XVIII. Biology, High School

High School Biology Test

The spring 2007 high school MCAS Biology test was based on learning standards in the Biology content strand of the Massachusetts *Science and Technology/Engineering Curriculum Framework* (2006). These learning standards appear on pages 54–58 of the *Framework*.

The *Science and Technology/Engineering Curriculum Framework* is available on the Department Web site at www.doe.mass.edu/frameworks/current.html.

In *Test Item Analysis Reports* and on the Subject Area Subscore pages of the MCAS *School Reports* and *District Reports*, Biology test results are reported under the following five MCAS reporting categories:

- Biochemistry and Cell Biology
- Genetics
- Anatomy and Physiology
- Ecology
- Evolution and Biodiversity

Test Sessions

The MCAS high school Biology test included two separate test sessions, which were administered on consecutive days. Each session included multiple-choice and open-response questions.

Reference Materials and Tools

The high school Biology test was designed to be taken without the aid of a calculator. Students were allowed to have calculators with them during testing, but calculators were not needed to answer questions.

The use of bilingual word-to-word dictionaries was allowed for current and former limited English proficient students only, during both Biology test sessions. No other reference tools or materials were allowed.

Cross-Reference Information

The table at the conclusion of this chapter indicates each item's reporting category and the *Framework* learning standard it assesses. The correct answers for multiple-choice questions are also displayed in the table.

Biology
Session 1

DIRECTIONS

This session contains twenty-three multiple-choice questions and three open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

1 If scientists search other planets for possible life, they are likely to focus on the presence of molecules containing which of the following elements?

A. carbon
B. iron
C. potassium
D. sodium

2 What is the **primary** function of the large intestine?

A. to digest proteins
B. to absorb nutrients
C. to break down complex carbohydrates
D. to remove water from undigested waste

3 Which of the following **best** describes the result of a mutation in an organism's DNA?

A. The mutation may produce a zygote.
B. The mutation may cause phenotypic change.
C. The mutation causes damage when it occurs.
D. The mutation creates entirely new organisms.

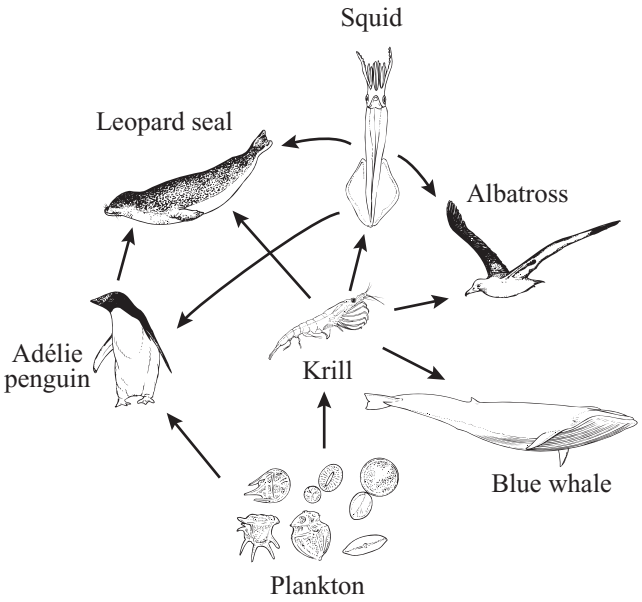
4 Starting in 1954, commercial fishers in the northwest Pacific were paid by weight, rather than by the individual fish, for pink salmon. The fishers increased the use of a type of net that selectively catches larger fish.

Which of the following effects did this change in fishing techniques **most likely** have on the salmon population over the next 20 years?

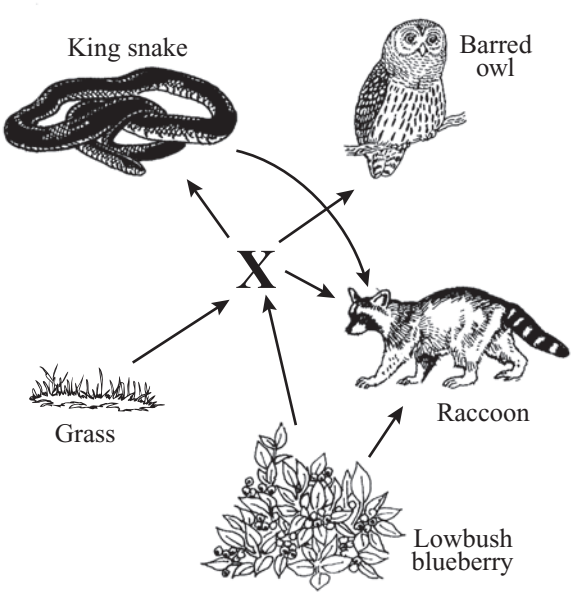
A. The average body size of the salmon population increased significantly.
B. The average body size of the salmon population decreased significantly.
C. The average body size of the males in the salmon population increased and the average body size of females in the salmon population stayed the same.
D. The average body size of the males in the salmon population stayed the same and the average body size of the females in the salmon population increased.

