

LIVING ENVIRONMENT

Friday, June 14, 2024 — 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 OPEN THIS EXAMINATION BOOKLET 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 In an animal cell, all of the organelles work together to carry out

- (1) photosynthesis
- (2) diffusion
- (3) metabolic processes
- (4) information storage

2 A colony of 47,000 quaking aspen trees, all connected by one root system, is considered to be Earth's most massive organism. When the trees are stressed, shoots are sent out from the roots and develop into new trees. Every new tree in this colony would contain

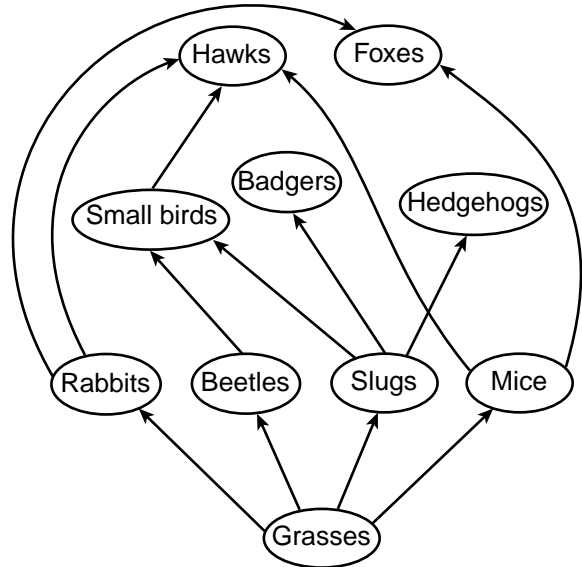
- (1) the same genetic information, because it is produced asexually
- (2) the same genetic information, because it is produced sexually
- (3) less genetic material, since it is produced from root cells
- (4) a different combination of genes, since it is produced from various roots

3 Scientists have found that different tissues in the prostate gland, a male reproductive organ, respond to different hormones. The tissues in the center area of the gland respond to testosterone and the tissues in the outer area of the gland respond to estrogen.

The cells that make up these two regions of the prostate are different in that

- (1) cells in the center area produce more estrogen than cells in the outer area
- (2) cells in the outer area have many testosterone receptors
- (3) they contain different receptors on their cell membranes
- (4) they contain different DNA sequences for the production of hormones

4 Energy transfers in a natural ecosystem are represented in the diagram below.



Which statement about this ecosystem is correct?

- (1) A reduction in the number of species present would most likely upset the stability of this ecosystem.
- (2) This ecosystem would not be affected if decomposers did not perform their function.
- (3) This ecosystem lacks producer organisms.
- (4) There are most likely more foxes than rabbits in this ecosystem.

5 The process of differentiation occurs when

- (1) two different cells, a sperm cell and an egg cell, combine to produce a zygote
- (2) different zygotes are formed each time that an egg and sperm unite
- (3) different kinds of cells and tissues form during embryonic development
- (4) two different sexes are present among the offspring, after sexual reproduction

6 Which two human systems work together to provide glucose for the cells of the body?

- (1) nervous and reproductive systems
- (2) nervous and respiratory systems
- (3) circulatory and digestive systems
- (4) circulatory and respiratory systems

7 The chart below includes structures found in a multicellular organism. Which row contains the structures that would be most numerous?

Row	Structures
(1)	organs
(2)	tissues
(3)	organelles
(4)	cells

8 Dioxin, a toxin associated with waste incineration and some plastics, has been found to directly disrupt normal gamete production in human females. Dioxin most likely affects the

- (1) testes and progesterone production
- (2) ovaries and estrogen production
- (3) DNA in the nuclei of sperm cells
- (4) pancreas and insulin production

9 A gene present only in a single plant species was found to regulate protein content. This gene could increase the protein content of other food crops in the developing world. The most likely method that scientists would use to incorporate this gene into a variety of food crops is

- (1) genetic engineering
- (2) selective breeding
- (3) sexual reproduction between the plants with this gene and those without it
- (4) deletion of the genes that limit protein production from each individual food crop plant

10 A decrease in predators within an ecosystem would lead to an increase in herbivores. The increase in herbivores would cause a *decrease* in

- (1) decomposers
- (2) prey
- (3) consumers
- (4) producers

11 The lioness (female lion) and cub shown below have similar characteristics.



Source: Kids Discover

In order for some of the genetic information in the lioness to be present in the cub, the genetic information from the mother must have been

- (1) copied and present in the egg cell of the lioness
- (2) combined with genetic information from another lioness
- (3) contained in half of the DNA found in the sperm cells of the father
- (4) able to make enzymes to produce all of the carbohydrates found in the mother

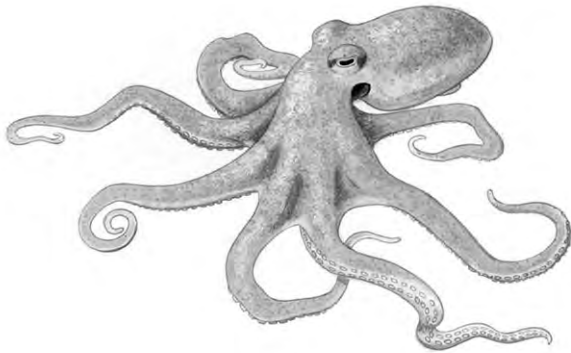
12 Which statement best describes a critical function of the placenta?

- (1) Meiosis occurs in the placenta, allowing for the development and release of eggs.
- (2) Blood from the mother and fetus mixes at the placenta, providing nutrients and oxygen.
- (3) The placenta filters out all harmful toxins and chemicals from the mother's blood, so that they cannot reach the fetus.
- (4) The exchange of oxygen and carbon dioxide occurs between the mother and developing fetus across the placenta.

13 Organisms maintain internal stability in a changing environment. To do this, they make a series of adjustments. The process of making these continual adjustments is referred to as

- (1) cellular respiration
- (2) active transport
- (3) natural selection
- (4) dynamic equilibrium

- 14 A species of octopus lives in the depths of the ocean where oxygen levels are low. These octopuses have specific proteins in their blood that allow for more efficient oxygen transport than in those that live in surface waters.



Source: <http://www.fisheat.it/octopus-octopus-vulgaris/>

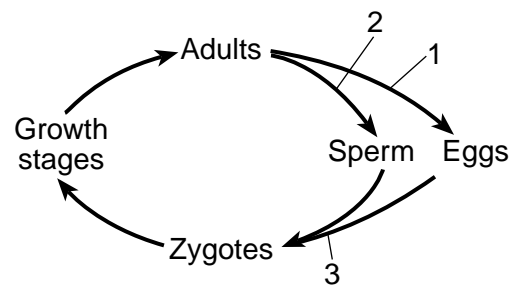
Which statement best explains the presence of these proteins in the octopuses living deep in the ocean?

