

REGENTS HIGH SCHOOL EXAMINATION

LIVING ENVIRONMENT

Thursday, June 18, 2026 — 9:15 a.m. to 12:15 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.

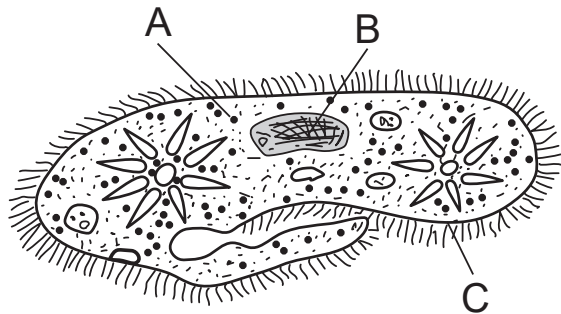
DO NOT START THIS EXAMINATION UNTIL THE SIGNAL IS GIVEN.

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 The diagram below represents a single-celled organism.



It is important that the parts of the cell labeled A, B, and C interact so that

- (1) glucose can be excreted
- (2) genetic information can be mutated
- (3) oxygen can be synthesized
- (4) homeostasis can be maintained

- 2 Some bacteria have one chromosome. Humans have 46 chromosomes. Even though these organisms are very different, *one* way in which they are similar is that their chromosomes can

- (1) change their DNA sequences as needed when sudden environmental changes occur
- (2) rearrange the amino acid sequences of their chromosomes slowly over time
- (3) prevent any mutations in the chromosomes that are harmful to the organism
- (4) replicate their genetic codes, which can then be passed on to their offspring

- 3 A student prepared a freshwater aquarium for classroom observation. She chose four mollies (freshwater fish) and three damselfish (saltwater fish). The main reason that the damselfish would have trouble living in the freshwater tank is that
- (1) excess water will enter their cells
 - (2) there are more mollies than damselfish in the tank
 - (3) the damselfish would soon outcompete the mollies for food
 - (4) excess water will leave their cells
- 4 Which phrase can be used to describe a gene?
- (1) a portion of DNA that codes for the production of a chromosome
 - (2) the functional region of a biological catalyst in the nucleus
 - (3) the sequence of base subunits that codes for a specific protein or function
 - (4) a group of three amino acids chemically bonded together

- 5 A culture of asexually reproducing yeast cells was exposed to radiation. A new yeast culture was grown from one of the irradiated yeast cells. A small molecular segment was removed from a cell in the new yeast culture and compared with the original molecular segment.

A-T-C-C-G-T-A-G → A-T-C-G-T-A-G

Sequence of original segment	Exposed to radiation	Sequence of new segment
------------------------------	----------------------	-------------------------

The type of alteration of the base sequence in the yeast is

- | | |
|--------------------|-------------------|
| (1) a substitution | (3) an insertion |
| (2) a deletion | (4) recombination |
- 6 After testing hundreds of cattle, a cow was found that was resistant to several serious diseases. The process that would best ensure the production of offspring with the same resistance is
- | | |
|-------------|-----------------------|
| (1) cloning | (3) random mating |
| (2) meiosis | (4) natural selection |

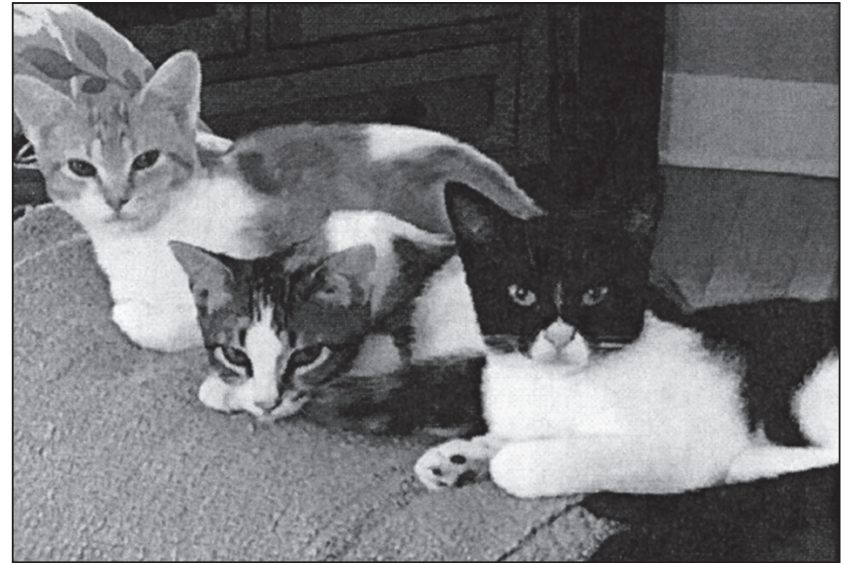
7 Some animals shiver when it is cold. Shivering requires muscle action and generates heat. The flow of blood to vessels located just under the skin may also be restricted to prevent some heat loss. These actions are an important part of

- (1) responses by the immune system
- (2) a feedback mechanism
- (3) the process of natural selection
- (4) active transport of nutrients to cells

8 An additional species of deer predator has been introduced into an area. These new predators run faster than the native deer predators. Which statement best describes what would most likely occur in the deer population after the introduction of these faster predators?

- (1) The deer would mutate their genes and be able to run faster to escape the new predator.
- (2) Slower deer would exercise their leg muscles and eventually be able to run faster.
- (3) The deer would mate with different species and produce offspring that run faster.
- (4) Faster deer would survive and reproduce, increasing the average speed of the deer population.

9 The photograph below shows three kittens from the same parents and in the same litter.



The differences in the kitten fur colorations are most likely due to each kitten

- (1) receiving more genes from one parent than the other
- (2) receiving all the genes from one parent
- (3) inheriting the same gene combinations from its parents
- (4) inheriting different gene combinations from its parents

10 The digestion of protein in the stomach requires the presence of specific enzymes. The rate at which these enzymes work can be influenced by the

- (1) pH of fluids in the stomach
- (2) carbohydrates present in the stomach
- (3) shape of the fat molecules in the stomach
- (4) presence of antibodies in the stomach

11 Some body cells normally produce the protein insulin. Which structures within these cells directly produce the insulin?

- (1) nuclei
- (2) ribosomes
- (3) chloroplasts
- (4) mitochondria

12 During which cellular process is ATP synthesized?

- (1) digestion
- (2) movement
- (3) respiration
- (4) excretion

13 The fish and plants shown in the fish tank below interact with each other for vital resources.



Which pair of processes is an example of *one* way the fish and the plants in the tank depend on each other?

- (1) digestion and active transport
- (2) immune response and dynamic equilibrium
- (3) sexual and asexual reproduction
- (4) respiration and photosynthesis

14 A class of students spent several days studying life in a pond ecosystem. The students identified 20 different microorganisms, 10 different species of plants, and five different species of animals in the pond. These data would be important in determining the

- (1) rate of evolution in the pond organisms
- (2) process of succession in the pond
- (3) feeding relationships and energy flow in the pond
- (4) rate at which different pond species cross-breed

15 A mushroom growing on a tree stump is an example of a

- (1) predator
- (2) parasite
- (3) decomposer
- (4) prey

16 *One* similarity between starches and proteins is that both molecules

- (1) are examples of inorganic substances
- (2) are composed of simple sugars
- (3) must be digested before their building blocks can be used by cells
- (4) contain amino acids used in the synthesis of DNA

17 Antibodies are protein molecules produced by the immune system. Their role in the immune system includes

- (1) receiving hormone signals and changing the activity of red blood cells
- (2) binding to antibiotic medications to cause infections
- (3) producing antigens to fight off pathogens
- (4) attacking and marking invaders for destruction

18 The size of a population of a species of fish in a lake remains fairly constant over a period of several years. This is most directly due to

- (1) the depth of the water
- (2) an excess of dissolved oxygen
- (3) the carrying capacity of the lake
- (4) a ban on fishing in the lake

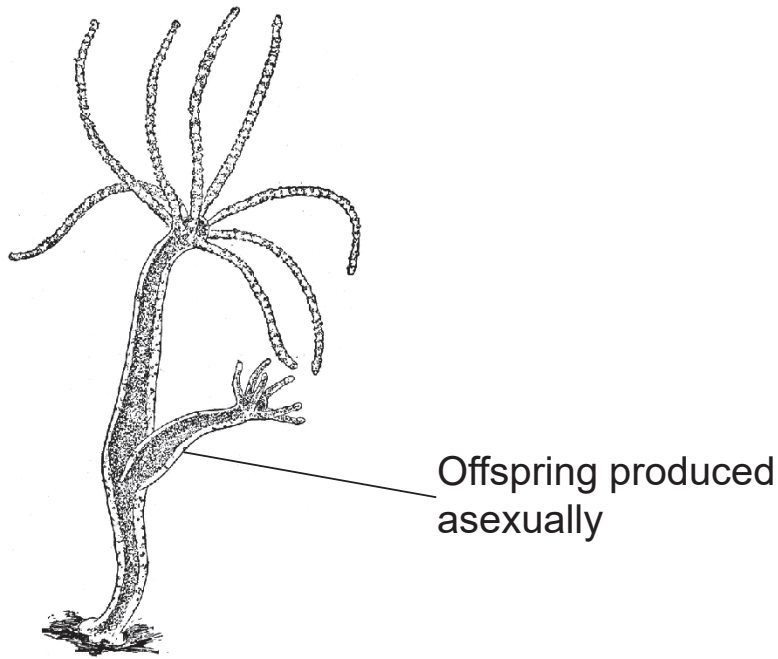
19 Which statement best explains a difference between natural selection and selective breeding?

- (1) Natural selection is determined by environmental pressures on a species, selecting which individuals will survive. Selective breeding is controlled by humans selecting which individuals will mate.
- (2) Natural selection requires genetic variation within the population. Selective breeding does not require any genetic variation within the population.
- (3) Natural selection only occurs within sexually reproducing species. Selective breeding occurs in both sexually and asexually reproducing species.
- (4) Natural selection only occurs when the environmental conditions are unchanging. Selective breeding occurs at any time because it is controlled by humans.

20 Changes in the size of the openings in plant leaves by guard cells regulate

- (1) air temperature
- (2) chloroplast production
- (3) enzyme activity
- (4) gas exchange

- 21 The brown hydra illustrated below is a multicellular aquatic animal that consumes small organisms.



Which statement best describes other characteristics of this animal?

- (1) It is an autotroph and requires carbon dioxide for the process.
- (2) It is a decomposer and obtains needed carbon dioxide from its environment.
- (3) It is a heterotroph, and mitotic cell division is involved in the form of reproduction illustrated.
- (4) It is a scavenger, and meiotic cell division is involved in the form of reproduction illustrated.

