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Commissioner’s Foreword

Dear Colleagues:

The Massachusetts Department of Elementary and Secondary Education is committed to working in partnership with policymakers, communities, parents, school districts, and students to build a system that will prepare all students to succeed as productive and contributing members of our democratic society and the global economy. To assist in achieving this goal, the Department regularly releases MCAS test items to provide information regarding the kinds of knowledge and skills that students are expected to demonstrate. In February 2013, an MCAS test in Biology was administered in high schools across the state. I am pleased to announce that all questions on which student results are based for the February 2013 Biology test are included in this document.

The Release of February 2013 MCAS Biology Test Items is available only through the Department website at www.doe.mass.edu/mcas/testitems.html. The test items can be printed from this site. I encourage educators to use the relevant sections of this document together with their test item analysis reports as guides for planning changes in curriculum and instruction that may be needed to support schools and districts in their efforts to improve student performance.

Thank you for your support as we work together to strengthen education for our students in Massachusetts.

Sincerely,

Mitchell D. Chester, Ed.D.
Commissioner of Elementary and Secondary Education
I. Document Purpose and Structure
Purpose

The purpose of this document is to share with educators and the public all of the test items from the February 2013 MCAS Biology test on which student results are based. Local educators will be able to use this information to identify strengths and weaknesses in their curriculum and to plan instruction to more effectively meet their students’ individual needs.

This document is also intended to be used by school and district personnel as a companion document to test item analysis reports. The reports list, for the school accessing the report, the names of all enrolled students who took the February 2013 Biology test, as well as information about how each student answered each common test item in this document. The reports also label each item as multiple-choice or open-response and identify the item’s MCAS reporting category. Item numbers in this document correlate directly to the “Item Numbers” in the test item analysis reports.

Structure

Chapter II of this document contains information for the February 2013 Biology test and has three main sections. The first section introduces the chapter by listing the Massachusetts curriculum framework content strands assessed by the Biology MCAS test. These content strands are identical to the MCAS reporting categories under which test results are reported to schools and districts. The first section also provides the Web address for the Science and Technology/Engineering Curriculum Framework and the page numbers on which the learning standards assessed by the test items in the chapter can be found. In addition, there is a brief overview of the test (number of test sessions, types of items, reference materials allowed, and cross-referencing information).

The second section contains the test items used to generate February 2013 MCAS student results for Biology. The test items in this document are shown in the same order and basic format in which they were presented in the test booklet.

The final section of the chapter is a table that cross-references each item with its MCAS reporting category and with the framework standard it assesses. Correct answers to multiple-choice questions are also listed in the table.

Materials presented in this document are not formatted exactly as they appeared in student test booklets. For example, in order to present items most efficiently in this document, the following modifications have been made:

- Some fonts and/or font sizes may have been changed and/or reduced.
- Some graphics may have been reduced in size from their appearance in student test booklets; however, they maintain the same proportions in each case.
- All references to page numbers in answer booklets have been deleted from the directions that accompany test items.
II. February 2013 Biology Test
February 2013 Biology Test


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 English language learner students only, during both Biology test sessions. No other reference 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-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. Ticks carry bacteria that cause Lyme disease. Ticks do not get Lyme disease, but they can transfer the bacteria to humans, who can get the disease.

Which of the following statements best describes the relationships among the bacteria, the ticks, and the humans?

A. The relationship between the bacteria and the ticks is competition, and the relationship between the ticks and the humans is predation.
B. The relationship between the bacteria and the ticks is competition, and the relationship between the ticks and the humans is parasitism.
C. The relationship between the bacteria and the ticks is commensalism, and the relationship between the ticks and the humans is parasitism.
D. The relationship between the bacteria and the ticks is commensalism, and the relationship between the ticks and the humans is predation.

2. A boy jumps into a cold swimming pool and his body temperature goes down. His muscles, blood vessels, and nervous system work together to restore his body temperature.

Which term best describes this process?

