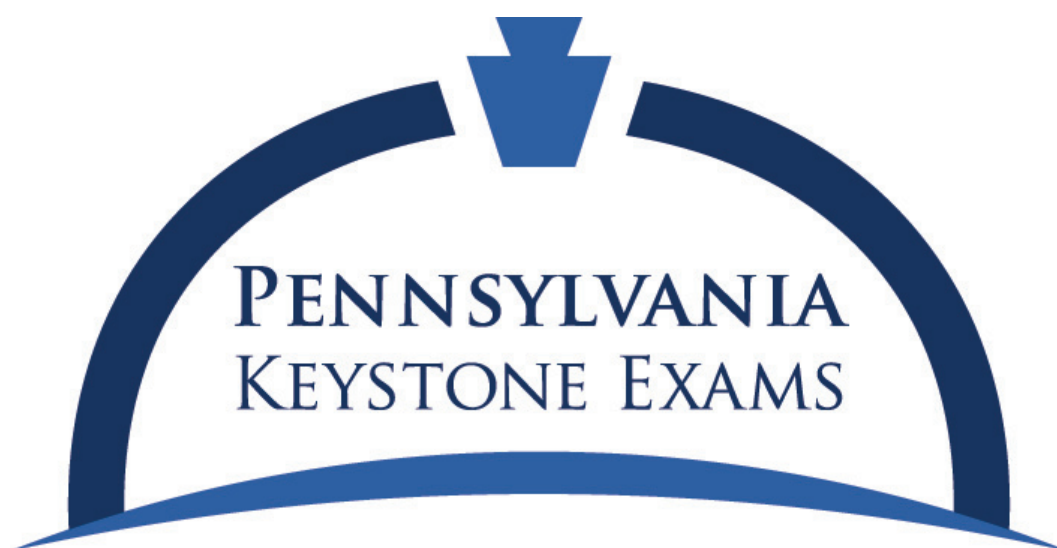




**pennsylvania**  
DEPARTMENT OF EDUCATION



**PENNSYLVANIA  
KEYSTONE EXAMS**

**BIOLOGY**

**ITEM AND SCORING SAMPLER**

**2011**

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## INTRODUCTION

The Pennsylvania Department of Education (PDE) provides districts and schools with tools to assist in delivering focused instructional programs aligned to the state assessment system. These tools include assessment anchor documents, assessment handbooks, and content-based item and scoring samplers. This 2011 Biology Item and Scoring Sampler is a useful tool for Pennsylvania educators in the preparation of local instructional programs and in preparing students for the Keystone Exams.

This Item and Scoring Sampler contains multiple-choice questions and constructed-response questions that are aligned to the Keystone Assessment Anchors and Eligible Content. They provide examples of the types of questions that will appear on the operational Spring 2011 Keystone Exams. Each question has been through a rigorous review process to ensure alignment with the Assessment Anchors and Eligible Content.

The questions in this sampler may be used as examples for creating assessment questions at the classroom level, and they may also be copied and used as part of a local instructional program.<sup>1</sup> Classroom teachers may find it beneficial to have students respond to the constructed-response questions in this sampler. Educators can then use the sampler as a guide to score the responses either independently or together with colleagues within a school or district.

## ABOUT THE KEYSTONE EXAMS

The Keystone Exams are end-of-course assessments designed to assess proficiency in various subject areas, including Algebra I, Algebra II, Biology, Chemistry, Civics and Government, English Composition, Geometry, Literature, U.S. History, and World History. The Keystone Exams are just one component of Pennsylvania's high school graduation requirements. Students must also earn state-specified credits, fulfill the state's service-learning and attendance requirements, and complete any additional local school system requirements to receive a Pennsylvania high school diploma.

For detailed information about how the Keystone Exams are being integrated into the Pennsylvania graduation requirements, please contact the Pennsylvania Department of Education or visit the PDE Web site at [www.pdesas.org](http://www.pdesas.org).