- 22 Researchers are working on a new technology that utilizes captured atmospheric carbon dioxide and a plant extract to make plastic. Plastic is usually made from fossil fuels. The new technology can help lessen the effects of climate change by

- (1) preventing ozone shield depletion
- (2) reducing a greenhouse gas
- (3) decreasing the diversity of plant species
- (4) eliminating the use of plastic

- 23 A student is studying interactions between body systems and the life processes they carry out. He constructs the table below. To help understand the interactions, he plans to fill out the table with phrases that describe one way these life processes interact to maintain the human body.

	Digestion	Respiration	Reproduction	Circulation	Movement	Immunity	Coordination
Digestion							
Respiration							
Reproduction							
Circulation			X				
Movement							
Immunity							
Coordination							

Which of these phrases could best be placed in the position marked with the X?

- (1) brings nutrients to the organs that produce gametes
- (2) breaks down large molecules so they can diffuse into the blood
- (3) provides carbon dioxide to muscle cells for movement
- (4) transports cells that synthesize glucose

24 The photos below show two different forest communities.



These forests represent a late stage in a series of changes that occur in various ecosystems. The changes most likely

- (1) occurred quickly over 20 to 50 years as the air temperatures in the areas changed
- (2) modified the areas where they grew, making the areas more suitable for the trees that now live there
- (3) caused several disasters that destroyed one stage and prepared the areas for the next stage
- (4) resulted from several mutations the trees needed to survive in the various stages that took place

25 Goats, like those pictured below, were originally brought to the Galapagos Islands by whalers and pirates. The goats ate vast amounts of vegetation. This resulted in erosion and threatened the survival of rare plants and trees. The goats competed for food with native animals, such as giant tortoises.



The vegetative destruction caused by the goats is most likely related to

- (1) humans upsetting the stability of an ecosystem by introducing specific organisms
- (2) industrialization bringing an increased demand for the island's natural resources
- (3) the modification of habitats through direct harvesting by humans
- (4) an increase in biodiversity and stability of the island ecosystem

26 Scientists are developing genomic vaccines. Rather than injecting an intact weakened pathogen, only specific segments of the pathogen's DNA or RNA are used. The DNA or RNA enters body cells. The cells then synthesize molecules normally produced by the pathogen to

- (1) act as antibodies that stimulate the immune system to produce pathogens
- (2) act as antigens that stimulate the production of specific proteins that bind to the pathogen
- (3) form enzymes that will destroy the pathogen
- (4) release energy needed to fight off the pathogen

27 Which human activity could involve genetic engineering that results in new traits in a species?

- (1) feeding hormones to farm animals
- (2) causing pollution that leads to the extinction of organisms
- (3) developing new crop varieties that are resistant to various diseases
- (4) using laboratory techniques to identify pathogenic organisms

28 Growing a variety of vegetables in a garden often involves removing weeds that grow along with the vegetable plants. This process is important to the growth of the vegetables because it

- (1) reduces damage from carnivores
- (2) increases the likelihood of plant diseases
- (3) decreases the need for decomposition in the soil
- (4) reduces competition for resources

29 Fixing environmental problems such as pollution, deforestation, and global warming will require an

- (1) increased reliance on finite resources
- (2) increase in global awareness and cooperation to find solutions
- (3) introduction of new species to current environments
- (4) exploration of new sources for fossil fuels

30 Corals are small animals that live in oceans. They form coral reefs, structures that serve as a habitat for many species of organisms. Increasing water temperatures have been linked to the destruction of coral reefs. In a laboratory, researchers have added a mixture of beneficial microbes (probiotics) to heat-stressed reefs. All of these probiotic-treated reefs survived exposure to increased water temperatures. A valid conclusion from this study is that

- (1) the stability of an ecosystem depends on interactions between living and nonliving factors
- (2) probiotics decrease the temperature of the water in the coral reef ecosystem
- (3) increased water temperature is beneficial to all coral reef ecosystems
- (4) microbes are not a natural part of any ecosystem and must be added

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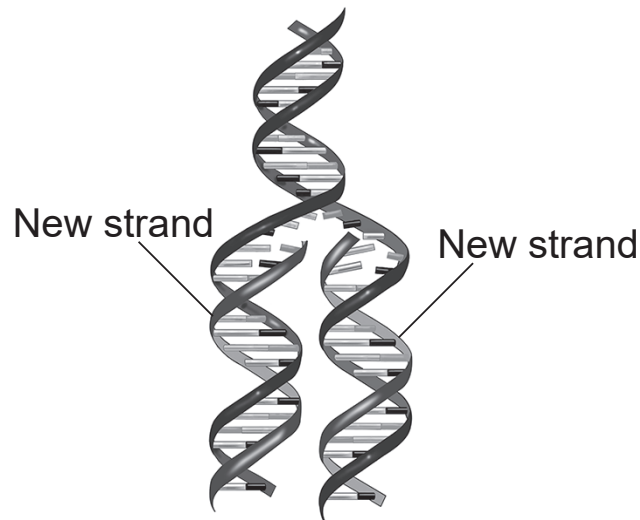
Part B–1

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.

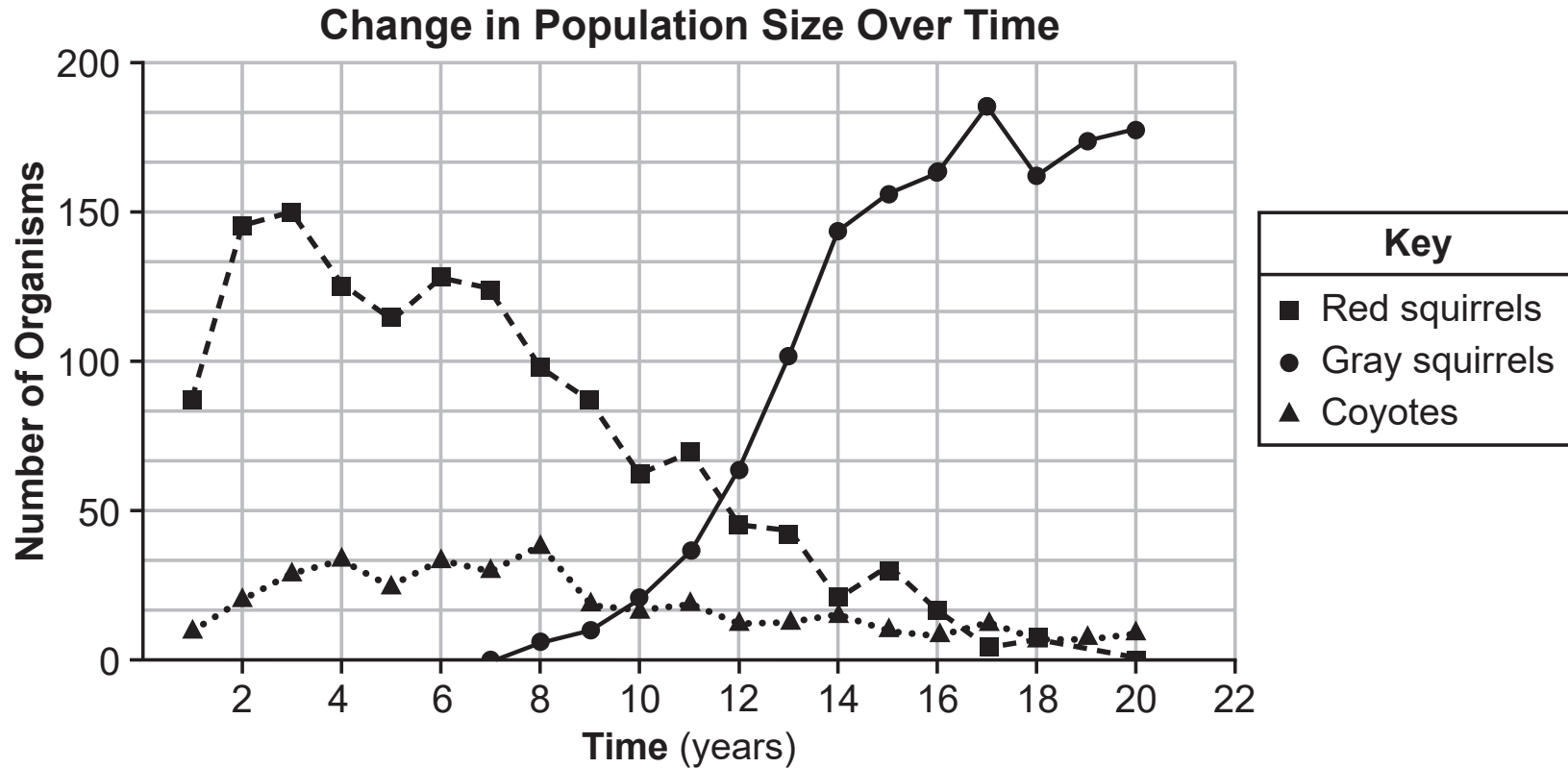
Base your answers to questions 31 and 32 on the diagram below and on your knowledge of biology.

The diagram represents a biological process that occurs in human body cells prior to cell division.



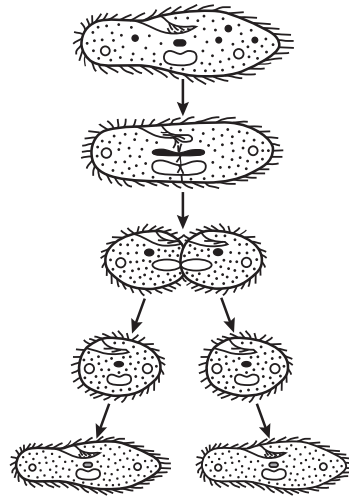
- 31 Which statement regarding the process shown in the diagram is accurate?
- (1) This process normally produces body cells that have different gene combinations.
 - (2) This process normally divides the genetic information found in gametes by one-half.
 - (3) This process normally generates altered genetic codes that all body cells will inherit.
 - (4) This process normally ensures that all body cells contain the same genetic information.
- 32 If an error is made during this process, the newly formed cells may no longer be able to
- (1) diffuse starch across cell membranes
 - (2) direct the production of specific proteins
 - (3) produce amino acids from glucose
 - (4) form cell walls to maintain cytoplasm levels
-

The graph below represents changes that have occurred in several populations inhabiting an ecosystem over 20 years.



- 33 According to the data in the graph, it can be inferred that the changes in the population sizes most likely occurred because
- (1) red squirrels outcompete gray squirrels for resources in this ecosystem
 - (2) gray squirrels are better adapted to escape predation by the coyotes
 - (3) the introduction of coyotes increased competition for resources between the two species of squirrels
 - (4) these two species of squirrels reproduce at different times of the year

- 34 While using a microscope to observe a single-celled organism, a student made the sketch shown below. The sketch shows an organism splitting into two cells over a short period of time.

