XVIII. Biology, High School

High School Biology Test

The spring 2015 high school 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*, which is available on the Department website at www.doe.mass.edu/frameworks/current.html.

Biology test results are reported under the following five MCAS reporting categories:

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

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.

Test Sessions

The 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.

During both Biology test sessions, the use of bilingual word-to-word dictionaries was allowed for current and former English language learner students only. No other reference tools or materials were allowed.

Biology

Session 1

DIRECTIONS

This session contains twenty-one 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.

1 The diagram below represents a small section of a DNA molecule.

Which section of DNA represents the complementary strand to the section of DNA above?

A. A T T C G G G A T A T T

B. T T A T A G G G C T T A

C. T A A G C C C T A T A A

D. A A T A T C C C G A A T

2 Which of the following statements **best** describes how the nose contributes to the efficient functioning of the lungs?

A. The nose filters dust and pollen from inhaled air.

B. The nose dries air as it enters the respiratory system.

C. The nose removes excess carbon dioxide from inhaled air.

D. The nose detects the amount of oxygen in the respiratory system.

3 For most nerve impulses to be transmitted from one neuron to another, which of the following must occur?

A. Smooth muscle must move the ends of the neurons.

B. Neurotransmitters must diffuse between the neurons.

C. Glucose molecules must be released from the neurons.

D. Capillaries must deliver carbon dioxide to the neurons.

4 In which of the following taxonomic levels are animals most closely related to one another?

A. class

B. genus

C. order

D. phylum

5 Cactus plants, which grow in deserts, have a thick waxy coating that helps prevent water loss. The plants' sharp spines provide protection from predators.

Which of the following statements **best** explains why cactus plants evolved to have these traits?

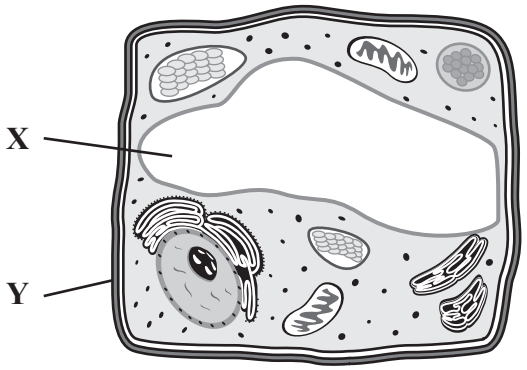
A. The genes of individual cactus plants mutated to develop these traits.

B. Individual cactus plants developed these traits to fill an environmental niche.

C. Cactus plants with these traits were better able than other cactus plants to interbreed with invasive species.

D. Cactus plants with these traits were better able than other cactus plants to survive and pass these traits on to their offspring.

6 The diagram below shows a plant cell with two parts labeled.



Which of the following roles is performed by parts **X** and **Y** working together?

A. moving genetic material

B. converting light to chemical energy

C. providing structural support to the cell

D. synthesizing proteins for cellular functions

7 Which of the following is the **best** example of homeostasis in the human body?

A. The secretions from oil glands in the skin decrease as a person ages.

B. Opposite muscles are used to bend and extend a person's arm at the elbow joint.

C. The villi of the small intestine increase the absorption of nutrients from the small intestine into the blood.

D. More growth hormone is released from the pituitary gland when the level of growth hormone in the blood falls too low.

The following section focuses on the recolonization of an area after a volcanic eruption.

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

Kilauea is a Hawaiian volcano that erupted in 1959, destroying vegetation and animal life over an area of 5 million square meters.

Before the eruption, many organisms lived on the volcano in a rain forest community. The rain forest was dominated by ohia trees and two species of tree ferns. Small trees, tall shrubs, and herbaceous plants (plants lacking woody tissues) were also present.

After the eruption, scientists closely monitored the area to track the recolonization of the devastated habitat. Scientists did not find any organisms living in this area for the first six months following the eruption. The table below shows the changes in one localized area that was covered by a massive amount of lava rock with many cracks and crevices. Despite the colonization of the area by several different types of organisms by year 9, the overall cover of the habitat was so low that the surface still looked barren.

Type of Organism	Percent of Community* 6 Months after Eruption	Percent of Community* 1 Year after Eruption	Percent of Community* 3 Years after Eruption	Percent of Community* 7 Years after Eruption	Percent of Community* 9 Years after Eruption
algae	0	25	40	22	17
mosses	0	50	30	17	17
ferns	0	25	20	17	17
lichens	0	0	10	9	6
seed plants	0	0	0	35	43

*Percent by number of species

Mark your answers to multiple-choice questions 8 through 11 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.