5 The diagrams below show a marine food web and an incomplete terrestrial food web.

Marine Food Web



Terrestrial Food Web



The organism in the terrestrial food web that corresponds to the krill in the marine food web is labeled X. Which of the following organisms is **most likely** organism X?

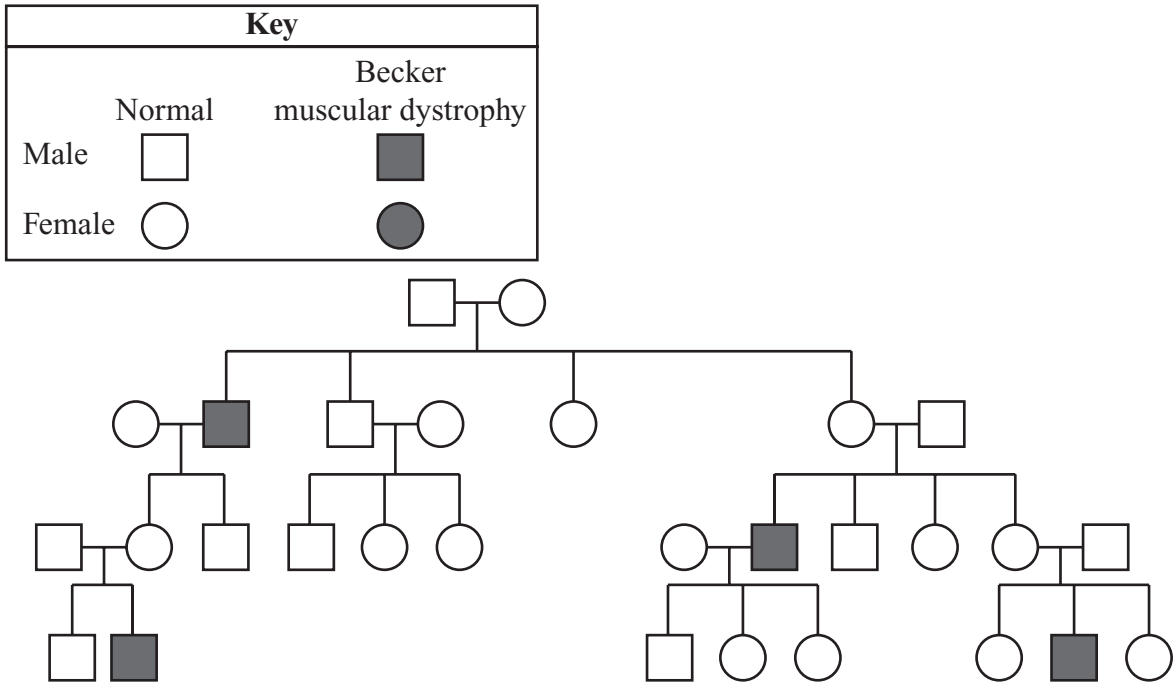
A. Mouse

C. Oak tree

B. Fox

D. Hawk

6 The pedigree below shows the occurrence of Becker muscular dystrophy in a family. Becker muscular dystrophy causes muscle weakness.



Based on this pedigree, it is **most** reasonable to conclude that Becker muscular dystrophy is which of the following?

A. a polygenic trait

B. a codominant trait

C. a sex-linked recessive trait

D. an autosomal dominant trait

7 A hurricane sweeps across a small Caribbean island, killing 50 percent of the herbivore species on the island. Which of the following is the most immediate result?

A. a reduction in biodiversity
B. an acceleration of the carbon cycle
C. an increase in predator populations
D. a decline in decomposer populations

8 *Caytonia* is an extinct plant that existed between 200 and 140 million years ago. It had reproductive structures that resemble structures in modern flowering plants.

How do scientists know about the structures of this ancient extinct plant?

A. Scientists study the DNA sequences of *Caytonia*.
B. Scientists genetically engineer modern plants to produce *Caytonia*.
C. Scientists excavate and examine the fossilized remains of *Caytonia*.
D. Scientists observe the adaptations of plants in habitats resembling those of *Caytonia*.

9 Many land plants store energy in starch. When energy is needed, the starch molecules can be broken down quickly.

This chemical reaction produces which of the following?

A. amino acids
B. lipids
C. monosaccharides
D. RNA chains

10 Which of the following **best** describes the formation of a zygote?

A. A sperm cell nucleus and an egg cell nucleus fuse.
B. A cell's DNA replication and mitosis are accelerated.
C. A succession of cell divisions produces a solid mass of cells.
D. A cell with 46 chromosomes divides to form cells with 23 chromosomes each.

Question 11 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 11 in the space provided in your Student Answer Booklet.

11 The illustrations below show a South American finch and some of the species of finches found on the Galápagos Islands. The map shows the relationship of the Galápagos Islands to the west coast of South America.