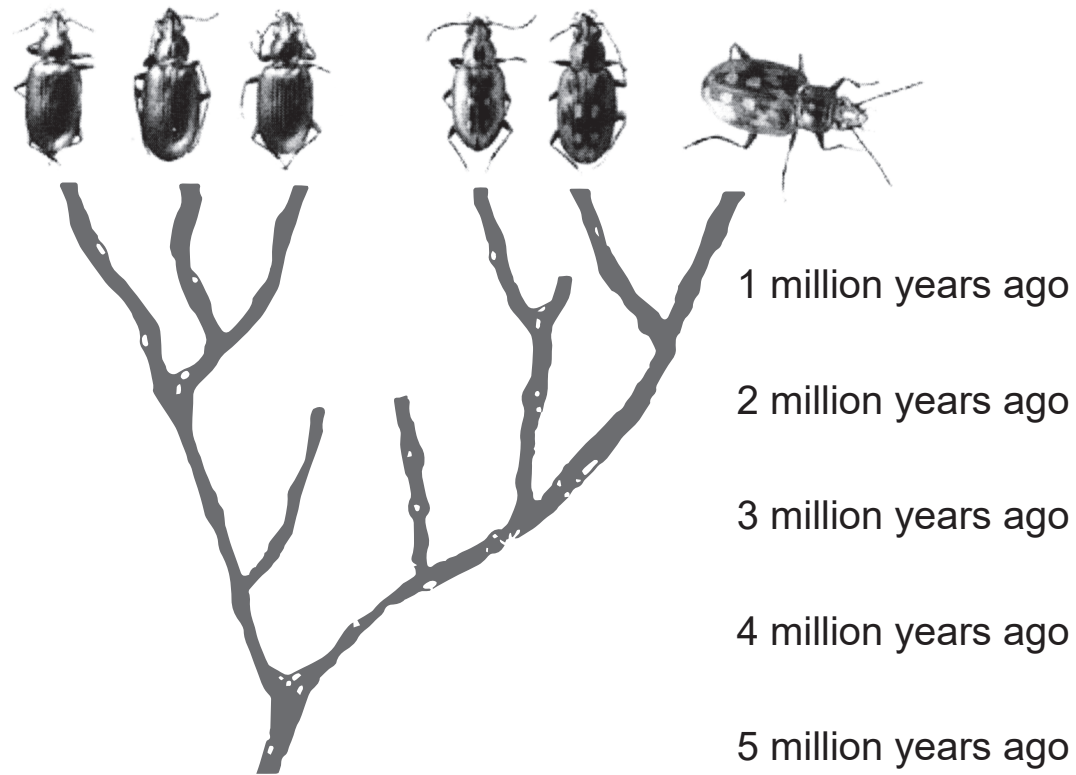


The student correctly claimed that the two cells would

- (1) be genetically identical since they formed by asexual reproduction
- (2) have variations due to the changing conditions in the environment
- (3) express different genes since they were produced by genetic engineering
- (4) become gametes that could be fertilized and produce offspring

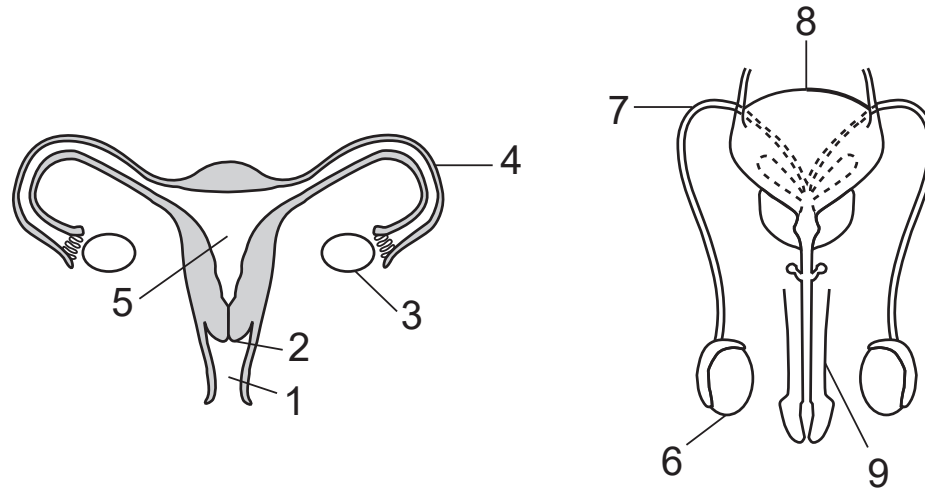
Base your answers to questions 35 and 36 on the information and diagram below and on your knowledge of biology.

The diagram represents the relationships among several beach beetle species.



- 35 The branches of the diagram where there are no beach beetles illustrated represent types of beetles that
- (1) migrated to different ecosystems and are no longer found living on ocean beaches
 - (2) have undergone mutations and evolved into other species of beetles
 - (3) lacked characteristics that allowed them to survive in a changing environment
 - (4) evolved into new species of insects
- 36 The six species of beetles illustrated at the top of the chart show similarities and differences. The similarities are an indication that the beetles all
- (1) reproduce only through asexual reproduction
 - (2) developed on the same beach
 - (3) have the same genetic makeup
 - (4) have a common ancestor
-

Base your answers to questions 37 and 38 on the diagrams of the human reproductive systems below and on your knowledge of biology.



37 Which structures produce gametes that combine during fertilization?

- (1) 1 and 7
- (2) 5 and 8

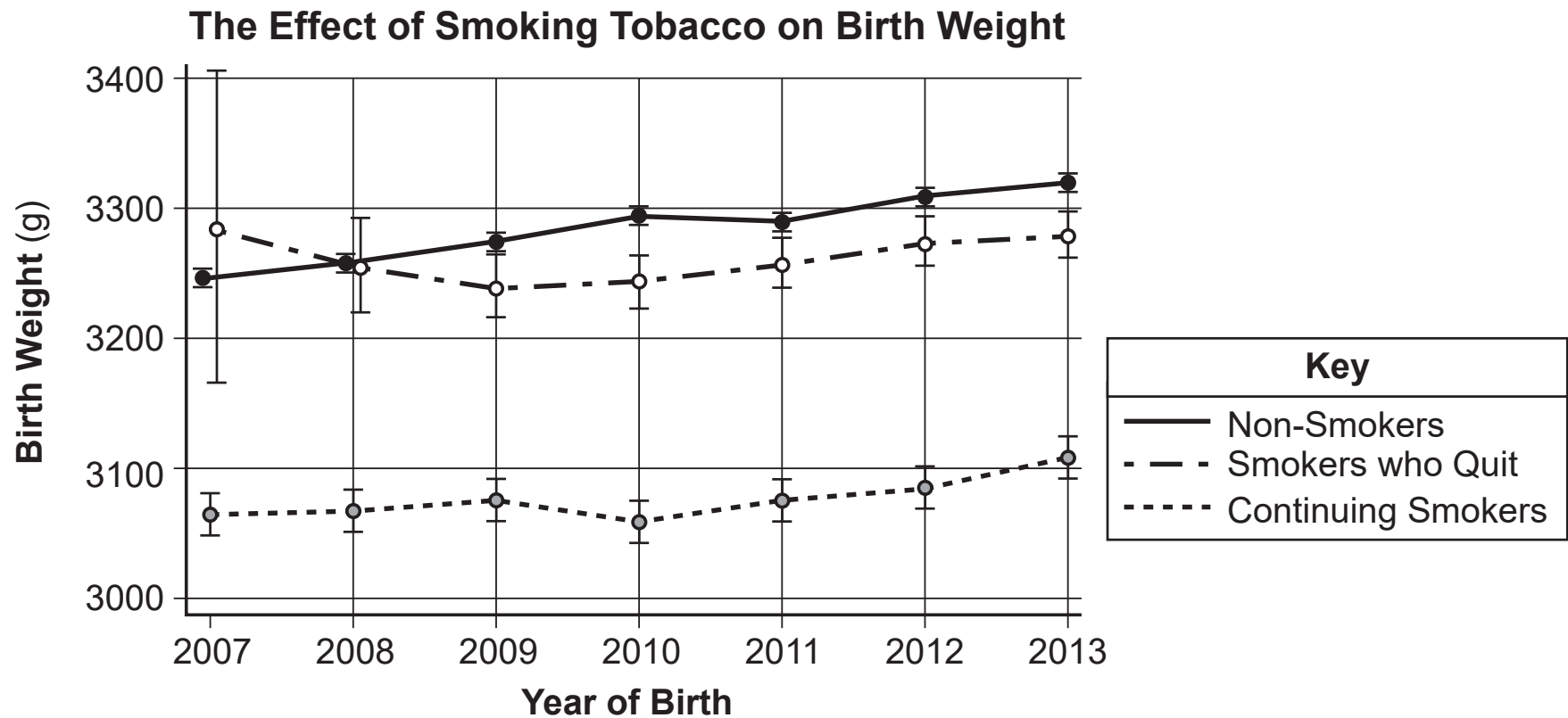
- (3) 3 and 6
- (4) 4 and 9

38 In which structure does the development of a male embryo take place?

- (1) 1
- (2) 8

- (3) 3
 - (4) 5
-

- 39 The graph below shows the relative birth weights of babies born to mothers who smoked cigarettes during their pregnancies, those who quit smoking, and those who were non-smokers.



Which statement best describes a pattern shown by the data?

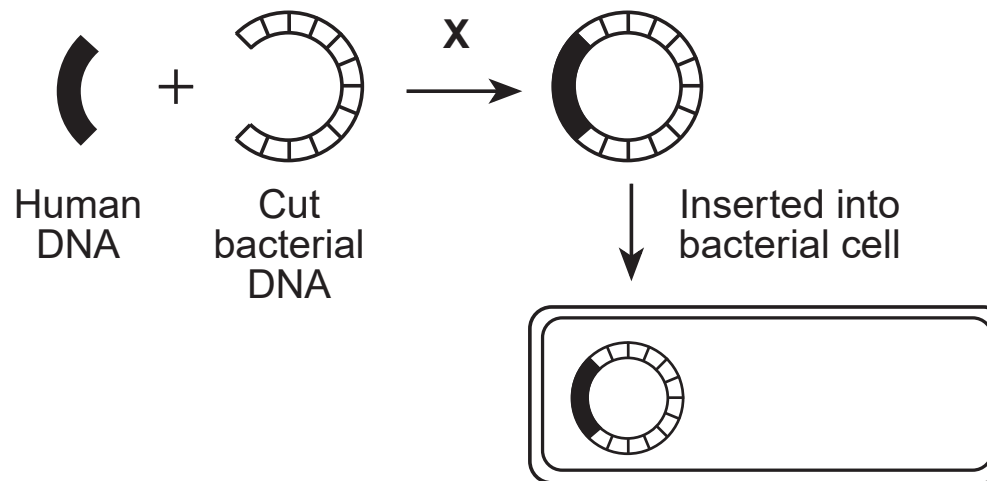
- (1) The birth weight of babies born to continuing smokers decreased during this study.
- (2) The smokers who quit had babies with higher birth weights between 2009 and 2013 than those who were born to non-smoking mothers.
- (3) Babies of mothers who did not smoke during pregnancy had higher birth weights than babies of mothers who were continuing smokers.
- (4) All the babies born in 2009 had the greatest birth weights, when compared to other years.