8 Pioneer species are the first species to take hold in a barren area after a disaster has occurred. Based on the data, most of the pioneer species in this area were which of the following types of organisms?

A. algae
B. mosses
C. ferns
D. seed plants

9 The recolonization of this area by algae, mosses, ferns, and seed plants reestablished which trophic level in the devastated ecosystem?

A. decomposer
B. primary consumer
C. producer
D. secondary consumer

10 Most organisms were unable to live in the area for the first six months after the eruption. Which of the following changes **most likely** needed to occur in the area so that organisms could return there?

A. increase in oxygen
B. increase in sunlight
C. increase in temperature
D. increase in soil nutrients

11 All the recolonizing species use which of the following processes to acquire food?

A. cellular respiration
B. decomposition
C. photosynthesis
D. predation

Question 12 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 12 in the space provided in your Student Answer Booklet.

12 The distribution of the recolonizing organisms on Kilauea changed over time.

a. In your Student Answer Booklet, graph the distribution of the types of organisms present for year 1 **and** year 9 after the eruption. Include the scale and the labels for the axes on your graph. Clearly label year 1 and year 9, or make a key for your graph.

b. Explain how immigration **and** competition changed the community structure from year 1 to year 9.

The community continued to change after year 9 of this study.

c. Describe the expected distribution of the five original types of organisms on Kilauea in another 20 years. Explain your reasoning.

Mark your answers to multiple-choice questions 13 through 22 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.

13 Which of the following represents a path that a nerve impulse could travel in the nervous system?

A. brain → motor neuron → spinal cord

B. brain → sensory neuron → motor neuron

C. sensory neuron → spinal cord → brain

D. motor neuron → spinal cord → sensory neuron

14 In squash plants, the allele for yellow fruit (**Y**) is dominant to the allele for green fruit (**y**). A plant with genotype **YY** is crossed with a plant with genotype **Yy**.

What are the expected genotype percentages in the offspring of this cross?

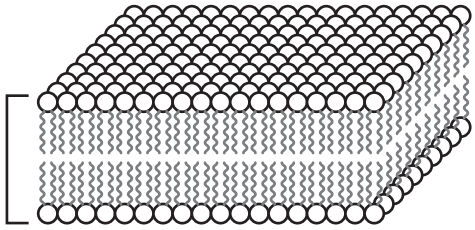
A. 100% heterozygous and 0% homozygous

B. 50% homozygous dominant and 50% heterozygous

C. 50% homozygous dominant and 50% homozygous recessive

D. 25% homozygous dominant, 50% heterozygous, and 25% homozygous recessive

15 The diagram below shows the basic structure of a cell's plasma membrane.



What is the primary function of lipid molecules in the plasma membrane?

A. to provide an energy source for most cell activities

B. to provide a substrate for enzyme activity in the cell

C. to provide a place to collect and store waste products within the cell

D. to provide a barrier to the movement of substances in and out of the cell

16 The table below gives information about the feather color phenotypes of parents and offspring for several different crosses of turkeys. Each parent turkey is true-breeding (homozygous) for its feather color.

Parent Cross	Offspring Phenotype
bronze × red	100% bronze
black × bronze	100% black
black × red	100% black

Based on the results of the crosses, which of the following statements best describes how alleles for feather color interact?

A. The red allele is dominant to the black allele and the bronze allele.

B. The bronze allele is recessive to the black allele and the red allele.

C. The black allele is dominant to the bronze allele and recessive to the red allele.

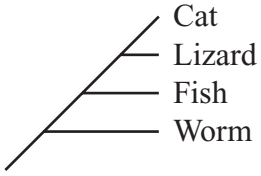
D. The bronze allele is dominant to the red allele and recessive to the black allele.

17 Cladograms are diagrams that represent evolutionary relationships among organisms. These relationships are determined by comparing certain characteristics. The table below indicates the presence (+) or absence (–) of some characteristics in four organisms.

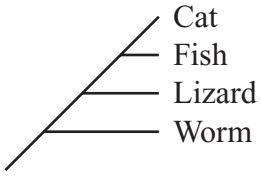
	Jaws	Hair	Limbs	Placenta
cat	+	+	+	+
worm	–	–	–	–
lizard	+	–	+	–
fish	+	–	–	–

Based on the table, which cladogram shows the most likely evolutionary relationships among the four organisms?