- (1) Migration to warmer and shallower ocean water favored the formation of the specific proteins.
 - (2) Octopuses that had the specific proteins were able to survive and reproduce in the deep water environment and passed the trait on to future generations.
 - (3) When some octopuses migrated to a deeper environment, they needed to produce new proteins so that their blood could carry more oxygen.
 - (4) Mutations occurred in the body cells of the octopuses, which resulted in the specific proteins being produced and passed on to their offspring.
- 15 Tissue engineering is being developed as a technology that would use laboratory-grown tissues to replace diseased or damaged human body parts, such as hearts and kidneys. In order to build these new body parts, scientists would start by
- (1) assembling molecules directly into tissues that can make body systems
 - (2) making organelles and using the organelles to develop organs
 - (3) engineering body systems in order to develop organelles for transplant
 - (4) growing cells to develop tissues and then growing these tissues to form an organ

- 16 People with cystic fibrosis have decreased levels of some digestive enzymes in their small intestines. It is essential that they take enzyme supplements in order to prevent malnutrition. These enzymes are an important part of the digestive process because they

- (1) break down foods so that nutrients can be absorbed and used
- (2) contain vitamins and other nutrients necessary for a healthy diet
- (3) allow the person to synthesize large, inorganic nutrient molecules
- (4) are the building blocks of carbohydrates and other nutrient molecules

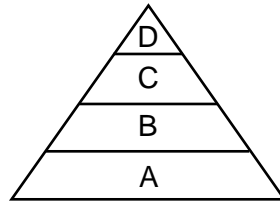
- 17 A reproductive cycle is illustrated below.



Which statement about this reproductive cycle is correct?

- (1) Mutations that occur during processes 1 and 2 will not be passed on to offspring.
 - (2) Exact copies of the parents are produced, which leads to a stable population.
 - (3) Sorting and recombining of genes occurs, which leads to new genetic combinations.
 - (4) The three processes result in offspring with half as much genetic information as the adults.
- 18 Kidney-transplant surgery places a healthy kidney from one person into the body of another. The body will often produce substances that work against this transplanted organ. The system most directly involved in attacking the transplanted kidney is the
- (1) excretory system
 - (2) nervous system
 - (3) circulatory system
 - (4) immune system

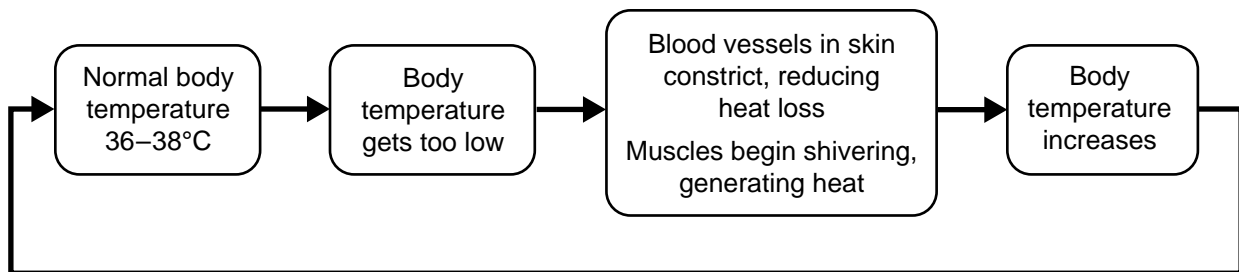
19 An energy pyramid for a forest ecosystem is represented below. The four levels (A-D) represent different types of organisms in the ecosystem.



Which numbered column in the chart below contains four terms that correctly identify the most likely types of organisms that could be found at each of the four levels in the pyramid?

Pyramid Levels	Types of Organisms			
	(1)	(2)	(3)	(4)
D	carnivores	carnivores	heterotrophs	producers
C	heterotrophs	carnivores	autotrophs	carnivores
B	producers	herbivores	herbivores	herbivores
A	herbivores	producers	producers	heterotrophs

20 The diagram below shows information about human body temperature regulation.



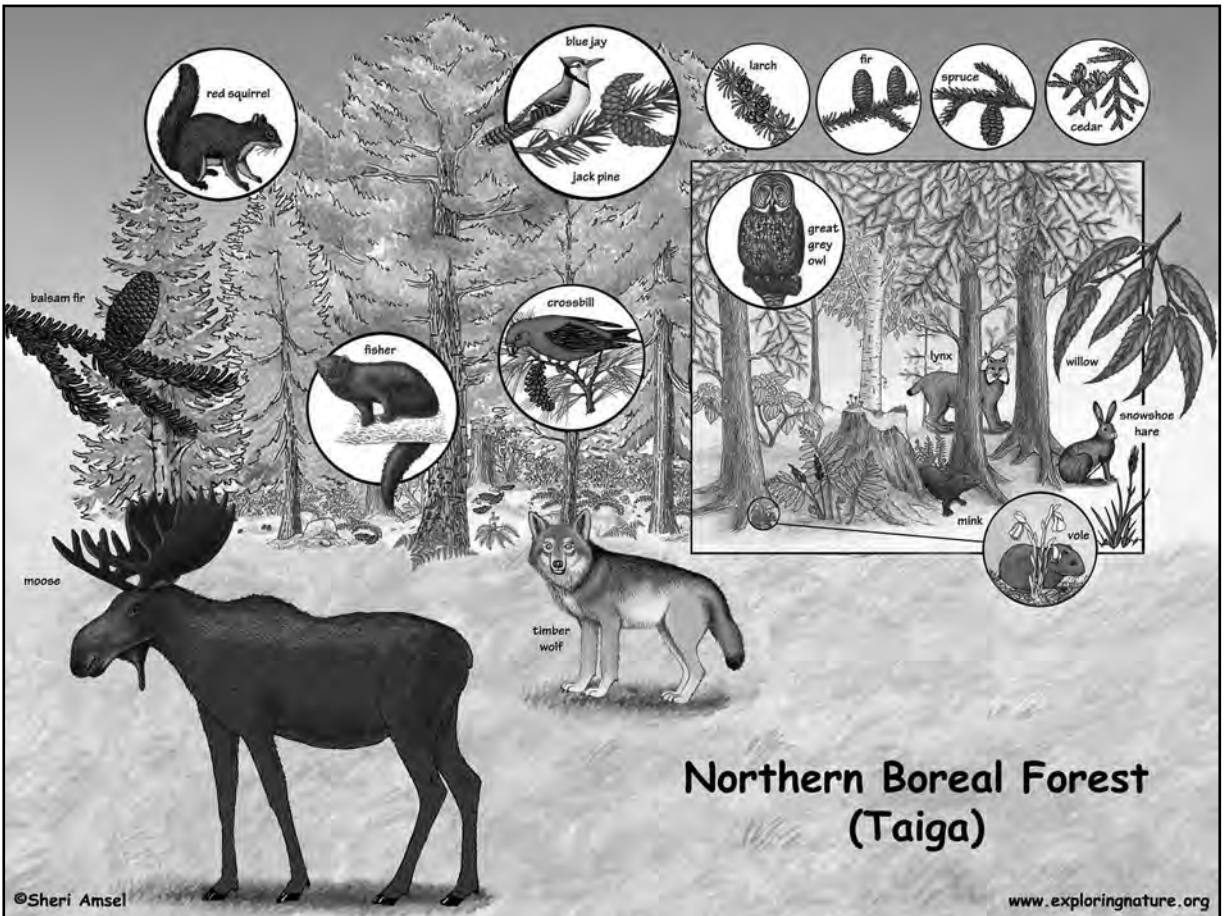
These events can be best described as an example of