- 40 Northern elephant seals were hunted to near extinction in the 1800s. In 2014, the population had rebounded to around 225,000 seals. Even though there are larger numbers of seals, scientists are concerned because all 225,000 seals share many of the exact same gene sequences.

Which statement expresses why many scientists would be concerned about these seals?

- (1) This population of seals may be unable to survive a change in environmental conditions.
- (2) Mutations are more likely when populations are below 300,000.
- (3) Having many of the same genes may result in the recombination of genes during sexual reproduction.
- (4) Seals will have to evolve new behaviors to counteract their genetic similarity.

- 41 The diagram below represents a process used in genetic engineering.



The compound represented by *X* is most likely

- (1) a hormone
- (2) a carbohydrate
- (3) an organic catalyst
- (4) an indicator

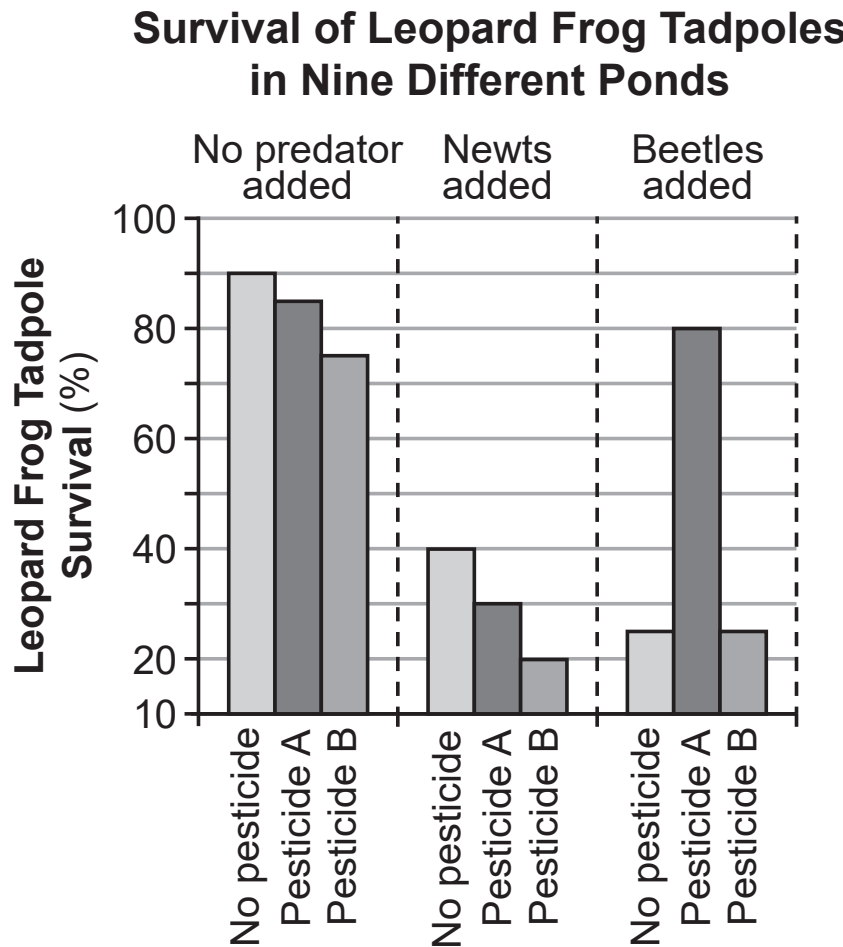
42 The diagram below represents a food chain found in a pond ecosystem.

algae → zooplankton → insects → sunfish → largemouth bass

Which event below would most likely happen if climate change resulted in a severe summer drought that *reduced* the largemouth bass population by as much as 50%?

- (1) The insect populations would increase.
- (2) The sunfish population would increase.
- (3) The zooplankton population would be decreased.
- (4) The algae population would be unaffected.

- 43 Scientists studied the effect of pesticides on leopard frog tadpoles in their natural pond environment. They first recorded data on the tadpole populations in different ponds before pesticides were added. Next, pesticides were added, along with newts or beetles, which are tadpole predators. Newts were added to some ponds and beetles to other ponds. Their findings are represented in the chart below.



When beetles were introduced along with pesticides, the results were unexpected. Which statement is a reasonable explanation for the results the scientist observed?

- (1) Pesticide A killed the tadpoles, causing the beetles to eat more of the remaining tadpoles.
 - (2) Pesticide A killed the tadpoles, providing more food, and the beetle population increased.
 - (3) Pesticide A killed the beetles, resulting in fewer tadpoles being eaten.
 - (4) Pesticide A killed the beetles, forcing the tadpoles to eat each other due to a lack of food.
-

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 answers to questions 44 through 49 on the information below and on your knowledge of biology.

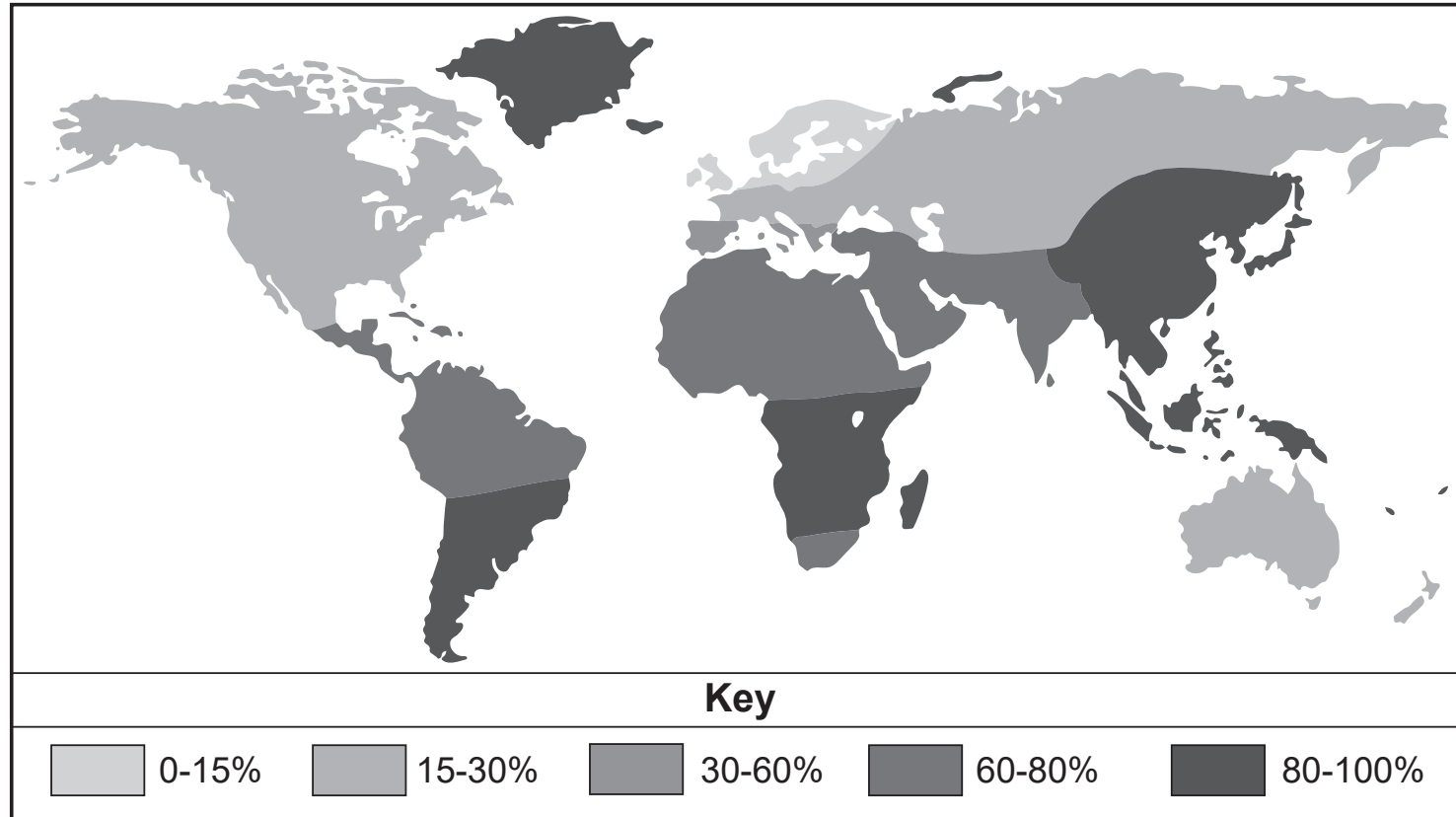
Got Lactose?

As baby mammals grow up, they stop drinking their mothers' milk and their bodies stop producing lactase, the enzyme needed to break down lactose, a carbohydrate in milk. Most mammals do not continue to produce lactase as adults and do not drink milk.

Humans are unique in that, as adults, some of them continue to drink the milk from cows or other mammals. This is possible because they continue to produce lactase. However, approximately 65% of the adult human population cannot digest it.

The map below shows how the ability to digest lactose varies in different parts of the world.

Percentages of Individuals Unable to Digest Lactose in Various Areas of the World



The enzyme lactase breaks down lactose into two simple sugars: glucose and galactose. These simple sugars then diffuse into the blood and can be used by the body. When a person who cannot digest lactose drinks milk, the undigested lactose passes from the small intestine into the large intestine. Bacteria break the lactose down, releasing several gases and other products, which may cause bloating, flatulence, and diarrhea.

- 44 State whether most adults from South America and Africa are more or less likely to be able to drink milk without any problems than adults in North America and Europe. Support your answer. [1]

Two students, *A* and *B*, wanted to know if they were able to digest lactose. One test to determine this is to monitor blood glucose levels for an hour after drinking milk. The blood glucose test results for the students are shown in Chart One below.

Chart One: Blood Glucose (mg/dL)

Individual	0 Minutes	15 Minutes	30 Minutes	45 Minutes	60 Minutes
Student A	97	112	135	155	143
Student B	96	99	105	101	98

Directions (45–46): Using the information in Chart One, construct a line graph on the grid provided, following the directions below.

