Release of
February 2012
MCAS Biology
Test Items

March 2012
Massachusetts Department of
Elementary and Secondary Education
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*Commissioner’s Foreword*

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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 2012, 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 2012 Biology test are included in this document.

The Release of February 2012 MCAS Biology Test Items is available only through the Department website at www.doe.mass.edu/mcas/testitems.html. The test items can be easily printed from this site. I encourage educators to use the relevant sections of this document together with their Test Item Analysis Rosters 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
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 2012 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’ needs.

This document is also intended to be used by school and district personnel as a companion document to the test item analysis reports. Each school in which a February Biology test was administered can access electronically a Test Item Analysis Roster for Biology. The roster provides data generated from student responses. The roster lists, for the school accessing the roster, the names of all enrolled students who took the February 2012 Biology test, and shows how each student answered each common test question (item) and the number of points earned on each open-response item. The roster also labels each item as multiple-choice or open-response and identifies the item’s MCAS reporting category. Item numbers in this document correlate directly to the “Item Numbers” in the test item analysis roster.

Structure

Chapter II of this document contains information for the February 2012 Biology test and has three main sections. The first section introduces the chapter by listing the Massachusetts curriculum framework content strand assessed by the Biology MCAS test, as well as 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 2012 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 2012 Biology Test
February 2012 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 items.

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 English language learner 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 items are also displayed in the table.
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. Which of the following is the best scientific evidence that mammals evolved from reptiles?
   A. similarities in the diets of extinct reptiles and modern mammals
   B. similarities in the average lifespans of modern reptiles and modern mammals
   C. fossils of ancient reptiles and mammals that appear together in the same layers of rock
   D. fossils that show gradual changes in skull shape from reptile-like organisms to mammal-like organisms

2. In garden pea plants, the tall allele (T) is dominant to the short allele (t), and the round seed allele (R) is dominant to the wrinkled seed allele (r).
   Which of the following crosses could produce short pea plants with wrinkled seeds?
   A. TtRr × TTRR
   B. TTRr × TTRr
   C. TtRr × Ttrr
   D. TtRR × ttRR

3. ATPases are enzymes that help convert ATP into ADP in cells. When a person exercises, ATPases directly increase which of the following?
   A. the amount of energy stored in muscle cells
   B. the number of mitochondria in muscle cells
   C. the number of muscle cells in muscle tissue
   D. the amount of energy released in muscle cells

4. Which term describes the maintenance of a steady internal state in the body?
   A. gametogenesis
   B. homeostasis
   C. mitosis
   D. respiration
In mice with black agouti coats, each hair is black and yellow. Two mice with black agouti coats are crossed. Among the offspring, most of the mice have black agouti coats, and the rest of the mice have nonagouti coats with solid black hairs.

Based on the results of the cross, which of the following statements describes the most likely genetics of the coat color in the mice?

A. The agouti allele is recessive to the nonagouti allele.
B. The agouti allele is dominant to the nonagouti allele.
C. The agouti allele and nonagouti allele are sex-linked.
D. The agouti allele and nonagouti allele are codominant.

Which of the following statements best explains why the chestnut-sided warbler, Dendroica pensylvanica, and the cerulean warbler, Dendroica cerulea, are classified as closely related species?

A. They eat the same types of insects.
B. They have similar DNA sequences.
C. They show similarities in their nesting behaviors.
D. They live in the same types of woodland habitats.

A biological process is represented in the diagram below.

Which of the following concepts is best illustrated by the diagram?

A. Crossing-over creates new genetic diversity in gametes.
B. Mitosis increases the number of chromosomes in zygote cells.
C. In asexual reproduction, the offspring produced are genetically identical to the parent.
D. In sexual reproduction, the offspring receive the same number of chromosomes from each parent.
The following section focuses on the ecology of a pond ecosystem in the northeastern United States. Read the information below and use it to answer the four multiple-choice questions and one open-response question that follow.

The illustration below shows a cross section of the edge of a pond in the northeastern United States. Many species of organisms are part of this ecosystem. Some of the organisms live on the land surrounding the pond, some spend time on the surface of the water, and some live below the pond’s surface.
The organisms in this ecosystem are related to each other through the food web shown below.
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 relationships exists between the frog and the mayfly?
   A. commensalism
   B. competition
   C. mutualism
   D. predation

9. The illustration below shows an organelle from a cell.

Which of the following organisms in the pond ecosystem uses this organelle to produce food?
   A. frog
   B. mayfly
   C. pickerel
   D. willow

10. Muskrats are omnivores that live in burrows on the pond banks. Which of the following would most likely lead to an increase in the size of the muskrat population over time?
   A. increased seed production by cattails
   B. increased outbreaks of disease in muskrats
   C. increased numbers of predators on muskrats
   D. increased amounts of competition from pickerel

11. Which of the following organisms is correctly matched to its role in the pond ecosystem?
   A. soil fungi—decomposer
   B. zooplankton—producer
   C. water lily—decomposer
   D. water snake—primary consumer
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.

