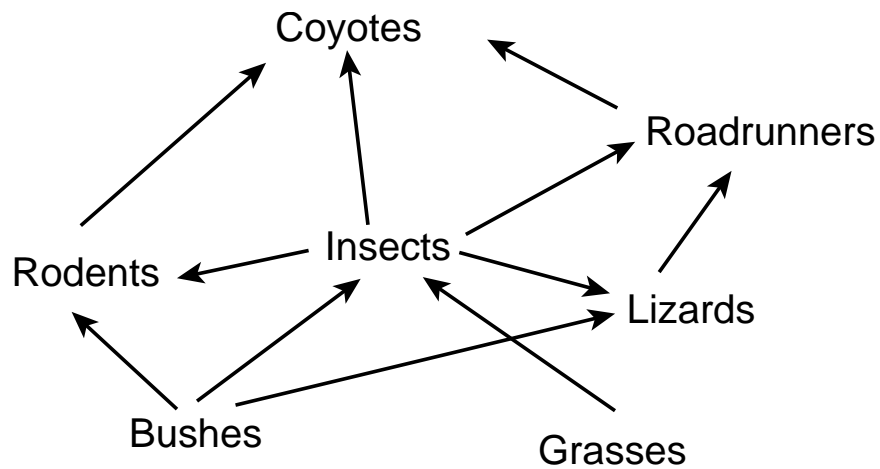
This variability is primarily the result of

- (1) asexual reproduction and mutation
- (2) mitosis and selective breeding
- (3) meiosis and recombination
- (4) sexual reproduction and cloning

- 11 Zebra mussels are aquatic animals found in many bodies of fresh water in New York State. These organisms are not native to North America. When these mussels first appeared, their populations increased rapidly, which led scientists to fear their potential impact on native species. Lately, it has been observed that the rate of population growth of the zebra mussels has decreased. A reason for this decrease may be

- (1) resources needed for the continued growth of their population are limited
- (2) competition between zebra mussels for limited resources has decreased
- (3) the food available for zebra mussels has decreased, reducing their rate of photosynthesis
- (4) a lack of natural predators and disease-causing organisms in their new environment

12 The diagram below represents a food web.



Which statement best describes a relationship represented in the diagram?

- (1) Bushes are herbivores that feed on insects.
- (2) Rodents are consumers that feed on lizards.
- (3) Roadrunners are carnivores that feed on insects.
- (4) Grasses are producers that are eaten by lizards.

13 Cell membranes inside the cells that line the stomach pump hydrogen ions from areas of low concentration inside the cells to areas of higher concentration outside the cells. Which activity produces the ATP that makes this pumping possible?

- (1) cellular respiration
- (2) active transport
- (3) carbohydrate digestion
- (4) enzyme synthesis

14 If scientists wanted to study the physical characteristics of an extinct animal that once lived in a specific area, the best source of information would be to investigate

- (1) plants living in habitats similar to those of long ago
- (2) the producer organisms living in that area at the current time
- (3) the animals that live in that area today
- (4) the fossil record of that area

15 Tasmanian devils are predators found on the Tasman Peninsula of Australia. Their numbers were greatly reduced after two forms of contagious cancer appeared in the population. Scientists have found an effective cancer vaccine that has saved a number of adult Tasmanian devils.



Source: <http://bigstory.ap.org/>

The beneficial effect of the vaccine will *not* be passed on to the Tasmanian devils' offspring because the

- (1) vaccine contained only a small amount of the cancer
- (2) cancer can mutate, and the vaccine would then be ineffective
- (3) cancer caused the body of the adults to produce antigens against it
- (4) vaccine did not produce a change in the sex cells of the adults

16 Usually, snakes reproduce sexually. However, some female copperhead snakes sometimes produce offspring asexually without sperm from a male. Compared with snakes formed by sexual reproduction, the offspring of these asexually reproducing snakes

- (1) have more genetic variation
- (2) have limited genetic variation
- (3) contain more DNA than the parent
- (4) grow larger than the parent

17 The brown anole is native to Cuba and the Bahamas. Males and females of the species share most of the same genes. They are the same size when they hatch out of their eggs. However, during the first year, the males grow to be three times larger than the females.



Source: Science Daily 3/1/17

The most likely explanation for the differences in size between male and female anoles is that

- (1) male organisms are always larger than the female members of a species
- (2) the males developed for a longer period of time
- (3) the females mutated during hatching, reducing their ability to grow
- (4) hormones can affect gene expression

18 Myasthenia gravis is an autoimmune disease characterized by weakness of the skeletal muscles. It occurs when normal communication between nerve and muscle cells is interrupted. The weakness is likely due to

- (1) the lack of ATP in the muscle caused by a decrease of available carbon dioxide
- (2) the brain failing to send the proper hormone signal to vacuoles within muscle cells
- (3) the failure of receptor molecules on the muscle to receive the chemical produced by nerve cells
- (4) the ribosomes in the muscle cells failing to produce enough sugar for muscle contraction

19 The removal of a short sequence of bases from a gene would most directly affect the

- (1) diffusion of materials into a cell
- (2) shape of a protein molecule
- (3) pH of the cytoplasm
- (4) size of a cell's nucleus

20 As energy moves through a forest ecosystem, it flows from

- (1) heterotrophs to autotrophs
- (2) animals to plants
- (3) herbivores to carnivores
- (4) carnivores to autotrophs

21 Each winter in the Adirondack Mountains, some of the salt applied to roadways gets washed into lakes. The increase in salt levels in areas where frogs breed has resulted in more male frogs hatching than females.



Source: https://www.adirondackexplorer.org/book_reviews/the-frogs-and-toads-of-north-america

This is an example of

- (1) asexual reproduction of male frogs
- (2) an abiotic factor affecting gene expression
- (3) the normal expression of a gene for female frogs
- (4) loss of genetic information for male frogs

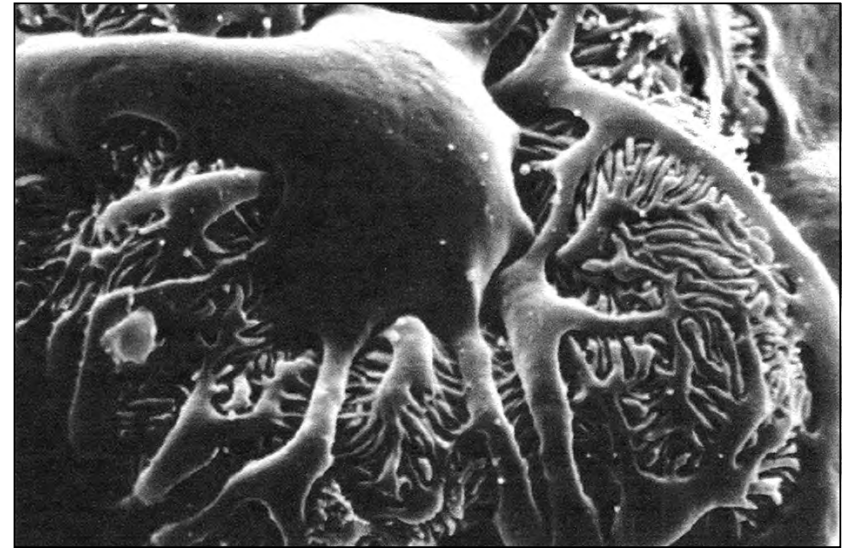
22 Which substances usually stimulate an immune response?

- (1) antibodies
- (2) antigens
- (3) carbon dioxide molecules
- (4) biological catalysts

23 A certain species of rough-skinned newt produces an extremely powerful toxin that helps prevent attacks by predators. However, one predator, the garter snake, can eat these newts without being affected by the toxin. Which statement best explains the resistance of garter snakes to the newt toxin?

- (1) The snakes needed to become resistant to the toxin in order to survive, so they developed a toxin-resistance gene.
- (2) As the newts became more toxic, the snakes became increasingly resistant in order to survive.
- (3) Exposure to newt toxin caused a mutation in the snakes, which increased resistance to the toxin in the snakes.
- (4) A random genetic mutation that resulted in toxin resistance increased the survival rates of the snakes that had it, and they passed it on to their offspring.

24 The photo below is of a magnified podocyte, a highly specialized cell that produces special proteins for filtering fluid in the human kidney.



Source: <https://s-media-cache-ak0.pinimg.com/originals/>

The specialized function of this cell is most dependent on

- (1) mutations that produce cells that have a specific shape for filtering the blood
- (2) the differentiation of the cell membrane and the functioning of vacuoles
- (3) the DNA codes in the cell and the activity of ribosomes
- (4) mitochondria in the cell that produce filtering organelles for the kidney

25 Maintaining stability in an ecosystem most likely depends on

- (1) a high level of diversity and few resources
- (2) little diversity and rapid ecological succession
- (3) a high level of diversity and multiple ecological niches
- (4) little diversity and multiple extinctions

26 Photosynthesis and cellular respiration both involve the gases carbon dioxide and oxygen. Which statement best identifies how these gases are involved in the two processes?

- (1) Photosynthesis and cellular respiration both use carbon dioxide and release oxygen.
- (2) Cellular respiration uses oxygen and releases carbon dioxide, while photosynthesis uses carbon dioxide and releases oxygen.
- (3) Cellular respiration uses carbon dioxide and releases oxygen, while photosynthesis uses oxygen and releases carbon dioxide.
- (4) Photosynthesis and cellular respiration both use oxygen and release carbon dioxide.