- (1) a feedback mechanism that maintains homeostasis
- (2) a cycle that regulates cellular communication
- (3) an immune system response to increasing heart rate
- (4) a body system regulating hormone production

21 The World Wildlife Federation’s recent report indicated that there has been a 60% decline in the size of monitored wildlife populations in just over 40 years. The most likely factor contributing to this decline was

- (1) animals reproducing successfully
- (2) the destruction of many natural habitats
- (3) passing environmental protection laws
- (4) the introduction of native species into habitats

22 An Adirondack Mountain ecosystem is represented below.

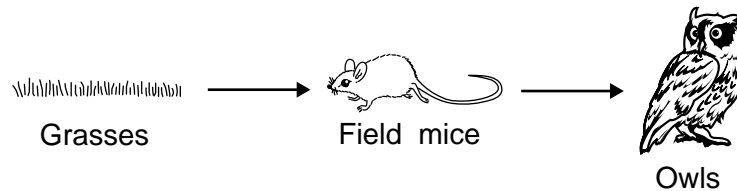


Source: <https://www.exploringnature.org/db/view/1709>

An abiotic factor in this ecosystem is the

- (1) pH of the soil where the trees grow
- (2) number of deer of reproductive age
- (3) different species of grass present
- (4) balance between predators and prey

23 A partial food chain is represented below.



A student observed owls hunting mice in a field. Some chemicals from the waste products of the owls were made available to be absorbed by the roots of the grasses due to the action of

- (1) autotrophs
- (2) carnivores
- (3) herbivores
- (4) decomposers

- 24 Which two terms are opposite processes?
- (1) autotrophic nutrition and photosynthesis
 - (2) asexual reproduction and cloning
 - (3) digestion and synthesis
 - (4) natural selection and evolution
- 25 Which human activity would most likely deplete finite resources?
- (1) recycling of aluminum and paper
 - (2) protection of wildlife habitats
 - (3) uncontrolled population growth
 - (4) regulations that reduce industrial pollution
- 26 Macaques are a species of monkey. They normally reproduce sexually, but, in January 2018, scientists cloned two baby macaques from a single body cell.



Source: <https://www.sciencenews.org/article/baby-macaques-primates-clones-dolly-sheep>

These monkeys are genetically

- (1) identical to each other, but different from the donor of the body cell
- (2) different from each other, but identical to the donor of the body cell
- (3) identical to each other and to the donor of the body cell
- (4) different from each other and from the donor of the body cell

- 27 Which event would most likely be the immediate result of significantly lowering the oxygen concentration in a freshwater lake?
- (1) a decrease in the number of fish
 - (2) an increase in the number of plants
 - (3) an increase in biodiversity
 - (4) a decrease in water temperature
- 28 Scientists have modified papayas to be resistant to the papaya ringspot virus and to decrease the time that it takes for them to ripen. These modifications
- (1) may cause papayas to ripen too slowly, causing loss of revenue
 - (2) are passed to any organism that eats them, making the organism resistant to the virus
 - (3) are an example of using agricultural technologies to increase farm yields
 - (4) could spread ringspot virus throughout the entire ecosystem
- 29 Vaccinated individuals are protected from disease because their bodies have been stimulated to
- (1) produce antibodies against specific pathogens
 - (2) synthesize antigens against harmful microbes
 - (3) make fewer white blood cells during infection
 - (4) manufacture more enzymes to react to microbes
- 30 A species of predatory wasp is introduced to control an insect pest. A possible *negative* consequence of this action is that the new predatory wasp may
- (1) limit the population of the insect pest
 - (2) prey on beneficial insects
 - (3) disrupt mineral availability in the ecosystem
 - (4) cause an increase in pesticide-resistant plants

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 below and on your knowledge of biology.

Mercury Levels in Various Fish or Seafood Types

Industrialization has contributed to unsafe levels of mercury compounds building up in aquatic ecosystems, including in the tissues of many predatory fish species. As a result, many people have concerns about eating any seafood. The mercury, at relatively high levels, can be especially harmful during development of a fetus and of young children. It can also affect adult health in various ways.

However, seafood is also an important part of a healthy diet. The omega-3 fats in seafood are essential to the proper functioning of the circulatory system. They are also important for optimal development of a baby's brain and nervous system.

The table below contains data about mercury levels in several kinds of seafood.

Fish or Seafood Type	Mercury Content (ppm/oz.)
Swordfish	0.995
King mackerel	0.73
Cod	0.11
Trout	0.07
Halibut	0.024
Tilapia	0.013
Shrimp	0.009

Source: Adapted from www.zmescience.com

- 31 Based on the information given, which statement concerning the eating of fish and seafood is most accurate?
- (1) People should avoid eating seafood because the negative effects of the mercury in seafood are far worse than any benefits that eating seafood may provide. Even shrimp and tilapia contain high levels of mercury.
 - (2) The normal development of a baby's nervous system requires that the mother be more concerned with eating enough seafood and less concerned with the side effects of higher levels of mercury on the child.
 - (3) Eating certain selected species of seafood can provide health benefits without the negative effects of high mercury intake.
 - (4) It is important that pregnant women eat a regular diet of seafood, including swordfish, halibut, and cod.
- 32 Which statement is best supported by the information provided about the levels of mercury present in seafood?
- (1) Human activities do not affect mercury levels in fish species.
 - (2) Future generations can be affected by choices made by past and present generations.
 - (3) Fish that consume plants have the highest levels of mercury compounds.
 - (4) If people stop eating fish, then the mercury levels in fish will decrease.

- 33 Grasshopper mice feed on bark scorpions, but, unlike other mice, grasshopper mice are unaffected by the painful venom of the scorpion. Scientists have determined that these mice have one amino acid difference in their pain receptors, which causes the receptor to function differently and prevents feeling the pain associated with the scorpion venom. This change in protein function was originally caused by a change in
- (1) molecular bases located in the nucleus (3) the amino acids in the DNA
 (2) fat molecules in the cell membrane (4) the genes located in the protein
- 34 Certain organisms living deep in the ocean can obtain energy from inorganic compounds that flow out of volcanic vents. They can use this energy to synthesize energy-rich organic compounds.

Which row in the chart below correctly pairs an organism that performs a similar function in land environments with the process involved?