One pond-dwelling species not shown in the illustration is Eurasian watermilfoil. Eurasian watermilfoil is an invasive plant species in the pond. It grows quickly and forms extremely dense mats in the water. None of the consumers included in the food web eat Eurasian watermilfoil.

The table below shows the changes in the population density of two pond species since the appearance of Eurasian watermilfoil.

<table>
<thead>
<tr>
<th>Species</th>
<th>Density before Eurasian Watermilfoil Appeared (number per square meter)</th>
<th>Density Two Years after Eurasian Watermilfoil Appeared (number per square meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>water lily</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>pondweed</td>
<td>2.6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

a. Based on the data in the table, describe what has happened to the water lily and pondweed populations since the appearance of Eurasian watermilfoil in the pond ecosystem.

b. Explain two ways that the Eurasian watermilfoil could have caused these changes in the water lily and pondweed populations.

c. Identify one primary consumer and one secondary consumer in the illustration. For each organism you identified, describe and explain the likely effect of the presence of Eurasian watermilfoil on the population. Be specific in your response.
The smooth-skinned, leaf-tailed gecko lives on Madagascar, an island off the coast of Africa. The gecko hunts at night and sleeps on trees by day. The color and pattern of the gecko’s body resembles leaves.

Which of the following statements best explains how the gecko’s unique body color and pattern evolved?

A. All the geckos needed to look like leaves in order to live in trees and therefore acquired the necessary trait.
B. Individuals with bodies that looked the most like leaves interbred only with other green or brown lizard species.
C. Gene sequences of all the geckos mutated to produce the leaf appearance when ancestral geckos moved from mud to trees.
D. Individuals with bodies that looked the most like leaves were better able than other individuals to avoid predators and passed on the trait.

A major reservoir for oxygen is the atmosphere. Which of the following processes adds oxygen to the atmosphere?

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

Radon is a radioactive gas that is sometimes present in homes. If radon is inhaled, its decay products are deposited in the lungs. Radioactive particles can penetrate cells and cause changes to the cells’ DNA.

These changes in DNA are an example of which of the following?

A. homeostasis
B. mitosis
C. mutation
D. transcription
16. The scientific name for the cougar is *Puma concolor*. Which of the following organisms is most closely related to the cougar?

A. Corythaixoides concolor  
B. Lynx rufus  
C. Panthera tigris  
D. Puma yagouaroundi

17. Vitamin D is an organic molecule that regulates the absorption of calcium by the body. Which of the following elements is most common in a molecule of vitamin D?

A. aluminum  
B. carbon  
C. magnesium  
D. sodium

18. Crohn’s disease causes inflammation of the digestive tract, particularly the small intestine. Inflammation of the small intestine would directly interfere with which of the following digestive functions?

A. liquefying food  
B. reabsorbing water  
C. absorbing nutrients  
D. moving food to the stomach

19. Two groups of very similar-looking finches are found on the Galápagos Islands. One group of finches is found only on Floreana Island. The other group of finches is found on several of the islands, including Floreana Island. On Floreana Island, these two groups of finches do not interbreed.

Which of the following conclusions is best supported by this information?

A. The two groups of finches have the same song.  
B. The two groups of finches are different species.  
C. The two groups of finches adapted to eat the same foods.  
D. The two groups of finches descended from different ancestors.
A scientist discovered a new organism in some caves in Pennsylvania. The organism has the following characteristics:

- It is multicellular.
- Its cells lack cell walls.
- It is motile.
- It is heterotrophic.

Based on this information, to which kingdom does the organism belong?

A. Animalia
B. Eubacteria
C. Fungi
D. Plantae

An RNA sequence is shown below.

AUGCCGAAACGU

Which of the following statements describes how the RNA sequence specifies the production of an amino acid chain?

A. Each individual RNA base codes for a single amino acid.
B. Each group of three RNA bases codes for a single amino acid.
C. Each group of three RNA bases codes for an enzyme that helps join amino acids together.
D. Each individual RNA base codes for the ribosome location where amino acids are assembled.

Which of the following roles does an enzyme play when the body processes sucrose (table sugar) into glucose and fructose?

A. An enzyme decreases the body’s need for sucrose.
B. An enzyme increases the amount of sucrose available.
C. An enzyme increases the rate at which the sucrose breaks down.
D. An enzyme decreases the amount of fructose and glucose product available.
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 diagram below shows parts of the human respiratory system.

![Respiratory System Diagram](diagram.png)

a. Identify the part of the respiratory system that functions to exchange gases between the respiratory system and the circulatory system.

b. Describe in detail how gases are exchanged between the respiratory system and the circulatory system in the part of the respiratory system you identified in part (a).

c. Select **two** other parts of the respiratory system labeled in the diagram. Describe the function of **each** of the parts you selected.
 Which of the following is an example of emigration?