A. homeostasis
B. hypothermia
C. reflex
D. respiration
Which of the following observations best supports the conclusion that dolphins and sharks do not have a recent common ancestor?

A. Dolphins form social groups, but sharks are solitary.
B. Dolphins hunt during the day, but sharks are nocturnal.
C. The number of dolphin species is far less than the number of shark species.
D. The jawbone structure in dolphins is very different from the jawbone structure in sharks.

A simple diagram of nutrient cycling is shown below.

What substances do X and Y represent in this nutrient cycle?

A. Substance X is salt and substance Y is water.
B. Substance X is glucose and substance Y is starch.
C. Substance X is nitrogen and substance Y is ammonia.
D. Substance X is carbon dioxide and substance Y is oxygen.
Wolves were reintroduced into Yellowstone National Park in 1995. Wolves hunt elk, but the elk population in the park has declined more than it was expected to decline from direct predation by wolves.

Other than direct predation, which of the following factors most likely contributed to the decline in the elk population?

A. decreased birth rate in elk
B. decreased emigration of elk
C. decreased parasite load in elk
D. decreased competition between elk

In the first step of glycolysis, glucose is converted to glucose-6-phosphate. Which of the following supplies the energy for the reaction?

A. ATP
B. RNA
C. oxygen
D. hydrogen

Which of the following diagrams represents a virus?

A. [Diagram with Nucleus]
B. [Diagram with Chromosome]
C. [Diagram with Capsule with DNA]
D. [Diagram with Food vacuole]
In the blood, the protein hemoglobin can slowly convert to a different form. This other form, called methemoglobin, is normally converted back to hemoglobin by an enzyme.

In a rare blood disease called hereditary methemoglobinemia (met-H), methemoglobin is not converted back to hemoglobin. People with type 1 met-H lack the enzyme necessary for converting methemoglobin back to hemoglobin because of a gene mutation. As a result, methemoglobin builds up in the blood and makes the skin and mucous membranes look blue. Type 1 met-H does not usually affect a person’s health in any other way, and daily doses of vitamin C or methylene blue convert the methemoglobin back to hemoglobin.

The pedigree for a family with a history of type 1 met-H is shown below. The pattern of inheritance for this form of met-H is autosomal recessive (allele m).
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. Which of the following individuals could have the homozygous dominant genotype?
A. Mark
B. Bill
C. Olivia
D. Shawn

9. Larry is treated for type 1 met-H with vitamin C, and his skin no longer looks blue. Which of the following statements describes how this affects the likelihood of Larry passing on the allele for type 1 met-H to his offspring?
A. Larry will now pass on a normal allele to his offspring.
B. Larry will still pass on an allele for type 1 met-H to his offspring.
C. Larry will only pass on an allele for type 1 met-H if his offspring is male.
D. Larry will have less of a chance of passing on an allele for type 1 met-H to his offspring.

10. If Olivia and Shawn have another child, which of the following genotypes is possible for the child?
A. Mm only
B. MM only
C. MM or mm only
D. MM, Mm, or mm

11. Most people with type 1 met-H have no symptoms except blue skin and mucous membranes. If the concentration of methemoglobin in the blood increases enough, the ability to carry oxygen decreases and other symptoms can develop.
Which of the following symptoms would most likely result if there were large amounts of methemoglobin in the blood?
A. hyperactivity
B. lack of energy
C. increased appetite
D. inflammation of kidneys
Mark and Sue have two children, both with type 1 met-H.

a. Draw a Punnett square for this parental cross. Based on the Punnett square, identify what percentage of Mark and Sue’s children are expected to have type 1 met-H.

b. Explain why the actual phenotype percentages in Mark and Sue’s children do not match the expected outcome on the Punnett square.

c. Mark and Sue’s grandchildren do not have type 1 met-H. If their grandson Steven has a child with a woman who is heterozygous, what is the probability that the child will have type 1 met-H? Draw a Punnett square to support your answer.
Insects that are camouflaged in their environment are less likely to be eaten by birds. The graph below shows the distribution of body color in a population of an insect species.