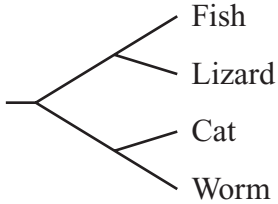
A.



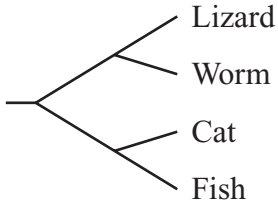
B.



C.



D.



18 *Aneides flavipunctatus* belongs to kingdom Animalia. Which of the following can most likely be concluded about *A. flavipunctatus*?

A. It is unicellular.

B. It is prokaryotic.

C. It reproduces using binary fission.

D. It obtains food from its environment.

19 Suppose a trait is controlled by a gene that has one dominant allele (**G**) and one recessive allele (**g**). Which of the following crosses would be expected to produce the greatest variety of genotypes among the offspring?

A. **GG** × **GG**

B. **GG** × **gg**

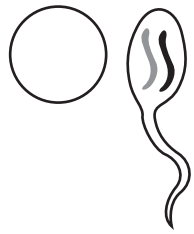
C. **Gg** × **Gg**

D. **Gg** × **gg**

20 The illustration below shows one chromosome pair in a zygote. The zygote was produced by sexual reproduction.

Assuming normal meiosis and fertilization occurred, which illustration shows the egg and sperm that produced this zygote?

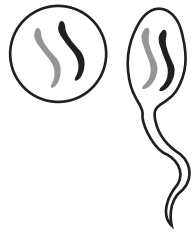
A.



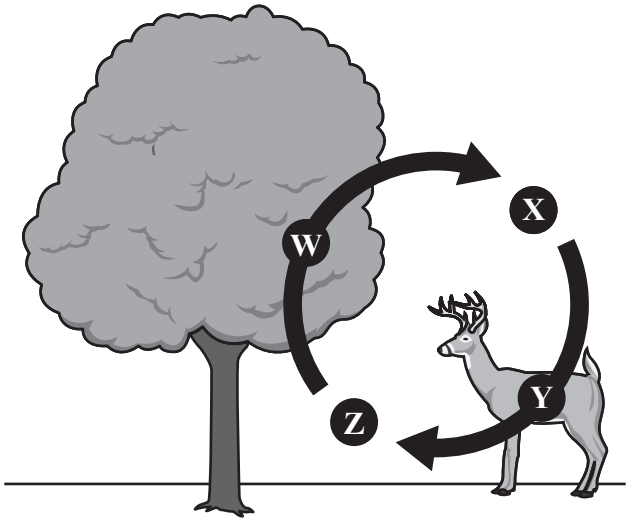
B.

C.

D.



21 Plants and animals play major roles in cycling materials in ecosystems. The diagram below represents one particular cycle. Letters W and Y represent different processes. Letters X and Z represent different gasses.



Which of the following statements correctly identifies part of this cycle?

A. Letter W represents cellular respiration.

B. Letter X represents oxygen gas.

C. Letter Y represents transpiration.

D. Letter Z represents nitrogen gas.

22 Two types of stickleback fish are found in a lake in British Columbia. One kind of stickleback is large, lives on the bottom of the lake, and eats other fish. The second kind of stickleback is small, lives in the open water, and eats plankton.

Based on this information, which of the following statements most likely describes the two kinds of stickleback fish?

A. They are two populations of the same species that will compete until one population is extinct.

B. They are two populations of the same species that will attract the same types of predators to the lake.

C. They are two different species that will evolve into one medium-sized species over time.

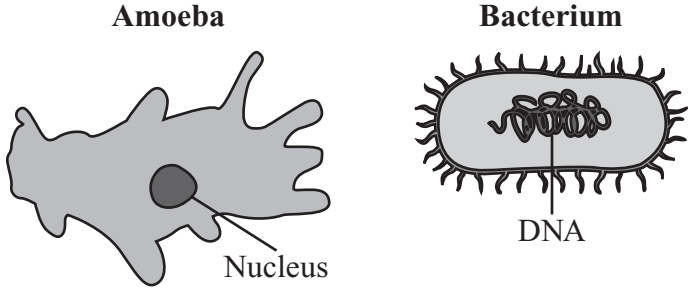
D. They are two different species that will remain reproductively isolated in different parts of the lake.