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

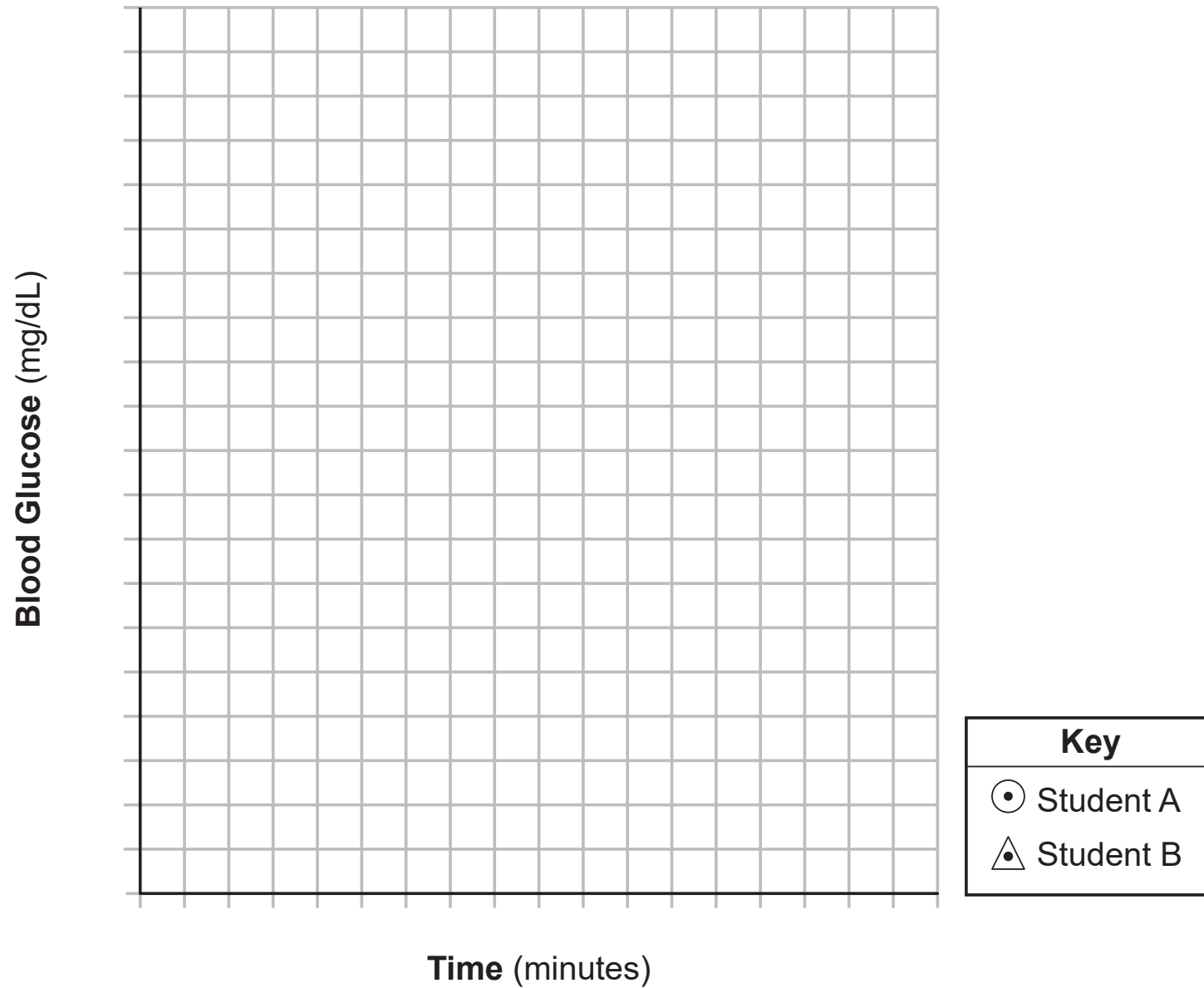
46 Plot the data points for both Students A and B, following the directions below: [1]

- Plot the data for Student A on the grid and connect the points. Surround each point for Student A with a small circle.
- Plot the data for Student B on the grid provided and connect the points. Surround each point for Student B with a small triangle.

Example:  (Student A)

Example:  (Student B)

Blood Glucose Results



The students learned that another way to test for the ability to digest lactose is the hydrogen breath test. One of the gases the bacteria in the large intestine produce as they break down undigested lactose is hydrogen. Hydrogen and other gases can leave the body as flatulence.

These gases can also leave the body by diffusing into the blood and be eliminated by way of the lungs. Chart Two shows the results of the hydrogen test for the same two students, *A* and *B*, after drinking milk.

Chart Two: Hydrogen Breath Levels (ppm)

Individual	0 Minutes	15 Minutes	30 Minutes	45 Minutes	60 Minutes
Student A	5	6	9	8	5
Student B	4	9	10	29	35

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

47 The students wanted to know how to interpret their test results. Information that would be the most useful in helping them do this would be

- (1) the range of glucose and hydrogen gas levels for individuals that can digest lactose
- (2) whether any of their relatives can digest lactose
- (3) whether drinking almond milk would also produce glucose and hydrogen gas
- (4) the amount of milk they drank the day before the tests

48 Explain why measuring blood glucose levels after drinking milk could be an indicator of lactase activity. [1]

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

49 Which statement best explains why the inability of a person to digest lactose is different from a milk allergy?

- (1) Digestion of lactose stimulates the immune system to digest milk, but a milk allergy shuts down the immune system.
- (2) An allergy is a reaction to a normally harmful substance, and digesting lactose is the ability to digest a normally harmless substance.
- (3) Not digesting lactose and a milk allergy are both diseases exclusive to humans.
- (4) An allergy results in an immune response, while not digesting lactose is due to the lack of an enzyme.

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

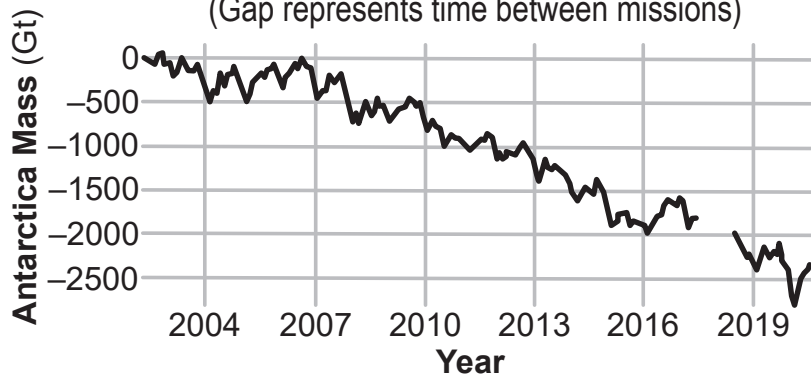
Scientists have become increasingly concerned with climate change and the melting of Earth's ice sheets and the possible increase in sea level that follows.

Data from NASA missions show that the land ice sheets in both Antarctica and Greenland have been losing gigatons (Gt) of mass since 2002, as shown in Graphs 1 and 3 below.

Sea-level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers and the expansion of seawater as it warms.

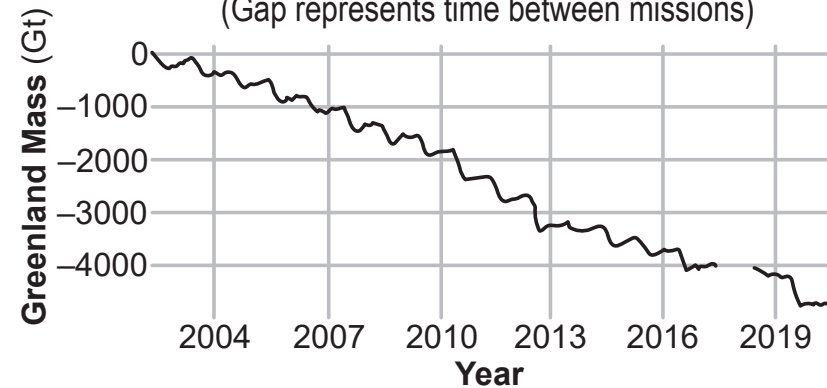
Graph 1: Antarctica Mass Variation 2002 to 2020

(Gap represents time between missions)



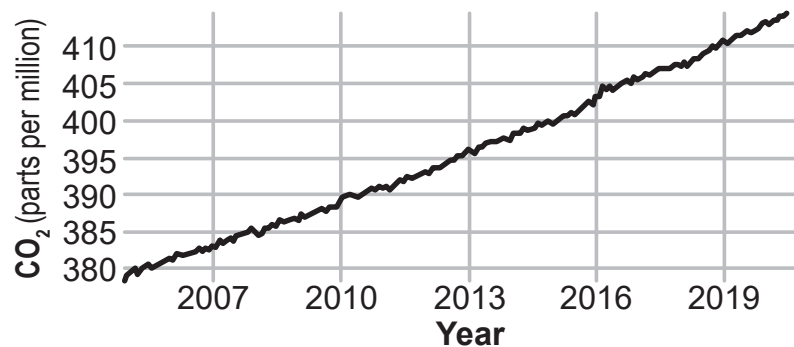
Graph 3: Greenland Mass Variation 2002 to 2020

(Gap represents time between missions)

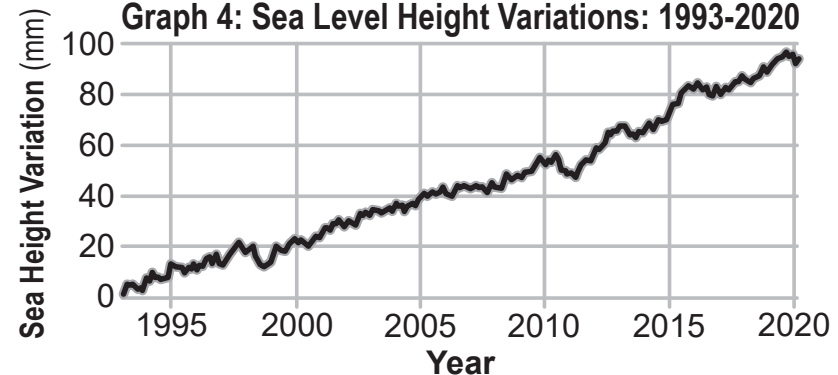


Graph 2: Atmospheric Carbon Dioxide

Measurements: 2005-2020



Graph 4: Sea Level Height Variations: 1993-2020



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

50 Which statement below best describes the connections, if any, that can be made by using data from Graphs 1 and 2?

- (1) There is no connection, since the carbon dioxide is a gas in the atmosphere, and the sea level change is due to more water from more ice melting.
- (2) There is no connection because the two graphs provide information for two different periods of time.
- (3) The connection is that more carbon dioxide leads to warming of the atmosphere, which may melt more ice.
- (4) The connection is that carbon dioxide in the atmosphere dissolves in seawater and warms it up, which may melt more ice.

51 Using data from Graphs 1 and 3, compare the mass of ice loss in the two locations between 2002 and 2020. Provide evidence to support your answer. [1]

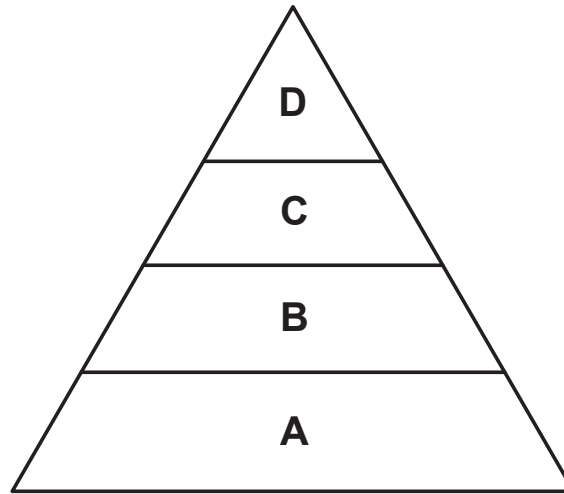
Base your answers to question 52 and 53 on the information below and on your knowledge of biology.