The insects live on trees. A black fungus begins to grow on the trees where the insects live. Which of the following graphs shows the most likely distribution of body color in the insect population after several years of fungus growth?
14. Which of the following provides the most convincing evidence that two different animal species evolved from a common ancestor?
   A. They live in similar environments.
   B. They have similar adult body shapes.
   C. They have similar methods of locomotion.
   D. They show similar features in embryonic development.

15. Under normal conditions, which of the following causes a zygote to form?
   A. Mitosis takes place.
   B. Meiosis takes place.
   C. Two gametes combine.
   D. Asexual reproduction occurs.

16. In the 1940s and 1950s, scientists did experiments to determine the molecule responsible for heredity. Their experiments demonstrated that the molecule that encodes and transmits information in organisms is
   A. DNA.
   B. glucosamine.
   C. insulin.
   D. vitamin D.

17. What is the primary role of the stomach in the human digestive system?
   A. producing specialized salts that absorb fats
   B. absorbing water and minerals from undigested food
   C. using muscle movements and enzymes to break down food
   D. transferring nutrients from digested food to the bloodstream
In guinea pigs, the allele for black hair (B) is dominant to the allele for brown hair (b). The allele for short hair (S) is dominant to the allele for long hair (s). The genes for hair color and hair length are located on different chromosomes.

Guinea pigs with black, short hair (BbSs) are crossed with guinea pigs with brown, long hair (bbss). Some offspring have black, short hair or brown, long hair like the parents. Additionally, some offspring have black, long hair or brown, short hair.

Which of the following explains the different phenotypes in the offspring?

A. The expression of the alleles for hair color is influenced by the alleles for hair length.
B. The alleles for hair color and hair length assort independently during gamete formation.
C. The alleles for hair color and hair length mutate during the first cell divisions of the offspring.
D. The interaction between the alleles for hair color and hair length is incomplete dominance.

Which of the following is most important in classifying two groups of bears into the same genus?

A. similar diets
B. similar genes
C. similar habitat
D. similar body size

Which group of organic compounds contains fatty acids?

A. carbohydrates
B. lipids
C. nucleic acids
D. proteins
21 Which of the following statements describes each new molecule of DNA produced when DNA replicates?

A. Each new molecule is half the length of the original molecule.
B. Each new molecule has only the coding portions of the original molecule in its sequence.
C. Each new molecule contains one strand from the original molecule and one newly synthesized strand.
D. Each new molecule retains the A, C, and G bases in the DNA sequence but replaces the T base with U.

22 A student views cells from several different prokaryotic and eukaryotic organisms under a high-powered microscope. Which of the following statements describes how the prokaryotic cells appear different from the eukaryotic cells?

A. The prokaryotic cells are much larger.
B. The prokaryotic cells do not have nuclei.
C. The prokaryotic cells have mitochondria.
D. The prokaryotic cells have a less distinct shape.
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 Several parts of the human nervous system are listed below.

- brain
- motor neurons
- sensory neurons
- spinal cord

a. Describe the primary function of each of the parts of the nervous system identified in the list.

b. A person sees a ball and kicks it, in part because of actions of the nervous system. Using the parts of the nervous system listed, describe the path of nerve impulses that cause the person to (1) see the ball and (2) kick the ball.
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 A partial food web is shown below. The insect species in this food web are ladybugs, aphids, caterpillars, and grasshoppers.

25 Cellular respiration involves a series of chemical reactions. Which of the following is a primary way that enzymes affect these reactions?
A. They decrease the pH of the products.
B. They increase the rate of the reactions.
C. They take the place of oxygen as a reactant.
D. They change the location of the reactions in the cell.