Row	Organism	Process
(1)	small mammal	respiration
(2)	grasses	photosynthesis
(3)	small mammal	photosynthesis
(4)	grasses	respiration

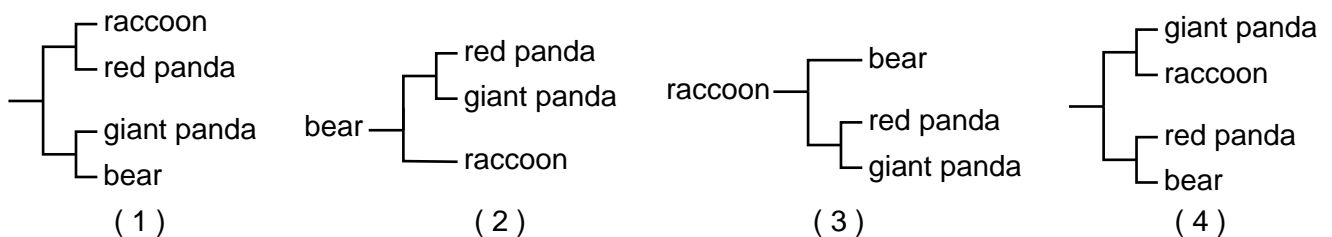
- 35 Scientists are concerned about the decreasing numbers in the populations of Atlantic salmon along the east coast of North America due to overfishing and changes in their breeding environments. Some businesses have developed farm-raised populations of certain varieties of salmon. Large, farm-raised populations have a limited genetic diversity as compared to wild-caught salmon.

Which row in the chart below correctly pairs possible effects of fish farming?

Row	Negative Effect of Fish Farming	Positive Effect of Fish Farming
(1)	Loss of biodiversity among farmed fish	Increased sales of fish, a food source
(2)	Increased sales of fish, a food source	Limited genetic diversity in salmon population
(3)	Loss of biodiversity in wild fish	Decreased population size
(4)	Increased biodiversity	Increased population size

- 36 DNA studies have shown that bears and raccoons evolved from a common ancestor about 50 million years ago. Giant pandas evolved from a more recent ancestor that was related to bears. The red panda evolved from a more recent ancestor that was related to raccoons.

Which evolutionary tree best represents these sequences of events?



37 Researchers studying water fleas (tiny organisms that live in fresh water) have noticed that the appearance of the water flea follows a pattern, as seen in the table below.

The Effect of Predator Type on Water Flea Appearance

Type of predator found in water flea environment	No predator	Stickleback fish	Backswimmer bug
Water flea appearance (Not drawn to scale)			

Source: <https://www.livescience.com/55297-how-water-fleas-grow-body-armor.html>

If all three water fleas are genetically identical, which statement best explains why the three water fleas have different appearances?

- (1) Random alterations of genes occur in water fleas when they eat different foods.
- (2) Predators in the water flea's environment cause mutations in the water flea.
- (3) Genes are not involved in the appearance of these water fleas.
- (4) Water flea gene expression can be influenced by the type of predator present in their environment.

Base your answers to questions 38 and 39 on the information below and on your knowledge of biology.

Mitochondria Inherited from Father

It was widely accepted that humans inherit their mitochondria only from their mothers. In 2002, an individual suffering from fatigue and muscle pain was found to have a mutation in his mitochondrial DNA. DNA sequencing of family members revealed that he had inherited the mutated mitochondria from his father. Since 2002, evidence of additional cases of children inheriting mitochondrial mutations from their fathers has been found.

38 The discovery that humans can inherit mitochondria from their fathers illustrates the concept that

- (1) inquiry does not judge the reliability of sources
- (2) experiments without controls are not valid
- (3) scientific explanations are tentative and subject to change
- (4) advancements in technology usually make scientific theories invalid

39 The most likely explanation for why children who inherited mutated mitochondria suffer fatigue and muscle pain is that their mitochondria fail to

- (1) provide the antigens needed to fight the mutated DNA
- (2) regulate the transport of nutrients to the muscle cells
- (3) synthesize the starch needed by the muscles
- (4) release enough energy for cells to function properly

Base your answers to questions 40 and 41 on the information and photo below and on your knowledge of biology.

Burmese pythons are an invasive species in the Everglades National Park. In 2010, there was a rare “hard freeze,” which residents hoped would eliminate these pests that were originally from very warm areas in Asia. Roughly 40% to 90% of the pythons were killed by the freeze event. Since not all of the pythons were killed during the freeze event, the members of the current large python population in the Everglades might differ from the members of the python population from before 2010.



Source: Associated Press, August 18, 2017

- 40 Which statement best describes a likely cause for the changes that might exist in the present python population?
- (1) The python species needed cold-tolerant genes, and they appeared in 2010 by rapid mutation.
 - (2) The freeze event served as a selecting agent, and a higher percentage of the pythons existing today are cold-tolerant.
 - (3) Many individual pythons were unable to reproduce during the freeze event and did not pass on their cold-tolerant genes.
 - (4) There was no actual change in the population, and if a similar freeze event occurred again, 40-90% of the snakes would die.
- 41 Pythons in their native habitat often eat a large animal and then do not feed again for weeks. In the Florida Everglades, food sources are often small mammals and birds. The current large python population in Florida can be described as a species that
- (1) will quickly die out because there are no appropriate food sources in their environment
 - (2) will develop new digestive organs as needed to succeed in the Florida Everglades
 - (3) has expanded only because small animals reproduce so quickly that they provide an unlimited food source
 - (4) has already successfully adapted to an unfamiliar environment through natural selection
-

Base your answers to questions 42 and 43 on the information and photo below and on your knowledge of biology.

Fishers

Fishers are mammals that prefer to live in forested areas. The fisher feeds on acorns, berries, and apples, as well as on smaller mammals and birds. They are one of the few organisms that are successful in killing and eating porcupines. Porcupines are large rodents that have sharp spines, or quills, that cover most of their body. The fisher has no natural enemies. Most fisher deaths are due to automobiles and trapping. The population has also been negatively affected by logging and road-building.



Source: www.massaudubon.org

- 42 Recently, new regulations have been adopted that affect the trapping of fishers. Which action would probably result in an increase in the fisher population?
- (1) removing all regulations regarding fisher trapping
 - (2) increasing the area where fisher trapping is allowed
 - (3) changing the fisher trapping season from 46 to 30 days
 - (4) decreasing the cost of the permit needed for fisher trapping
- 43 Humans have negatively affected the ecosystem that fishers occupy. An altered or changed ecosystem can
- (1) never recover or become stable again
 - (2) usually recover gradually to a point of long-term stability
 - (3) never recover unless there is a decrease in biodiversity
 - (4) usually recover quickly into the same ecosystem as it was previously
-

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 48 on the information below and on your knowledge of biology.

Monarch Butterfly Parasites

Monarch butterflies are in trouble! Their populations have been declining quickly in recent years due to several factors, including habitat loss, climate change, and infection by parasites.

To investigate ways to reduce this decline, some scientists studied a parasite that often infects and weakens monarch larvae (caterpillars). The larvae ingest parasite spores as they feed on milkweed plants. Once in the intestinal tract of the caterpillar, some of the spores can infect the cells of the intestine and reproduce.

The scientists collected samples of the parasite from four areas of North America where monarchs live. They found four different variations in the parasites. Scientists cloned each of the four variations of parasites in order to have enough to test with the monarch larvae.

Monarch larvae feed exclusively on milkweed plants. Two types of milkweed monarchs feed on are swamp milkweed (SM) and tropical milkweed (TM). Both kinds of plants contain chemicals known as cardenolides, but tropical milkweed has higher levels of these chemicals. These chemicals are absorbed into the tissues of the larvae as they feed on milkweed. The cardenolides give the larvae some resistance to infection by the parasites.

