Large-Type Edition

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

LIVING ENVIRONMENT

Wednesday, August 17, 2022 — 12:30 to 3:30 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 Studying fossils provides evidence for evolution because fossils

(1) take a long time to form
(2) can show patterns of biological change over time
(3) always contain complete DNA sequences
(4) found in the same area are usually closely related to each other

2 Which statement best describes the interactions between the structures found within a single-celled organism?

(1) They allow the organism to maintain homeostasis.
(2) They prevent homeostasis from damaging the cell.
(3) They must act independently of each other and prevent homeostasis.
(4) They carry out the same life process in order to maintain homeostasis.

3 Sexually reproduced offspring have traits similar to their parents because they receive

(1) all of the proteins from each parent
(2) some of the proteins from both parents
(3) all of the genes present in both parents
(4) some of the genes present in each parent

4 Which row in the chart below correctly pairs a group of organisms with the type of nutrition they carry out?

Row	Autotrophic Nutrition	Heterotrophic Nutrition
(1)	carnivores	herbivores
(2)	decomposers	carnivores
(3)	herbivores	producers
(4)	producers	decomposers

5 Rubber usually comes from petroleum or from the Asian rubber tree plant. Scientists have modified a single trait in the domestic plant, guayule, to increase its ability to produce rubber for commercial use. Young guayule plants are shown in the photograph below.

Source: http://agresearchmag.ars.usda.gov

The process that was most likely used to modify the plants' trait and increase their natural rubber production was

(1) selective breeding of two similar plant varieties
(2) genetic recombination during sexual reproduction
(3) genetic engineering to alter a specific gene
(4) fertilizing the plants with key substances found in petroleum

6 A response of a normally functioning immune system that can be harmful is

(1) being infected by the flu virus
(2) rejecting an organ transplant
(3) recognizing chemical signals
(4) fighting off a bacterial infection

7 Which molecules are normally found in single-celled organisms?

(1) organic molecules, only
(2) inorganic molecules, only
(3) both organic and inorganic molecules
(4) neither organic nor inorganic molecules

8 Hammerhead sharks are unlike most other shark species. Nearly all shark species either lay eggs or give birth to live young after their eggs hatch internally. Hammerhead sharks form a placenta, a structure more commonly found in mammals, such as humans. One role of the placenta in the development of offspring is normally to

(1) produce blood cells
(2) provide milk
(3) produce gametes
(4) transfer nutrients

9 PCR, Polymerase Chain Reaction, is a method for carrying out DNA replication. In order to perform this technique, a scientist would need

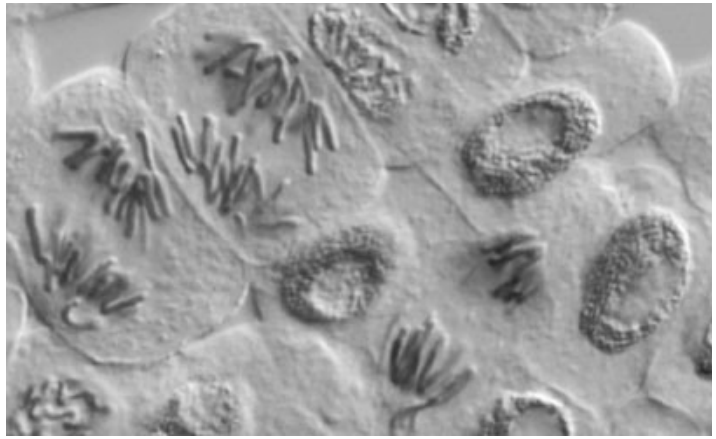
(1) a DNA template, ATP, and 20 different amino acid subunits

(2) enzymes, several types of simple sugars, and starch molecules

(3) a DNA template, enzymes, and subunits with A, G, T, and C bases

(4) enzymes, specific receptor molecules, and several hormones

10 A student used a microscope to examine some cells. He observed strands located in the nuclei of these cells.



Source: https://www.icr.org/i/wide/mitosis_wide.jpg

These strands are responsible for coding different proteins and are known as

(1) chromosomes

(2) mitochondria

(3) ribosomes

(4) chloroplasts

11 Farmers have been planting crops that express an insecticide gene, so that when pests consume these crops, the pests are poisoned. Unfortunately, since these plants were introduced in 1996, growing numbers of insect pests have developed resistance to the insecticide. The process that led to the insect resistance can best be explained by

(1) ecological succession
(2) selective breeding
(3) asexual reproduction
(4) natural selection

12 Killer whales are an endangered species. The decline in the whales' numbers has been linked to poor nutrition, resulting in the inability to maintain a pregnancy. This risk to developing whale embryos is most likely a result of

(1) an environmental factor not associated with the embryo's genes
(2) an infection caused by the embryo's exposure to a pathogen
(3) faults in the genes of the embryo itself
(4) toxins that are introduced into the mother from the embryo's blood

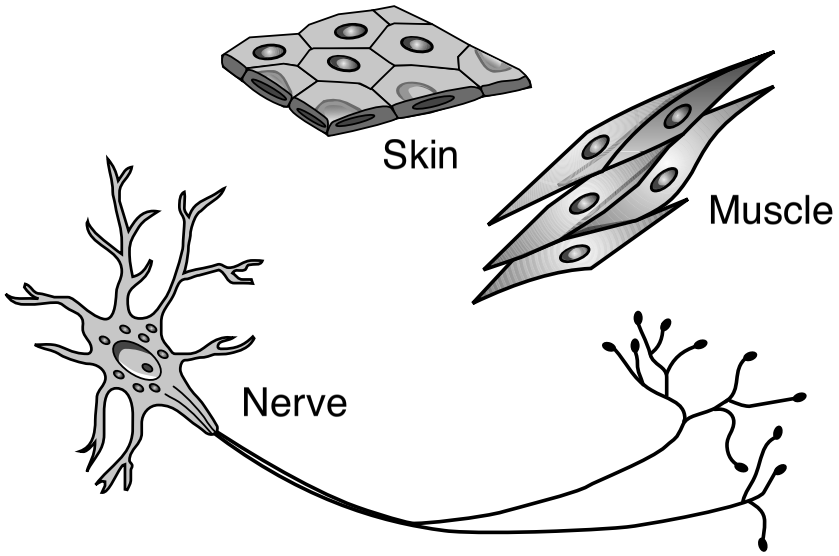
13 A biotechnology tool, known as CRISPR-Cas9, allows scientists to precisely edit genes. In order to edit genes, CRISPR-Cas9 must be able to

(1) alter the base sequence of DNA
(2) prevent cells from differentiating
(3) block cell receptors from receiving signals
(4) change the rate at which a cell uses ATP

14 By measuring the colors of light reflected by different tree species in a forest, scientists can determine the amount of biodiversity present in different areas. Maintaining biodiversity is important because it

(1) reduces the carrying capacity of a forest ecosystem
(2) guarantees that all species within a forest ecosystem will survive
(3) increases the number of predators that control the population size of prey
(4) ensures the availability of a variety of genetic material

15 The cells in the diagram below were present in the same individual.



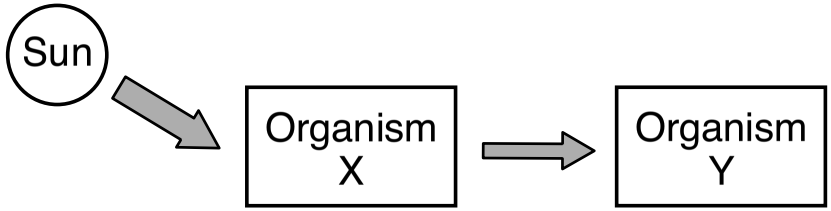
These cells are most similar in the

(1) amount of energy they release
(2) type of proteins they synthesize
(3) rate of their metabolism
(4) information stored in their DNA

16 Large numbers of white-tailed deer on Long Island are infested with ticks that transmit Lyme disease to other mammals. One attempt to control reproduction in these ticks has been the release of large numbers of sterilized male ticks. When compared to using pesticides, this method to control ticks would

(1) cause more environmental pollution
(2) lead to a decrease in the deer population
(3) be less likely to harm the environment
(4) result in an increase in the tick population

17 The model below summarizes one pathway of energy transfer in an ocean ecosystem.



The type of organism represented by box *X* could be

(1) algae
(2) fungi
(3) small fish
(4) sea birds

18 Which sequence best represents the correct order of events in the formation of a sexually reproduced individual?

(1) embryo → zygote → gamete → fetus
(2) zygote → embryo → fetus → gamete
(3) gametes → embryo → fetus → zygote
(4) gametes → zygote → embryo → fetus

19 Direct harvesting occurs when

(1) pine trees are cut from a forest for use as lumber
(2) corn is planted in a newly plowed field
(3) zebra mussels are accidentally imported to the Great Lakes
(4) roots of plants continually take in water

20 In New York State, it is common for farmers to plant large fields of one crop, such as the cornfield shown below.

Source: https://www.123rf.com/photo_40944515_corn-fields.html

A *negative* outcome of this practice is that

(1) the corn will interbreed with weeds in the area
(2) new predators will be introduced into the ecosystem
(3) the stability of the ecosystem will be reduced
(4) new species of insect-resistant corn will evolve

21 The process of differentiation is best described as the

(1) production of a genetically identical copy of an organism
(2) change in shape of a protein due to high temperatures
(3) process by which cells specialize and develop into a specific type of cell
(4) process in which genes are made and transferred into other organisms

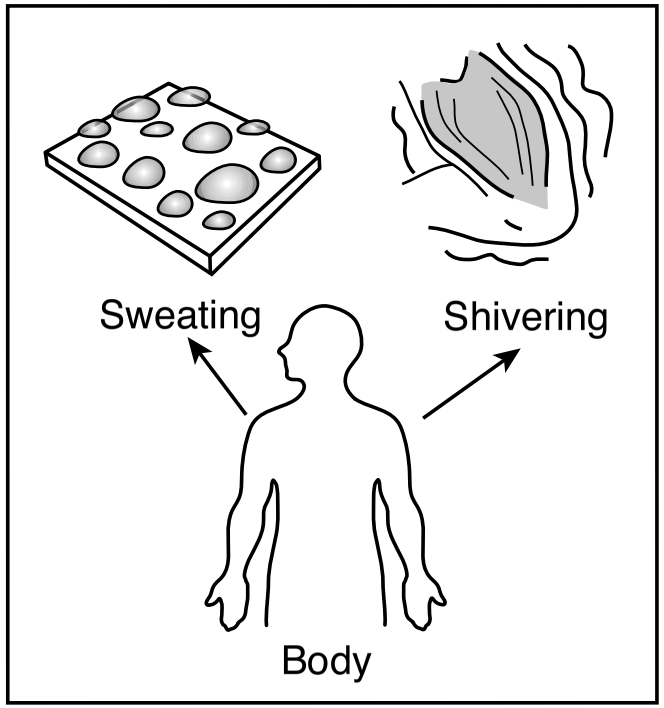
22 Humans are able to positively or negatively affect their environment in many ways. Which statement accurately describes *one* of these possible effects?

(1) A positive environmental effect is that burning fossil fuels to generate electricity reduces carbon dioxide levels in the atmosphere.
(2) A positive environmental effect is the cutting of trees in rain forests to provide large quantities of lumber to build homes for the increasing world population.
(3) A negative environmental effect is that industrialization provides many jobs and helps the economy grow.
(4) A negative environmental effect is that unregulated fishing in the ocean can disrupt the interactions between organisms in existing food webs.

23 Which statement best describes the process of competition?

(1) It may be for abiotic or biotic resources.
(2) It is not affected by changes in the environment.
(3) It always occurs between members of different species.
(4) It allows nutrients in an ecosystem to move from herbivores to autotrophs.