## ALIGNMENT

The Biology Keystone Exam consists of exam questions arranged into **two modules**: Cells and Cell Processes and Continuity and Unity of Life. Each module corresponds to specific content aligned to statements and specifications included in the course-specific assessment anchor documents. The Biology content included in the Keystone Biology multiple-choice questions will align with the Assessment Anchors as defined by the Eligible Content statements. The process skills, directives, and action statements will also specifically align with the Assessment Anchors as defined by the Eligible Content statements.

The content included in Biology constructed-response questions aligns with content included in the Eligible Content statements. The process skills, directives, and action statements included in the performance demands of the Biology constructed-response questions align with specifications included in the Assessment Anchor statements, the Anchor Descriptor statements, and/or the Eligible Content statements. In other words, the verbs or action statements used in the constructed-response questions or stems can come from the Eligible Content, Anchor Descriptor, or Assessment Anchor statements.

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<sup>1</sup> The permission to copy and/or use these materials does not extend to commercial purposes.

**KEYSTONE EXAM FORMAT**

The Biology Keystone Exam includes questions that require students to select the best answer from four possible answer options. Students read each question and record their answers in the space provided. The correct answer for each multiple-choice question is worth one point.

The Biology Keystone Exam also includes questions that require students to write responses. Students read the question and write their responses in the spaces provided. Each constructed-response question is designed to take about eight minutes to complete. During an actual exam administration, students are given additional time as necessary to complete the exam. Each constructed-response question in Biology is scored using an item-specific scoring guideline based on a 0–3-point scale. In this sampler, each item-specific scoring guideline is combined with sample student responses representing each score point to form a practical, item-specific scoring guide.

The sampler also includes the General Description of 3-point Scoring Guidelines for Biology used to develop the item-specific scoring guidelines. These general guidelines should be used if any additional item-specific scoring guidelines are created for use within local instructional programs.

## GENERAL DESCRIPTION OF 3-POINT SCORING GUIDELINES FOR BIOLOGY

### 3 POINTS

- The response demonstrates a *thorough* understanding of the scientific content, concepts, and/or procedures required by the task(s).
- The response provides a clear, complete, and correct response as required by the task(s). The response may contain a minor blemish or omission in work or explanation that does not detract from demonstrating a *thorough* understanding.

### 2 POINTS

- The response demonstrates a *partial* understanding of the scientific content, concepts, and/or procedures required by the task(s).
- The response is somewhat correct with *partial* understanding of the required scientific content, concepts, and/or procedures demonstrated and/or explained. The response may contain some work that is incomplete or unclear.

### 1 POINT

- The response demonstrates a *minimal* understanding of the scientific content, concepts, and/or procedures required by the task(s).
- The response is somewhat correct with *minimal* understanding of the required scientific content, concepts, and/or procedures demonstrated and/or explained. The response may contain some work that is incomplete or unclear.

### 0 POINTS

- The response provides *insufficient* evidence to demonstrate any understanding of the scientific content, concepts, and/or procedures required by the task(s).
- The response may show only information copied or rephrased from the question or *insufficient* correct information to receive a score of 1.

**MULTIPLE-CHOICE QUESTIONS****A.1.2.1**

1. Which statement **best** describes a difference between prokaryotic cells and eukaryotic cells?
- A. The presence of both DNA and ribosomes in prokaryotic cells indicates that they are more complex than eukaryotic cells.
  - B. The larger size of prokaryotic cells indicates that they are more complex than eukaryotic cells.
  - C. The presence of membrane-bound organelles in eukaryotic cells indicates that they are more complex than prokaryotic cells. \*
  - D. The larger size of eukaryotic cells indicates that they are more complex than prokaryotic cells.