South American Finch

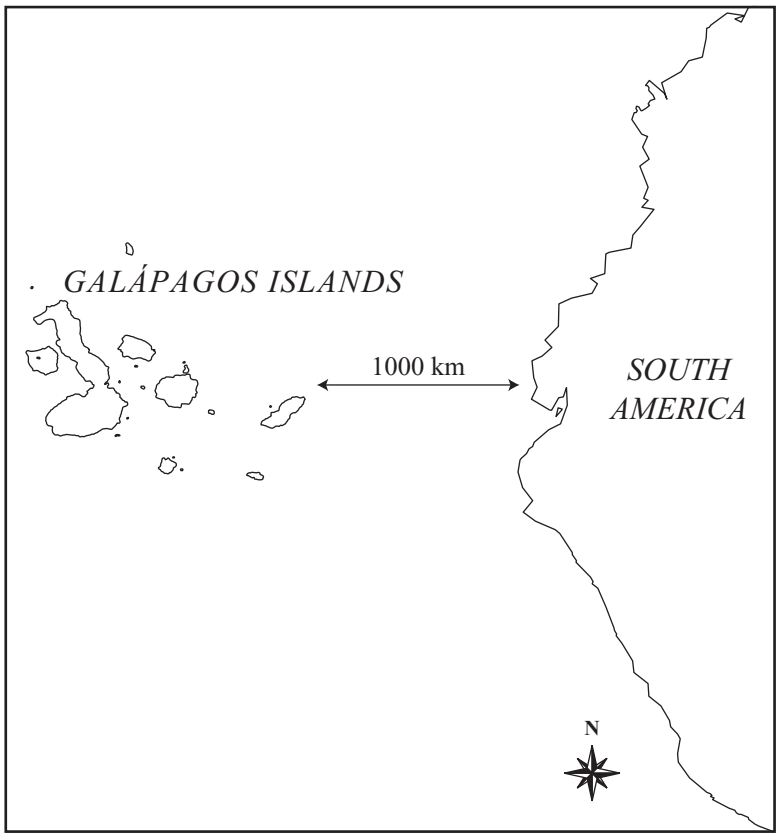
Food source: small seeds

Three Types of Galápagos Finches

Food source: small insects

Food source: cactus flowers, fruit, and nectar

Food source: large seeds

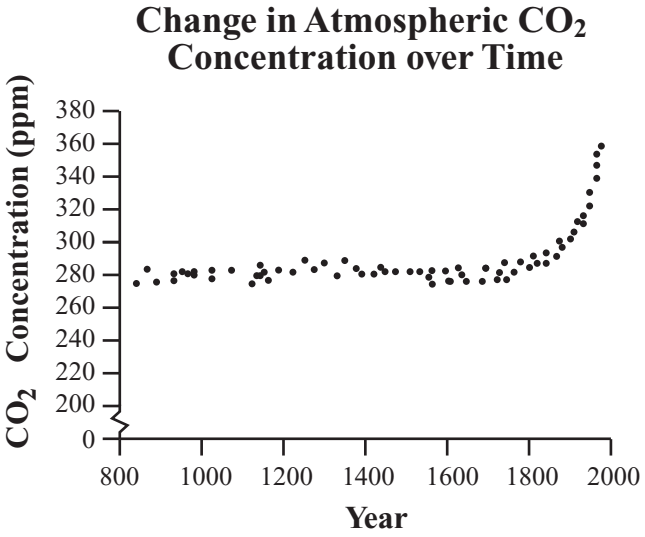


There are 13 species of finches found on the Galápagos Islands. These finches have a wide variety of food sources and beak shapes. There is one genetically similar species of finch found on the South American mainland. This finch eats small seeds.

Use the map and the bird illustrations to identify and explain **two** ways that these finches provide evidence that supports the theory of evolution.

Mark your answers to multiple-choice questions 12 through 20 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

12 A graph of atmospheric carbon dioxide concentration over time is shown below.



Scientists are investigating the cause of the large increase in atmospheric carbon dioxide concentration since about 1800. Which of the following provides the **best** explanation for the increase?

A. eruptions of large volcanoes

B. use of fossil fuels by humans

C. natural fluctuations of climate

D. photosynthesis by phytoplankton

13 Which of the following functions does active transport perform in a cell?

A. packaging proteins for export from the cell

B. distributing enzymes throughout the cytoplasm

C. moving substances against a concentration gradient

D. equalizing the concentration of water inside and outside the cell

14 European rabbits were introduced to Australia in 1859. The rabbits reproduced rapidly in their new habitat, displaced other animals, and overgrazed vegetation. In an attempt to reduce the rabbit population, a virus was introduced in 1951. This virus is usually deadly to European rabbits.

When the virus was first introduced, the rabbits died in large numbers, but the death rate decreased over time. Which of the following **best** explains the decrease in the rabbit death rate?