24 Changes in external temperatures often result in a person either sweating or shivering, as represented in the diagram below.



Source: Adapted from http://askabiologist.asu.edu/sites/default/files/resources/articles/singing_in_rain/temp_control.gif

These responses are one way

(1) to counteract feedback mechanisms that would otherwise be beneficial

(2) to make the body release insulin to control blood circulation

(3) the body is able to maintain dynamic equilibrium

(4) skin and muscle cells are able to disrupt homeostasis

25 Which statement about the response of the body to pathogens is correct?

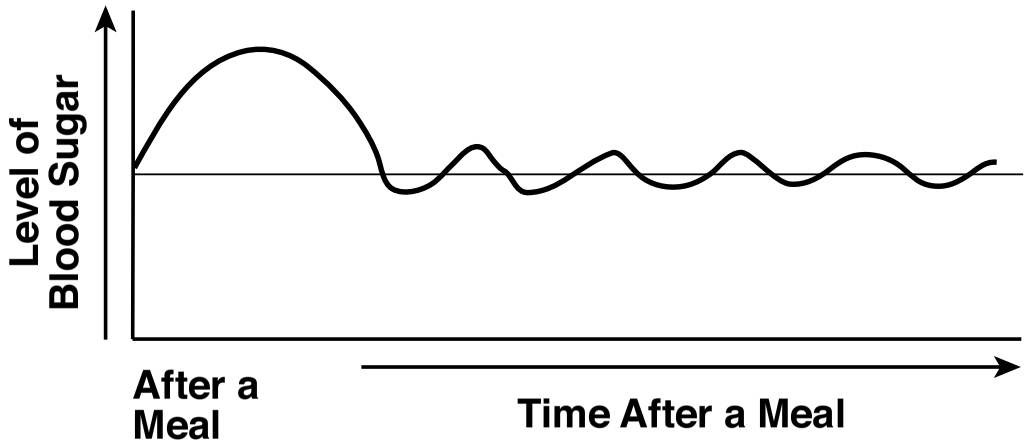
(1) Red blood cells engulf invaders and produce antibodies that attack invaders.

(2) Vaccinations may contain weakened microbes that stimulate the formation of antibodies.

(3) AIDS is a bacterial disease that strengthens the immune system.

(4) All allergic reactions are caused by an immune response to microorganisms.

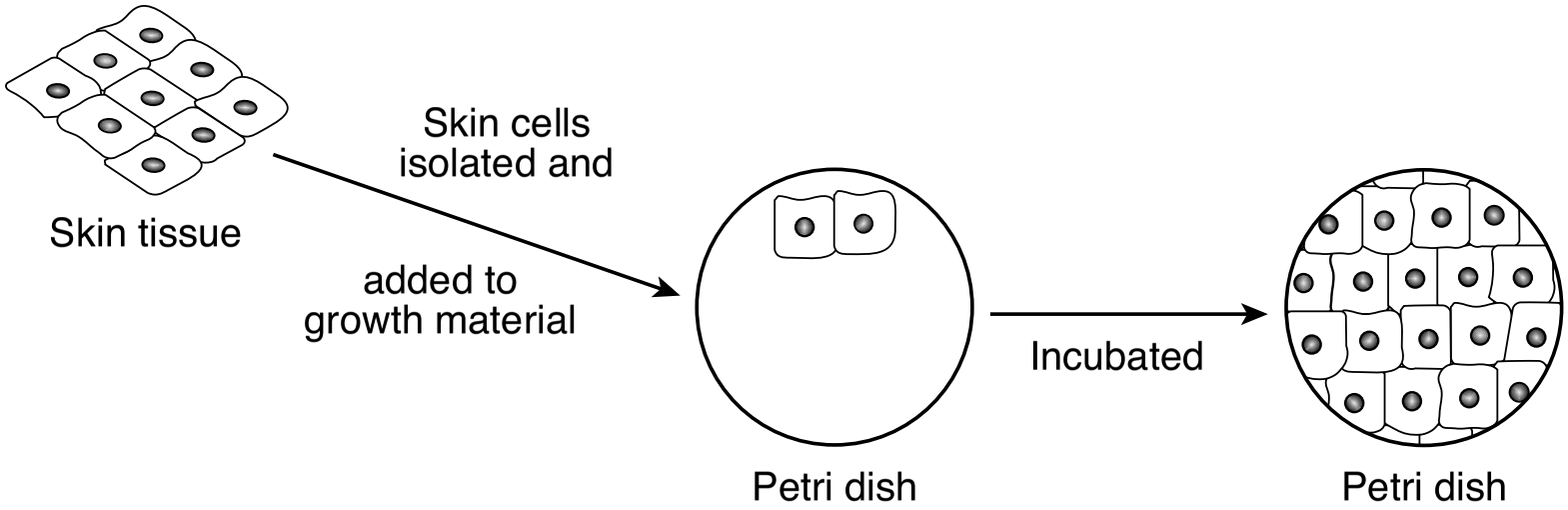
26 Blood sugar levels increase after a meal and eventually return to normal. This is represented in the diagram below.



This constant correcting of blood sugar levels within the body is accomplished by

(1) a feedback mechanism
(2) an immune response
(3) an allergic reaction
(4) manipulating a gene

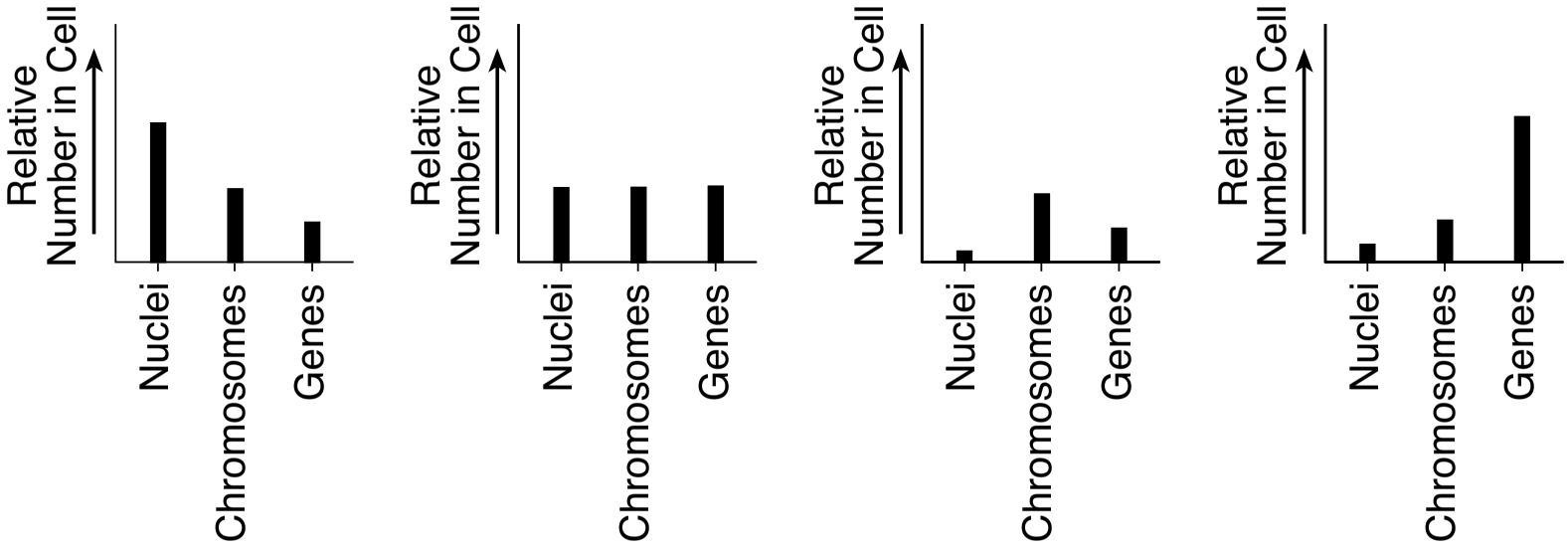
27 Sheets of skin are grown in a culture in order to replace the skin of victims with severe burns or frostbite. Undamaged skin cells are obtained from the victim, put in a Petri dish with the proper growth materials, and incubated, as represented in the diagram below.



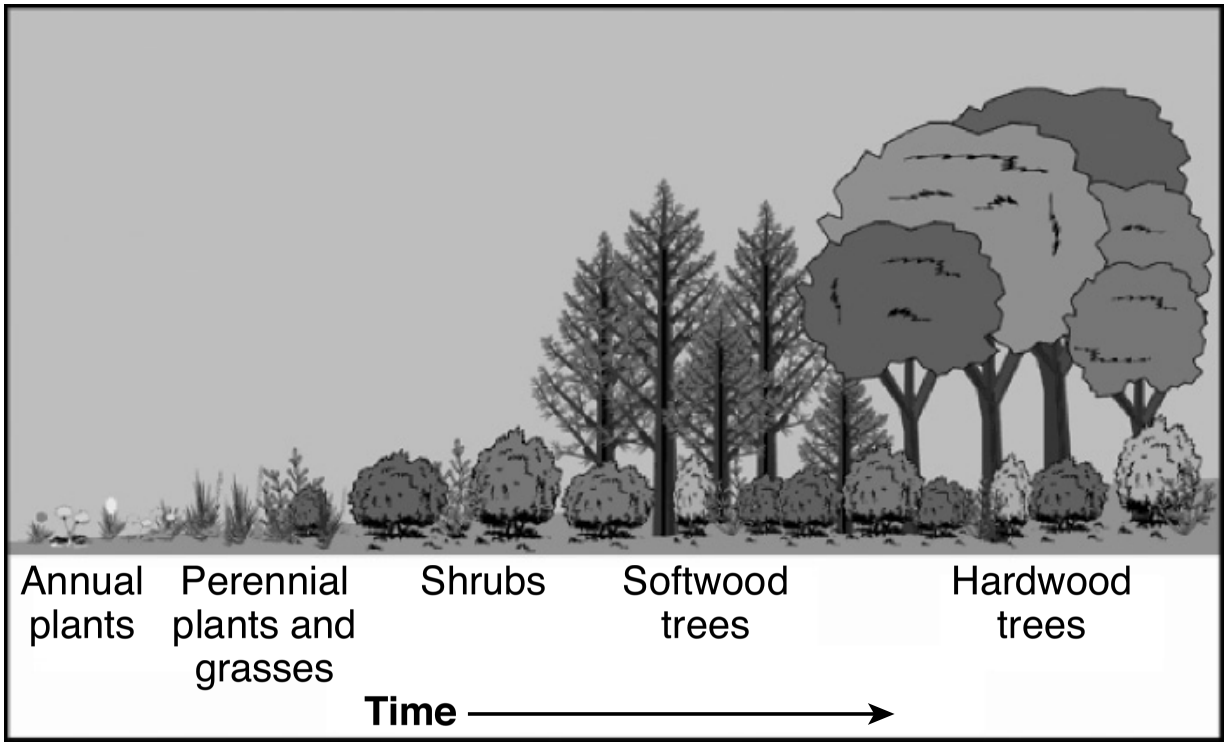
These new skin cells form as a result of

(1) meiotic cell division
(2) sexual reproduction
(3) mitotic cell division
(4) gene recombination

28 Which graph below best represents the relationship between the relative number of nuclei, genes, and chromosomes in a typical human cell?