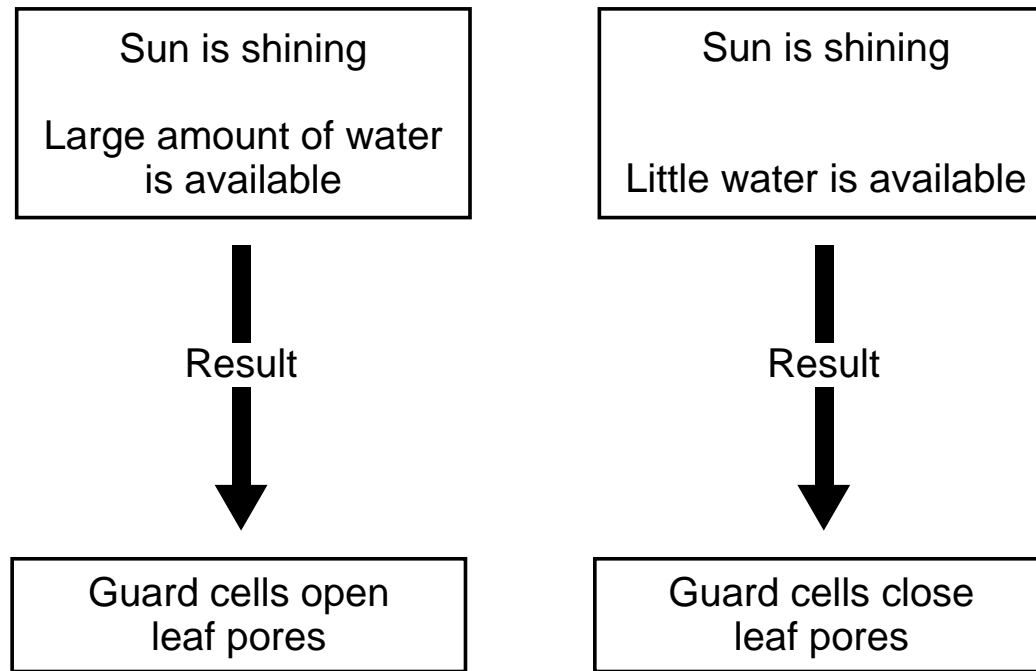
27 Antibodies produced against one pathogen infecting the human body may not work against a different pathogen because antibodies are

- (1) only produced once in the body so they can't work on any other infection
- (2) unable to produce effective antibiotics against the infection
- (3) made of DNA the second pathogen doesn't contain
- (4) specific for the shape of the proteins present on a particular pathogen

28 A multicellular organism has cells that perform various roles in that organism. This is most likely due to the

- (1) differentiation of cells during embryonic development
- (2) specialization of gametes
- (3) cloning of cells during embryonic development
- (4) specialization of zygotes

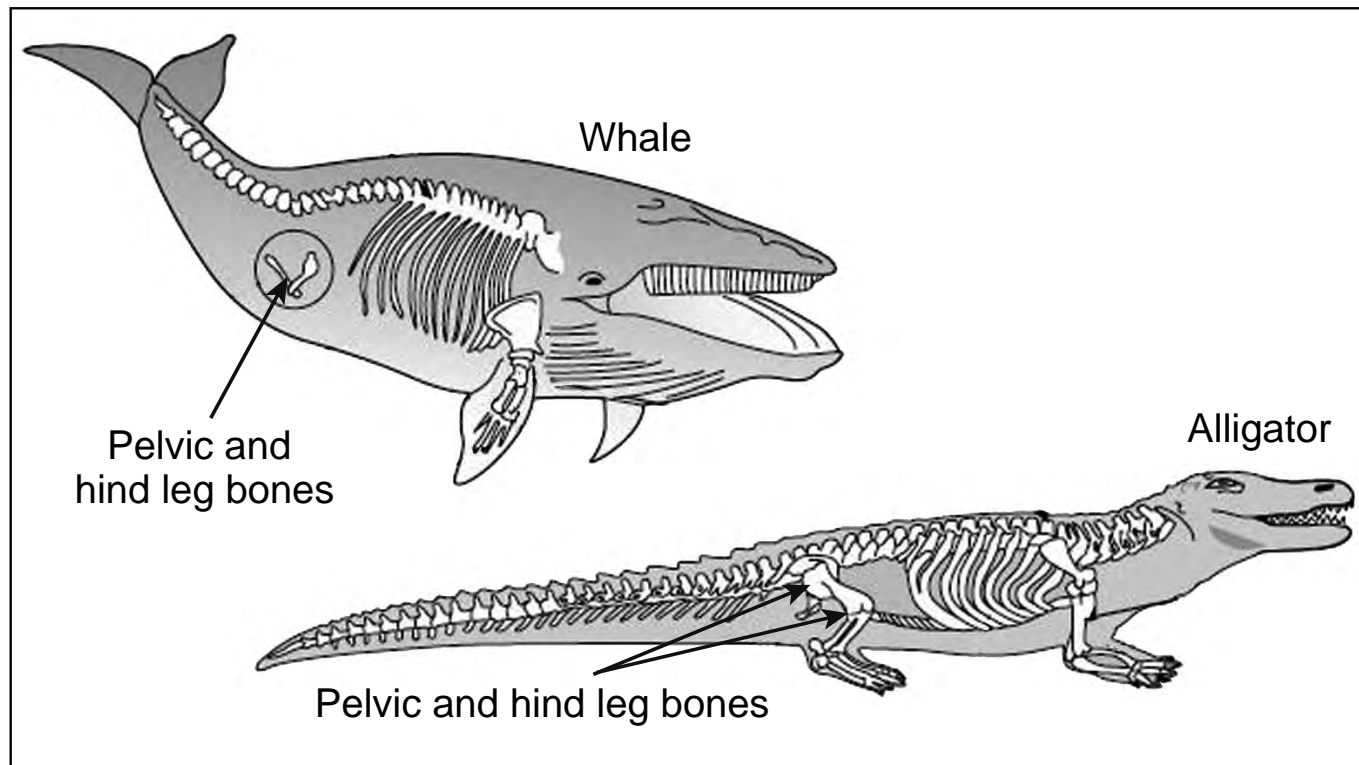
29 The diagrams below represent a response that occurs in the guard cells of a plant.



The changes in the guard cells' activity illustrate

- (1) an immune response intended to limit water use
- (2) passive transport in response to the Sun shining
- (3) a feedback mechanism to control water loss
- (4) genetic manipulation caused by the presence or absence of water

30 Today's whales and alligators both have pelvic and hind leg bones, yet these bones only function in alligators.



Source: Adapted from <http://www.cpalms.org/Public/PreviewStandard/Preview/1992>

This similarity between whales and alligators supports the idea that

- (1) whales evolved from alligators
- (2) alligators evolved from whales
- (3) alligators and whales share a common ancestor
- (4) alligators and whales share the same genetic mutations

Part B-1

Answer all questions in this part. [13]

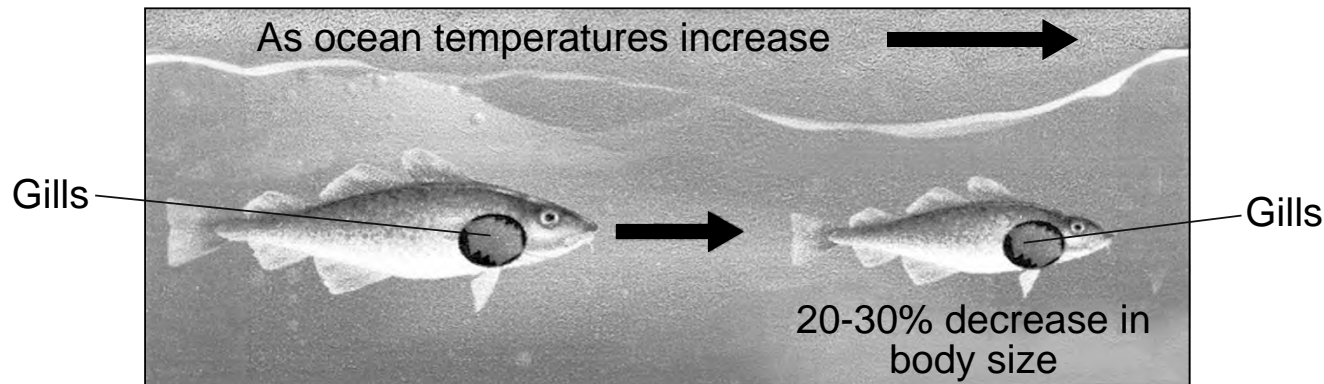
Directions (31–43): For *each* statement or question, record on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

Base your answers to questions 31 and 32 on the information and diagram below and on your knowledge of biology.

Warming Water Leaves Fish Gasping for Air and Shrinking in Size

As fish grow into adulthood, their body mass increases and so does their demand for oxygen. However, the gills, through which oxygen is obtained, do not increase in size at the same rate as the body.

Scientists have observed that as the ocean waters become warmer, there is less dissolved oxygen in the water. The result is that the average size of many fish species becomes smaller.