A. Young rabbits learned to avoid being infected with this virus.

B. Natural selection favored rabbits that are resistant to this virus.

C. The lifespan of this virus is too short to affect rabbits over a long period of time.

D. The rabbits that were originally infected with this virus have been dead for many years.

15 Which of the following is a main function of the cell wall?

A. to store carbohydrates for later use

B. to give the cell a rigid structure

C. to package proteins for export

D. to carry out photosynthesis

16 The mold *Aspergillus flavus* grows on grain. *A. flavus* produces a toxin that binds to DNA in the bodies of animals that eat the grain.

The binding of the toxin to DNA blocks transcription, so it **directly** interferes with the ability of an animal cell to do which of the following?

A. transport glucose across the cell membrane into the cytoplasm

B. produce ATP using energy released from glucose and other nutrients

C. transfer proteins from the endoplasmic reticulum to Golgi complexes

D. send protein-building instructions from the nucleus to the cytoplasm and ribosomes

17 In a mouse population inhabiting a grassland area, a mutation occurs that results in a new coat color allele.

Which of the following factors has the **greatest** effect on whether the new coat color will become more common in the mouse population?

A. whether abundant food is available in the grassland

B. whether the new coat color allele is dominant or recessive

C. whether the rate of reproduction in the mouse population is stable

D. whether the new coat color allele increases the survival of mice in their environment

18 Capillaries are part of which body system?

A. skeletal system

B. nervous system

C. digestive system

D. circulatory system

19 Similar structures are present in the embryos of fish, chickens, and rabbits. In fish, these structures develop into gills, but in chickens and rabbits, they either disappear or develop into other body parts later in embryonic development.

Which of the statements below **best** explains the presence of these structures in the embryos of all three species?

A. The embryos of the three species are similar in size.

B. Breathing structures are similar among the young of the three species.

C. The three species have a common ancestor with these embryonic structures.

D. The reproductive mechanisms are similar among the adults of the three species.

20 Human blood types are genetically determined. The table below shows the symbols used to represent two of the alleles for blood types and gives a description of each allele.

Two Alleles Controlling Human Blood Type

Symbol	Allele Description
$\mathbf{I^A}$	produces antigen A on red blood cells
$\mathbf{I^B}$	produces antigen B on red blood cells

In homozygous individuals, two $\mathbf{I^A}$ alleles result in blood type A and two $\mathbf{I^B}$ alleles result in blood type B. The $\mathbf{I^A}$ and $\mathbf{I^B}$ alleles are codominant, resulting in blood type AB in individuals heterozygous for the two alleles.

A male and a female both have blood type AB. If they have a child, what is the probability that the child will also have blood type AB?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