29 The diagram below represents a biological process.

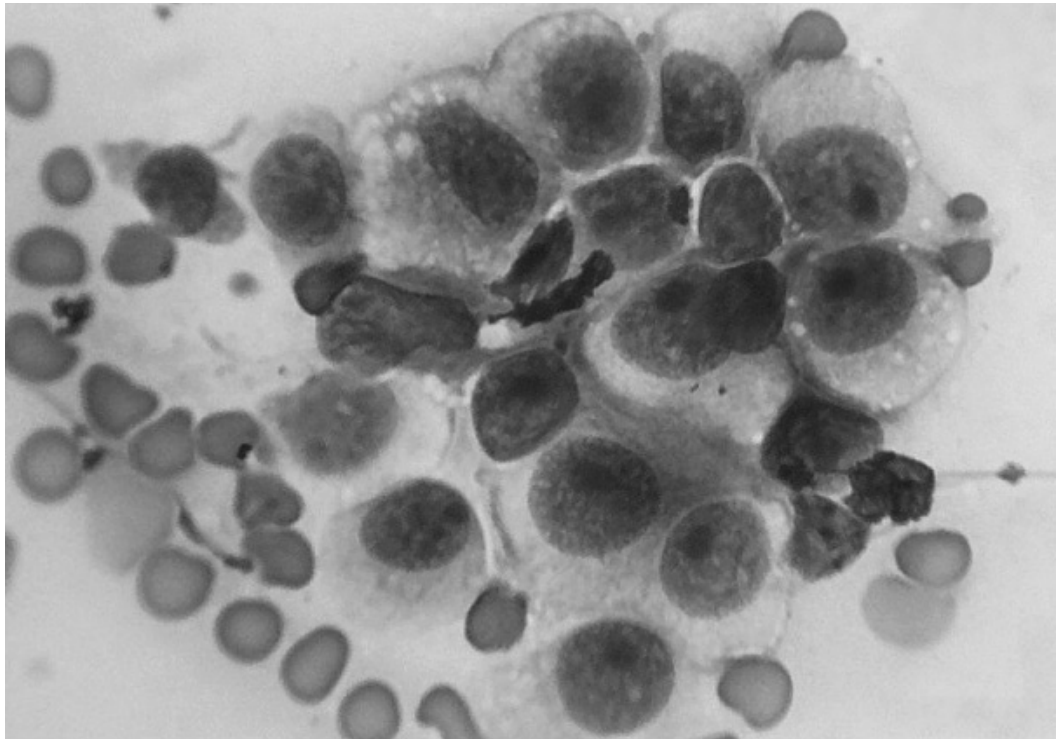


Source: Adapted from http://www.physicalgeography.net/fundamentals/9i.html

Which statement is true about the biological process shown?

(1) This is a short-term process resulting from sudden changes.
(2) This process cannot be altered by humans and other organisms.
(3) If the hardwood trees are destroyed, the altered ecosystem cannot recover.
(4) The shrubs modify the environment, making it more suitable for the softwood trees.

30 Cells may divide abnormally and produce cells like some of those shown in the photograph below.



Source: www.popsci.com/July 2018

When cells such as the skin cells shown reproduce abnormally, it could be a sign of

(1) an immune response
(2) dynamic equilibrium
(3) cancerous cell growth
(4) a cellular adaptation

GO RIGHT ON TO THE NEXT PAGE ➡

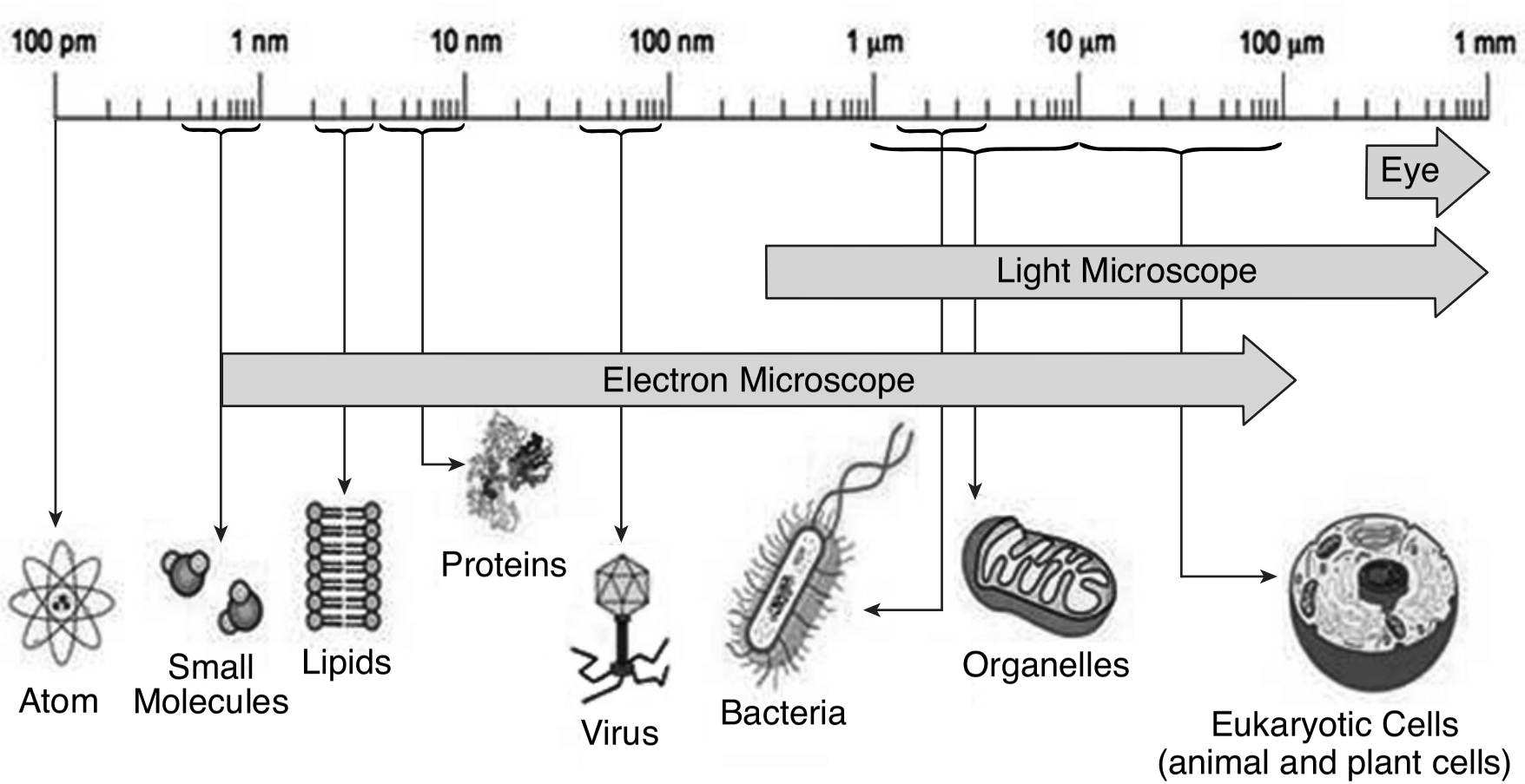
Part B–1

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.

Sizes of Various Structures and Ways to View Them



Source: Adapted from https://microbiologyinfo.com/different-size-shape-and-arrangement-of-bacteria-cells/

31 Only an electron microscope can be used to view

(1) bacteria
(2) mitochondria
(3) animal cells
(4) viruses

32 A scientist is developing a system to remove harmful bacteria from a contaminated water supply. In order to trap the bacteria and prevent them from going through the filter, she must make sure the pores in the filter are no larger than

(1) 1 nm
(2) 1 µm
(3) 10 µm
(4) 100 µm

33 For native human populations in tropical areas, the intensity of ultraviolet (UV) rays from the Sun is strong, and skin color is generally dark. Melanin pigments found in people with darker skin color help block the effects of the UV radiation on skin cells.

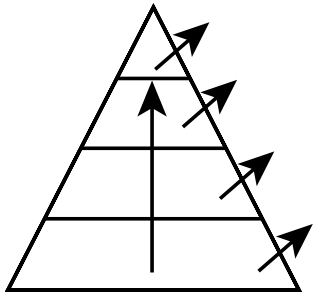
In tropical areas, the best explanation for having increased melanin in human skin cells is that it

(1) increases the occurrence of mutations
(2) provides a survival advantage
(3) acts as a feedback mechanism to increase UV exposure
(4) produces antibodies that destroy pathogens

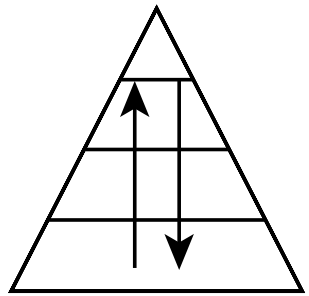
34 Smoking increases the risk of certain cancers of the mouth, esophagus, pancreas, kidneys, and uterus. This finding would be most reliable if it were based on

(1) data collected from patients in one cancer-research hospital
(2) research done by scientists in many different countries
(3) reading the information on cigarette cartons
(4) cancer information published on social media sites

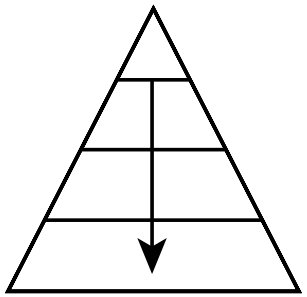
35 Which diagram below best represents the direction that energy flows through an energy pyramid?



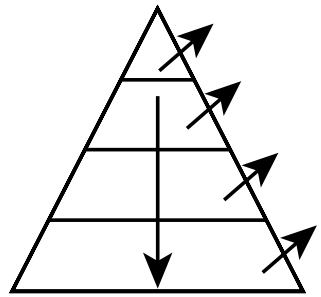
(1)



(3)

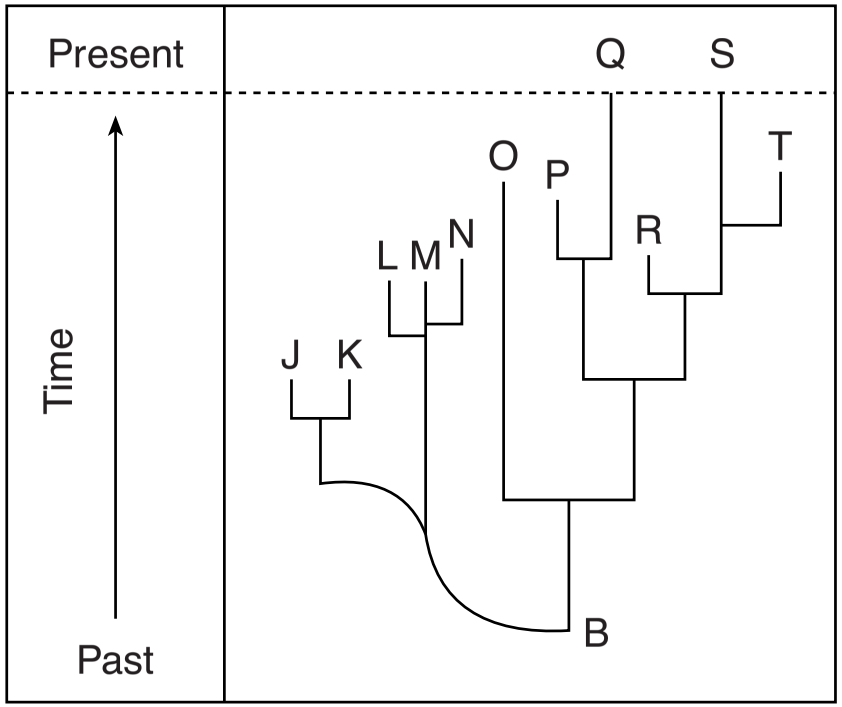


(2)



(4)

36 An evolutionary tree is shown below.



Which conclusion is correct, based on the evolutionary tree?

(1) All of these species have certain DNA sequences in common.
(2) Species *S* is the best adapted of all the species shown.
(3) A common ancestor of species *L* and *M* is species *N*.
(4) Species *O* and *P* are more closely related than species *P* and *Q*.