The scientists conducted experiments to determine how the harm caused by these parasites may be affected by the amounts of cardenolides in the two kinds of milkweed.

The monarch larvae were divided into groups. Each of the groups was fed one of the two types of milkweed and then exposed to one of the four parasite clones: E-1, E-11, F-3, or F-13.

The overall purpose of the testing was to determine whether it was the type of parasite clone or the type of plant that the larvae were fed that would have the greatest effect on the percent of caterpillars that became infected.

The data table below shows the results obtained by the scientists.

Infections Based on Type of Food Plant and Parasite Clone

Parasite Clone to Which Larvae were Exposed	Percent of Larvae Feeding on Tropical Milkweed (TM) that Became Infected	Percent of Larvae Feeding on Swamp Milkweed (SM) that Became Infected
E-1	83	100
E-11	88	92
F-3	75	100
F-13	86	100

Directions (44–45): Using the information in the data table, construct a bar graph on the grid provided, following the directions below.

44 Mark an appropriate scale on the axis labeled “Percent of Monarch Larvae Infected.” [1]

45 Construct a bar graph following the directions below. [1]

- Construct vertical bars in the area provided on the grid to represent the results for each parasite clone for the larvae that were fed tropical milkweed (TM) in the areas marked TM.

Shade the TM bars in black, as shown:



- Construct vertical bars in the area provided on the grid to represent the results for each parasite clone for the larvae that were fed swamp milkweed (SM) in the areas marked SM.

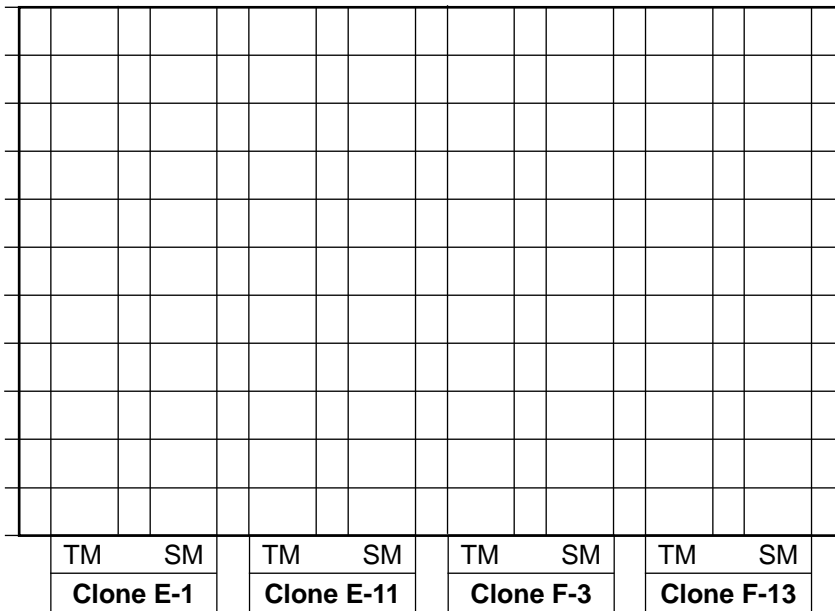
Shade the SM bars with diagonal lines, as shown:



44–45

Infections Based on Type of Food Plant and Parasite Clone

Percent of Monarch Larvae Infected



Key

Fed Tropical Milkweed (TM):

Fed Swamp Milkweed (SM):

46 State whether the types of milkweed that the larvae were fed made a difference in whether or not the larvae became infected. Support your answer. [1]

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

47 Which row in the chart below correctly identifies the average percent of infection of the larvae that ate tropical milkweed and the average percent of infection of the larvae that ate swamp milkweed?

Row	Average Percent Infected that Ate Tropical Milkweed (TM)	Average Percent Infected that Ate Swamp Milkweed (SM)
(1)	75	92
(2)	88	100
(3)	83	98
(4)	98	83

48 Describe how the results of the experiment might have been different if very few spores of parasite clone F-13 were placed on the milkweed leaves, compared with the number of spores placed on leaves for the other three clones. [1]

Base your answers to questions 49 through 51 on the information below and on your knowledge of biology.

Frogsicles: Frozen but Still Alive

The wood frog has the amazing ability to survive winter in a frozen state. Ice crystals touching the frog can trigger the freezing of its body fluids. Most of the water moves out of their cells and into body cavities, where it turns into solid ice. Their cells are protected from dehydration and frostbite by the antifreezing effect of their cells absorbing extremely high concentrations of sugar. When these frogs freeze, they stop breathing, their heart stops beating, and they enter a state of dormancy that can last several months. In spring, the frogs thaw, and the excess sugar moves out of their cells. The frogs resume normal activities in less than 24 hours.



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

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

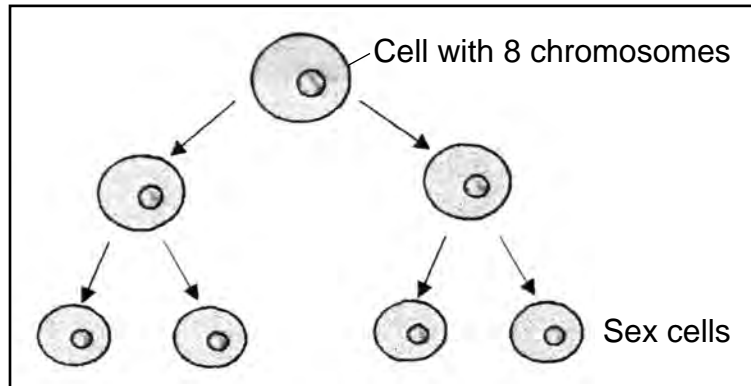
- 49 A wood frog's body systems' responses to ice crystals touching it in winter and to the conditions in the spring can best be explained by
- (1) the differentiation of mature body cells during development
 - (2) a response of their cells to changing environmental conditions
 - (3) the enzymatic breakdown of water as the frog freezes
 - (4) a response of the immune system to excess sugar levels

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

- 50 Which scientific question could lead to an investigation to help determine the stimulus that causes wood frogs to thaw in the spring?
- (1) Do the frogs thaw if the air temperature remains below freezing all winter?
 - (2) Does the changing length of daylight or warming cause the frogs to thaw?
 - (3) Do the frogs get hungry when they are frozen?
 - (4) Does the weight of the frog change after they freeze?

- 51 Identify *one* structure present in the cells of these frogs that plays a role in the rapid removal of water and the absorption of high concentrations of sugar. Justify your answer. [1]

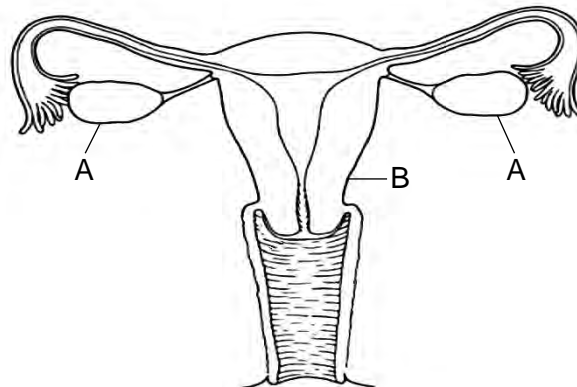
52 A cellular process that produces sex cells in fruit flies is represented in the diagram below.