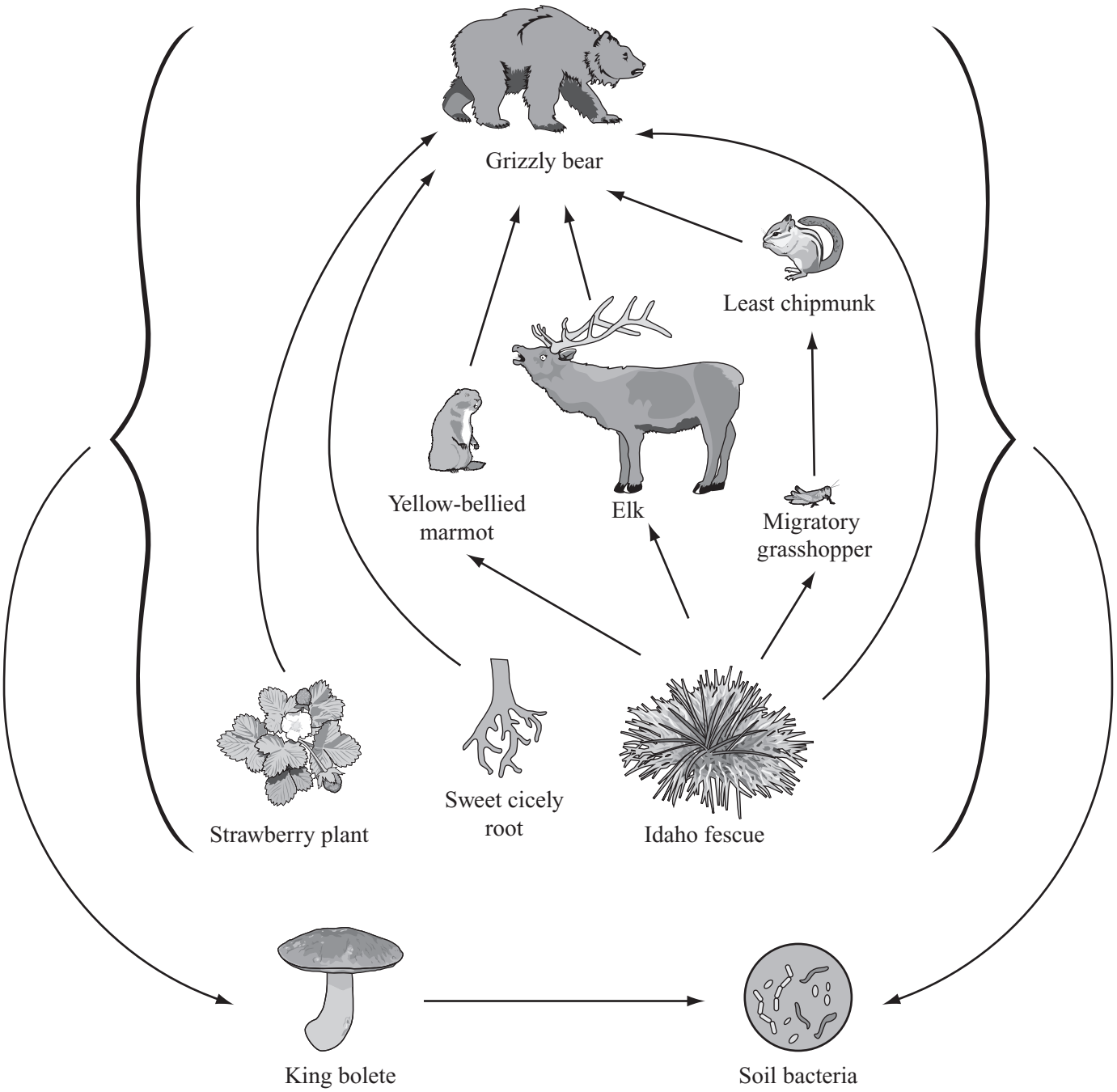
C. $\frac{3}{4}$

D. $\frac{1}{1}$

The following section focuses on the interactions of organisms in a food web.

Read the information below and use it to answer the four multiple-choice questions and one open-response question that follow.

A partial food web for organisms in Yellowstone National Park is shown below.



Mark your answers to multiple-choice questions 21 through 24 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

21 Which process do the animals in the food web use to convert energy from food into ATP?

A. cellular respiration
B. osmosis
C. photosynthesis
D. transcription

22 Which organism in the food web is classified into kingdom Fungi?

A. Idaho fescue
B. king bolete
C. migratory grasshopper
D. yellow-bellied marmot

23 Which of the following organisms is a secondary consumer in this food web?

A. yellow-bellied marmot
B. strawberry plant
C. least chipmunk
D. king bolete

24 Which of the following releases oxygen into this food web ecosystem?

A. elk respiration
B. Idaho fescue photosynthesis
C. sweet cicely root decomposition
D. migratory grasshopper reproduction

Question 25 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 25 in the space provided in your Student Answer Booklet.

25 Assume the elk population in Yellowstone National Park increases. Discuss how this increase in elk will **most likely** affect each of the following populations:

- Idaho fescue
- migratory grasshopper
- grizzly bear

Be sure to include specific reasons to support each of your responses.

Question 26 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 26 in the space provided in your Student Answer Booklet.

26 In 1950, Erwin Chargaff and colleagues examined the chemical composition of DNA and demonstrated that the amount of adenine always equals that of thymine, and the amount of guanine always equals that of cytosine. This observation became known as Chargaff's rule.

a. Based on current knowledge of the structure of DNA, explain the basis of Chargaff's rule.

b. The diagram below represents a single-stranded segment of DNA. In your Student Answer Booklet, write the complementary DNA strand that would form from this strand during replication. Use the letters A, C, G, and T to designate the bases: A = adenine; C = cytosine; G = guanine; T = thymine.

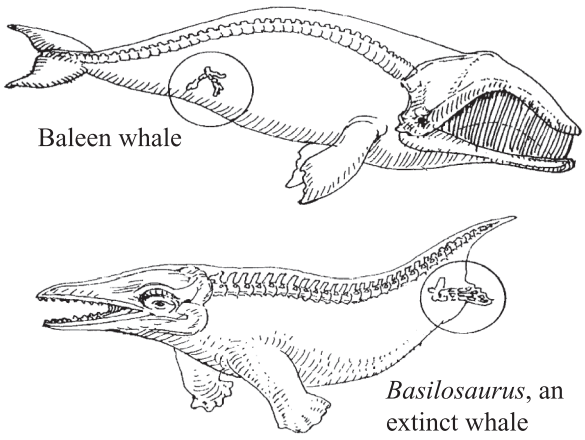
c. Why is Chargaff's rule so important to DNA's ability to replicate itself accurately?

Biology
Session 2

DIRECTIONS

This session contains seventeen multiple-choice questions and two open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

27 The illustrations below show vestigial pelvic bones of a baleen whale and vestigial hind limb bones of an extinct whale.



The presence of these bones in the baleen whale and extinct whale provides evidence of which of the following?