Base your answers to questions 37 and 38 on the information and photographs below and on your knowledge of biology.

An arctic fox has a gland in its brain that secretes a hormone that regulates the production of melanin, a pigment that accounts for brown fur. In the winter, the foxes secrete more of this hormone and their cells stop making melanin, so they appear white. The pictures below illustrate two variations of fur color.

Source: http://www.nationalgeographic.com/animals/mammals/a/arctic-fox/

Questions 37 and 38 are continued on the next page. ➡

37 Which *two* rows best support the information provided?

A	winter	increased melanin	white fur
B	summer	increased melanin	brown fur
C	winter	decreased melanin	white fur
D	summer	decreased melanin	brown fur

(1) *A* and *B*
(2) *B* and *C*
(3) *C* and *D*
(4) *D* and *A*

38 Which statement is the most likely explanation for the color differences in the fur of the fox at different times of the year?

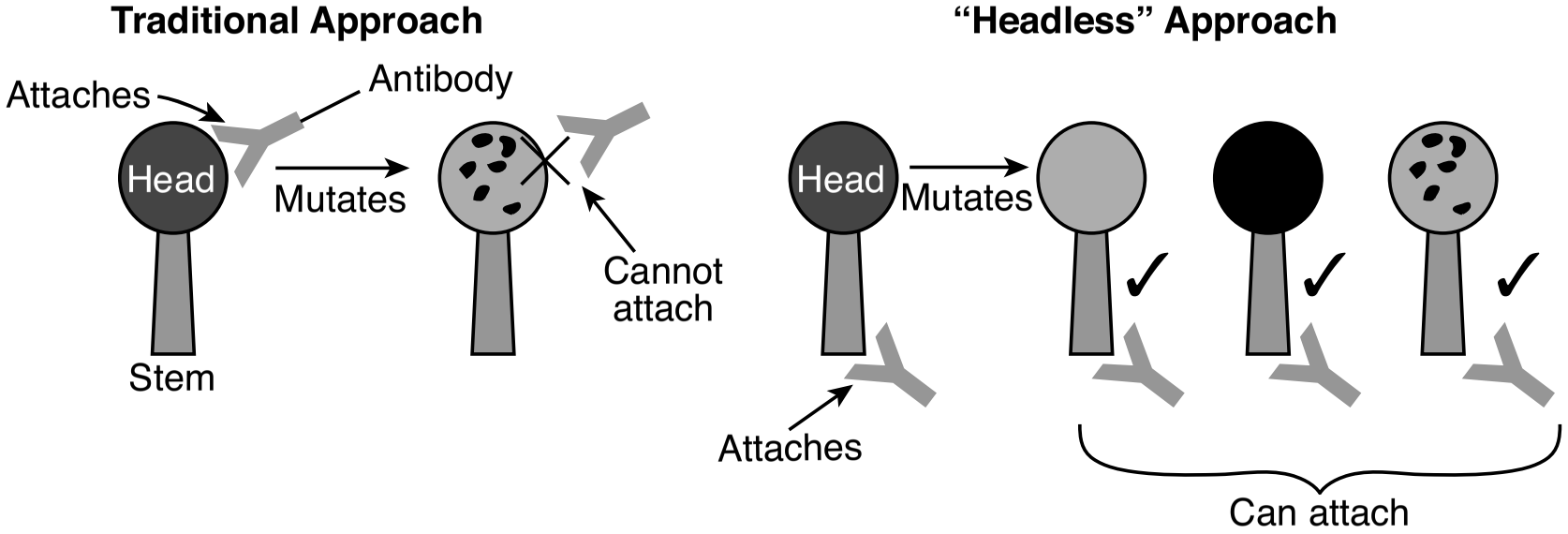
(1) Mutations can be caused by changes in the number of biotic factors in the environment.
(2) The expression of genes can be modified by the external environment.
(3) Hereditary information is contained in genes located in the chromosomes of each cell.
(4) Random changes in DNA can occur to change the expression of a gene.

Base your answer to question 39 on the information below and on your knowledge of biology.

Fighting the Flu

A new technique to attack flu virus antigens is being tested on mice. Normally, antibodies attack the "head" portion of antigens on the surface of the flu virus.

Since the "head" portions mutate frequently, the antibodies do not provide protection for very long. The new technique is to develop antibodies that attack the "stem" portion of the antigen. Since the "stem" regions do not mutate very often, the effectiveness of the vaccine should last longer. This technique is represented below.



Source: Adapted from www.sciencenews.org/"A Universal Flu Shot May Be Nearing Reality"/October 28,2017.

Question 39 is continued on the next page. ➡

39 Which statement describes an observation that would best support the continued study of using antibodies produced by this new technique against the flu?

(1) A group of 50 mice with flu antibodies formed using the new technique were exposed to mutated forms of the flu. None of the mice became ill.
(2) The use of these antibodies in mice stopped mutations that occur in flu viruses.
(3) Chemical tests showed that the stem antibodies attached to the heads of some flu viruses and destroyed them.
(4) Blood tests showed that only "stem" antibodies attacking the stem of flu antigens can cause the flu in mice. Those attacking the "head" did not.

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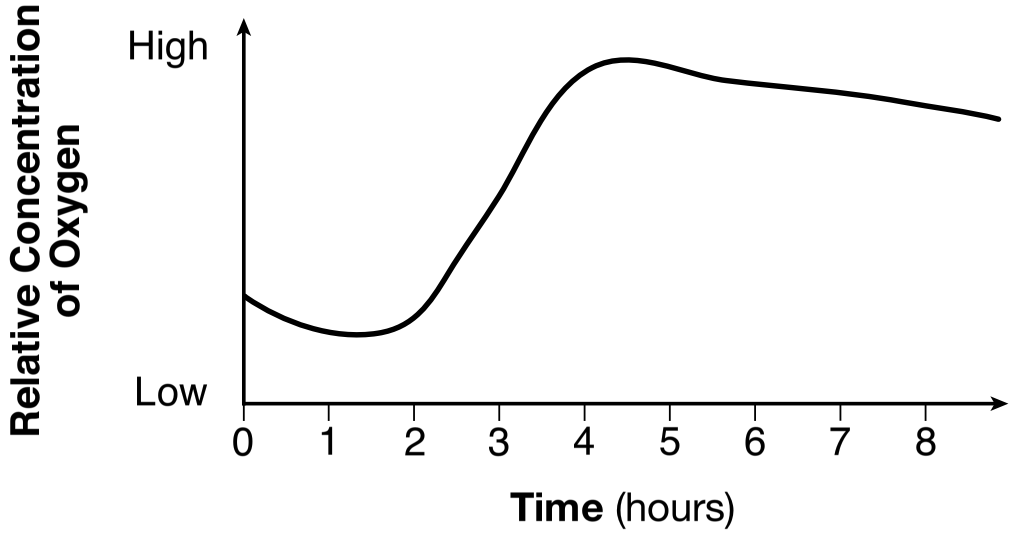
40 Scientists have discovered that pathogenic organisms and the chemicals they produce can cause foodborne illnesses. These illnesses harm the body as a result of interactions between the digestive and immune systems.

Which statement most correctly describes how these two systems interact when an individual comes down with a foodborne illness?

(1) Chemicals produced by pathogens enter the immune system through a cut in the skin. The circulatory system carries the chemical to the digestive system, resulting in foodborne illness.
(2) When specific chemicals produced by pathogens enter the digestive system in contaminated foods, the ability of the immune system to fight off foodborne illness is reduced.
(3) When foods contaminated with pathogens are eaten, the immune system prevents the pathogens from entering the digestive system.
(4) The digestive system breaks down the pathogens in the contaminated foods so that they are harmless. These harmless pathogens are then transferred to the immune system.

Base your answers to questions 41 and 42 on the information and diagram below and on your knowledge of biology.

A live plant was placed in a closed container in a lab. Sensors were set up to monitor the levels of oxygen in the container over several hours.



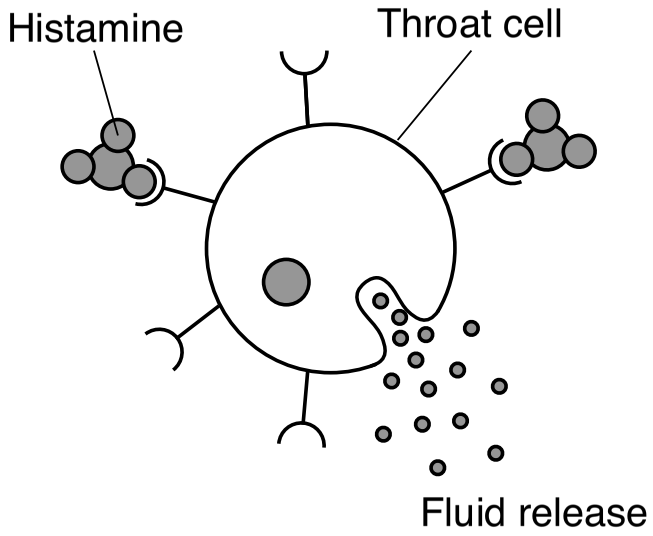
41 At which hour were the lights turned on in the lab?

(1) 8
(2) 2
(3) 0
(4) 4

42 During the 8 hours studied, the plant performed

(1) photosynthesis, only
(2) respiration, only
(3) both photosynthesis and respiration
(4) neither photosynthesis nor respiration

43 Human cells have many molecules attached to their surfaces. Some of these molecules are involved in producing the symptoms associated with allergies. Histamine is a chemical produced by some human cells. When histamine binds to molecules on the surface of cells that line the nose and throat, the cells will swell and leak fluid, causing the characteristic itching, sneezing, and congestion associated with allergies. A model of this mechanism is represented below.



Antihistamines are medications taken to block this reaction. Which of the antihistamine molecules represented below would be the most effective?

(1) (2) (3) (4)

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, the data table on the next page, and on your knowledge of biology.

West Nile Virus

West Nile virus (WNV) has been detected in a variety of bird species. Crows and jays are known to get sick and die when infected. WNV also infects other animals, including horses, cats, dogs, chipmunks, alligators, and humans.

WNV affects the nervous system. It was first detected in the U.S. in New York City during the summer of 1999, when nearly 5500 crows died within a four-month period. Since then, WNV has spread rapidly throughout the country. Although the virus is widespread, symptoms in humans are usually mild. However, about 1 in 150 people who are infected develop severe, sometimes fatal, symptoms that include the inflammation of the brain and membranes surrounding the brain and spinal cord. There is no human vaccine for WNV. The virus is transmitted to certain bird species when they are bitten by infected mosquitoes. When these bird species are not available, mosquitoes are more likely to bite humans. Humans are a dead-end host, which means that even when infected with the virus, it is not passed on.

The Centers for Disease Control and Prevention (CDC) recorded the number of cases of WNV per 100,000 people in the U.S. from 2002-2014. These data are recorded in the table on the next page.

Incidence of West Nile Virus in the U.S. per 100,000 People	
Year	**Cases per 100,000 People**
2002	1.02
2004	0.39
2006	0.50
2008	0.23
2010	0.20
2012	0.91
2014	0.42

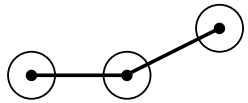
Source: https://www.epa.gov/climate-indicators/climate-change-indicators-west-nile-virus

Questions 44 and 45 are continued on the next page. ➡

Directions (44–45): Using the information in the data table on page 29, construct a line graph on the grid provided on the next page, following the directions below.