Based on the information in the diagram, how many chromosomes will be present in each of the sex cells of the fruit fly? [1]

_____ chromosomes

53 The model below represents the reproductive system of human females.



Describe the roles of structures A and B in the production of offspring. [1]

A: _____

B: _____

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

A student placed four different test tubes in a water bath at 37°C, human body temperature. The contents of the test tubes are listed below. Two of them contain a human enzyme.

Test Tube	Contents
1	ground meat, water, protein-digesting enzyme
2	bread, water, starch-digesting enzyme
3	ground meat, water
4	bread, water

After 15 minutes, the student tested the contents of each tube for the presence of both amino acids and glucose. He obtained the results shown in the table below.

Test Tube Number	Indicator for Amino Acids	Indicator for Glucose
1	positive	negative
2	negative	positive
3	negative	negative
4	negative	negative

54 Describe the results that the student would most likely obtain if he ran the same experiment again but placed the test tubes in a hot water bath at 65°C for 15 minutes. Justify your answer. [1]

55 Identify the purpose of Test Tubes 3 and 4 in this experiment. Justify your answer. [1]

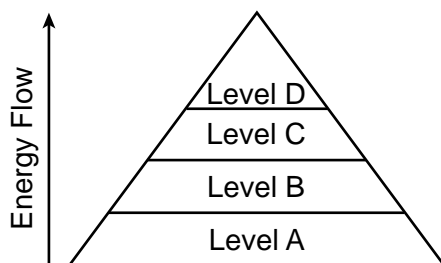
Part C

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 and 57 on the information below and on your knowledge of biology.

The process of photosynthesis is responsible for providing the energy necessary to sustain most ecosystems on Earth. The flow of energy in an ecosystem is represented in the diagram below.



56 Identify the source of energy for an ecosystem and describe how it is transferred from one level in the system to the next. [1]

The chart below is a summary of the net number of atoms in the molecules used and produced during the process of photosynthesis.

Type of Atom	Number of Atoms in the Molecules Used for Photosynthesis	Number of Atoms in the Molecules Produced by Photosynthesis
Carbon (C)	6	6
Hydrogen (H)	12	12
Oxygen (O)	18	18

57 A student claimed that there is no gain or loss of matter during photosynthesis. Provide evidence from the data to support this claim. [1]

Base your answers to questions 58 through 61 on the information and charts below and on your knowledge of biology.

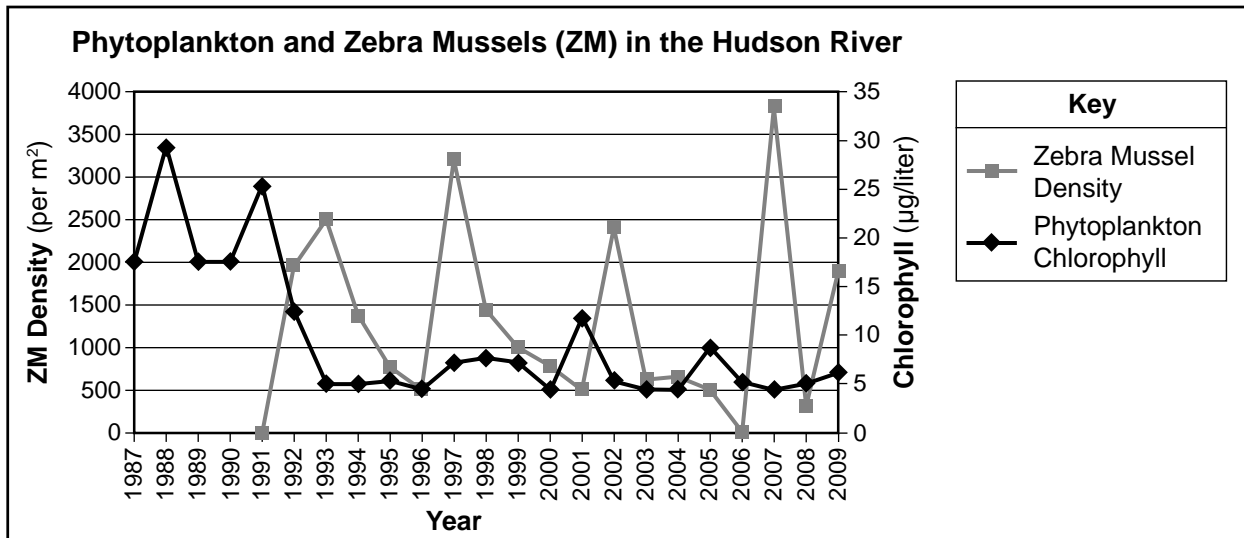
Hudson River Zebra Mussels

Researchers have been monitoring the effects of zebra mussels in the Hudson River. Zebra mussels are small, aquatic, clam-like animals that arrived in the United States in cargo ships traveling from Europe to the Great Lakes in the 1980s. Since waterways connect the Hudson River to the Great Lakes, zebra mussels had spread to the Hudson River by 1991. Zebra mussels can produce a million eggs per year, and the larvae drift before attaching to hard surfaces.

Mussels feed by filtering water through their gills and straining out algae, called phytoplankton, and microscopic animals. By the end of 1992, without a predator, the zebra mussels outweighed all other consumers in the river. They filtered a volume of water equal to all of the water in the river every one to four days during the summer, removing food and dissolved oxygen. Zebra mussels caused problems by clogging water pipes and damaging boats, docks, buoys, and other structures.

Graph 1 below represents data collected by the researchers. The phytoplankton levels were based on the data regarding the chlorophyll that they contained.

Graph 1



Source: Adapted from www.caryinstitute.org

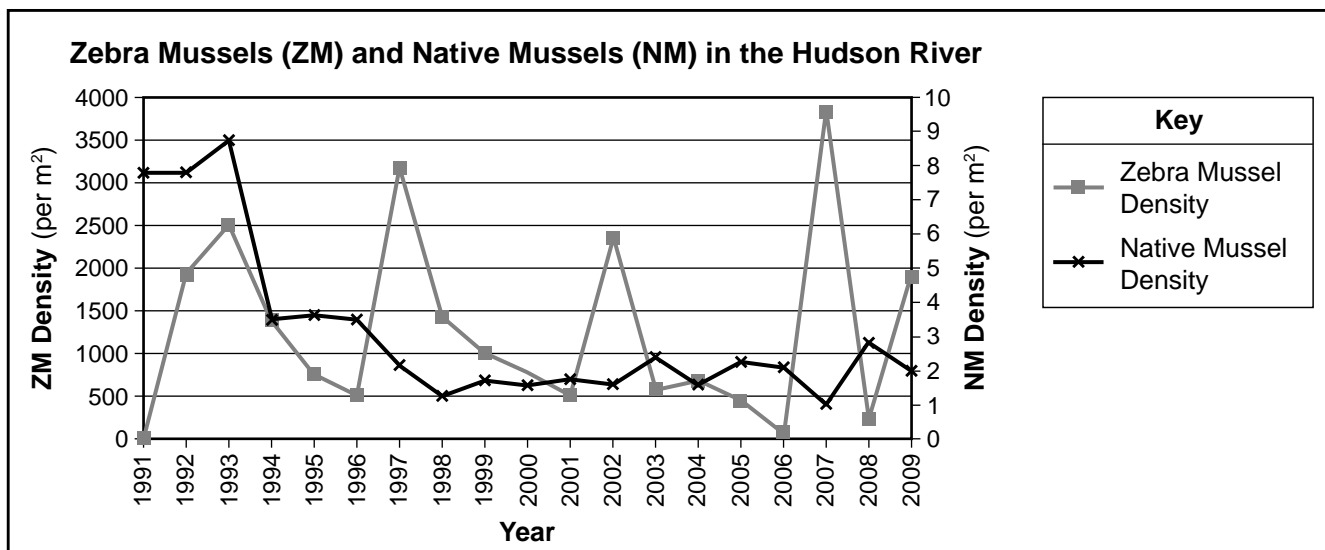
58 State *one* reason that the zebra mussels could successfully spread throughout the rivers and lakes in the U.S. [1]