- A. *Both cell types contain DNA and ribosomes; prokaryotes have less-complex cell organization.*
- B. *Prokaryotes have less-complex cell organization and are generally smaller than eukaryotes.*
- C. *Key: Eukaryotes are more complex because they have organelles that are membrane bound, such as the nuclei which contain their DNA. Prokaryotes have DNA, but it is not bound by a membrane as in eukaryotes.*
- D. *A high surface-area-to-volume ratio usually increases cell efficiency; therefore, larger cells are usually less efficient than smaller cells.*

## A.1.2.2

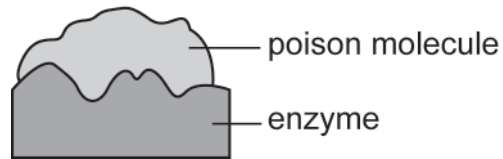
2. Alveoli are microscopic air sacs in the lungs of mammals. Which statement **best** describes how the structure of the alveoli allows the lungs to function properly?
- A. They increase the amount of energy transferred from the lungs to the blood.
  - B. They increase the flexibility of the lungs as they expand during inhalation.
  - C. They increase the volume of the lungs, allowing more oxygen to be inhaled.
  - D. They increase the surface area of the lungs, allowing efficient gas exchange. \*

- A. *The structure of the alveoli has little impact on the lung's ability to transfer energy.*
- B. *The structure and function of the alveoli has little impact on the flexibility of lung tissue.*
- C. *The millions of alveoli in the lungs of mammals decrease the total volume of the lungs.*
- D. *Key: The millions of alveoli in mammals greatly increase the surface area of the lungs, thereby providing a larger surface area for gas exchange.*

## A.2.3.1

Use the diagram below to answer question 3.

**Poison Bonding to an Enzyme**



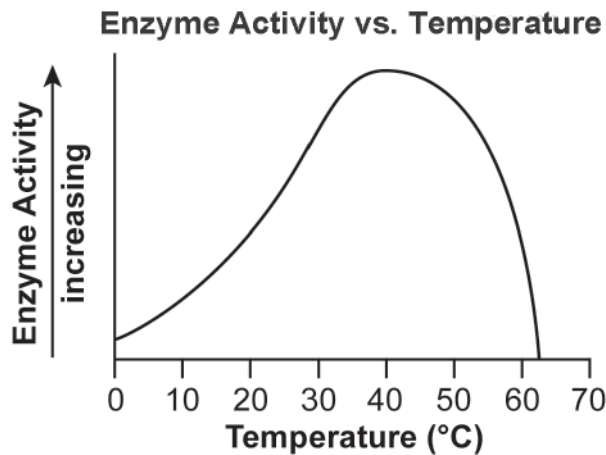
3. The diagram models how a poison bonds to the active site of an enzyme. Which function is the enzyme **most likely** unable to perform because of the attachment of the poison molecule?
- A. the release of stored chemical energy
  - B. the donation of electrons to the substrate
  - C. the supply of activation energy for a reaction
  - D. the catalysis of the reaction with the substrate \*

- A. *Release of any chemical energy comes from the substrate and not from the enzyme.*
- B. *Enzymes do not donate electrons to the substrate.*
- C. *Enzymes lower the activation energy needed for the chemical reaction to occur.*
- D. *Key: Most enzymes react with only one reactant, so when a poison blocks the active site, the enzyme can no longer bond with the substrate, causing the chemical reaction to stop.*



## A.2.3.2

Use the graph below to answer question 4.



4. The graph shows how the activity of an enzyme changes at different temperatures. Which statement **best** describes what happens to the enzyme when the temperature of the reaction increases to 63°C?
- A. The enzyme is used up and the reaction stops.
  - B. The enzyme begins to decrease the rate of the reaction.
  - C. The enzyme continues to increase the rate of the reaction.
  - D. The enzyme changes shape and can no longer speed up the reaction. \*

- A. *An enzyme is not consumed during the chemical reaction.*
- B. *The enzyme does not have the ability to decrease the rate of a reaction; the rate of reaction is affected by temperature, pH, concentration of substrate, etc.*
- C. *The graph illustrates that enzyme activity decreases as the temperature increases beyond 40°C. A temperature of 63°C would cause the rate of the reaction to decrease, not increase.*
- D. *Key: Enzymes have an optimal temperature range at which they function; when the temperature exceeds that range, the enzyme will denature, causing it to change its shape and no longer be able to bind with the substrate.*