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

45 Plot the data for the incidence of West Nile virus in the U.S. per 100,000 people. Connect the points and surround each point with a small circle. [1]

Example: 

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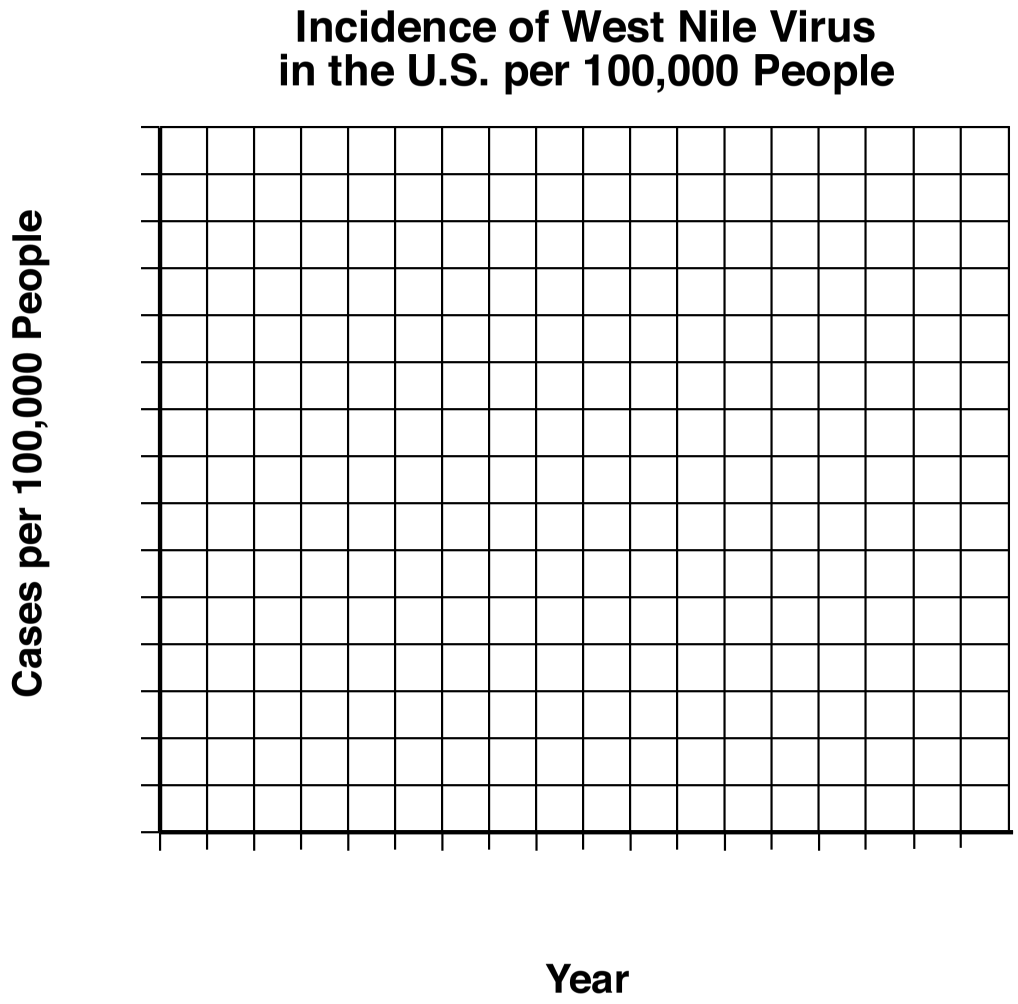
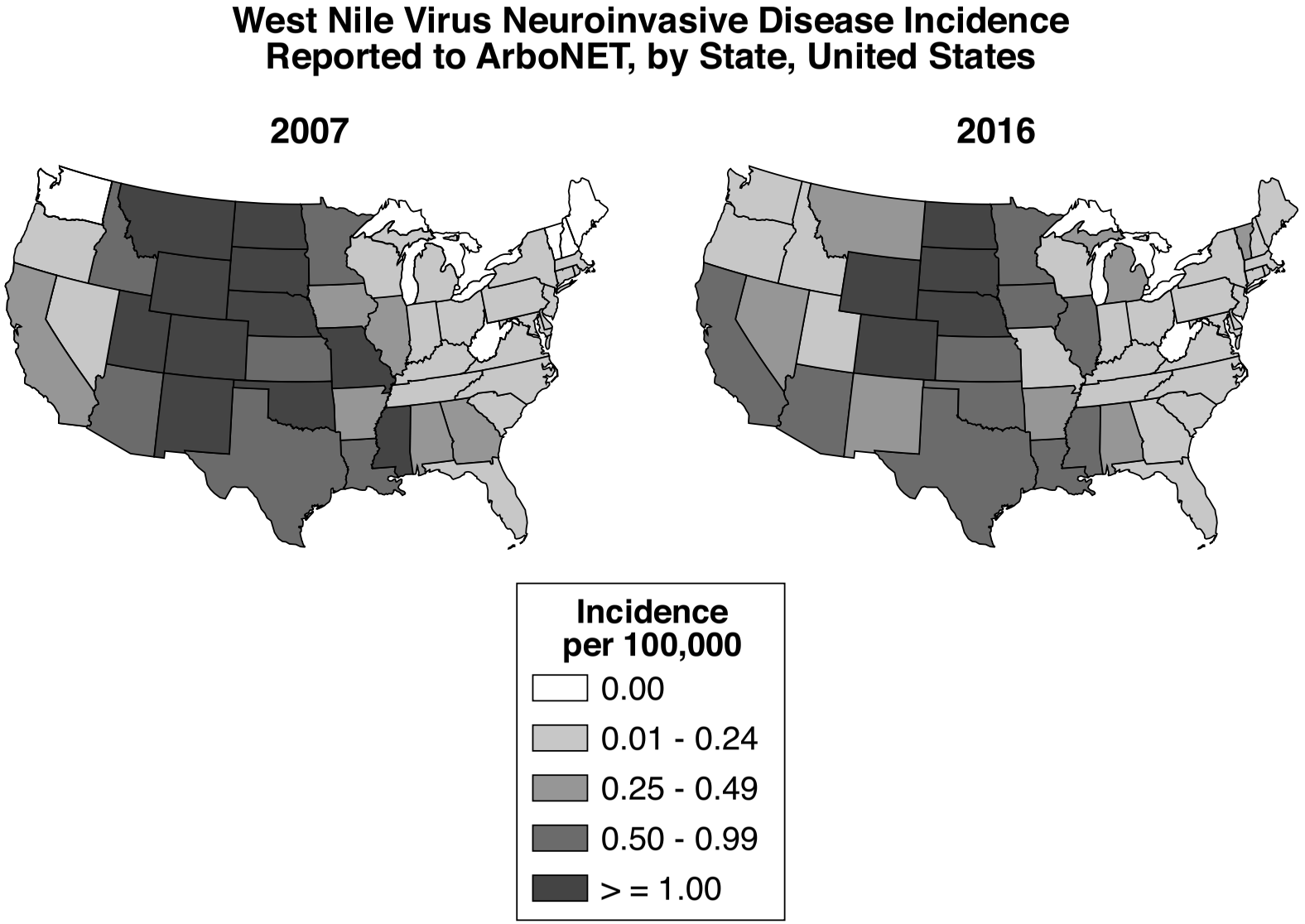


46 Based on the data, is it possible to predict what the number of cases per 100,000 people will be for the year 2020? Support your answer with data from the graph. [1]

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

47 The two maps below show the number of human cases of West Nile virus per 100,000 people for the years 2007 and 2016.



Source: http://www.cdc.gov/westnile/resources/pdfs/data/2007StateincidenceMap.pdf
Source: http://www.cdc.gov/westnile/resources/pdfs/data/WNV-Neuro-Incidence-by-State-Map_2016 _09292017.pdf

The data represented on the maps best indicate that

(1) birds have spread WNV to every state in the United States
(2) New York State has the highest rate of WNV infection for both of the years shown
(3) once WNV reaches a state, the number of people infected increases every year
(4) for any given year, it is difficult to know which states will have the greatest number of cases

48 Explain why some people may be more severely affected by West Nile virus than others. [1]

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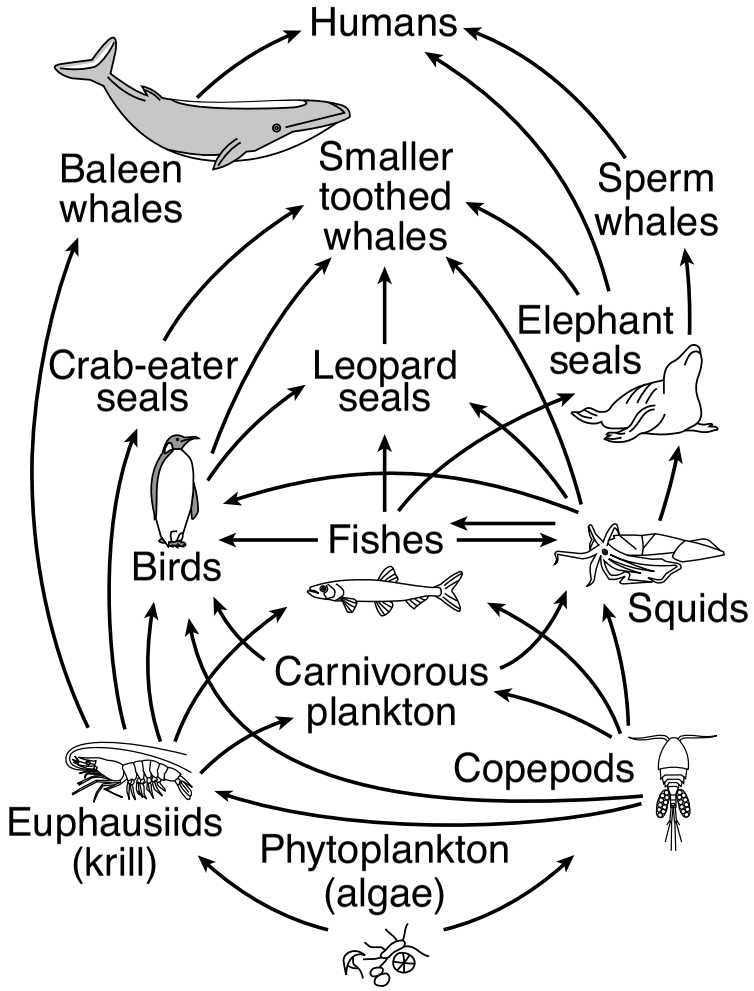
Base your answers to questions 49 through 51 on the food web below and on your knowledge of biology.



Questions 49 through 51 are continued on the next page. ➡

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

49 Based on the food web, the population that contains the greatest amount of available energy would be

(1) seals
(2) fishes
(3) phytoplankton
(4) humans

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

50 Which statement best describes what would happen in this ecosystem if the phytoplankton were removed from the food web?

(1) Copepods and krill would fill the vacant niche.
(2) The number of heterotrophs would increase.
(3) The food web would be disrupted, and organisms would die.
(4) The food web would remain stable.