All life is dependent upon energy. Living things use highly regulated biochemical processes to convert energy into a form that they can use.

52 Describe how the process of photosynthesis makes energy available to plants. [1]

53 Explain why the process of photosynthesis must continue to take place in order for ecosystems to remain stable. [1]

54 Energy relationships in an ecosystem can be represented with a pyramid of energy, as shown below.



Identify the feeding niche of the organisms that would occupy level *B* of this pyramid. Support your answer. [1]

55 Explain how cells in an embryo are able to become muscle, skin, nerve, or other types of cells. [1]

Part C

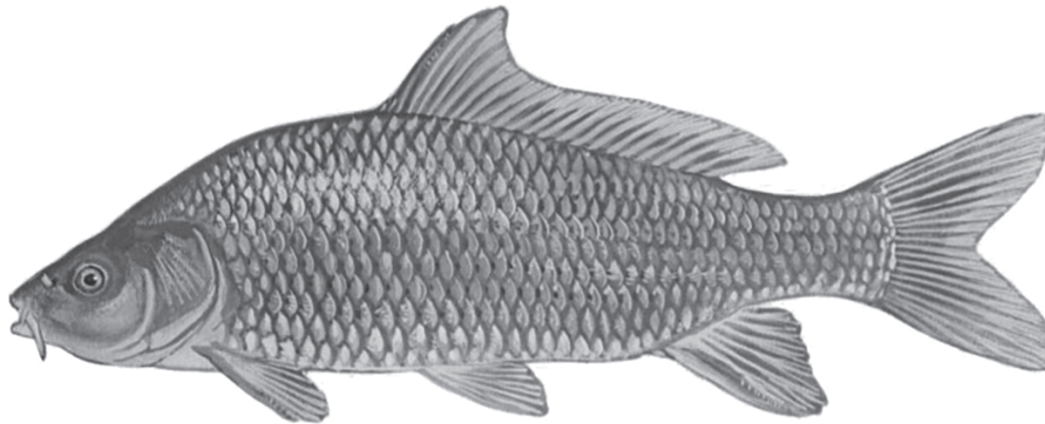
Answer all questions in this part. [17]

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

Base your answers to questions 56 through 62 on the information below, on the following pages, and on your knowledge of biology.

Too Many Carp

The common carp is a close relative of goldfish and is native to Europe and Asia. They have been introduced to nearly every part of Earth except for the polar regions. Although carp are used as food in many areas, elsewhere they are often regarded as a pest because they frequently outcompete native fish species.



Carp were brought to the United States in the 1880s and spread far and wide by well-meaning citizens. By 1910, it became evident that their introduction was a mistake.

Carp are tolerant of poor water quality and are able to uproot and eat many kinds of water plants. They also consume a great variety of aquatic animals. They reproduce rapidly, with many adult females able to lay up to 300,000 eggs during each breeding season. Carp have adapted very well to their new environments, especially without their original predators and pathogens. As a result, carp often cause significant damage to ecosystems.

56 Explain *one* way that carp populations affect biodiversity in areas where they are present. [1]

57 Explain why the carp introduced into many areas of the United States in the 1880s were so successful. [1]

Controlling or eliminating carp populations in many areas has become an environmental priority. Several methods have been developed and tested. Descriptions of four of the methods follow.

Method 1: Bluegills

Carp lay their eggs in shallow, grassy areas. The fertilized eggs are sticky, so they cling to the pond vegetation and other objects as they settle. Bluegills readily eat these eggs.

When bluegills are present in areas where carp spawn (reproduce), the spawning success rate is greatly reduced.

Some scientists have suggested stocking bluegills in areas where carp spawn if the bluegills are not already found there.

58 Explain why the bluegill method of controlling the carp population could be a problem. [1]

Method 2: Technology and Nets

In shallow lakes, carp are less active when the water cools in winter, and they form into large groups. In several lakes, researchers attached devices to a few of the fish in the fall, then used signals from these devices to locate these groups of carp. Then, using special nets, they captured large numbers of the fish and removed them from the lake. They had to be careful though, because the carp that managed to escape a few times were harder to catch again because they had learned to avoid the nets when they saw them.

- 59 State *one* reason why the technology and nets method of eliminating carp from areas they have invaded might *not* work. [1]

Method 3: Controlling Carp Populations With Chemicals

A toxic substance, Antimycin A, can be used to treat corn seeds that are then placed in carp-infested waters. Since carp are the most likely fish to eat corn seeds dumped into lakes, Antimycin A would only be expected to kill the carp.

- 60 Describe *one* possible *negative* result of using the chemical method to control carp populations. [1]

Method 4: Using the Naturally Occurring Koi Herpes Virus (KHV):

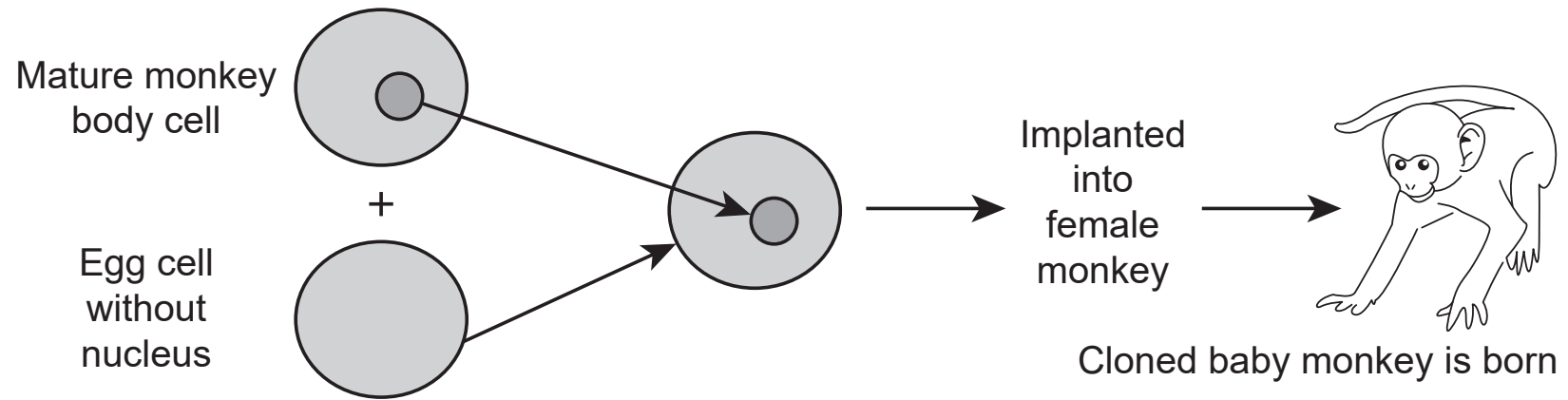
This virus sometimes infects carp and their relatives, including koi and goldfish. People sometimes have koi ponds, where they keep these attractive ornamental fish. The KHV only infects these species of fish. Fish infected with KHV shed the virus into the water, where it could infect additional carp, koi, and goldfish.

The virus causes damage to the gills (breathing organs in fish) and leads to suffocation in 90% of those infected.

- 61 If there is a plan to use KHV to control carp in an area, describe *one* environmental concern people living nearby might raise. [1]

- 62 As with the carp situation, there are often multiple solutions that could be used to control or eliminate an invasive species. Explain why exploring various actions before deciding on the best one to choose for an area would lead to the greatest chance of success and the least likelihood of further negative effects on the environment. [1]

In 2018, researchers in China announced that they had successfully cloned primates for the first time. Two monkeys were used to produce a clone using the technique shown in the model below.



63 Identify the source of the cloned monkey's primary genetic material. Support your answer with evidence from the model. [1]

Base your answers to questions 64 and 65 on the information below, on the next page, and on your knowledge of biology.

Cacao Plants

The cacao plant produces large pods that contain cacao beans that are used to make chocolate. The cacao plant has a microbiome – a mixture of harmful and beneficial bacteria, fungi, and other microbes that live on and in the plant. Black pod rot is a disease caused by a fungus that is part of this microbiome. The fungus consumes the nutrients within the pods and interferes with the normal growth and development of the pod. The fungus damages 20-30% of the cacao crop every year.



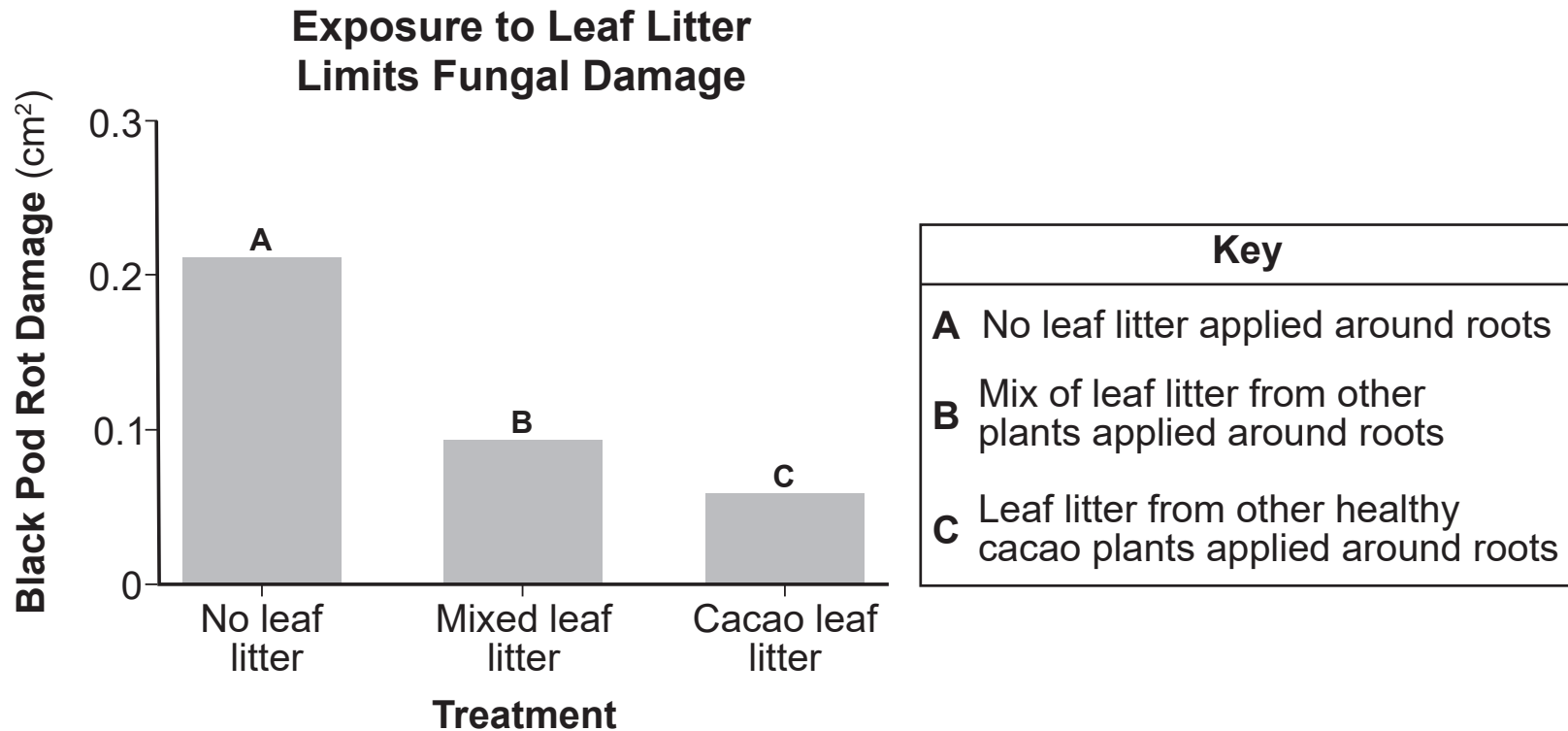
Healthy pod



Pod with black pod rot

64 Provide evidence from the passage that supports the claim that the fungus that causes black pod rot is a parasite. [1]

Researchers hypothesized that cacao plants picked up their microbiome, including beneficial microbes that might protect the plants from black pod rot, from their environment. They grew cacao plants with or without leaf litter around their roots and exposed them to the pathogen that causes black pod rot. They did this in order to determine if the plants actually did pick up protective microbes from leaf litter in their environment. Their data are shown below.