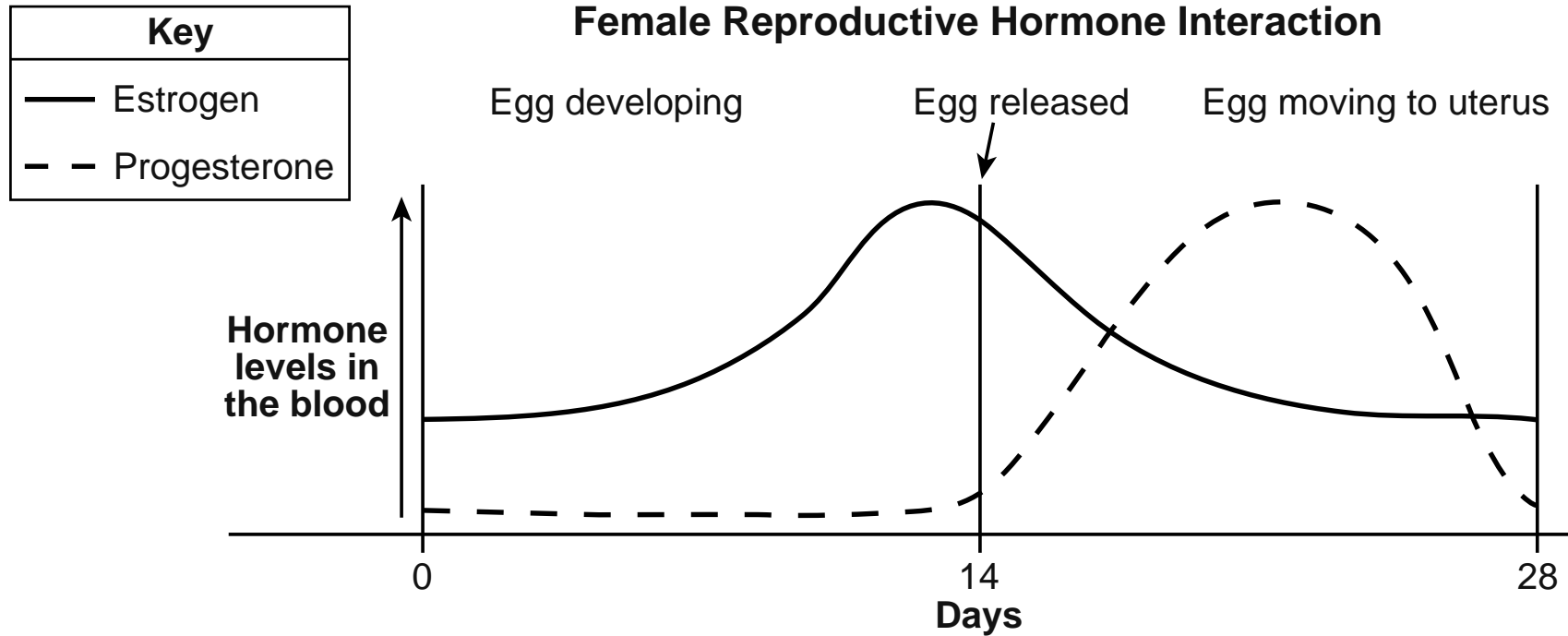


Source: Adapted from Pauly D. Cheung WWL.

- 31 The most likely reason decreased levels of oxygen in the water result in a decrease in the body size of some fish species is
- (1) due to the presence of more plant species carrying out photosynthesis
 - (2) the species producing more ATP molecules and less oxygen
 - (3) due to an increase in the size of the gills bringing in more carbon dioxide
 - (4) the species being unable to meet the energy requirements of a larger body size
- 32 One human activity that most directly contributes to the decrease in the amount of oxygen present in ocean water is
- (1) overfishing, causing a lack of biodiversity
 - (2) planting more trees, causing more soil erosion
 - (3) introducing foreign species, causing more competition
 - (4) industrialization, which releases large amounts of carbon dioxide into the atmosphere
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33 The graph below represents the interactions of two female reproductive hormones.



Based on the graph, which statement is correct regarding the interaction of the levels of estrogen and progesterone?

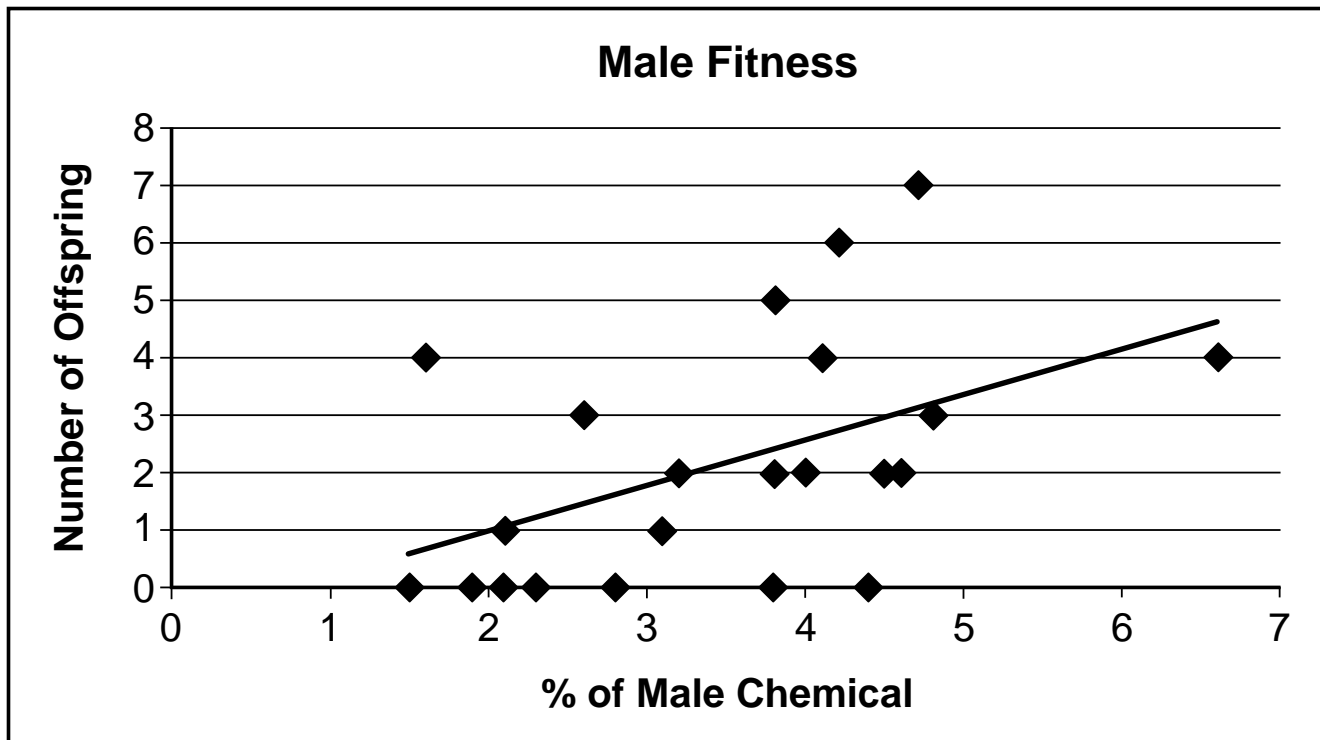
- (1) When the amounts of estrogen and progesterone are at the same level, an egg begins to develop in the ovary.
- (2) When an egg is released from the ovary, the level of estrogen is higher than the level of progesterone.
- (3) The level of progesterone controls the cycle since it is always higher than the level of estrogen.
- (4) After an egg is released from the ovary, the level of estrogen keeps increasing, causing the level of progesterone to decrease.

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Base your answer to question 34 on the information below and on your knowledge of biology.

Fitness of Male Juncos

Animals communicate with each other in many ways. For example, many male birds have bright colors to signal their fitness to females. Scientists hypothesized that female birds also use their sense of smell to gather information about the fitness of their potential mates. To test this, scientists gathered male juncos and determined the amount of a chemical produced by the male birds that is sensed by the female birds. Scientists then collected data on the number of offspring produced by each male during one breeding season. The results are shown in the chart below.



Source: Adapted from http://datanuggets.org/wp-content/uploads/2014/09/Sexy-Smells_StudentA.pdf

34 Which conclusion is most valid, based on the data?

- (1) Male juncos with a higher percentage of the male chemical have greater reproductive success.
 - (2) Male juncos with a lower percentage of the male chemical have greater reproductive success.
 - (3) The percentage of the male chemical has no effect on the reproductive success of the male juncos.
 - (4) There is a negative relationship between the percentage of male chemical produced and the reproductive success of the male juncos.
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35 Pikas are small mammals found in the grassland ecosystems of the Tibetan plateau. Pikas are prey for many of the predators also inhabiting the Tibetan grasslands, which serves as an important watershed for the area. This watershed drains large amounts of groundwater during the rainy season. Pikas have large burrow systems that help to quickly drain the groundwater. The burrows also serve as nesting sites for numerous bird species. Because they compete with livestock for grass, many people want the pikas totally removed from the Tibetan plateau.