51 Describe the relationship represented by the arrows between squids and fishes. [1]

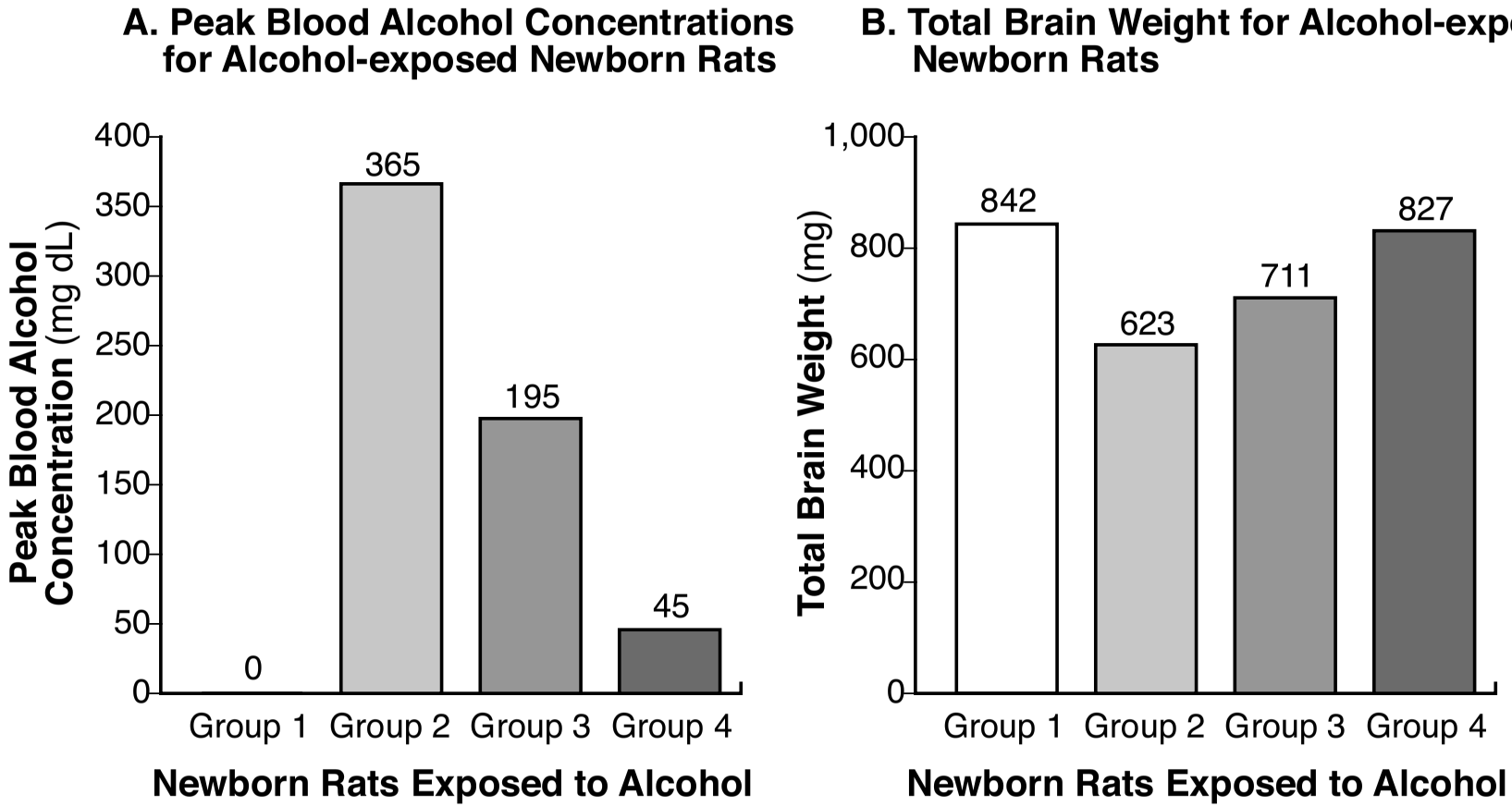
Base your answers to question 52 on the information below, the graphs on the next page, and on your knowledge of biology.

Scientists are interested in studying the effects of a mother's alcohol consumption on the brain development of the fetus during pregnancy. In order to collect data, scientists typically use newborn rats because the rats' brain development after birth is roughly equivalent to that of a human fetus during the third trimester (late in pregnancy). Scientists divided newborn rats into four groups and exposed them to alcohol using the following methods:

Alcohol Exposure in Newborn Rats

Rat Group	Alcohol Exposure
1	No alcohol exposure
2	4.5g/kg/day given over a 4-hour period
3	4.5g/kg/day given over an 8-hour period
4	6.6g/kg/day given over a 24-hour period

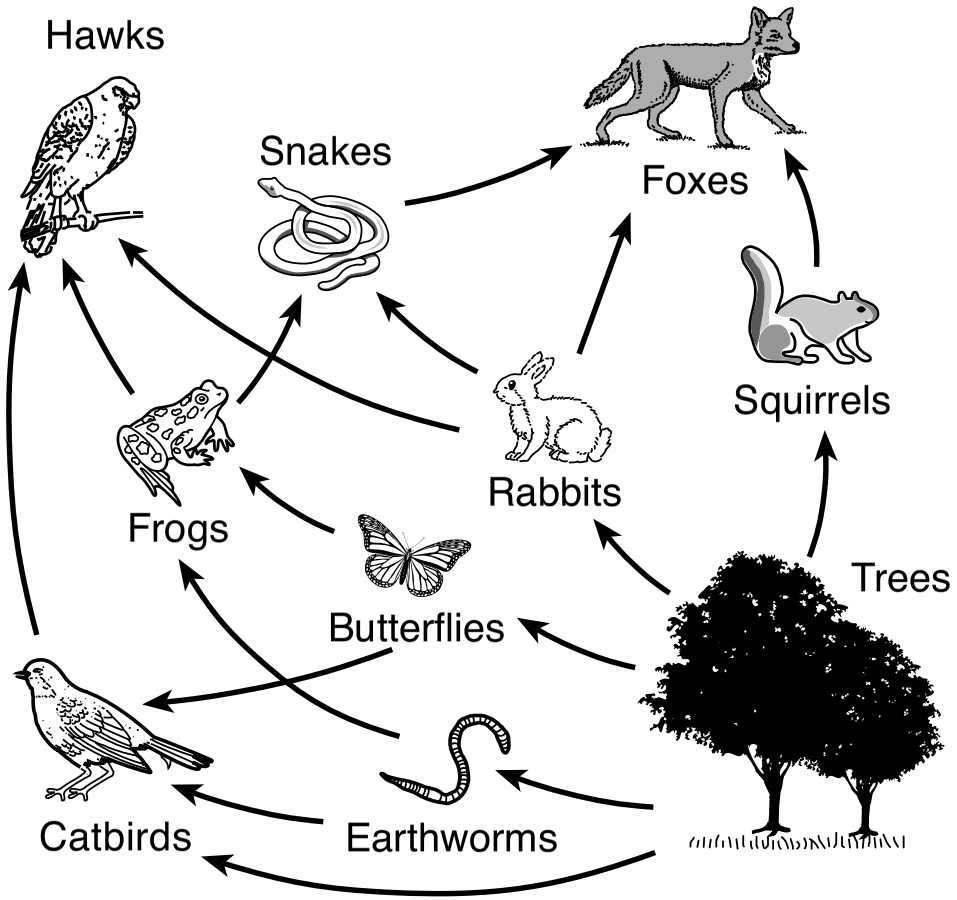
At the end of the experiment, scientists measured the total brain weight of the newborn rats, as represented in the graphs on the next page.



Source: Adapted from https://pubs.niaaa.nih.gov/publications/arh25-3/168-174.htm

52 State the relationship between peak blood alcohol concentration and total brain weight for alcohol-exposed newborn rats. [1]

Base your answers to questions 53 and 54 on the diagram below and on your knowledge of biology. The diagram represents a food web in a forest ecosystem.



Source: Adapted from The American Biology Teacher vol.78, No.7, September 2016, p.577

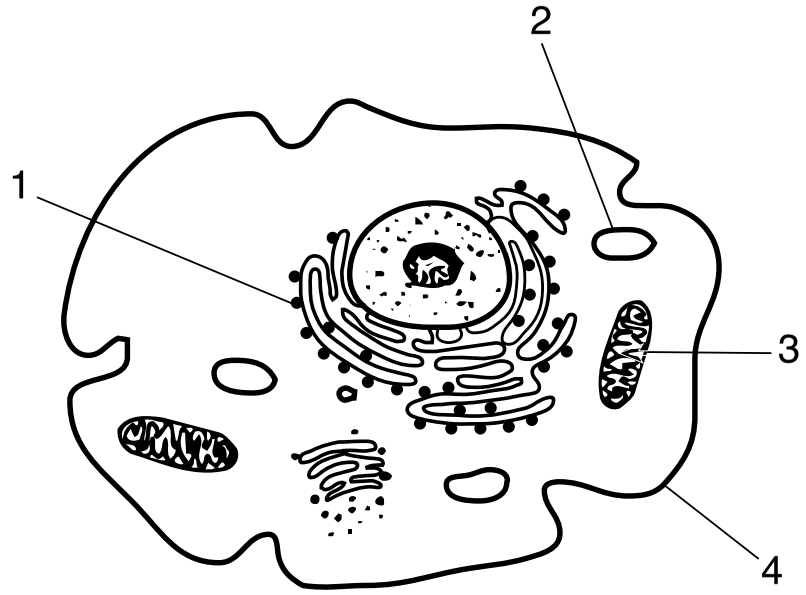
Questions 53 and 54 are continued on the next page. ➡

53 A student claims that this food web represents a stable ecosystem. State whether or not her claim is correct. Support your answer. [1]

54 Select *two* organisms from this food web that compete with each other for food, and state *one* reason why they are able to survive in the same ecosystem. [1]

Organisms: _____ and _____

55 In the cell below, identify *both* the number and name of the structure in the cell that produces proteins. [1]



Number of structure: _____

Name of structure: _____

_____

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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 answer to question 56–57 on the information below and on your knowledge of biology.

Fragile X Syndrome

Fragile *X* syndrome is a genetic disorder associated with a mutation in a gene located on a particular human chromosome called the *X* chromosome. The disorder results in a critical protein, FMR1, not being produced. The normal FMR1 protein helps regulate the production of other proteins that play a role in the development of nerve cells. The situation is summarized below:

Normal X chromosome → normal FMR1 protein produced → nerve cell development is regulated

Abnormal fragile X chromosome → no FMR1 protein produced → nerve cell development is unregulated

56–57 Explain how the mutation in the fragile *X* chromosome affects the body. In your answer, be sure to:

- state *one* specific reason why the mutated gene on the fragile *X* chromosome is unable to produce the FMR1 protein. [1]
- explain why children with fragile *X* syndrome would often have learning disabilities, including speech and language problems and intellectual disabilities. [1]

Answer space for question 56-57 is on the next page. ➡

GO RIGHT ON TO THE NEXT PAGE ➡

Base your answers to questions 58 and 59 on the information below and on your knowledge of biology.

The chart shows the reproductive characteristics of three species living in an area that has recently undergone a major environmental change.

Species	Method of Reproduction	Frequency of Reproduction	Average Number of Offspring Produced Each Time
A	Asexual	Every two days	2
B	Sexual	Every two years	4
C	Sexual	Every year	20

58 Explain why species *C* might have a greater chance of avoiding extinction in the changed environment than species *B*. Support your answer. [1]

59 State *one* possible reason why species *A* could be the most successful in surviving an environmental change. Support your answer. [1]

GO RIGHT ON TO THE NEXT PAGE ➡

Base your answers to questions 60 through 63 on the passage below and on your knowledge of biology.

Plastic Bags Everywhere!

As of 2016, Americans used approximately 100 billion plastic bags annually. An average family brought home about 1500 plastic bags a year. Less than 1% of those bags were returned for recycling. Therefore, most of the bags ended up in landfills, where it takes anywhere from months to hundreds of years for them to be broken down. These growing landfills are destroying natural habitats. Many of the bags also make their way into oceans where, if mistaken for food, they can cause animals to choke or starve to death.

A group of researchers in Europe discovered that wax moth caterpillars could break the chemical bonds in polyethylene, a polymer used to produce plastic bags and other products. Though the scientists don't know the exact chemical that the caterpillar is using to break down the plastic, they predict it is an enzyme. Once they isolate the chemical, scientists may be able to mass-produce the chemical in order to break down the plastic bags accumulating in the environment.