65 Describe how the information collected by these scientists could be used by farmers to treat other plant diseases. [1]

66 When an individual is bitten by a mosquito carrying a pathogen such as West Nile virus, pathogens enter the individual's bloodstream. As the pathogens circulate through the body, the immune system detects them and responds.

Explain how the immune system detects the presence of pathogens and destroys them. [1]

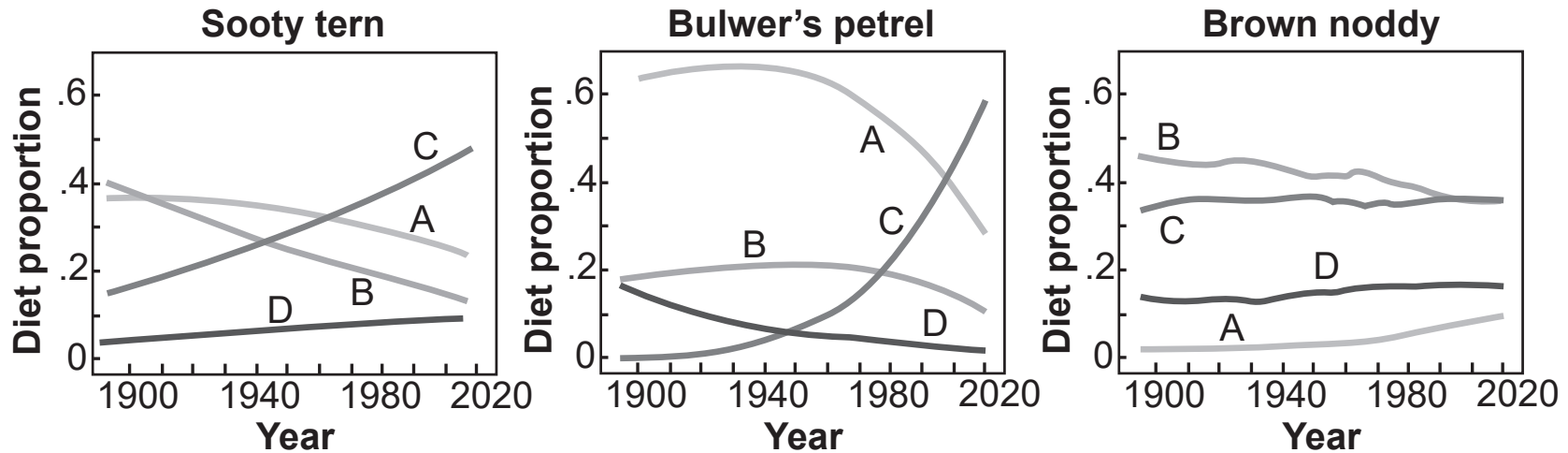
Jellyfish are 95% water and contain so few food calories that it was long assumed by scientists that they were a poor source of food and rarely eaten by animals. Recently, DNA analysis has allowed researchers to trace the chemicals contained in prey organisms to the tissues of their predators. Chemical evidence from jellyfish DNA has been found in turtles, ocean sunfish, tuna, albatrosses, penguins, eel larvae, and many microbes.

67 Explain how this discovery increases our understanding of marine food webs. [1]

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Base your answers to questions 68 and 69 on the information below and on your knowledge of biology.

The feeding trends for three specific seabird species are represented in the three graphs below.

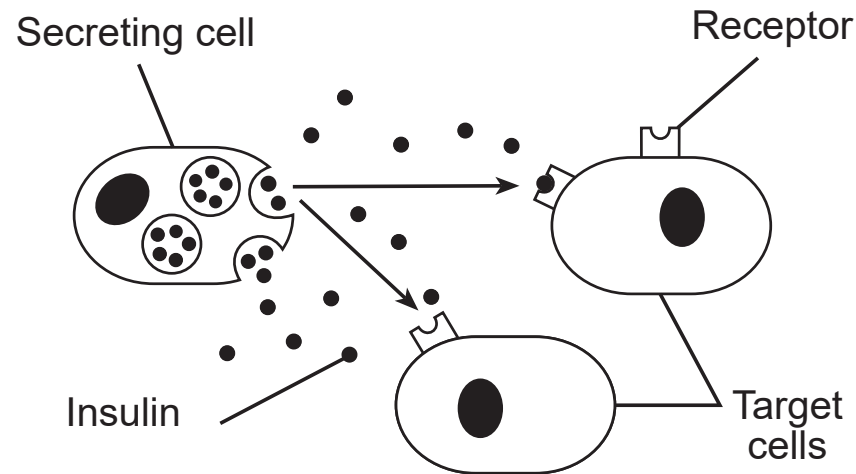


Key	
A: Lanternfish and hatchetfish	C: Squid
B: Goatfish and flying fish	D: Jacks and scads

68 Explain how rapid squid population changes could alter the populations of these seabirds. [1]

69 Which one of these seabird species appears to have had its feeding pattern affected most by changes in its environment? Support your answer. [1]

The diagram below represents interactions that take place between molecules and cells in humans.



70 Identify the organ in the human body where the secreting cell is located. [1]

In a field of plants with white flowers, a scientist noted the sudden appearance of a small patch of the same type of plants, but with blue flowers. Each year after this, the number of plants in the field with blue flowers increased. Several years later, the number of plants with blue flowers was much higher than the number of plants with white flowers.

- 71 Identify *one* possible adaptation present in the plants with blue flowers that may have been responsible for their population increase in the field. [1]

Botulinum toxin [Botox] is a protein produced by the bacterium *Clostridium botulinum*. It causes a serious form of food poisoning in humans. In a very dilute form, it is also commonly used to eliminate some signs of aging, such as wrinkles.

Usually, nerve cells release molecules of a chemical messenger known as acetylcholine into the space where a nerve cell meets a muscle. Acetylcholine causes the muscle to contract. Botulinum toxin prevents the release of acetylcholine.

- 72 Botulinum toxin is also used to treat muscle spasms, cramps, and tremors. Explain why botulinum toxin would be an effective treatment against these types of disorders. [1]

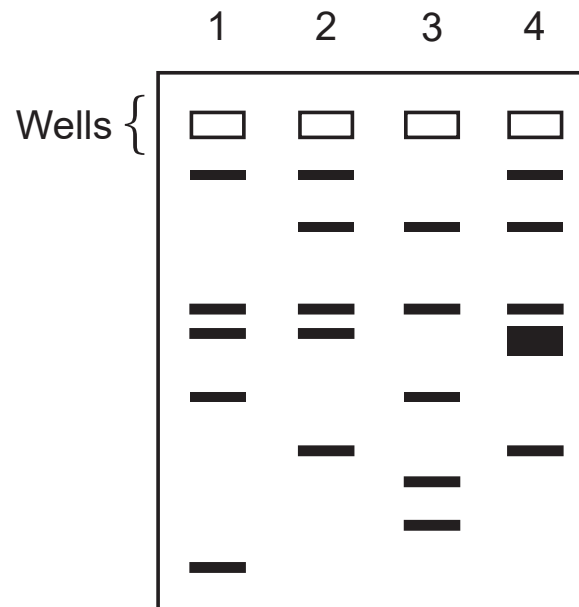
Part D

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.

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

- 73 The diagram below represents the results of a biological technique used to separate the DNA fragments from four different organisms.



Which row in the chart below identifies the column in the diagram that contains the *smallest* molecular fragments and provides an appropriate explanation?

Row	Column	Explanation
(1)	1	smallest fragments move more quickly through the gel
(2)	2	smallest fragments move more slowly through the gel
(3)	3	smallest fragments will not be seen since they do not leave the wells
(4)	4	smallest fragments will bond together and form thicker bands

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

- 74 Scientists report the results of their experiments in scientific journals. This is very important because
- (1) other scientists can repeat the experiments to verify the conclusions
 - (2) they need to understand that a hypothesis is just a guess
 - (3) it allows them to change their results to support the hypothesis
 - (4) it is how they get the title for their experiment

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

- 75 Which lab procedure was performed to separate plant pigments in the *Relationships and Biodiversity* lab?
- (1) gel electrophoresis
 - (2) chromatography
 - (3) data analysis
 - (4) staining

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

During a classroom activity, seven students each measured their resting pulse rate three times. They averaged the three readings, and then recorded their data in the table below.

Average Resting Pulse Rates

Student	Age (years)	Average Resting Pulse (bpm)
1	14	70
2	14	62
3	14	90
4	15	80
5	14	70
6	14	54
7	14	201

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

76 When this data was presented to the class, the students noticed that the pulse rate of Student 7 was much higher than the rest of the students' pulse rates.

What error did Student 7 make in calculating his average?

- (1) He measured the pulse rate for only 30 seconds, not a full minute.
- (2) He failed to calculate his average properly.
- (3) He was resting when the pulse was taken.
- (4) He measured the pulse on the right wrist but the other students used the left wrist.