Which of the following statements describes what will most likely happen if another animal that preys on insects enters the community?
A. The plant populations will decrease.
B. The ladybug population will increase.
C. The small bird population will decrease.
D. The grasshopper population will increase.
A particular genetic disorder leads to very high levels of blood cholesterol. The gene linked to this trait has two alleles, \( N \) and \( n \). The table below shows how the three different combinations of these alleles are expressed.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Expressed Phenotype</th>
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<tr>
<td>( NN )</td>
<td>normal cholesterol levels</td>
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<tr>
<td>( Nn )</td>
<td>slightly elevated cholesterol levels</td>
</tr>
<tr>
<td>( nn )</td>
<td>greatly elevated cholesterol levels</td>
</tr>
</tbody>
</table>

Which of the following statements describes the interaction of the \( N \) and \( n \) alleles for the gene?

A. The \( N \) allele is recessive to the \( n \) allele.
B. The \( N \) allele is incompletely dominant to the \( n \) allele.
C. The \( N \) allele assorts independently from the \( n \) allele.
D. The \( N \) allele completely masks the phenotype of the \( n \) allele.

Only 0.001% of water on Earth is present as soil moisture. In the water cycle, which of the following can happen to this water next?

A. absorption by plants
B. condensation into streams
C. decomposition by bacteria
D. transpiration to the atmosphere
A dog gives birth to five puppies. What percentage of its chromosomes does each puppy share with the mother?
A. 25%
B. 50%
C. 75%
D. 100%

Cellulose is a complex carbohydrate that makes up the cell walls of plants. Which of the following elements are main components of cellulose?
A. calcium and chlorine
B. carbon and hydrogen
C. potassium and chlorine
D. sodium and hydrogen
30 Fossils typically provide evidence for evolution because
A. they are millions of years old.
B. they exist in all types of rocks.
C. they supply good samples of RNA.
D. they show patterns of biological change.

31 Continuing development of land in the southeastern United States has resulted in large sections of forest being broken into smaller, isolated fragments. Scientists studying these forest fragments have found that the smaller the forest fragment, the closer together birds build their nests.

As a result of the nests being close together, which of the following will most likely happen to the birds in a particular forest fragment?

A. Finding food will become easier for the birds.
B. Most of the birds will lay eggs later in the year.
C. Fewer birds will migrate out of the region for the winter.
D. Viral diseases will spread among the birds more quickly.
In an investigation, students performed the following steps and made some observations:

1. The students poured fresh water into a beaker and added a few drops of a chemical solution called bromthymol blue. The water in the beaker turned blue.

2. One student blew through a straw into the water in the beaker. The water in the beaker turned yellow.

3. The students then placed some waterweed (a plant) into the water in the beaker and placed the beaker under a bright light.

4. After a short period of time, the students observed the beaker. The water had turned blue again and there were bubbles on the waterweed leaves.

The setup of this investigation is shown below.

a. The water changed from blue to yellow when the student blew into it (step 2). Identify the compound that caused the water to change from blue to yellow.

b. Explain why the water turned blue again when the beaker with the waterweed was under the bright light (step 4). In your explanation, identify the process that caused this change.

c. Explain why there were bubbles on the waterweed leaves (step 4).

d. Write the complete equation for the process that caused the changes in step 4. You may use words or symbols in your equation.
In the early 1900s, California citrus growers sprayed their trees with cyanide gas to kill scale insects. By 1914, some scale insects were surviving the spraying, and eventually the whole population showed resistance to cyanide. Which of the following statements best explains how resistance to cyanide spread in the scale insect population?

A. Insects with a resistance gene survived the first cyanide sprayings and passed the gene to their offspring.
B. Insects without a resistance gene underwent mutation upon contact with the cyanide to acquire resistance.
C. Predators put greater selection pressure on insects with a resistance gene than on insects without a resistance gene.
D. Parasites infecting the insect population carried the trait from insects with a resistance gene to insects without a resistance gene.

The diagram below shows a process that occurs in cells. Which process is shown in the diagram?