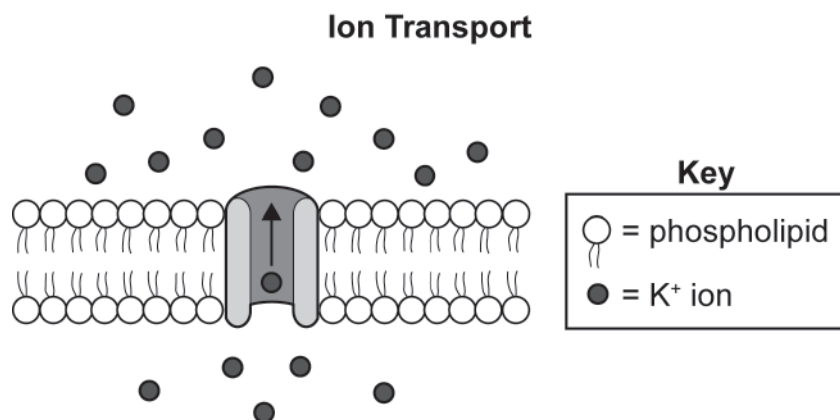
## A.3.2.1

5. Which statement **best** compares the energy transformations of photosynthesis and cellular respiration?
- A. Only photosynthesis uses oxygen to create energy.
  - B. Only photosynthesis causes an increase in kinetic energy.
  - C. Photosynthesis and cellular respiration both store energy in chemical bonds. \*
  - D. Photosynthesis and cellular respiration both require chemical energy to make food.

- A. *Photosynthesis uses the energy from sunlight to convert carbon dioxide and water into sugars and oxygen.*
- B. *Photosynthesis causes electromagnetic energy from sunlight to be transformed into chemical energy in sugars.*
- C. *Key: Both photosynthesis and cellular respiration store energy within the bonds of sugar and/or ATP molecules.*
- D. *Photosynthesis uses energy from sunlight to produce sugars.*

## A.3.2.2

Use the diagram below to answer question 6.

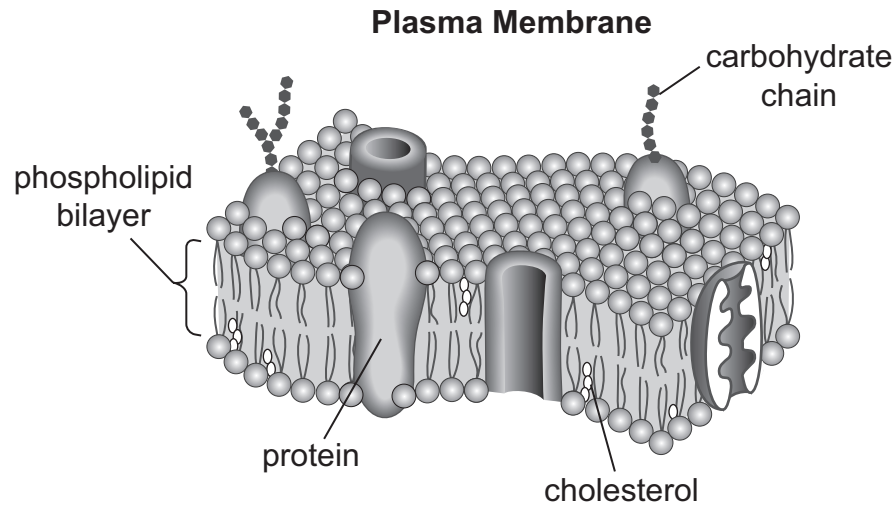


6. The diagram shows the movement of ions against a concentration gradient to an area of higher concentration. Which molecule provides the energy needed for this movement to occur in a cell?
- A. ATP \*
  - B. mRNA
  - C. protein
  - D. lipid

- A. *Key: ATP is an energy molecule that can be used to actively transport ions across a concentration gradient.*
- B. *An mRNA molecule contains genetic information and is not an energy molecule.*
- C. *Protein molecules can be used as the channel or pump from which the ions move, but they do not provide the energy to actively transport ions.*
- D. *Lipid molecules are part of a cell membrane, but they do not provide the energy to actively transport ions.*

## A.4.1.1

Use the diagram below to answer question 7.