60 State *one negative* effect the overuse of plastic bags is having on the environment. [1]

61 Explain why the researchers suspect it is an enzyme that is enabling wax moth caterpillars to break down the plastic bags. [1]

62 Explain why using the chemical produced by the caterpillars to break down plastic bags could be considered an ecologically friendly solution to the problem. [1]

63 Suggest a plan of action, that could be carried out in your local community, which would be a step toward solving the plastic bag problem. [1]

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

Plants Clean Up Mining Wastes

The mining of certain metal ores, such as copper and lead, can result in the contamination of soils. Wastes from the mining process can be toxic to plants and animals in the area. It has been discovered that some species of grass are able to grow in these contaminated areas. These grass plants can actually remove some of the toxic wastes from the soil and accumulate them in their tissues.

Growing these resistant grass plants in contaminated soil, then harvesting them to remove the toxic wastes from the environment, has been suggested as a possible way to clean up these areas.

64 Describe *one* positive and *one negative* outcome of mining metal ores. [1]

65 Explain why importing grasses to clean up mining wastes in areas where those grasses do not normally grow could lead to unexpected environmental problems. [1]

66 Today, many diseases have been linked to mutations that cause mitochondria to fail. Patients who suffer from mitochondrial diseases may suffer from fatigue and weakness. Explain why patients with a mitochondrial disease would tend to experience these symptoms. [1]

_____

_____

GO RIGHT ON TO THE NEXT PAGE ➡

Base your answers to questions 67 through 70 on the information below and on your knowledge of biology.

Lessening Snow Cover Affects Survival of Snowshoe Hare

Snowshoe hares are found in the northern evergreen forests of the United States. The physical characteristics of the hares enable them to hunt for food and hide from their predators during the cold, snow-covered winters. They have large, snowshoe-shaped feet and thick fur. A change in fur color during an annual molt (shedding) occurs before the winter season, causing white fur to replace the brown fur of summer.

The amount of snow cover in these northern forests has decreased in recent years. Research has shown that this decrease has had a significant effect on the snowshoe hare population, even though the carrying capacity of the forests has not changed. Researchers have estimated that for every seven days that snow covers the ground, the snowshoe hare populations are four times more likely to survive.

Since the molt from brown fur to white fur is a response to the decreasing hours of daylight in the fall and not the arrival of snow, the later the snow arrives, the greater the chance that the white hares will be caught by their predators.

The snowshoe hare plays a major role in the stability of these forest ecosystems. Their loss would affect other species such as lynx and great horned owls. If the amount of snow cover continues to decrease, researchers are concerned that it will be harder for the snowshoe hare to survive in their current habitats.

Snowshoe Hare

Source: Science News, April 30, 2016

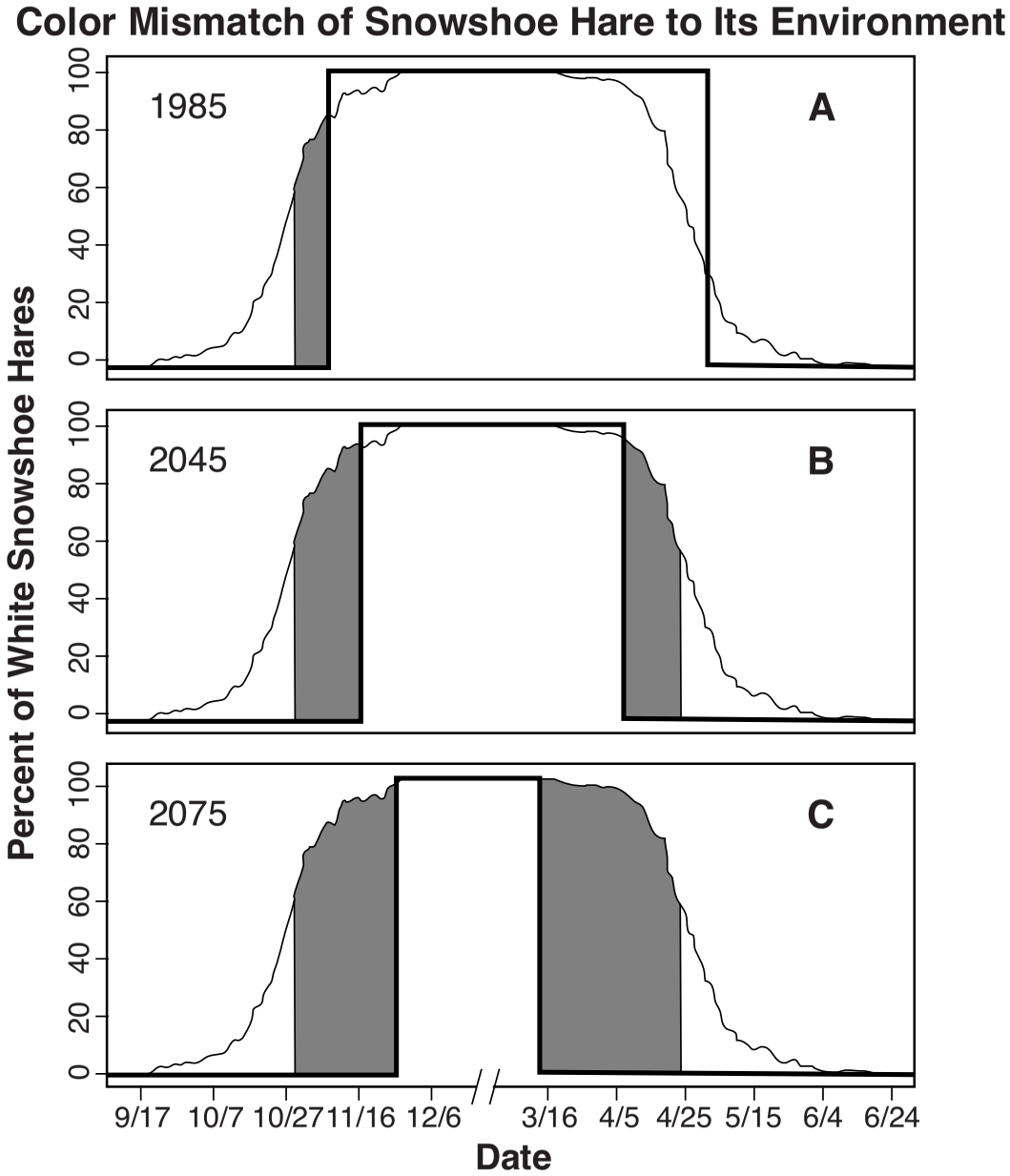
Questions 67 through 69 are continued on the next page. ➡

67 Explain how snow cover affects the population of the snowshoe hare. [1]

68 Identify the environmental factor that stimulates the fur color of the hare to change from brown to white. [1]

69 Identify a specific environmental issue that is most likely to affect snowshoe hare populations in northern ecosystems. Support your answer. [1]

70 Graph *A* below, based on 1985 data, represents the time of the year when the fur color of the snowshoe hares in the northern Rockies does not match the color of their surroundings. The bold line on each graph indicates the period of time that snow covers the ground. The shaded area in the graphs represents this mismatch of color. Graphs *B* and *C* show future projections.



Source: Adapted from L.Scot Mills,et al. PNAS(2013).DOI:10.1073/pnas.1222724110

Question 70 is continued on the next page. ➡

Identify *one* change in the characteristics of the snowshoe hares in this ecosystem that would most likely be selected for if the trend shown in graphs *B* and *C* proves to be true. [1]

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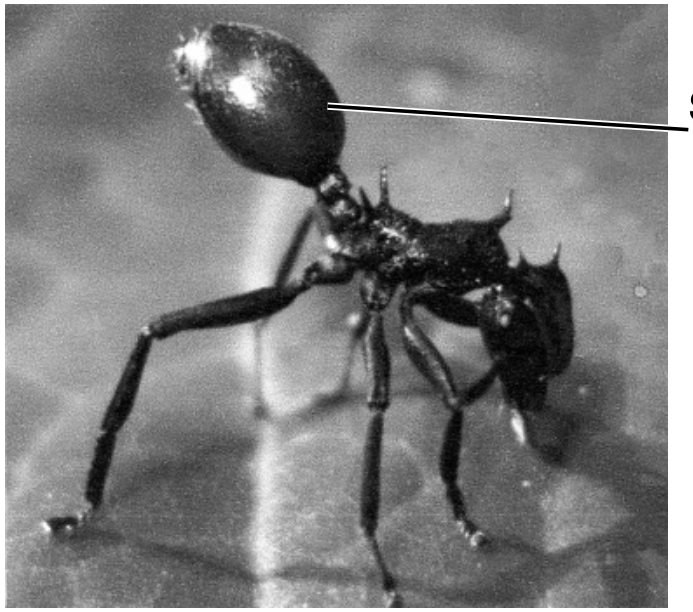
Base your answers to questions 71 and 72 on the information below, on the next page, and on your knowledge of biology.

Tropical worker ant (*Cephalotes atratus*)



Source: The American Naturalist, 2008, 171:4, 536-544

Questions 71 and 72 are continued on the next page. ➡

Roundworm Parasite Causes Tropical Ant to Look Like a Berry

Scientists have discovered a parasitic roundworm that makes its ant host look like a juicy, red, ripe berry. Worker ants collect materials from the soil to feed the larval ants. Often, the soil also contains roundworm eggs that are consumed by the ant larvae.

The roundworms develop from the eggs within the ant larvae, mate, and produce hundreds of roundworms. As the roundworms develop, they cause increased reddening of the developing ant's abdomen and take nutrients from the ant. Just as a fruit reaches peak color when its seeds are ready for dispersal, the infected ant's abdomen reaches peak redness as the roundworm eggs mature.

Birds don't normally eat the foul-tasting ants, but are thought to eat the ants infected with roundworms since they look like red berries. The roundworm eggs move through the bird's digestive system unaffected and pass to the soil in the bird's feces.

71 State *one* reason this roundworm is considered a parasite to this species of tropical ant. [1]

72 Describe *one* advantage the roundworm has by having birds involved in part of its life cycle. [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.

Base your answers to questions 73 and 74 on the information below, on the next page, and on your knowledge of biology. The photograph shows two birds on a feeder.

Source: http://birdfeederhub.com/best-large-capacity-bird-feeders/

Questions 73 and 74 are continued on the next page. ➡

Studies have shown that the length of beaks within a songbird population may be influenced by the presence of bird feeders. When bird feeders were widely used in one area, birds were observed to have longer beaks. In an area where bird feeders were *not* used, the beaks of these species were of average length.