Source: <https://www.theguardian.com/environment/2016/aug/26>

If the pika populations are completely removed from the grasslands of the Tibetan plateau, the most likely result will be that the grassland ecosystems will become

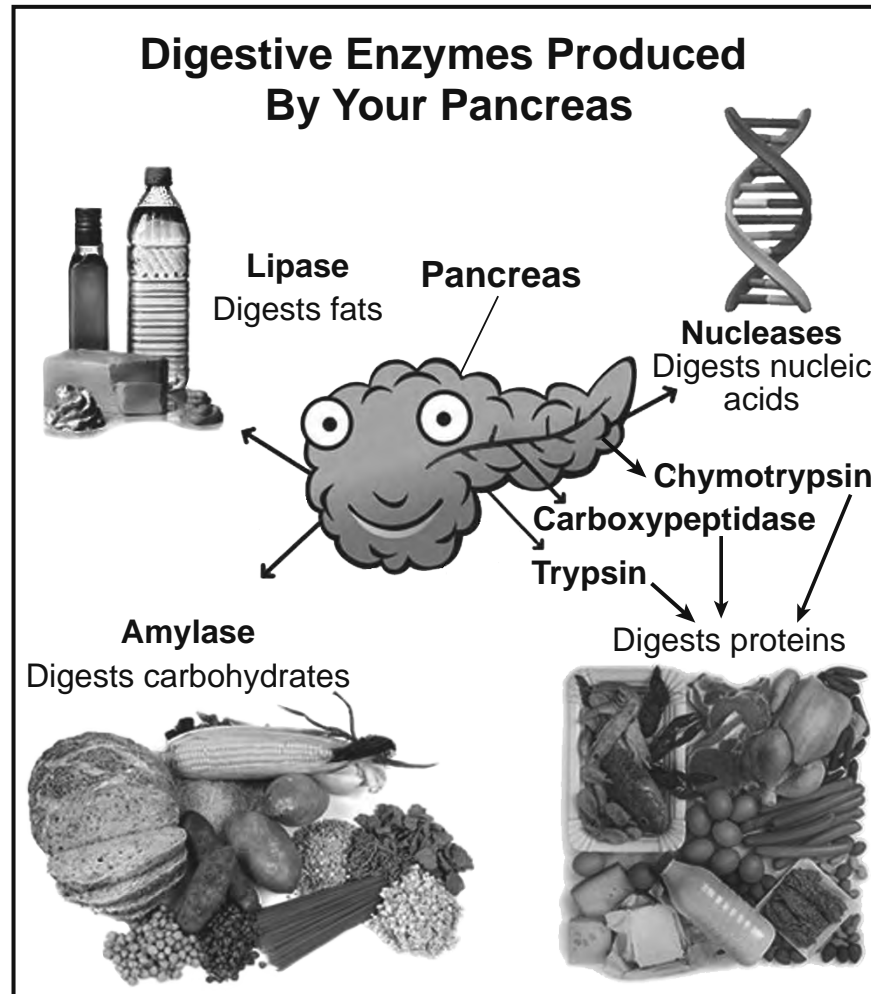
- (1) unstable, because predators will have fewer prey, the birds will have fewer nesting sites, and groundwater supplies will be disrupted
- (2) more stable, because the pikas will be replaced by other species, the birds will adapt to nesting above ground, and the soil will become more fertile since it is not drained by groundwater
- (3) unstable, because predators will migrate to nearby ecosystems, birds will nest in nearby trees, and other small animals will make burrows in the soil
- (4) more stable, because the pikas will no longer be eating the grasses, the birds will migrate to other ecosystems during the nesting season, and small lakes will form because the water will not drain without the pika burrows

36 Jean-Baptiste Lamarck was a French naturalist who proposed the idea that modern-day organisms developed new characteristics through a process known as the inheritance of acquired traits. As more evidence became available, this theory was eventually replaced by Charles Darwin's theory of evolution. This modification of scientific knowledge illustrates that

- (1) scientists do not communicate with each other and often make mistakes
- (2) all scientific explanations are tentative and subject to change or improvement
- (3) scientists often ignore evidence that does not help prove their theory
- (4) hypotheses seldom change even when new discoveries are made

Base your answers to questions 37 through 39 on the information and diagram below and on your knowledge of biology.

The diagram provides information about some of the digestive enzymes produced by the human pancreas.



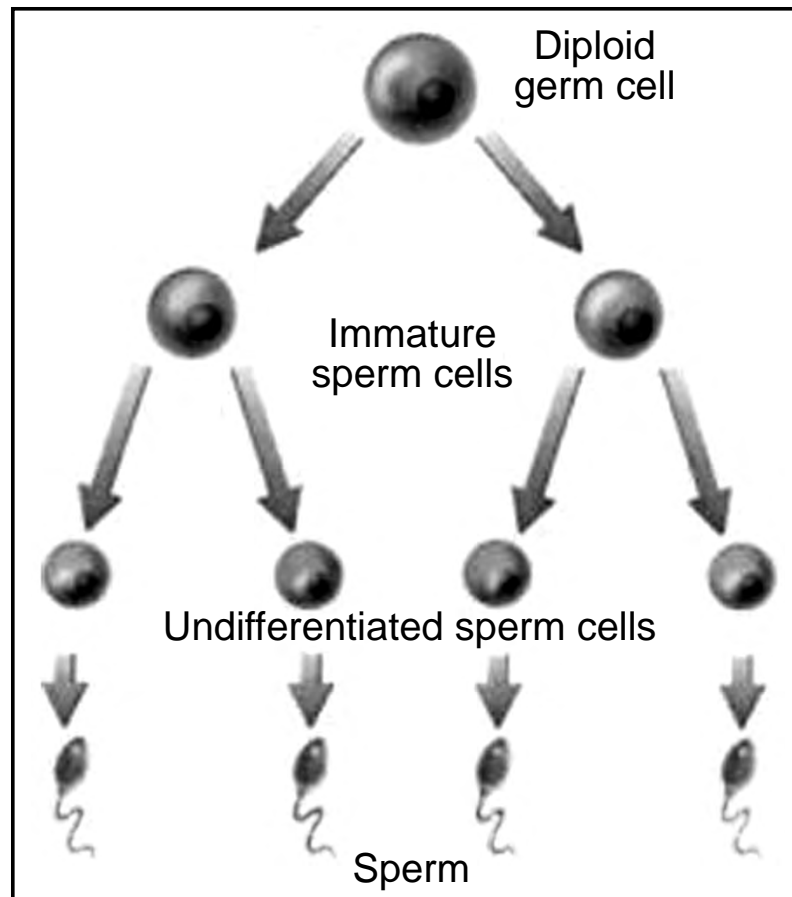
Source: Adapted from <http://www.return2health.net/articles/riseand-fall-digestive-enzymes/>

- 37 The activity of nuclease enzymes would most likely result in the release of
- (1) four different kinds of molecular bases
 - (2) glucose
 - (3) a variety of different amino acids
 - (4) hormones
- 38 The end products resulting from the action of amylase would most likely be
- (1) starches and proteins
 - (2) carbon dioxide and water
 - (3) amino acids
 - (4) simple sugars
- 39 Another important molecule *not* shown in the diagram is also produced by the pancreas. It functions to decrease glucose levels in the blood. This molecule is
- (1) progesterone
 - (2) insulin
 - (3) testosterone
 - (4) ATP
-

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40 The process of meiotic division in human males is represented below.

Spermatogenesis



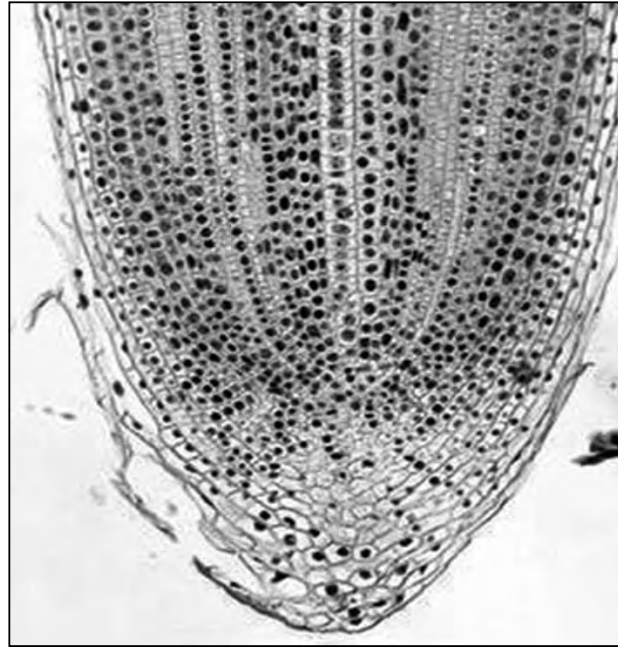
Source: Adapted from <http://bio-education.weebly.com/uploads/9/4/9/5/949532/4040231.jpg?495x268>

This process produces four sperm cells, each with

- (1) all of the genetic information contained in the diploid germ cell
- (2) one-quarter of the genetic information contained in the diploid germ cell
- (3) twice the genetic information found in the diploid germ cell
- (4) one-half of the genetic information found in the diploid germ cell

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41 A student viewed a slide of an onion root tip with a compound light microscope. The photograph below represents what he saw.



Source: <http://slideplayer.com/slide/760969/2/images/77/Onion+root+tip.jpg>

In order to observe whether or not this root tip was growing, the student should

- (1) switch to a higher magnification and look for evidence of cell division
- (2) switch to a lower magnification and look for evidence of cell division
- (3) switch to a lower magnification and add a stain to the onion root tip cells
- (4) switch to a higher magnification and add salt solution to the onion root tip cells

42 Which statement is an example of a hypothesis that can be tested through experimentation?

- (1) The number of times a dog wags its tail is a direct measure of how happy the dog is.
- (2) Is the ability of a fish to taste food affected by how clear the water is where it lives?
- (3) A plant's fear of herbivores increases as the plant grows older.
- (4) Bacterial growth will rapidly increase as the temperature increases.