59 A student made a claim that once zebra mussels were established in the Hudson River, the zebra mussel population would affect the food webs by reducing the food available for native consumer populations. Explain how the data in graph 1 could be used to support the student's claim. [1]

60 Other than reducing the food available for native populations, state *one negative* consequence of failing to keep zebra mussels out of the Great Lakes. [1]

The graph below shows changes in two mussel populations in the Hudson River.

Graph 2



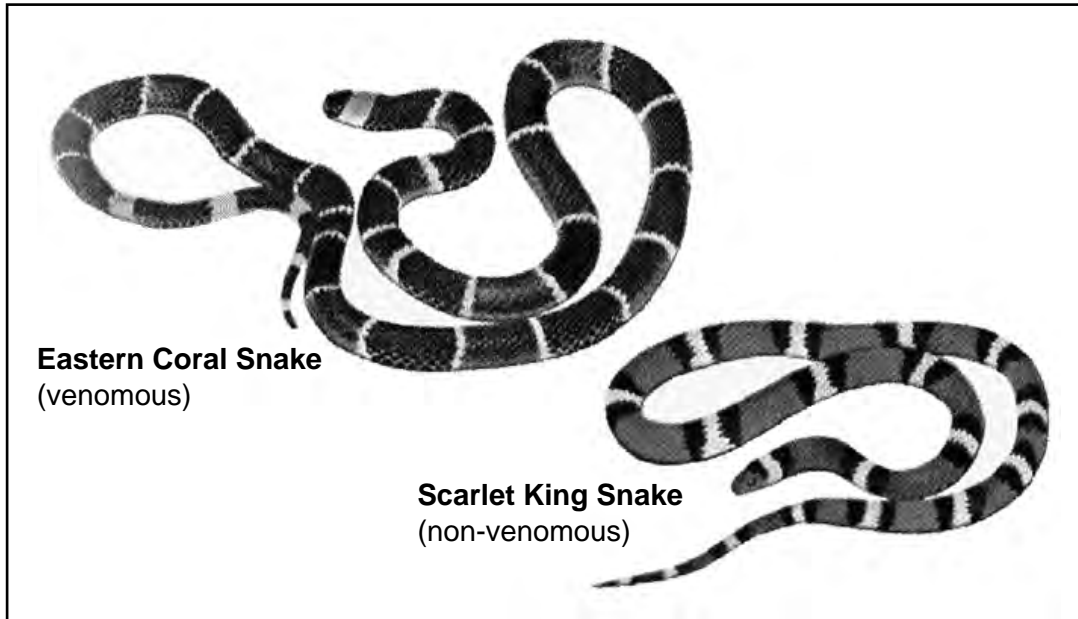
Source: Adapted from www.caryinstitute.org

61 The native mussels and zebra mussels have similar ecological roles. State *one* reason for the pattern represented by the data in Graph 2. [1]

Base your answers to questions 62 and 63 on the information and illustration below and on your knowledge of biology.

Mimicry in Snakes

Mimicry is an evolved resemblance between two species. The harmless scarlet king snake mimics the Eastern coral snake. The king snake has evolved red, yellow, and black bands that make it look very similar to the venomous coral snake. In some areas, both snakes are found together and consume some of the same organisms for food.



Source: https://www.petmd.com/sites/default/files/coral_snake.gif

62 Explain how mimicry is a benefit to the king snake species. [1]

63 Predict how the population size of king snakes might change over time *without* coral snakes in the area where they live. Justify your answer. [1]

Base your answers to questions 64 and 65 on the passage below and on your knowledge of biology.

Predators in the Adirondacks

To help keep the number of deer in check, an environmental group proposes the reintroduction of large predators, such as mountain lions, into the Adirondacks. Coyotes are a main predator of deer, especially the sick and young ones. Opponents of the proposal believe that the Adirondack deer population has been regulated by coyotes, hunting, bad winters, and land development projects. They also question the ability of the mountain lions to survive in the current Adirondack environment.

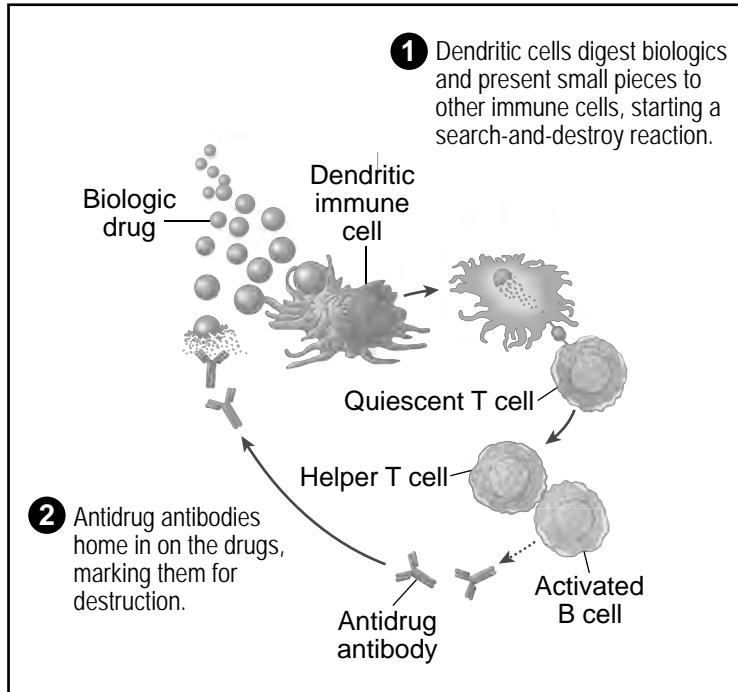
64 Describe *one* possible result of reintroducing mountain lions into the Adirondacks. [1]

65 Explain how land development projects could reduce the deer population in the Adirondacks. [1]

Base your answers to questions 66 through 68 on the information below and on your knowledge of biology.