A. A small number of hummingbirds leave an island.
B. A large number of hummingbirds die in a hurricane.
C. A species of hummingbird lays its eggs in the summer months.
D. A species of hummingbird adapts to its environment over time.

Sea otters are small marine mammals that prey on fish, clams, crabs, and sea urchins. Sea otters’ natural predators include bears, sharks, and killer whales, but humans have also threatened sea otter populations. Hunting of sea otters for their fur severely reduced sea otter populations in the 18th and 19th centuries. After laws and programs were put into place to protect sea otters, their populations started increasing. Some sea otter populations in Alaska are now decreasing again. Which of the following is the most likely cause of these decreases?

A. greater numbers of killer whales
B. larger populations of sea urchins
C. less competition from other marine mammals
D. limited immigration of sea otters from California
26. An extinct shark named Scapanorhynchus existed over 100 million years ago. It had a long snout, sharp teeth, and a long tail fin. Which of the following statements explains how scientists most likely learned this information about Scapanorhynchus?

A. They studied fossilized remains of Scapanorhynchus.
B. They analyzed the DNA sequence of Scapanorhynchus.
C. They looked at the skeletons of modern sharks that live where Scapanorhynchus lived.
D. They studied the anatomy of other aquatic animals that lived when Scapanorhynchus lived.

27. In snapdragons, the allele for red flower color ($C^R$) is incompletely dominant to the allele for white flower color ($C^W$). Snapdragons that are heterozygous for flower color have a pink phenotype. Which of the following crosses could yield all three flower color phenotypes (red, white, and pink) among the offspring?

A. $C^R C^R \times C^W C^W$
B. $C^R C^R \times C^R C^W$
C. $C^R C^W \times C^R C^W$
D. $C^R C^W \times C^W C^W$
Some areas of a forest contain rich soil, while in other areas the soil is poor. Plants of a certain species grow taller in the rich soil than in the poor soil. The taller plants receive more sunlight and are able to produce more offspring than the shorter plants. If these offspring grow in rich soil, they are tall, but if they grow in poor soil, they are short. Which of the following statements best explains why this situation is not an example of evolution by natural selection?

A. The observed differences in plant height are not due to genetics.
B. The differences in soil conditions do not affect all plants equally.
C. The short plants and tall plants are not isolated enough from each other.
D. The short plants are not accumulating gene mutations as quickly as the tall plants.

What do disaccharides, such as sucrose, and polysaccharides, such as starch, have in common?

A. They are lipids made of fatty acids.
B. They are proteins made of amino acids.
C. They are nucleic acids made of nucleotides.
D. They are carbohydrates made of simple sugars.
30. The role of an enzyme in a chemical reaction is to change which of the following?

A. the type of reaction
B. the activation energy of the reaction
C. the pH at which the reaction occurs
D. the temperature at which the reaction occurs

31. Polycystic kidney disease (PKD) can result in kidney failure. In most cases, PKD is caused by a dominant allele. What is the chance that a child will have PKD if the father is unaffected and the mother is heterozygous for PKD?

A. 0%
B. 25%
C. 50%
D. 75%
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 Garden pea plants can have green or yellow pods. The green pod allele \((G)\) is dominant to the yellow pod allele \((g)\).

a. Draw a Punnett square for the cross of a heterozygous plant with green pods and a plant with yellow pods.

b. Give the expected phenotype ratio of the offspring for the cross in part (a).

c. In another cross, 449 offspring plants had green pods and 151 offspring plants had yellow pods. Identify the most likely genotypes of the parent pea plants and include a Punnett square to support your answer.
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 type of molecule in the yolk of a chicken egg provides the most energy for a developing chick?

A. lipid
B. nucleic acid
C. salt
D. water

34 A process is illustrated in the diagram below.

1. 2.

3. 4.

Which process is illustrated in the diagram?

A. bacterial conjugation
B. facilitated diffusion
C. gamete formation
D. viral reproduction

35 An EEG is a medical instrument that measures and records the electrical activity of the brain. The brain’s electrical activity is directly caused by which of the following?

A. production of ATP
B. synthesis of hormones
C. repair of damaged tissue
D. transmission of nerve impulses

36 Which of the following describes the function of DNA?

A. encoding genetic information
B. storing energy in chemical bonds
C. speeding up biochemical reactions
D. destroying substances that enter the cell
A picture of a horseshoe crab is below. Horseshoe crabs are arthropods, related to crustaceans, insects, and spiders.

In the 1990s, the harvesting of horseshoe crabs for fishing bait and biomedical use led to a significant decrease in the size of horseshoe crab populations on the Mid-Atlantic coast of the United States. Recovery efforts for the horseshoe crab populations are most challenged by which of the following?