A. diffusion
B. recombination
C. respiration
D. translation
A group of mammals migrates away from the general population to a new habitat. Under which of the following conditions will this group most likely develop into a separate species?

A. The new habitat is geographically close to the old habitat.

B. The group returns to the general population each mating season.

C. The ratio of males to females in the group is different than in the general population.

D. The new habitat has conditions that differ significantly from those in the old habitat.

The diagram below shows changes in the concentrations of sodium and potassium ions inside and outside a nerve cell. These changes prepare the nerve cell to conduct an electrical impulse.

Which of the following processes is directly responsible for these changes in the concentrations of sodium and potassium ions inside and outside the nerve cell?

A. active transport
B. enzyme activity
C. osmosis
D. transcription
The illustration below shows a phase of mitosis.

Which of the following statements describes what is occurring in this phase?

A. The chromosomes are duplicating their DNA.
B. The copies of each chromosome are separating.
C. The chromosomes are moving toward the center of the cell.
D. The homologous chromosomes are preparing for crossing over.

A diagram of a body system is shown below.

Which of the following is a primary function of this system?

A. maintaining body temperature
B. supporting the weight of the body
C. filtering nitrogenous waste from the blood
D. coordinating nervous responses in the body
In a population of rodents, birth rate plus immigration rate is greater than death rate plus emigration rate. Which of the following occurs under these conditions?

A. The size of the population always increases.
B. The size of the population always decreases.
C. The size of the population never changes.
D. The size of the population never reaches its carrying capacity.

A cell is shown in the diagram below. Which of the following cell characteristics provides evidence that this cell comes from a plant and not from an animal?

A. a large vacuole
B. a single nucleus
C. a functional mitochondrion
D. a semipermeable cell membrane
Brown tree snakes were accidentally carried to the island of Guam in the cargo bays of military planes after World War II. Brown tree snakes prey upon birds. There are no natural predators of brown tree snakes on Guam.

Which of the following most likely happened as a result of the arrival of the brown tree snakes on Guam?

A. Forest biodiversity increased.
B. Many bird populations disappeared.
C. Immigration of new species of birds decreased.
D. All reptile species experienced increases in population size.
Some lizards have an adaptation that allows their tails to break off with minimal damage to bones, nerves, blood vessels, and muscles. This type of lizard can then regrow the missing portion of the tail.

Which of the following statements best explains why this adaptation is selected for in lizard populations?

A. Lizards with this adaptation are better at climbing trees.
B. Lizards with this adaptation are more likely to escape from predators.
C. Lizards with this adaptation can use their tails as lures to attract more food.
D. Lizards with this adaptation can camouflage themselves more easily in vegetation.

A diagram of a cell is shown below.

Which of the following is a function performed by the cell part labeled X?

A. generating ATP
B. synthesizing polypeptides
C. storing genetic information
D. breaking down unneeded materials
A student is studying four beetles, pictured below. Three of the beetles belong to the same genus, and one does not.

Hippodamia convergens  Hippodamia variegata

Peltodytes muticus  Hippodamia glacialis

a. Identify whether *Hippodamia convergens* and *Hippodamia variegata* can mate and produce fertile offspring. Explain your answer.

b. Which of the beetles must belong to the same family? Explain your answer.

c. Describe two types of evidence, other than mating and producing fertile offspring, that scientists can use to determine taxonomic classification and relationships among insects. Explain how each type of evidence is used.
Write your answer to question 45 in the space provided in your Student Answer Booklet.

45 A partial food web for a deep-sea vent is below.

![Food Web Diagram]

a. Which organism or organisms are the producers in this food web? Explain your answer using evidence from the food web.

b. Compare how much of the energy initially entering the vent ecosystem is available to the Atlantic vent shrimp and to the eelpout based on their trophic levels. Explain why there is a difference in the amount of energy available to each species.
**Biology**

February 2013 Released Items: Reporting Categories, Standards, and Correct Answers*

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* Answers are provided here for multiple-choice items only.