Question 23 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 23 in the space provided in your Student Answer Booklet.

23 The diagrams below show an amoeba and a bacterium.



(Not to scale)

a. Which of the pictured organisms is a eukaryote? Explain your answer using evidence from the diagrams.

b. Describe **two** similarities between the cells of prokaryotes and eukaryotes.

c. Describe **one** difference between the cells of prokaryotes and eukaryotes. You may not use the evidence you described in part (a).

Biology
Session 2

DIRECTIONS

This session contains nineteen 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.

24 The chemical pyrethrin was once commonly used to kill insect pests called bedbugs. In 2010, however, it was observed that many bedbug populations were not affected by pyrethrin.

Which of the following is the **most likely** reason pyrethrin is no longer effective against some bedbugs?

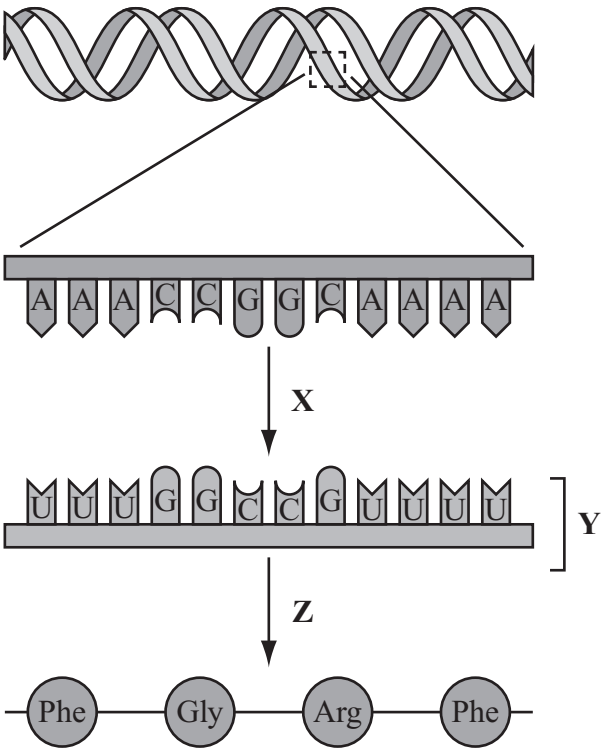
A. an increase in the range of locations where bedbugs live

B. an increase in pesticide resistance in other insects living near bedbugs

C. an increase in the number of bedbugs with gene mutations coding for pyrethrin resistance

D. an increase in the number of bedbugs with specialized cell receptors for pyrethrin molecules

25 The diagram below represents the expression of the genetic code in organisms. Three parts of the diagram are labeled X, Y, and Z.



What do X, Y, and Z represent in the diagram?

A. X is replication, Y is a gene, and Z is mutation.

B. X is crossing over, Y is DNA, and Z is mitosis.

C. X is transcription, Y is mRNA, and Z is translation.

D. X is meiosis, Y is a chromosome, and Z is transport.

26 Lions and tigers do not usually interact in the wild, but in captivity a lion and a tiger may mate with each other and produce offspring. These offspring do not generally live long and cannot typically reproduce.

Which of the following conclusions about lions and tigers is **best** supported by this information?

A. Lions and tigers are two distinct species.

B. Lions and tigers evolved at different times.

C. Lions and tigers are products of artificial selection.

D. Lions and tigers are adapted to different environments.

27 A single gene with two alleles helps determine whether some mice are resistant or susceptible to arthritis. The allele for having resistance to arthritis (**a**) is recessive to the allele for being susceptible to arthritis (**A**).

Two heterozygous (**Aa**) mice are crossed. Which of the following results would provide evidence that the parent alleles segregated during reproduction?