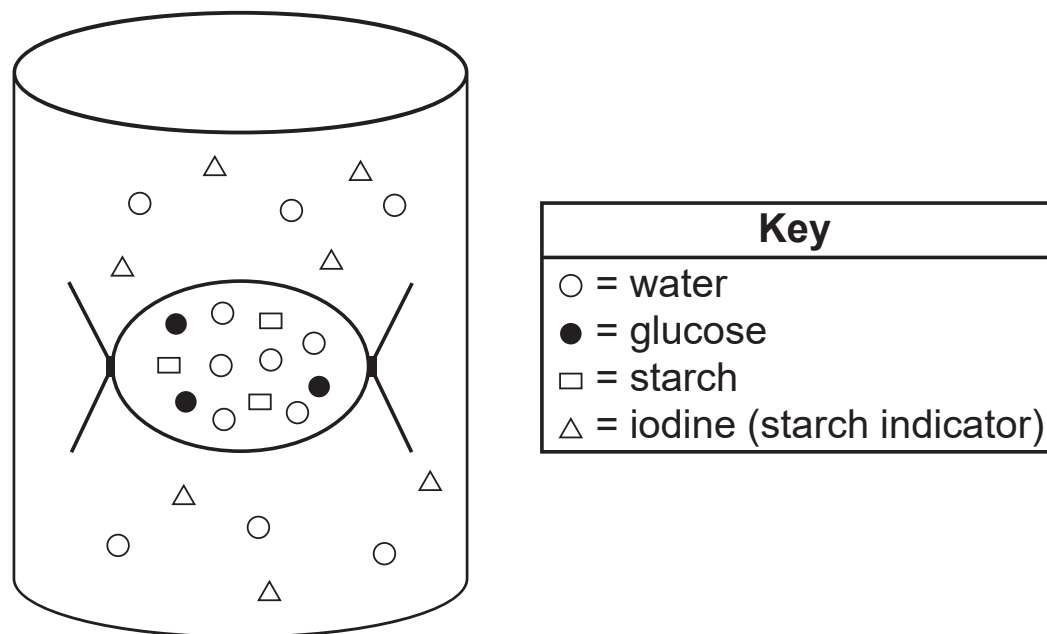
77 What is the average resting pulse rate for the other six students in the table? [1]

78 After the students measured and recorded their resting pulse rates, they ran in place for one minute and calculated their average pulse rate for the class again.

State *one* hypothesis that this experimental procedure would test. [1]

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

A laboratory setup involving an artificial cell is represented in the diagram below.



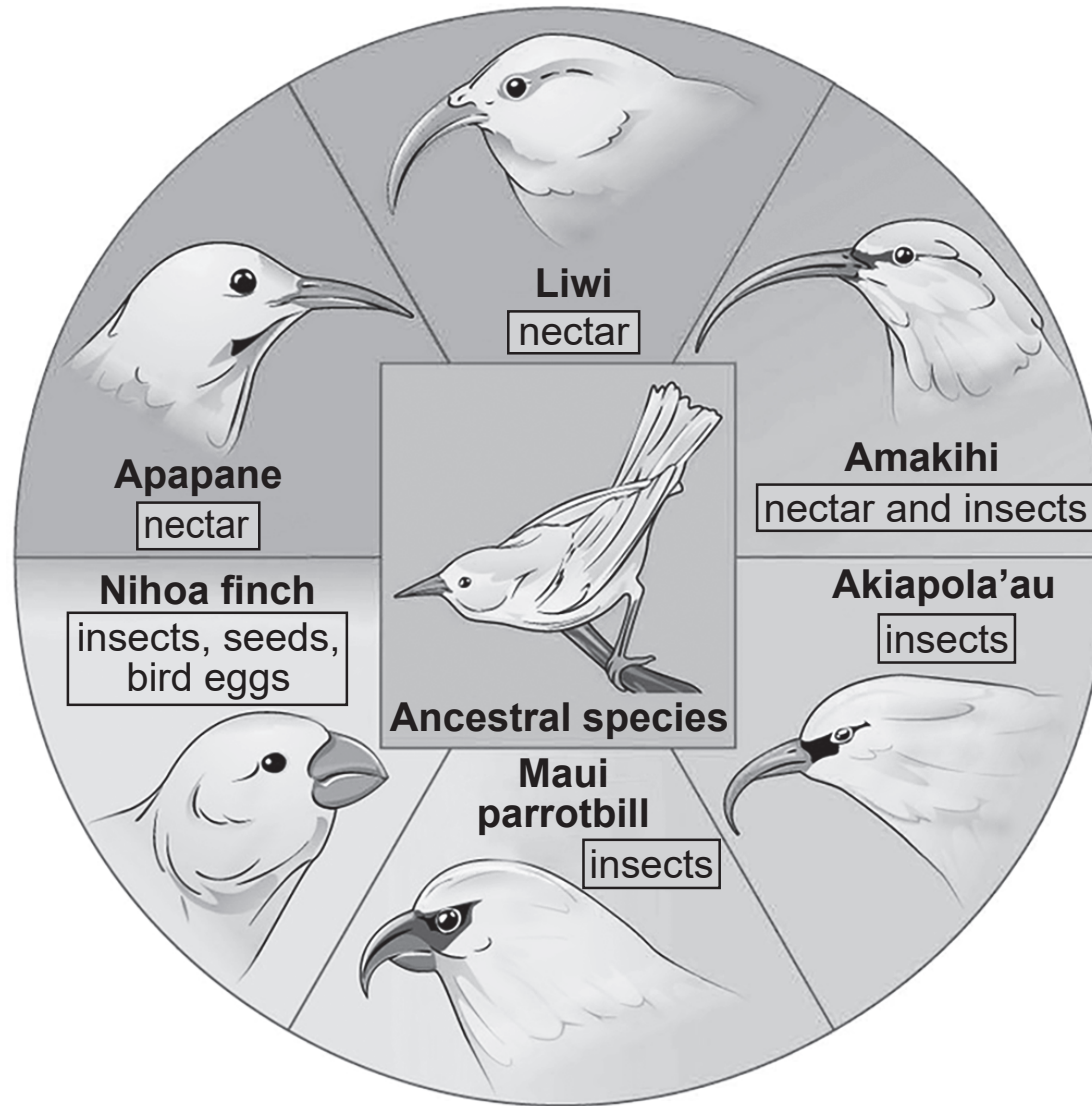
79 Identify the process by which glucose molecules move out of the cell. [1]

80 Identify a factor that affects the ability of a molecule to move through the membrane of an artificial cell. [1]

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Base your answers to questions 81 through 84 on the following information and on your knowledge of biology.

Hawaiian honeycreepers are small birds found only on the Hawaiian Islands. Even though the birds vary in their appearance, they are all descended from one ancestral species.



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

81 Which Hawaiian honeycreeper species is most likely to survive in an environment where the food sources are constantly changing?

(1) Akiapola'au

(3) Nihoa finch

(2) Liwi

(4) Maui parrotbill

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

82 Which *two* honeycreepers would most likely compete for food?

(1) Maui parrotbill and Apapane

(3) Apapane and Akiapola'au

(2) Liwi and Akiapola'au

(4) Liwi and Apapane

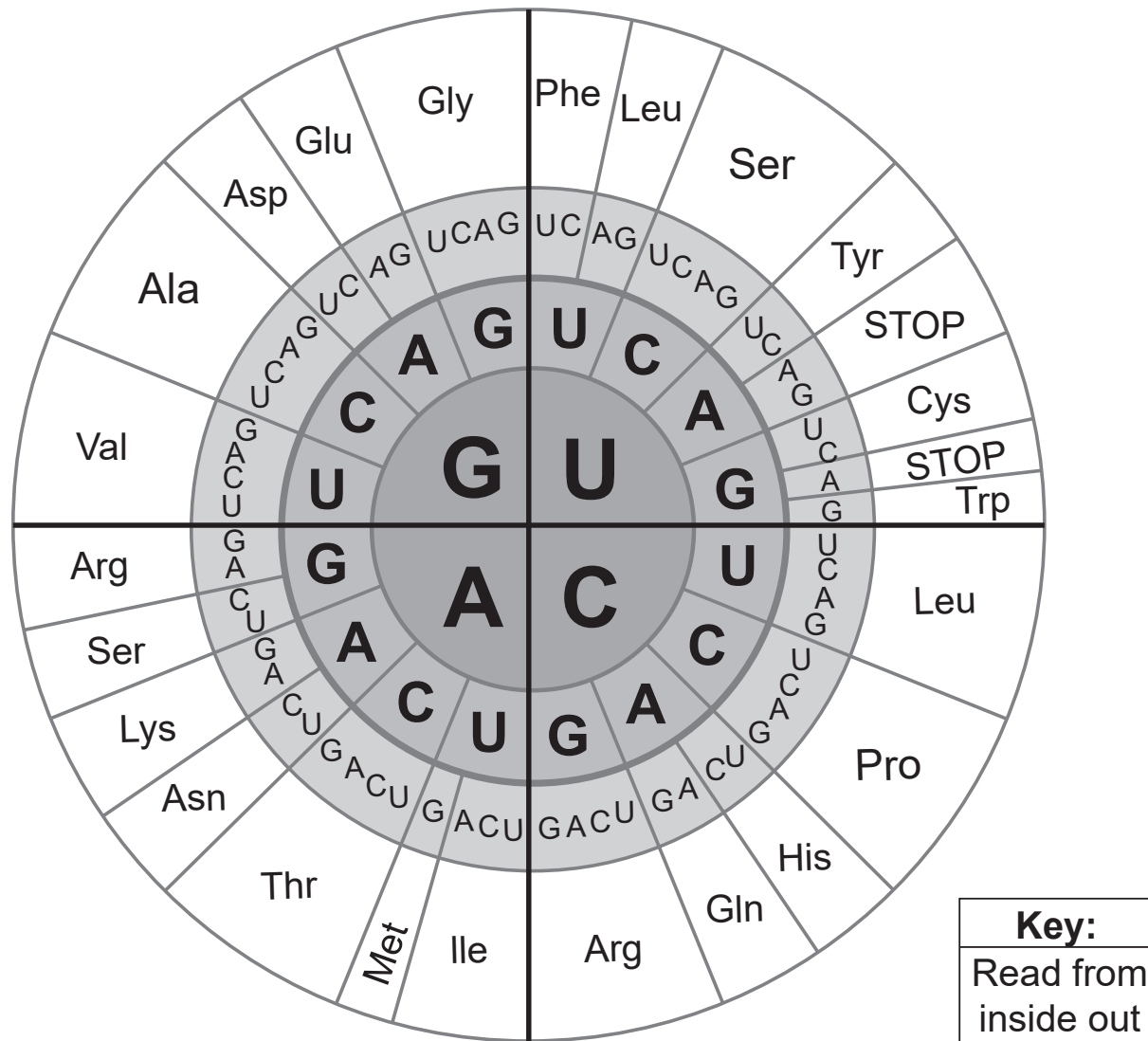
83 Explain how the beak of the Amakihi species is beneficial to its survival. [1]

84 State *one* reason why the Maui parrotbill and Akiapola'au, when found on the same island, might *not* compete with each other even though they both feed on insects. [1]

Base your answer to question 85 on the diagram below and on your knowledge of biology.

The diagram shows a genetic code chart for mRNA and the corresponding amino acids.

Genetic Code Chart for mRNA



85 Identify the amino acid sequence that is coded for by the following mRNA codons: [1]

CCC – UAC – CGG – GGU