43 Deforestation is a major cause of soil loss. Without trees and other plants to hold the soil in place, it either washes or blows away. Governments, international organizations, and others are working to decrease the rate of deforestation. In addition to slowing the rate of soil loss, another potential benefit of this action would be

- (1) a decrease in atmospheric carbon dioxide levels
 - (2) more land available for agriculture
 - (3) a decrease in the amount of firewood for heating
 - (4) more locations for the construction of new homes
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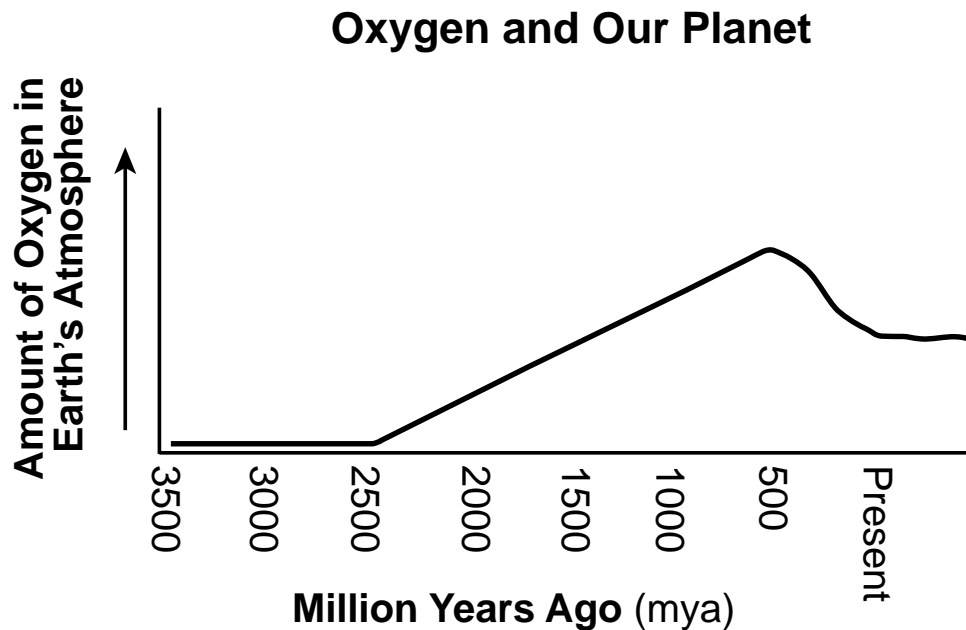
Part B-2

Answer all questions in this part. [12]

Directions (44–55): For those questions that are multiple choice, record on the separate answer sheet the *number* of the choice that, of those given, best completes each statement or answers each question. For all other questions in this part, follow the directions given and record your answers in the spaces provided in this examination booklet.

Base your answer to question 44 on the information and graph below and on your knowledge of biology.

The graph shows the amount of oxygen in Earth's atmosphere from 3500 million years ago to present. Scientists can use this information to learn more about the evolution of different species.



Source: Adapted from <https://www.indiana.edu/~ensiweb/lessons/foot-topo-10inch.pdf>

44 Identify when during Earth's history autotrophs most likely first appeared. Support your answer using information from the graph. [1]

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Base your answers to questions 45 through 49 on the information and data table below and on your knowledge of biology.

Whitebark Pines in Yellowstone Park

Scientists claim that mountain pine beetles have been blamed for the death of mature whitebark pine trees in the Greater Yellowstone forest ecosystem. The beetles burrow into the trees to lay their eggs. When the eggs hatch, the larvae feed on the tree, cutting off the flow of water. As a result, the trees become stressed and begin to die. An increase in the temperature is contributing to the increase in beetles. Cooler temperatures tend to keep the beetle population controlled. Many organisms, including squirrels, birds, and even grizzly bears, have been impacted by the decrease in the numbers of trees. Many organisms use whitebark pine seeds for food.

The data table below shows the proportion of live mature whitebark pine trees compared with their population in 2000.

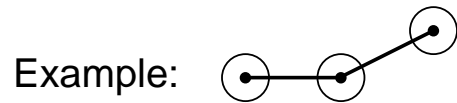
Mature Whitebark Pine Trees in the Greater Yellowstone Ecosystem

Year	Proportion of Live Mature Whitebark Pine Trees Compared with Their Population in 2000
2000	1.00
2002	1.00
2004	0.70
2006	0.60
2008	0.40
2010	0.25
2012	0.25

Directions (45–46): Using the information in the data table, construct a line graph on the grid on the next page, following the directions below.

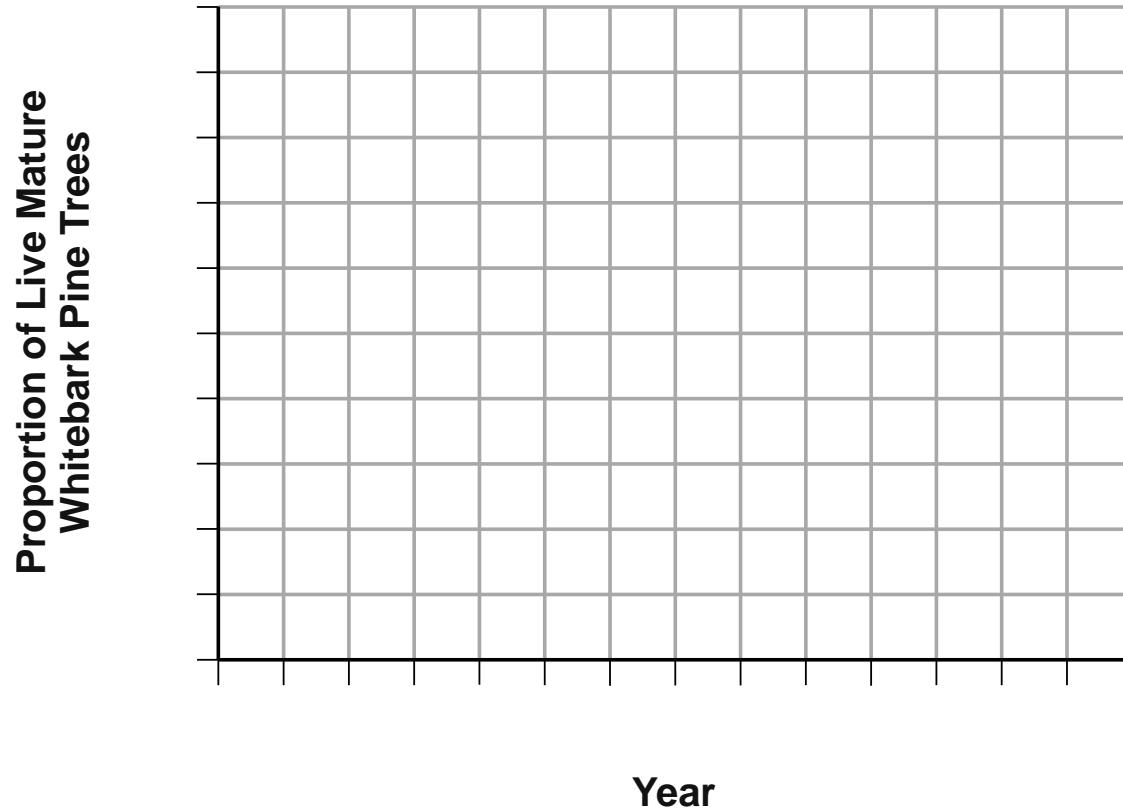
45 Mark an appropriate scale, without any breaks in the data, on each labeled axis. [1]

46 Plot the data on the grid. Connect the points and surround each point with a small circle. [1]



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Whitebark Pine Trees in the Greater Yellowstone Ecosystem



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Note: The answer to question 47 should be recorded on your separate answer sheet.

47 The nutritional roles of the whitebark pine trees and the beetles are best described as

- | | |
|----------------------------|-----------------------------|
| (1) producer and carnivore | (3) predator and decomposer |
| (2) producer and herbivore | (4) herbivore and parasite |

48 Warmer climatic temperatures are one of the reasons for the increase in the pine beetle population. State *one* action that humans can take to help to reduce this warming trend. [1]

Note: The answer to question 49 should be recorded on your separate answer sheet.

49 The dependent variable in this study is the

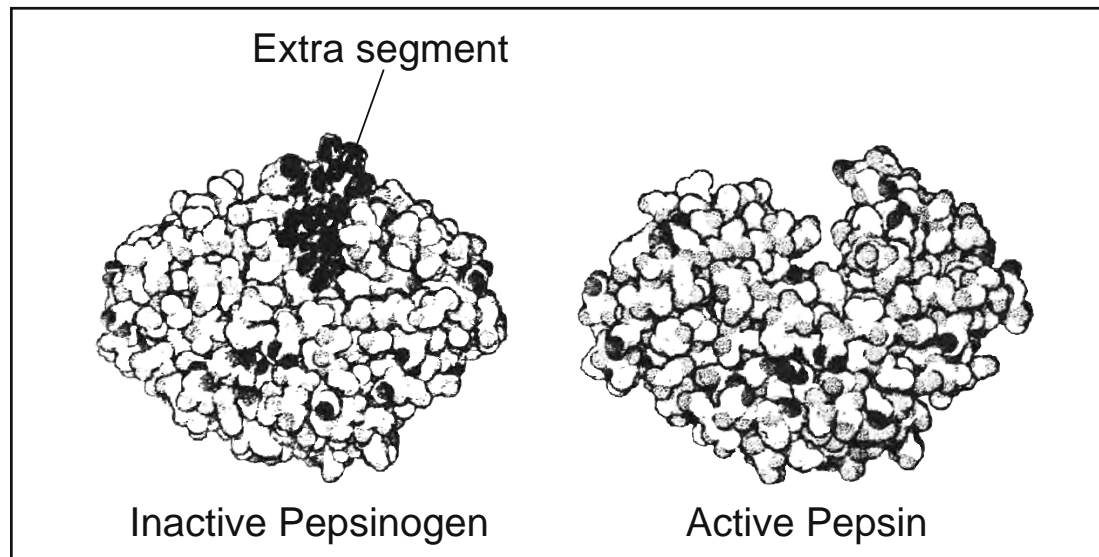
- | | |
|---|--|
| (1) proportion of mountain pine beetles | (3) time that the study was conducted |
| (2) increasing temperature of the area | (4) proportion of live mature whitebark pine trees |

Base your answers to questions 50 and 51 on the information below and on your knowledge of biology.