A. All of the offspring are susceptible to arthritis.

B. All of the offspring have a heterozygous genotype.

C. Some of the offspring susceptible to arthritis have a heterozygous genotype.

D. Some of the offspring are resistant and some of the offspring are susceptible to arthritis.

28 Which of the following is an example of active transport?

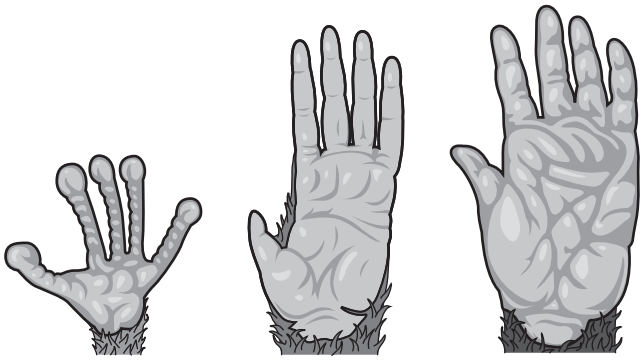
A. chromosomes migrating during cell division

B. water diffusing throughout the cytoplasm of a cell

C. cilia moving rapidly to propel a single-celled organism through water

D. proteins moving ions from low to high concentration across a cell membrane

29 The hands of three primates are shown below.



Tarsier Orangutan Gorilla

In addition to having similar external appearances, the primates' hands have similar bone structures. Which of the following conclusions is **best** supported by the similarity of these primates' hands?

A. Tarsiers, orangutans, and gorillas eat the same types of foods.

B. Tarsiers, orangutans, and gorillas are descended from a common ancestor.

C. Tarsiers, orangutans, and gorillas were the first mammals to evolve from reptiles.

D. Tarsiers, orangutans, and gorillas are classified as different subspecies of the same species.

30 Which of the following is the **best** example of immigration in a population?

A. Individuals in an algae population survive, grow, and reproduce during the warm summer months.

B. Females in a brown bear population give birth to their cubs in winter and come out of their dens in spring.

C. A large butterfly population lives in one area of southwestern England because the plant it feeds upon is located there.

D. A ring-necked pheasant population in Washington increases in size due to the arrival of more pheasants from another state.

31 When red-flowered snapdragon plants are crossed with white-flowered snapdragon plants, all the offspring have pink flowers. Based on these results, which of the following inheritance patterns determines flower color in snapdragons?

A. incomplete dominance

B. multiple allele

C. polygenic

D. sex-linked

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 An apple contains sugar and starch, which are used by the body when they are digested.

Parts of the digestive system include the following:

- esophagus
- large intestine
- mouth
- rectum
- small intestine
- stomach

a. List the parts of the digestive system in the order in which the apple passes through them.

b. Identify **one** part of the digestive system listed above where mechanical digestion takes place. Explain how the apple is mechanically digested.

c. Identify **one** part of the digestive system listed above where chemical digestion takes place. Explain how the apple is chemically digested.

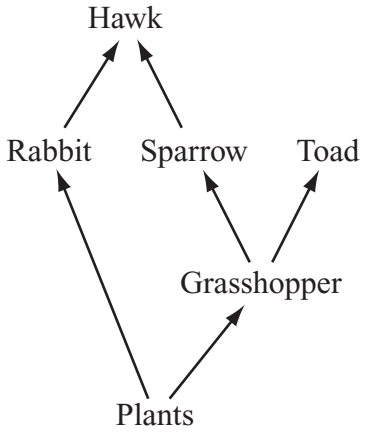
d. Identify the final product of starch digestion **and** describe how it is delivered to body cells.

Mark your answers to multiple-choice questions 33 through 43 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 Which of the following expressions can be used to calculate the change in the size of a population?

A. (births − deaths) + (immigrants − emigrants)
B. (births + deaths) + (immigrants − emigrants)
C. (births − deaths) + (immigrants + emigrants)
D. (births + deaths) + (immigrants + emigrants)

34 A partial food web is shown below.



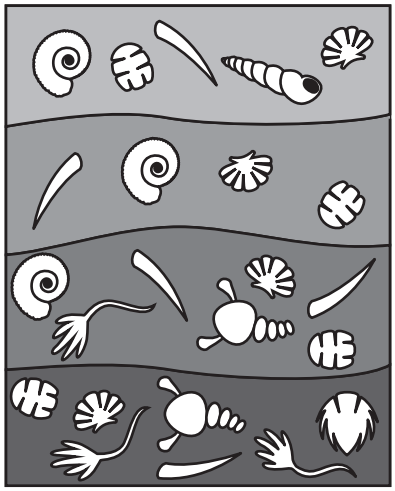
Which of the following terms **best** describes the relationship between the sparrow and the toad?

A. commensalism
B. competition
C. mutualism
D. predation

35 A flu virus can remain infectious on surfaces such as desks and doorknobs for long periods of time. How does the ability of the flu virus to remain infectious on surfaces lead to high rates of flu illness?