A. Horseshoe crabs are most active at night.
B. Horseshoe crabs have to shed their exoskeletons as they grow.
C. Horseshoe crabs can live on the Atlantic coast from Maine to Mexico.
D. Horseshoe crabs take nine to twelve years to reach maturity and reproduce.

Some unicellular protists, such as dinoflagellates, use mitosis to reproduce. Which of the following statements describes the offspring?

A. The offspring are twice as large as the parent.
B. The offspring are genetically identical to the parent.
C. The offspring develop from a parent’s fertilized egg.
D. The offspring have half as many chromosomes as the parent.

Which of the following organisms is a prokaryote?

A. Agaricus arvensis, horse mushroom
B. Rhizopus stolonifer, bread mold fungus
C. Saccharomyces cerevisiae, baker’s yeast
D. Thiopedia rosea, purple sulfur bacterium
Over time, a type of plant called Darwin’s orchid has evolved a long, 28 cm nectar tube on its flowers. A particular species of moth pollinates the Darwin’s orchid. Which of the following evolutionary changes was most likely favored in the moth because of its relationship with the Darwin’s orchid?

A. faster flying speeds in the moths
B. larger average size of the moths’ eyes
C. longer average length of the moths’ tongues
D. more elaborate mating behaviors in the moths

The table below shows the approximate amounts of nitrogen fixed per year by various processes worldwide.

<table>
<thead>
<tr>
<th>Process</th>
<th>Amount of Nitrogen Fixed per Year (× 10^6 metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nonbiological</strong></td>
<td></td>
</tr>
<tr>
<td>industrial</td>
<td>50</td>
</tr>
<tr>
<td>combustion</td>
<td>20</td>
</tr>
<tr>
<td>lightning</td>
<td>10</td>
</tr>
<tr>
<td><strong>Biological</strong></td>
<td></td>
</tr>
<tr>
<td>microorganisms on agricultural land</td>
<td>90</td>
</tr>
<tr>
<td>microorganisms on forest and nonagricultural land</td>
<td>50</td>
</tr>
<tr>
<td>microorganisms in water</td>
<td>35</td>
</tr>
</tbody>
</table>

Based on the data, which of the following conclusions can be made?

A. Aquatic ecosystems are more nitrogen-rich than terrestrial ecosystems.
B. Forests and nonagricultural land need more nitrogen than agricultural land needs.
C. The global nitrogen cycle would be relatively unaffected if no fixation occurred by industrial processes.
D. The amount of nitrogen fixed by biological processes is more than two times the amount fixed by nonbiological processes.
The diagram below represents a process that occurs in the nucleus of a eukaryotic cell.

Which of the following statements describes what is happening in this process?

A. Molecules of RNA are forming chromosomes.
B. A molecule of mRNA is directing the production of tRNA.
C. Molecules of DNA are being packaged for export to the ribosomes.
D. A molecule of DNA is being replicated to make two identical copies.

Scientists are researching a way to regenerate cartilage. In a lab, cartilage-forming cells are grown on a synthetic carbon surface. If continued trials are successful, the synthetic surface can be applied to which of the following areas in the human body to treat cartilage damage or loss?

A. muscle fibers
B. major arteries
C. the ends of bones
D. the axons of nerve cells
The table below shows small portions of the amino acid sequences of a particular protein in four animal species.

<table>
<thead>
<tr>
<th>Animal Species</th>
<th>Portion of Amino Acid Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Met-His-Leu-Ala-Pro</td>
</tr>
<tr>
<td>2</td>
<td>Met-His-Leu-Glu-Glu</td>
</tr>
<tr>
<td>3</td>
<td>Met-Tyr-Leu-Ala-Pro</td>
</tr>
<tr>
<td>4</td>
<td>Met-Ala-Leu-Arg-Trp</td>
</tr>
</tbody>
</table>

a. Based on the data in the table, which two species are most closely related? Explain your answer.

b. Describe and explain three other forms of scientific evidence that could be used to study the relatedness of these four animal species.
Animal cells carry out many basic functions. Four of these functions are listed below:

- bringing nutrients and materials into the cell
- getting energy from food molecules
- getting rid of wastes in the cell
- making necessary protein products such as enzymes

For each function listed, identify one animal cell structure involved and explain how that structure performs the given function.
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Page No.</th>
<th>Reporting Category</th>
<th>Standard</th>
<th>Correct Answer (MC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>Evolution and Biodiversity</td>
<td>5.1</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>Genetics</td>
<td>3.5</td>
<td>C</td>
</tr>
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<td>Biochemistry and Cell Biology</td>
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<td>D</td>
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<td>D</td>
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<td>Biochemistry and Cell Biology</td>
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<td>13</td>
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*Answers are provided here for multiple-choice items only.*