Biologics

The newest drugs to treat deadly illnesses like cancer, autoimmune diseases, and heart disease are called biologics. Biologics are drugs that mimic naturally occurring proteins. These biologics are injected into patients. Doctors recently noticed that these drugs do not work for some patients. They developed the model below to explain why the drugs are ineffective in as many as 50% of patients.



Source: Adapted from *Scientific American*, January 2018

66 Based on the information in the model, explain why the biologic drugs are ineffective for some people. [1]

67 Explain why biologic drugs may be more effective in patients diagnosed with AIDS. [1]

68 In order to make the biologic drugs more effective, doctors experimented with coating the biologic drugs with a synthetic vaccine particle (SVP). This SVP changes the way that the immune system responds to the drug particle by blocking the production of antidrug antibodies.

Explain why a person would still have immunity to other pathogens after being exposed to these SVPs. [1]

Base your answers to questions 69 through 71 on the information below and on your knowledge of biology.

Plants Rebound in the Chesapeake Bay

Chesapeake Bay vegetation, including sea grass and freshwater plants, is an important part of the area's coastal ecosystem. These areas act as nurseries that shelter young fish and invertebrates, clean the water, and stabilize shorelines by preventing erosion.

In the 1950s, the human population greatly increased in the Bay area. As the growth continued, cities and farms were releasing large amounts of nitrogen compounds and other nutrients into the water. These nutrients had a very positive effect on the growth of small microscopic organisms, such as algae and plankton, in the Bay. As the algae continued to grow near the surface, the growth of more complex plants living deeper in the Bay decreased.

In the 1980s, state and federal regulations were passed that limited the amount of nutrients that could be present in the runoff from farms and wastewater treatment plants. As a result, underwater plants are now growing again in the Bay, and there has been a large decrease in the amount of nitrogen compounds present in the water.

69 State *one* possible reason why the rapid growth of algae in the Bay resulted in a decline in the number of complex underwater plants. [1]

70 Explain *one* specific way in which the change from more complex plants to more algae could disrupt food webs in the Bay region. [1]

71 In order to determine which nutrient had the greatest effect on the overgrowth of the algae, several types of data were collected. Identify *one* type of evidence that researchers would look for to support the conclusion that nitrogen compounds were responsible for the algae growth. [1]

Mosquitoes are insects whose bite can cause discomfort and disease in humans. In an attempt to control mosquito populations, scientists have used radiation to prevent the males from producing functional sperm.



Source: <https://www.orkin.com/other/mosquitoes>

72 Explain how the mosquito population can be controlled as a result of this procedure. [1]

Part D

Answer all questions in this part. [13]

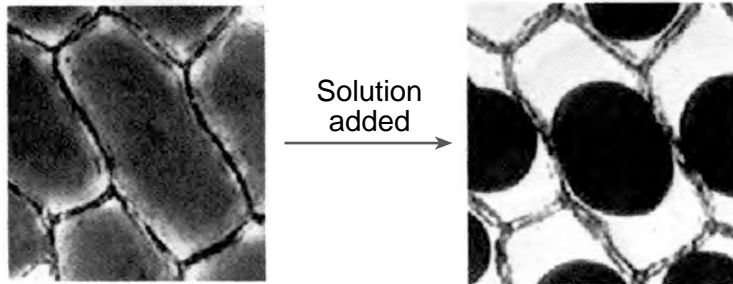
Directions (73–85): For those questions that are multiple choice, record on the separate answer sheet the *number* of the choice that, of those given, best completes each statement or answers each question. For all other questions in this part, follow the directions given and record your answers in the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

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

- 73 After exercising outside on a cold day, a student noticed that his fingers were not as cold as when he started. One possible explanation for this phenomenon would be that exercising
- (1) causes more sweat to be produced, which cools the body
 - (2) increases the blood circulation, causing body parts to feel warmer
 - (3) increases the breathing rate to remove waste products
 - (4) decreases the amount of energy needed, so the fingers feel warmer

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

- 74 The diagram below represents changes in some red onion cells being observed with a compound microscope after a particular solution was added.



Which statement best explains the changes observed?

- (1) Distilled water was added to the slide and diffusion caused water to move out of the onion cells.
- (2) Salt solution was added to the slide and active transport caused water to move out of the onion cells.
- (3) Distilled water was added to the slide and active transport caused water to move out of the onion cells.
- (4) Salt solution was added to the slide and diffusion caused water to move out of the onion cells.

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

Base your answer to question 75 on the information below and on your knowledge of biology.

A homeowner observed different types of birds feeding at bird feeders filled with an assortment of food.

- 75 Competition arises most often when two birds have similar
- (1) enzymes
 - (2) niches
 - (3) habitats
 - (4) ecosystems

Base your answers to questions 76 and 77 on the information below and on your knowledge of biology.

To demonstrate some of the steps involved in the analysis of DNA, a student was given two paper strips with single-stranded DNA sequences recorded on them. The two strips are illustrated below.

Strip 1: TTACCGGATTACCCGATTACCGGATAATCTCCGGATATCCGTT

Strip 2: TTAGGCTTAAGCTAATGGCCTAATAGTTAATACGGTAATACAT

The student cut between the C and G in each of the shaded CCGG sequences in strip 1 and between the As in the shaded TAAT sequences in strip 2. Both sets of DNA fragments were arranged on a paper model of a gel.

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

76 The results of this type of DNA analysis are often used to help determine

- (1) if two organisms contain the same carbohydrate molecule
- (2) the number of DNA molecules in an organism
- (3) if the DNA codes for the synthesis of fat molecules in all cells of an organism
- (4) the evolutionary relationship between two organisms from different species

77 Identify the specific type of molecules performing the action of cutting the DNA samples. [1]

78 In the *Making Connections* lab, for trial 1, students squeezed a clothespin as many times as they could in a minute. State *one* specific biological reason why their muscle cells “got tired” during the second trial. [1]

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

An experiment was conducted to measure the effect of exercise on pulse rate for a group of high school students. The table below shows the results.

Student Tested	Pulse Rate at Rest	Pulse Rate After Exercising
1	70	92
2	52	87
3	80	118
4	72	104
5	60	96
6	66	124

79 Explain why the resting pulse rates for these students were *not* all the same. [1]

80 Explain how the increased pulse rate as a result of exercising helps the body maintain homeostasis. [1]

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

Shown below are two tools that students used as models of finch beaks during the *Beaks of Finches* lab investigation.



81 Which important concept of natural selection do these model beaks represent?

- (1) dynamic equilibrium
- (2) limiting factor
- (3) environment
- (4) variation

84 Other than beak adaptations, identify *one* characteristic that would help finches on an island compete successfully, and explain specifically why that characteristic would make them successful. [1]

85 During a hurricane, a large raft made up of tree trunks, branches, and other vegetation was washed off the coast of an island. A few days later, this raft washed up on the shore of a new island a few miles away. Along with the vegetation present in the raft, there were about a dozen lizards that were native to the original island, but their species was not living on the new island. A similar species of lizard did live there and had for many years.

Once the lizards arrived at the new island, they found food and other resources that they needed to survive.

Describe *one* specific way that the newly arriving lizards might affect the population of lizards already present on the new island. [1]