A. The virus has time to grow to a very large size.
B. The virus can go through many reproductive cycles.
C. The virus has many chances to enter a host in which it will reproduce.
D. The virus can exchange genetic material with other disease-causing agents.

36 The diagram below represents several undisturbed rock layers and the fossils they contain.



According to this fossil record, which of the following organisms became extinct first?

A. 

B. 

C. 

D. 

37 Carbohydrates, lipids, proteins, and nucleic acids are organic molecules essential for life. Which of the following elements makes the large structures of these organic molecules possible?

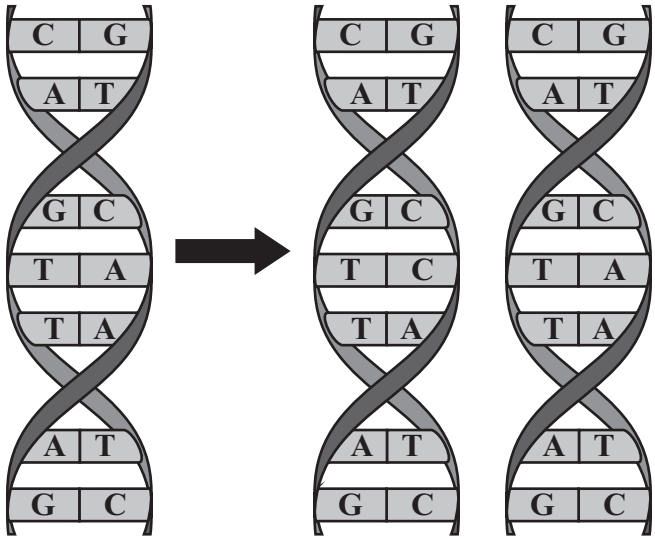
A. calcium

B. carbon

C. oxygen

D. zinc

38 The diagram below shows a process that occurred in the nucleus of a cell.



Which of the following statements describes what happened in this process?

A. DNA was translated.

B. DNA was converted to RNA.

C. A mutation occurred as DNA was replicated.

D. Pieces of DNA from different chromosomes were joined.

39 The loss of the producers in an ecosystem would most likely result in which of the following changes?

A. a decrease in the primary consumers and the secondary consumers

B. an increase in the primary consumers and the secondary consumers

C. an increase in the primary consumers and a decrease in the secondary consumers

D. a decrease in the primary consumers and an increase in the secondary consumers

40 A certain disease in humans is caused by swelling in the kidneys. The swelling affects the ability of the kidneys to function properly.

Which of the following **most likely** occurs in the body as a result of this disease?

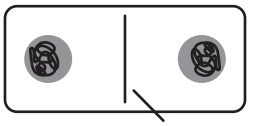
A. Nervous system functioning increases.

B. Nitrogenous waste builds up in the blood.

C. Other body organs do the work of the kidneys.

D. Hormones are transported by the muscular system.

41 The diagram below shows a plant cell at a particular stage in the cell cycle.



This stage occurs immediately **after** which cellular process?

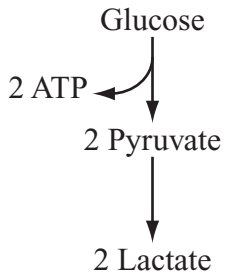
A. crossing over

B. DNA replication

C. fertilization

D. mitosis

42 If a person is constantly feeling weak and has low energy levels, a doctor may test the blood for lactate. High lactate levels may indicate that the person's body is breaking down glucose by fermentation instead of by aerobic respiration. The diagram below represents the process of fermentation.



Based on the diagram, which of the following statements best explains why an increase in fermentation and a decrease in aerobic respiration might cause a person to feel weak and have low energy levels?

A. Less ATP is being produced.

B. Less pyruvate is being produced.

C. The amount of lactate available as a product is limited.

D. The amount of glucose available as a reactant is limited.

43 Scientists compare a specific type of enzyme from two species. One species is a bacterium that lives in hot springs. The other species is a shrimp that lives in cold ocean water. The scientists observe the activity of the enzyme from each species over a range of temperatures from 0°C to 100°C.

Which of the following statements describes what the scientists **most likely** observe?