A. Whales can travel on land when necessary.
B. Whales evolved from four-legged animals.
C. Whales have functional legs that are hidden by fat and skin.
D. Whales are developing into animals with four functioning limbs.

28 In phenylketonuria (PKU), an enzyme that converts one amino acid into another does not work properly. Which of the following is the **most likely** cause of this genetic condition?

A. an error in the transcription of the gene for the enzyme
B. a mutation in the DNA sequence that codes for the enzyme
C. an excess of the amino acids necessary to produce the enzyme
D. a structural variation in the amino acid modified by the enzyme

29 The water cycle would **not** occur if which of the following were missing?

A. animals
B. bacteria
C. ice caps
D. solar energy

30 Which of the following statements correctly matches a cell part with its function?

A. The cell membrane packages lipids for export.

B. The mitochondria perform photosynthesis.

C. The lysosome digests molecules.

D. The nucleus produces energy.

31 Which of the following is one of the functions of the human skeleton?

A. producing hormones

B. bringing gases into the body

C. removing waste from the body

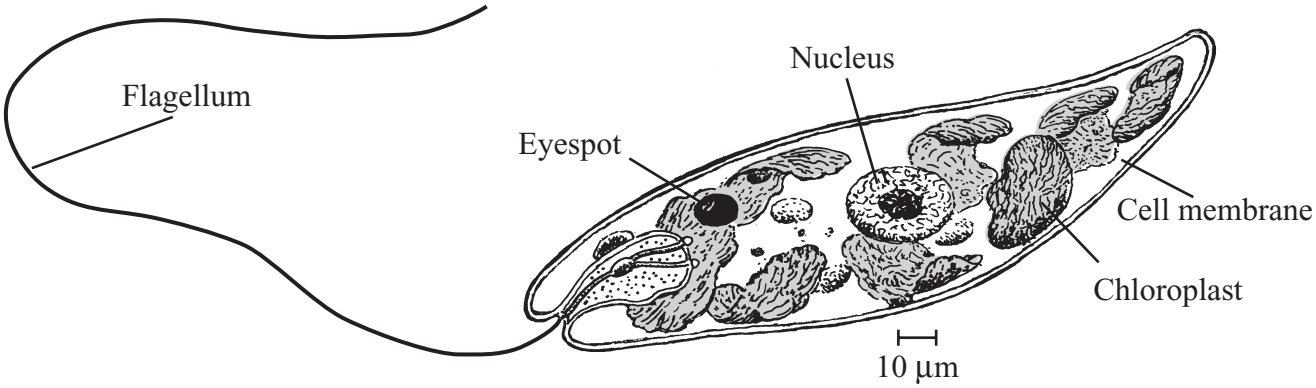
D. providing a site for blood cell formation

Question 32 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 32 in the space provided in your Student Answer Booklet.

32 The drawing below represents an organism that a student observed when examining a sample of pond water with a light microscope.



The student identified this organism as a prokaryote.

a. Is the student's identification accurate? Explain your answer using information from the diagram.

b. Identify **three** similarities between the cells of prokaryotes and eukaryotes.

Mark your answers to multiple-choice questions 33 through 38 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

33 Some willow trees alter the chemical composition of their leaves when attacked by caterpillars. Compared to normal leaves, the chemically altered leaves are less nutritious and are more difficult for caterpillars to digest.

Which of the following is a likely effect of this ability to alter leaf composition?

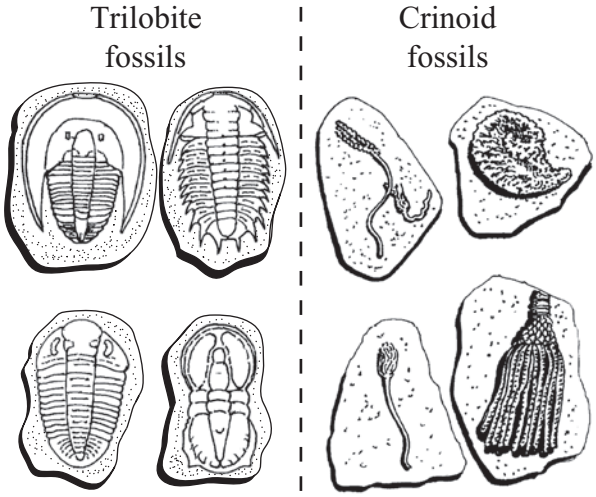
A. Willow trees with this ability will attract more caterpillars than other willow trees.

B. Willow trees with this ability will have a survival advantage over other willow trees.

C. More butterflies will lay their eggs on willow trees with this ability than on other willow trees.

D. Caterpillars that feed on willow trees with this ability will be larger than caterpillars on other willow trees.

34 The drawings below show some trilobite and crinoid fossils.



Which of the following is the **most** reasonable conclusion when fossils of these two different types of organisms are found in the same layers of rock?