Pepsin is a protein-digesting enzyme. It is produced inside cells that line the stomach and then secreted into the stomach cavity, where it begins to work.

When first produced, the pepsin exists in an inactive form called pepsinogen. Pepsinogen cannot work because it has an extra segment that keeps it from interacting with the proteins it would normally digest.

When it is secreted into the stomach cavity, the acid there causes the pepsinogen molecule to lose this extra segment, which changes it into the active pepsin that can begin to digest food proteins.



Source: <http://pdb101.rcsb.org/motm/12>

Note: The answer to question 50 should be recorded on your separate answer sheet.

50 Which statement most accurately summarizes the function of pepsin?

- (1) It prevents harmful substances from entering the stomach.
- (2) It regulates the transport of starch across the cell membrane.
- (3) It controls the rate at which certain chemical reactions occur.
- (4) It prevents the production of harmful by-products in stomach cells.

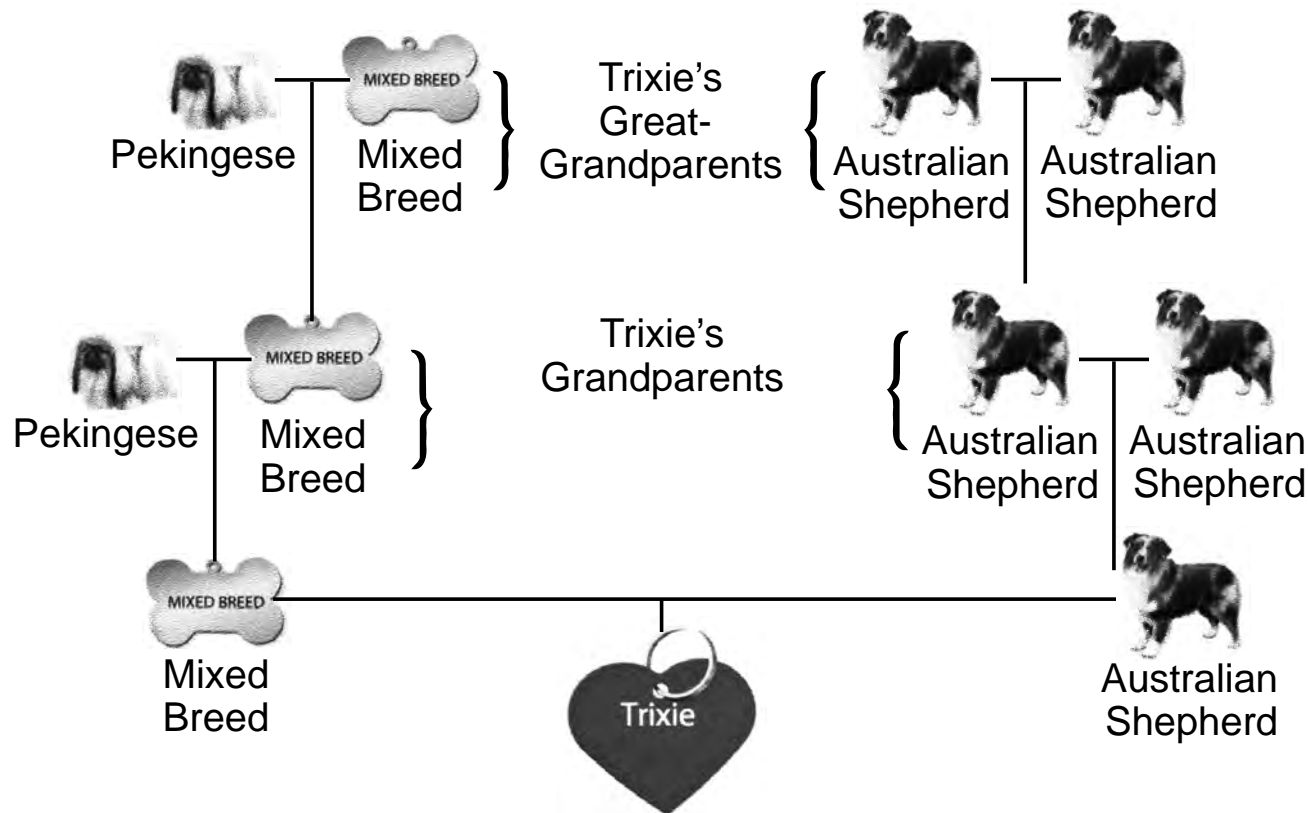
51 Explain why the extra segment prevents pepsinogen from interacting with food proteins. [1]

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Base your answers to questions 52 and 53 on the information below and on your knowledge of biology.

Trixie's Pedigree

Pet owners today have access to genetic technologies that can provide them with information about their pets. For example, ancestry charts (pedigrees) can be developed for dogs by analyzing specific DNA sequences that are present in their cells. The presence of these DNA sequences can be used to determine the types of breeds present in the dogs' ancestors. The chart below represents the family tree of a dog named Trixie.



Pekingese Mix Crossed with Australian Shepherd

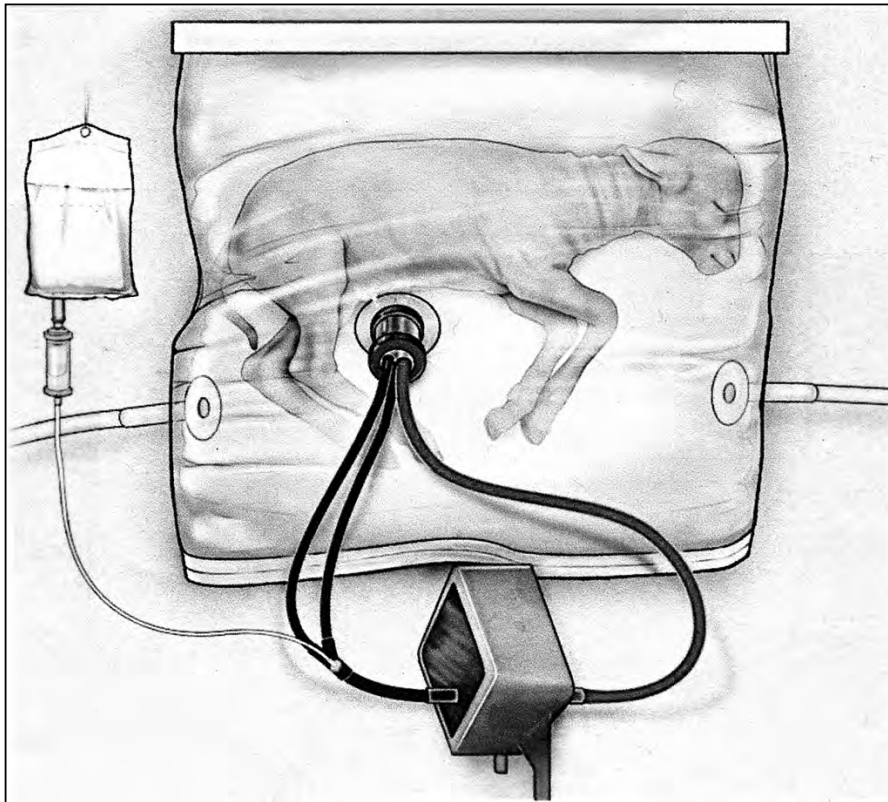
Source: Adapted from Wisdom Panel

52 Explain why it only requires a sample of cheek cells present in the dog’s saliva, rather than using a mix of cells present in different tissues of the dog, to determine the breeds making up the dog’s ancestry. [1]

53 State *one* possible reason why Trixie could express a trait that was *not* expressed by any of her ancestors. [1]

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Base your answers to questions 54 and 55 on the information below and on your knowledge of biology.



Source: Children's Hospital of Philadelphia/Discover Magazine, January/February 2018, Page 24

Biobag System

After decades of research, scientists have developed a biobag system with the potential to save extremely premature babies. They have successfully removed eight lamb fetuses from their mothers and placed them into biobags. Eventually, the fetuses developed into healthy sheep.

The biobag is a clear plastic bag filled with a solution of water containing various salts. A machine outside the bag is attached to the blood vessels in the lamb's umbilical cord. The lamb's umbilical cord brings in nutrients, and its heart pumps blood through an external oxygenator that removes carbon dioxide from the blood and adds oxygen.

The biobag models early development in the reproduction of mammals. In the future, this system may be able to be used with human premature babies. The biobag system could allow them to continue to develop for a longer period of time.

54 Two parts of the biobag system are the plastic bag and the external oxygenator. Select *one* of these parts and circle it below. Identify the structure in the reproductive system that the part of the biobag system you selected represents, and state the function of that part. [1]

Circle one:

Plastic bag

External oxygenator

55 State *one* reason why medical advances that might be helpful to people are tested first on organisms such as sheep. [1]

Part C

Answer all questions in this part. [17]

Directions (56–72): Record your answers in the spaces provided in this examination booklet.

Base your answers to questions 56 through 58 on the information below and on your knowledge of biology.

Acid Rain

Acid rain comes in many forms: wet deposition, such as rain, snow, sleet, hail, and fog, and dry deposition, such as deposits of acid particles, aerosols, and gases. It is formed when sulfur dioxide (SO_2) and nitrogen oxides (NO_x) combine with moisture in the atmosphere to produce sulfuric acid and nitric acid. Damage to aquatic and forest ecosystems, serious human illness, and the slow destruction of buildings and bridges have all been linked to acid rain.