A. The bacterial enzyme works faster than the shrimp enzyme at all temperatures.

B. The bacterial enzyme has a different optimal temperature than the shrimp enzyme.

C. The bacterial enzyme denatures faster than the shrimp enzyme at room temperature.

D. The bacterial enzyme catalyzes more reactions than the shrimp enzyme at any temperature.

Questions 44 and 45 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH 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 44 in the space provided in your Student Answer Booklet.

44 In a particular plant species, the position of the flowers on the stem is controlled by a gene with two alleles. The allele coding for flowers growing in the middle of the stem (**G**) is dominant to the allele for flowers growing only at the end of the stem (**g**).

a. Using the allele symbols, identify the genotype of a plant that is heterozygous for this trait.

b. Draw a Punnett square to show the cross of two heterozygous plants.

c. Using the cross in part (b), explain how heterozygous crosses demonstrate that alleles segregate. Be sure to describe the law of segregation in your answer.

d. Identify the process that accomplishes segregation of alleles into sex cells.

Write your answer to question 45 in the space provided in your Student Answer Booklet.

45 Marine iguanas, *Amblyrhynchus cristatus*, live on the Galápagos Islands. Scientists think these marine iguanas evolved from iguanas that dispersed to the islands from the South American mainland, about 900 km away.

a. Explain why geographic isolation on the Galápagos Islands favored the evolution of a new iguana species.

Marine iguanas are herbivores. They dive into the cold ocean to find algae to eat. When the iguanas are not feeding, they rest on the lava rocks near the island shores to warm their bodies. Compared to land iguanas, marine iguanas have darker body coloring, flatter tails, shorter snouts, and longer, curved claws.

b. Choose one of the adaptive body features of marine iguanas listed above **and** describe how this feature is beneficial to marine iguanas in their environment.

c. According to natural selection, describe how marine iguanas would have evolved the feature you identified in part (b).

High School Biology
Spring 2015 Released Items:
Reporting Categories, Standards, and Correct Answers*

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
1	297	*Genetics*	3.1	C
2	297	*Anatomy and Physiology*	4.3	A
3	298	*Anatomy and Physiology*	4.7	B
4	298	*Evolution and Biodiversity*	5.2	B
5	298	*Evolution and Biodiversity*	5.3	D
6	299	*Biochemistry and Cell Biology*	2.1	C
7	299	*Anatomy and Physiology*	4.8	D
8	301	*Ecology*	6.2	B
9	301	*Ecology*	6.3	C
10	301	*Ecology*	6.2	D
11	301	*Biochemistry and Cell Biology*	2.4	C
12	302	*Ecology*	6.2	
13	303	*Anatomy and Physiology*	4.4	C
14	303	*Genetics*	3.6	B
15	304	*Biochemistry and Cell Biology*	1.2	D
16	304	*Genetics*	3.4	D
17	305	*Evolution and Biodiversity*	5.1	A
18	306	*Biochemistry and Cell Biology*	2.3	D
19	306	*Genetics*	3.6	C
20	306	*Biochemistry and Cell Biology*	2.7	C
21	307	*Ecology*	6.4	B
22	307	*Evolution and Biodiversity*	5.2	D
23	308	*Biochemistry and Cell Biology*	2.2	
24	309	*Evolution and Biodiversity*	5.3	C
25	309	*Genetics*	3.2	C
26	310	*Evolution and Biodiversity*	5.2	A
27	310	*Genetics*	3.5	D
28	311	*Biochemistry and Cell Biology*	2.1	D
29	311	*Evolution and Biodiversity*	5.1	B
30	312	*Ecology*	6.1	D
31	312	*Genetics*	3.4	A
32	313	*Anatomy and Physiology*	4.1	
33	314	*Ecology*	6.1	A
34	315	*Ecology*	6.3	B
35	315	*Biochemistry and Cell Biology*	2.8	C
36	316	*Evolution and Biodiversity*	5.1	D
37	316	*Biochemistry and Cell Biology*	1.1	B
38	316	*Genetics*	3.3	C
39	317	*Ecology*	6.3	A

Item No.	Page No.	Anatomy and Physiology	Standard	Correct Answer (MC)*
40	317	*Anatomy and Physiology*	4.2	B
41	317	*Biochemistry and Cell Biology*	2.6	D
42	318	*Biochemistry and Cell Biology*	2.5	A
43	318	*Biochemistry and Cell Biology*	1.3	B
44	319	*Genetics*	3.5	
45	320	*Evolution and Biodiversity*	5.3	

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