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

73 One possible reason for the increase in beak length is that birds with longer beaks

(1) were less likely to have offspring with long beaks
(2) had a more successful adaptation for survival in the area
(3) needed to reach the seed within the bird feeder, so their beaks grew longer
(4) had more competition than other birds at the bird feeders

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

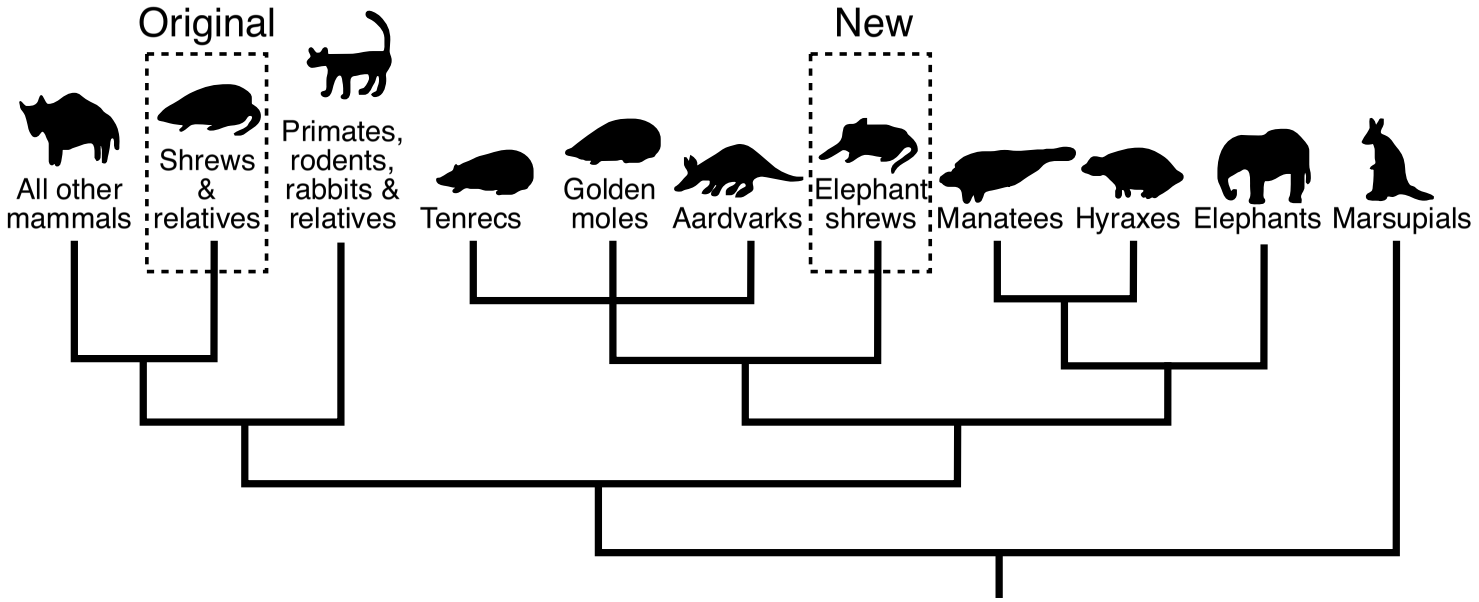
74 The presence of bird feeders in an area would represent a

(1) selecting agent
(2) feedback mechanism
(3) source of mutation
(4) biological catalyst

Base your answers to questions 75 through 77 on the information below and on your knowledge of biology.

The Elephant Shrew

The elephant shrew spends its days searching the leaf litter on the forest floor for insect prey. When first discovered, due to structural similarities, the elephant shrew was classified with other shrews and their relatives. However, scientists recently reclassified the elephant shrew, as shown in the evolutionary tree below:



Source: Adapted from http://evolution.berkeley.edu/evolibrary/news/080301_elephantshrew

Questions 75 through 77 are continued on the next page. ➡

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

75 The new, more accepted classification of the elephant shrew is most probably based on an analysis of

(1) the coloration of the elephant shrew's fur
(2) the feeding habits of the elephant shrew compared to other shrews
(3) a number of newly found shrew fossils
(4) the DNA present in the cells of the elephant shrews

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

76 According to the new evolutionary tree, elephant shrews are most closely related to

(1) manatees and hyraxes
(2) shrews and their relatives
(3) tenrecs, golden moles, and aardvarks
(4) primates, rodents, rabbits, and relatives

77 The elephant shrew is at risk for extinction because its habitat is very limited. The elephant shrew can only be found in two forest locations within the country of Tanzania. Even though these locations are protected, they could be harmed by fires and human activity. Explain why it is important to continue to protect the habitat in which the elephant shrew is found. [1]

Base your answers to questions 78 and 79 on the information below and on your knowledge of biology.

A student hypothesized that the pulse rates of his classmates would increase after walking. The student then obtained pulse rates from five classmates after they walked for 15 minutes. The data, in beats per minute, were recorded as: 78, 68, 84, 88, and 90.

78 Identify the dependent variable in this investigation. [1]

_____

79 Identify *one* error in the experimental procedure. [1]

_____

_____

_____

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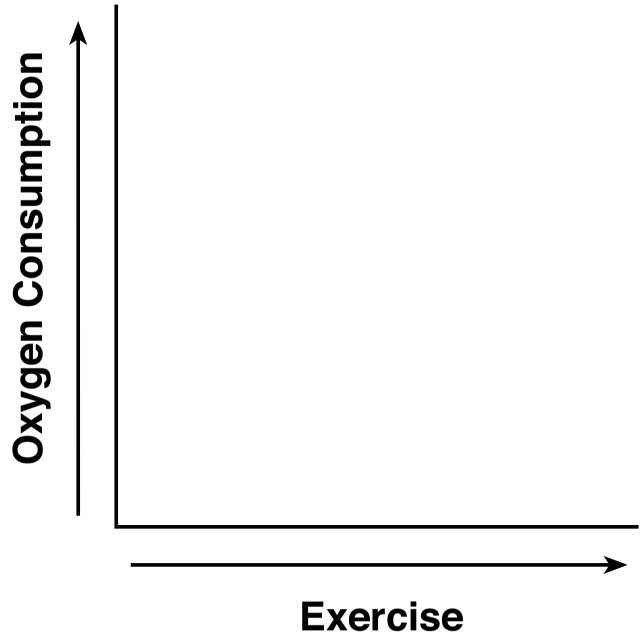
80 Draw a line on the graph provided that shows the relationship between exercise and oxygen consumption. Support your answer. [1]



Support: _____

_____

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Base your answers to questions 81 and 82 on the information below, on the next page, and on your knowledge of biology.

A student prepared two potato cubes by cutting 2 cm x 2 cm sections from the same potato. Next, she determined the mass of each of the cubes and recorded the information in her lab notebook.

She then placed one cube in a beaker of distilled water and the other in a beaker with an equal volume of concentrated salt solution. After 20 minutes, she removed both of them from the beakers and again determined the mass of each cube.

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

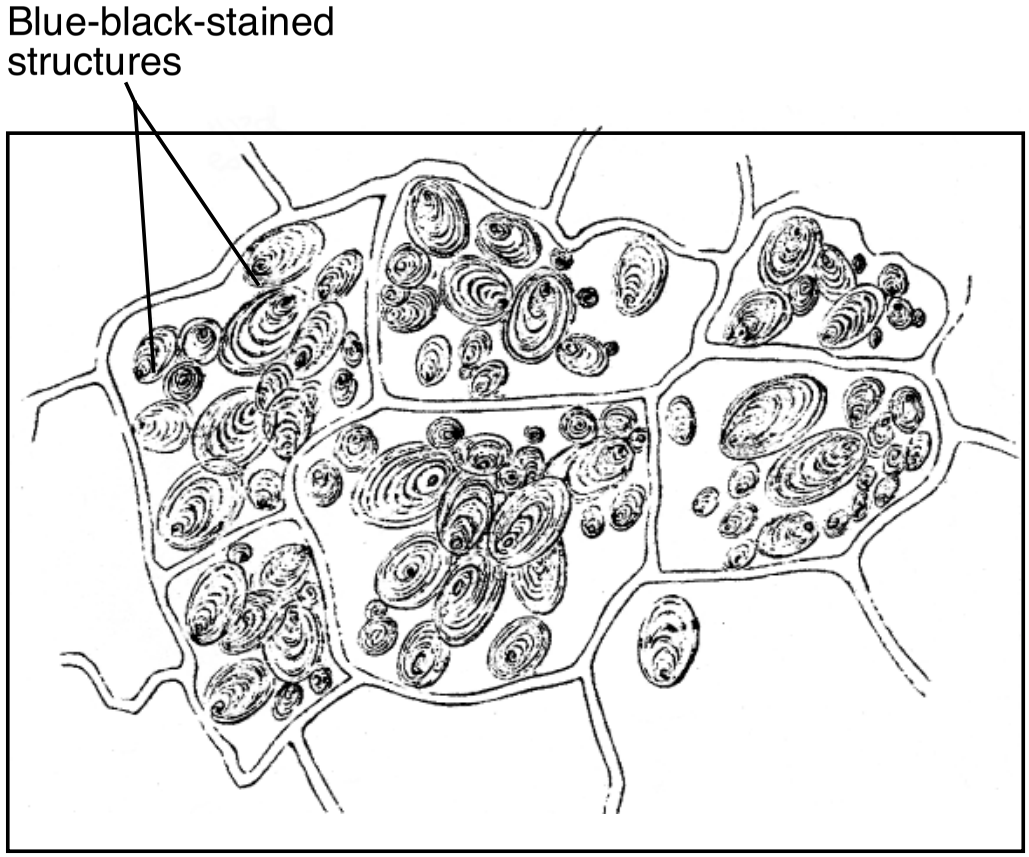
81 Which statement correctly describes the effect on the mass of one of the cubes after the 20-minute period?

(1) In distilled water, the mass of the potato cube increased due to salt leaving the cells of the potato.
(2) In distilled water, the mass of the potato cube increased due to water moving into the cells from high concentration to low concentration.
(3) In the concentrated salt solution, the mass of the potato cube increased due to salt moving into the cells from low concentration to high concentration.
(4) In the concentrated salt solution, the mass of the potato cube remained the same due to the cell wall preventing the movement of molecules into or out of the cells.

GO RIGHT ON TO THE NEXT PAGE ➡

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

82 The student placed a thin slice of potato in a drop of water on a glass slide. She added a coverslip and a drop of indicator. Using a compound light microscope, she examined the slide of potato and made the drawing below.



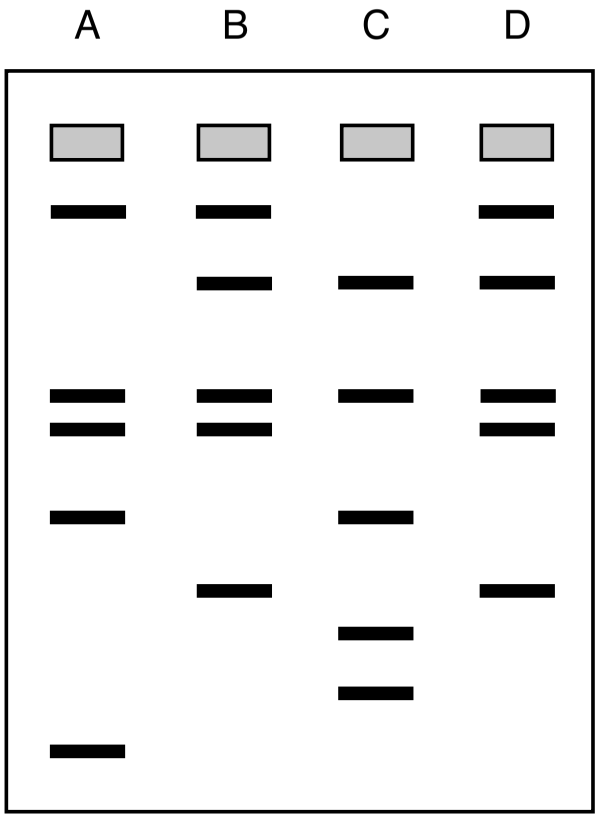
Source: https://commons.wikimedia.org/

The blue-black-stained structures labeled in her drawing are most likely

(1) chloroplasts
(2) starch grains
(3) ribosomes
(4) sugar molecules

Base your answers to questions 83 through 85 on the diagram below and on your knowledge of biology.

Tests were performed to help identify the person who committed a crime. Lane *D* contained DNA from evidence found at the crime scene. Lanes *A*, *B*, and *C* contained DNA from each of the three suspects.



Questions 83 through 85 are continued on the next page. ➡

83 Identify the technique used to obtain the results seen in the diagram. [1]

_____

84 Based on the data, which lane most likely contained DNA from the suspect who committed the crime? Support your answer. [1]

_____

_____

85 Identify the lane that contained the band with the shortest fragments of DNA. Support your answer. [1]

_____

_____

_____