Two sources that contribute to producing acid rain include:

- Emissions from airplanes, automobiles, and industries
- Emissions of SO_2 and NO_x from power plants

Source: Adapted from New York State Department of Environmental Conservation (<http://www.dec.ny.gov/chemical/8418.html>)

56 Explain why a change in the pH of lakes and forests as a result of acid rain can upset the dynamic equilibrium of these ecosystems. [1]

57 Identify *one* specific action individuals could take to significantly reduce the amount of acid rain falling in New York State. [1]

58 Explain how the specific action you identified in question 57 would decrease the formation of acid rain. [1]

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Base your answers to questions 59 through 61 on the information below and on your knowledge of biology.

Lionfish Invasion

Lionfish are native to the Indian and Pacific Oceans. They have recently been found along the southeast coast of the U.S., the Caribbean, and in parts of the Gulf of Mexico. Experts speculate that the lionfish invasion was caused by people dumping unwanted lionfish into the Atlantic Ocean from home aquariums.

Lionfish have venomous spines and feed on small crustaceans and many fish, including the young of important commercial fish species such as snapper and grouper. The current invasion of lionfish most likely started with the dumping of about 12 fish. Today, there are thousands of them over a wide area.



Source: <http://dailymail.co.uk/sciencetech/article-4564472/Invasive-lionfish-Caribbean-sea-preying-new-species.html>

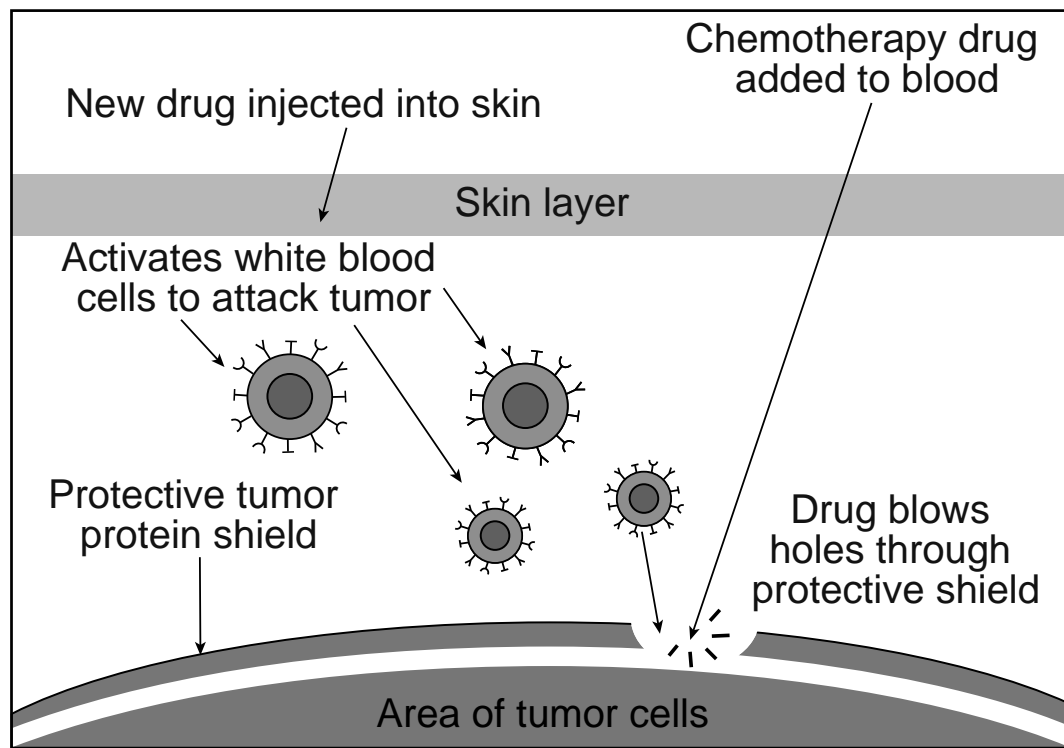
59 State *one* specific reason why these invasive fish have been able to rapidly increase their population and range over the last 20 years. [1]

60 Explain why the amount of genetic diversity within the invasive lionfish population would be expected to be quite low. [1]

61 State *two* ways invasive species can disrupt ecosystems. [1]

Base your answers to questions 62 through 64 on the information below and on your knowledge of biology.

How the New Drug Works



Source: Adapted from <https://www.theguardian.com/science/2016/sep/06>

New Drug “Wakes up” Immune System to Fight Pancreatic Cancer

Pancreatic cancer makes up three percent of all cancers. Recently, scientists announced the discovery of a new drug that has helped extend the lives of some patients with pancreatic cancer.

Pancreatic tumors usually have a protective protein layer surrounding them. The protein is produced by the tumor cells. This protein shield seems to deactivate white blood cells that would normally recognize and target the tumor cells for destruction.

The new drug reactivates these white blood cells, stimulating them to attack the tumor again. A specific chemotherapy drug blows holes in the protective protein layer around the tumor. This action then allows the activated white blood cells to directly attack the tumor. The process is modeled in the diagram on the left.

62 State whether the new drug used without the chemotherapy drug would enable the immune system to successfully attack the cancer cells. Support your answer. [1]

63 Explain the role of white blood cells in the process of killing cancer cells. [1]

64 Explain why this new cancer treatment would most likely be *less* effective if the cancer patient also had AIDS. [1]

Base your answers to questions 65 through 67 on the information below and on your knowledge of biology.



Source: <https://www.smithsonianmag.com>

The Cougars of Zion National Park

Researchers claim that the crowds of visitors at Utah's Zion National Park have led to the displacement of cougars, the area's top predator, resulting in a devastating series of changes to the region's biodiversity. The researchers compared Zion Canyon's ecosystem with a nearby habitat called North Creek, where human visits are infrequent and the cougars still thrive.

In Zion Canyon, there are many more deer, the cougar's main prey, and fewer cottonwood trees than in North Creek. Zion also has a reduced number and diversity of butterflies, amphibians, and wetland plants.

To measure the impact of the shrinking cougar population, researchers collected data on Zion Canyon's deer populations dating back to the 1930s, when tourism began to increase. Currently, with over three million visitors per year, the cougars, which usually avoid humans, are becoming increasingly rare.

The researchers also estimated the age and abundance of cottonwoods, a favorite food of young deer, and found a healthy mix of old and young cottonwoods in North Creek, where cougars are common.

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65 Students drew a few models of the food chain in Zion National Park, as described in the reading.

A	Cottonwoods → Deer → Cougar
B	Deer → Cottonwoods → Cougar
C	Cougar → Deer → Cottonwoods

Record the letter of the model that represents the actual food chain in Zion National Park and explain why the model you chose is correct. [1]

66 Destabilization is a phenomenon that has been observed in a variety of ecosystems when the number of predators has been significantly reduced. Explain how the destabilization caused by the loss of cougars in Zion National Park has resulted in a *decrease* in the cottonwood trees. [1]

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67 The researchers claimed the decrease in the cougar population is a result of the increase in the number of visitors in the park. Describe evidence the researchers could use to support their claim. [1]

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Base your answers to questions 68 through 70 on the information below and on your knowledge of biology.



Source: <https://www.naturalworldpets.co.uk/canary-care-sheet/>

Meet the Sentinels

Canaries are the most familiar example of a sentinel species, which are animals and plants that serve as harbingers [indicators] of danger to human health and the environment. In the case of canaries, if odorless carbon monoxide were present in a high enough concentration in a coal mine, the small bird would die first and give miners time to escape.

Cats, too, have been sentinels. In the 1950s, people in the town of Minamata, Japan, began to notice that local cats were acting strangely; The cats were unable to walk straight and uncontrollably jumped about. After some time, people began to act similarly. The cause of the “dancing cat fever” was quickly connected to the release of methylmercury in the wastewater of a local chemical factory. The discharge fed into the city’s harbor, where it bioaccumulated in [tissues of] fish and shellfish. Although several thousand people were affected with what became known as Minamata disease, the outcome could have been worse were it not for the warning from the dancing cats. ...

Source: C&EN/CEN.ACS.Org/November 20, 2017

68 Bald eagle populations declined when a pesticide called DDT was used to kill insects. Once DDT was banned in 1972, the population of bald eagles rebounded. State *one* reason why the bald eagles could be considered a sentinel species like canaries in coal mines. [1]

69 Explain why the banning of certain pesticides might cause a problem for humans. [1]

70 Describe *one* specific human action, other than banning its use, that could reduce the chance that a toxic chemical could contaminate the environment. [1]

Base your answers to questions 71 and 72 on the information below and on your knowledge of biology.

Dinosaur Extinction

The hypothesis that an asteroid strike led to the mass extinction of dinosaurs is widely accepted. It is understood that the asteroid strike caused a massive and quick shift in Earth's temperature and blocked much of the sunlight. While devastating for the dinosaurs, this dramatic event provided opportunities for other species. For example, surviving birds and mammals underwent a time of rapid evolution, which led to the thousands of birds and mammal species present on Earth today.