A. Crinoids were prey for trilobites.

B. Crinoids were ancestors of trilobites.

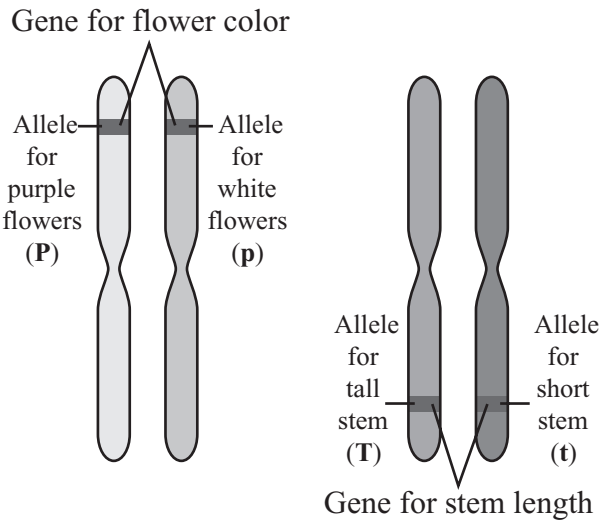
C. Crinoids and trilobites had similar behaviors.

D. Crinoids and trilobites lived at the same time.

35 In red blood cells, the compound carbonic anhydrase increases the rate at which carbon dioxide is converted to bicarbonate ions for transport in the blood. In red blood cells, carbonic anhydrase acts as which of the following?

A. an enzyme
B. a hormone
C. a lipid
D. a sugar

36 The diagram below shows the positions of the genes for flower color and stem length in a pea plant. The chromosomes represented below will replicate before meiosis.



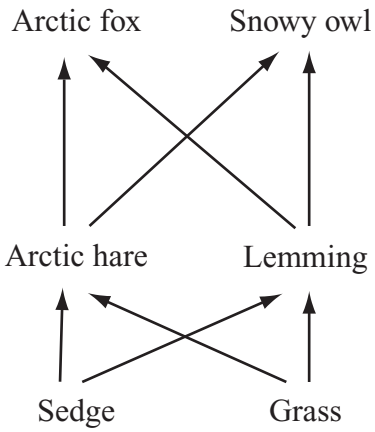
For these two genes, what is the maximum number of different allele combinations that can be formed normally in gametes produced from this cell?

A. 2
B. 4
C. 6
D. 8

37 Many plants have waxy coatings on some surfaces. This coating reduces water loss because it is not water-permeable. This waxy coating is which of the following types of organic molecule?

A. carbohydrate
B. lipid
C. nucleic acid
D. protein

38 Part of a tundra food web is shown below.



Which of the following describes the relationship between the sedge and the arctic hare?

A. competition
B. host-parasite
C. mutualism
D. producer-consumer

Question 39 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 39 in the space provided in your Student Answer Booklet.

39 When a person exercises, the rate of cellular respiration increases to supply the body with more energy in the form of ATP. Mitochondria require oxygen to carry out cellular respiration.

Describe how the respiratory, circulatory, and muscular systems interact to transport a molecule of oxygen from the air to a mitochondrion. Be sure to discuss all three systems in your response.

Mark your answers to multiple-choice questions 40 through 45 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

40 Which of the following terms applies to traits, such as human eye color, that are controlled by more than one gene?

A. codominant
B. polygenic
C. recessive
D. sex-linked

41 Which of the following is the **best** example of an organism maintaining homeostasis?

A. a wolf panting after a chase
B. a spider catching an insect in a web
C. a cricket becoming infected by a virus
D. a mole digging tunnels in the ground

42 Which of the following explains why legume plants are less likely than other terrestrial plants to experience nitrogen limitation?

A. Legume plants need less nitrogen than other plants do.
B. Legume plants have nitrogen-fixing bacteria on their roots.
C. Legume plants catch insects to supply themselves with nitrogen.
D. Legume plants can absorb nitrogen directly from the atmosphere.

43 In pigeons, the allele **B** produces ash-red feathers. The allele **b** produces blue feathers. The **B** allele is dominant to the **b** allele.

A pigeon with genotype **Bb** is crossed with a pigeon with genotype **bb**. What percent of the offspring are expected to have ash-red feathers?