Source: <https://www.independent.co.uk/>



71 Describe *one* way the temporary blocking of the sunlight could have impacted the survival of the dinosaurs. [1]

72 Suggest *one* possible explanation for why some birds were able to survive the mass extinction. [1]

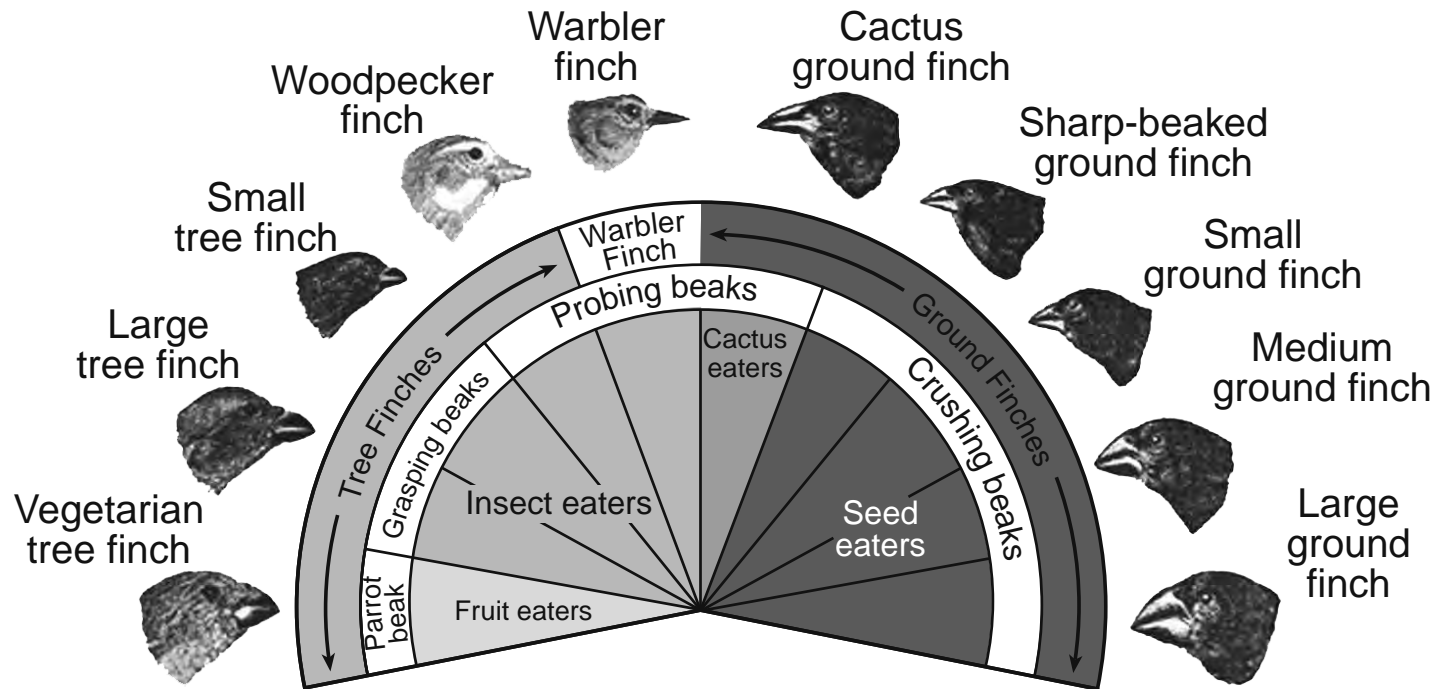
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Part D

Answer all questions in this part. [13]

Directions (73–85): For those questions that are multiple choice, record on the separate answer sheet the *number* of the choice that, of those given, best completes each statement or answers each question. For all other questions in this part, follow the directions given and record your answers in the spaces provided in this examination booklet.

Base your answer to question 73 on the information below and on your knowledge of biology.



Source: Adapted from www.pbs.org

Note: The answer to question 73 should be recorded on your separate answer sheet.

73 Which two species of finch would be affected if a bird with a grasping beak that ate ants and beetles was introduced into their habitat?

- (1) large ground finch and warbler
 - (2) woodpecker finch and small ground finch
 - (3) large tree finch and small tree finch
 - (4) cactus finch and medium ground finch
-

Note: The answer to question 74 should be recorded on your separate answer sheet.

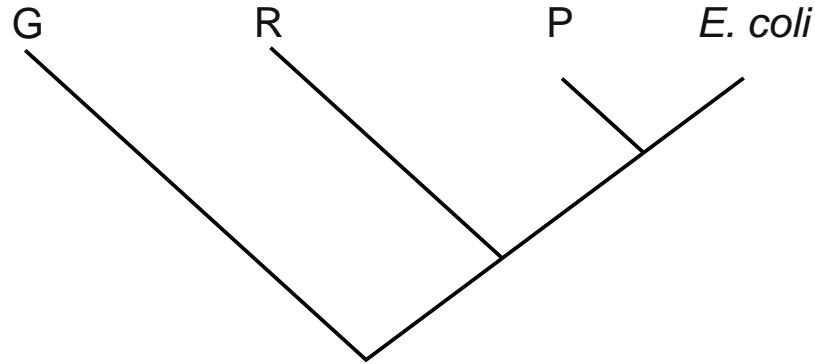
74 Comparisons between species can be done using both structural and molecular evidence. An example of using structural evidence is comparing

- (1) seed characteristics
- (2) enzyme characteristics
- (3) amino acid sequences
- (4) DNA banding patterns

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Note: The answer to question 75 should be recorded on your separate answer sheet.

75 The DNA from three different bacterial species are compared with a specific strain of *E. coli* bacteria. These data were used to construct the evolutionary tree below.



Which row in the data table below best supports the evolutionary diagram constructed by the scientists?

Species Comparison
(Percent of Identical DNA)

Row	<i>E. coli</i>	Species G	Species R	Species P
(1)	100%	99%	95%	93%
(2)	100%	93%	95%	99%
(3)	100%	99%	93%	99%
(4)	100%	95%	99%	93%

Base your answers to questions 76 through 78 on the information below and on your knowledge of biology.

A student conducted an experiment to determine the effect of exercising on breathing rate. The student measured the breathing rate of three classmates at rest and again after exercising for intervals of 30, 60, and 90 seconds. Her results are shown in the data table below.

Breathing Rate in Breaths/Minute

Time Exercising (seconds)	Student A	Student B	Student C	Average
0 (Resting)	12	12	15	_____
30	25	18	20	21
60	38	27	28	31
90	43	33	38	38

Note: The answer to question 76 should be recorded on your separate answer sheet.

76 The purpose of checking the breathing rate before exercising is that it

- (1) serves as a control for the experiment
- (2) is needed to form a hypothesis
- (3) can be changed to form a conclusion
- (4) can be used to predict the results

77 Calculate the average resting breathing rate for this group of students. Record your answer in the appropriate space in the data table above. [1]

78 State *one* biological benefit of the breathing rate increasing while exercising. [1]

Base your answers to questions 79 and 80 on the information below and on your knowledge of biology.

Three potato slices with the same mass were each placed in three beakers, each labeled with its number and contents. After 30 minutes, the potato slices were removed from the solutions, dried with a paper towel, and the mass was determined. The results are shown in the table below.

Change in Mass of Potato in Different Solutions

Beaker	Solution	Change in Mass
1	distilled water	gained 4.0 grams
2	6% salt solution	lost 0.4 grams
3	16% salt solution	lost 4.7 grams

79 Identify a process that caused these changes in mass of each of the three slices. [1]

80 Explain why the potato slice in distilled water (Beaker 1) was the only one to gain mass after 30 minutes. [1]

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Base your answers to questions 81 through 83 on the information below, on the next page, and on your knowledge of biology.

Universal Genetic Code Chart
Messenger RNA Codons and the Amino Acids for Which They Code

		SECOND BASE				
		U	C	A	G	
FIRST BASE	U	UUU } PHE UUC } UUA } LEU UUG }	UCU } UCC } SER UCA } UCG }	UAU } TYR UAC } UAA } STOP UAG }	UGU } CYS UGC } UGA } STOP UGG } TRP	U C A G
	C	CUU } LEU CUC } CUA } CUG }	CCU } CCC } PRO CCA } CCG }	CAU } HIS CAC } CAA } GLN CAG }	CGU } CGC } ARG CGA } CGG }	U C A G
	A	AUU } ILE AUC } AUA } MET or AUG } START	ACU } ACC } THR ACA } ACG }	AAU } ASN AAC } AAA } LYS AAG }	AGU } SER AGC } AGA } ARG AGG }	U C A G
	G	GUU } VAL GUC } GUA } GUG }	GCU } GCC } ALA GCA } GCG }	GAU } ASP GAC } GAA } GLU GAG }	GGU } GGC } GLY GGA } GGG }	U C A G

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Note: The answer to question 81 should be recorded on your separate answer sheet.

81 Using the Universal Genetic Code Chart, how many messenger RNA codons code for the amino acid leucine (LEU)?

- (1) 6
- (2) 2
- (3) 8
- (4) 4

The table below shows a section of messenger RNA for five species of similar organisms.

Messenger RNA of Similar Species

Species	Messenger RNA Codons
X	UUA CCC AAU AGA
1	CUG CCC AAU AGA
2	GUC CCC AAU AGA
3	UGG CCC CAU ACA
4	UGU CGC UUU GCG

Note: The answer to question 82 should be recorded on your separate answer sheet.

82 What is the DNA sequence that codes for the messenger RNA codons shown in Species X?

- (1) AAT GGG ATT TCT
- (2) ACC AAT GGG TCT
- (3) AAT GGG TTA TCT
- (4) TCT AAT GGG TCT

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83 Write the number of the species in the table that would produce the same sequence of amino acids as Species X. [1]

Base your answer to question 84 on the information below and on your knowledge of biology.

A group of students designed an experiment to determine if an individual's age had any effect on pulse rate. The data collected are recorded in the table below.

Effect of Age on Pulse Rate

Age	8	17	18	22	28	31	37	43	51	60
Pulse rate/minute	76	61	67	58	68	69	62	48	84	54

84 Based on these data, the students concluded that pulse rate increases with age. State *one* reason why this conclusion might be questioned. [1]

85 Identify an organ of the human body where diffusion occurs, and identify *one* specific molecule that diffuses between that organ and the blood. [1]