A. 0%

B. 25%

C. 50%

D. 100%

44 Which of the following is the basic structural unit of the nervous system?

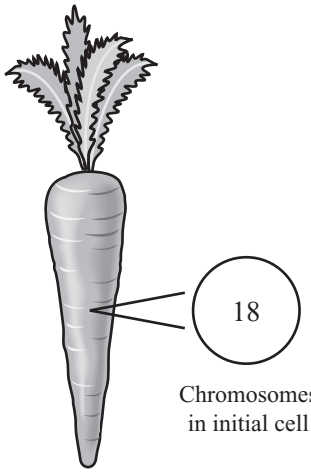
A. axon

B. neuron

C. red blood cell

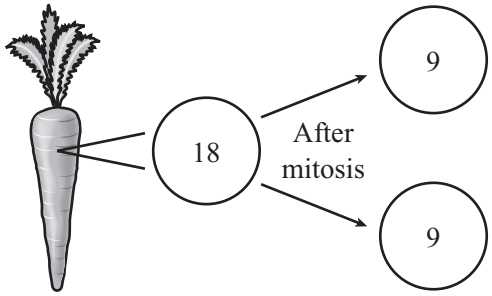
D. white blood cell

45 The diagram below provides information about a carrot cell.

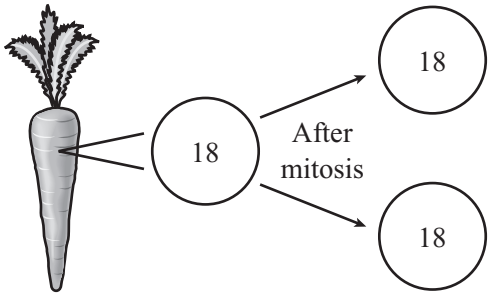


A carrot cell contains 18 chromosomes. Which of the following diagrams illustrates the correct number of chromosomes in new cells produced by mitosis?

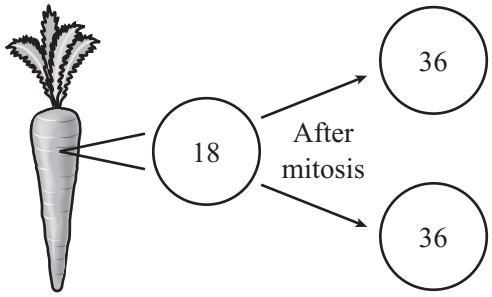
A.



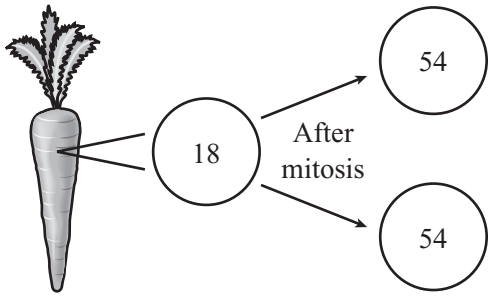
B.



C.



D.



High School Biology
Spring 2007 Released Items:
Reporting Categories, Standards, and Correct Answers

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
1	459	*Biochemistry and Cell Biology*	1.1	A
2	459	*Anatomy and Physiology*	4.1	D
3	459	*Genetics*	3.3	B
4	459	*Evolution and Biodiversity*	5.3	B
5	460	*Ecology*	6.3	A
6	461	*Genetics*	3.4	C
7	462	*Ecology*	6.2	A
8	462	*Evolution and Biodiversity*	5.1	C
9	462	*Biochemistry and Cell Biology*	1.2	C
10	462	*Biochemistry and Cell Biology*	2.7	A
11	463	*Evolution and Biodiversity*	5.1	
12	464	*Ecology*	6.4	B
13	464	*Biochemistry and Cell Biology*	2.1	C
14	465	*Evolution and Biodiversity*	5.3	B
15	465	*Biochemistry and Cell Biology*	2.1	B
16	465	*Genetics*	3.2	D
17	466	*Evolution and Biodiversity*	5.3	D
18	466	*Anatomy and Physiology*	4.2	D
19	466	*Evolution and Biodiversity*	5.1	C
20	467	*Genetics*	3.6	B
21	469	*Biochemistry and Cell Biology*	2.4	A
22	469	*Biochemistry and Cell Biology*	2.3	B
23	469	*Ecology*	6.3	C
24	469	*Ecology*	6.4	B
25	470	*Ecology*	6.3	
26	471	*Genetics*	3.1	
27	472	*Evolution and Biodiversity*	5.1	B
28	472	*Genetics*	3.3	B
29	472	*Ecology*	6.4	D
30	473	*Biochemistry and Cell Biology*	2.1	C
31	473	*Anatomy and Physiology*	4.5	D
32	474	*Biochemistry and Cell Biology*	2.2	
33	475	*Evolution and Biodiversity*	5.3	B
34	475	*Evolution and Biodiversity*	5.1	D
35	476	*Biochemistry and Cell Biology*	1.3	A
36	476	*Genetics*	3.5	B
37	477	*Biochemistry and Cell Biology*	1.2	B
38	477	*Ecology*	6.3	D
39	478	*Anatomy and Physiology*	4.8	
40	479	*Genetics*	3.4	B
41	479	*Anatomy and Physiology*	4.8	A
42	479	*Ecology*	6.4	B

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
43	480	*Genetics*	3.6	C
44	480	*Anatomy and Physiology*	4.4	B
45	481	*Biochemistry and Cell Biology*	2.6	B

* Answers are provided here for multiple-choice items only. Sample responses and scoring guidelines for open-response items, which are indicated by shaded cells, will be posted to the Department's Web site later this year.