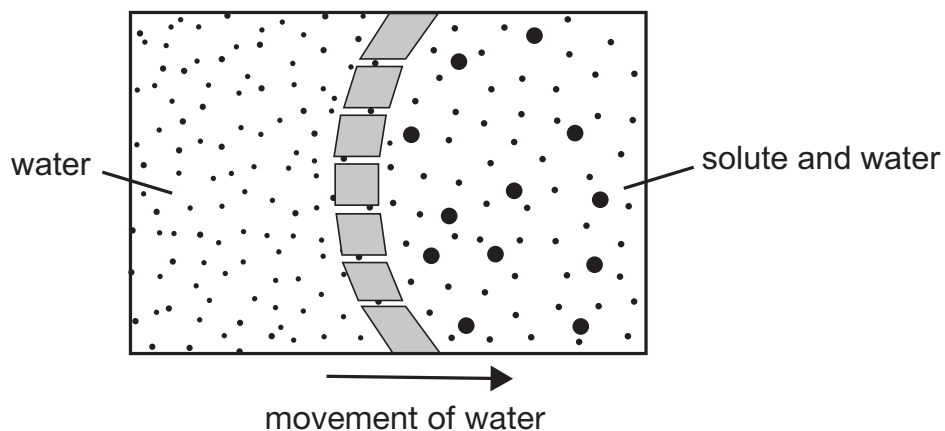
7. Which component of this membrane contains a hydrophobic region and acts as the primary barrier to **most** foreign substances?
- A. protein
  - B. cholesterol
  - C. carbohydrate chain
  - D. phospholipid bilayer \*

- A. *The function of the proteins in a plasma membrane is to allow the movement of substances across the membrane.*
- B. *The main functions of cholesterol in a plasma membrane are to help make the phospholipid bilayer more rigid, which decreases its permeability, and to prevent phase shifts in the membrane.*
- C. *Carbohydrate chains often function in cellular recognition.*
- D. *Key: Each phospholipid of the bilayer consists of two main parts: a hydrophilic phosphate group and hydrophobic lipid tails. This structure allows the bilayer to be impermeable to most water-soluble (hydrophilic) molecules and ions.*

## A.4.1.2

Use the diagram below to answer question 8.

### Water Movement and the Cell Membrane



8. The relative concentration of solute inside and outside a cell can cause water molecules to move across the membrane. Which phrase would be an alternate title to the diagram?
- A. Exocytosis in a Cell
  - B. Active Transport in a Cell
  - C. Osmosis Across a Membrane \*
  - D. Facilitated Diffusion Across a Membrane

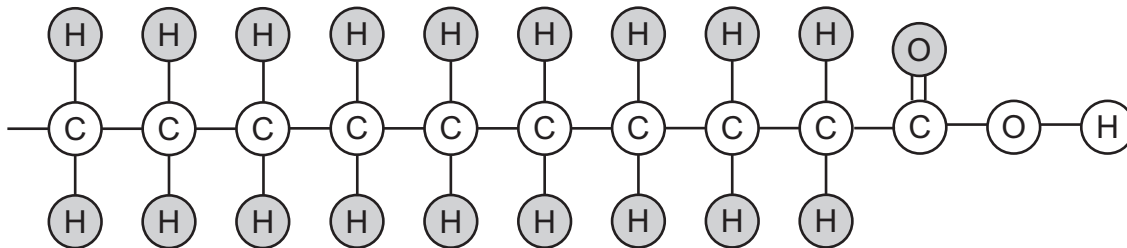
- A. *The diagram does not show the movement of a vesicle across a cell membrane.*
- B. *The diagram does not show energy being used to facilitate the movement of water.*
- C. *Key: The diagram shows osmosis, which is the movement of water across a semipermeable membrane from an area of dilute solute concentration to an area of higher solute concentration.*
- D. *The diagram does not show cell-membrane proteins that move molecules across the cell membrane.*

Use the information below about a chemical discovery to answer questions 9 and 10.

### Chemical Discovery

A scientist formed Chemical X in a laboratory. The material was then analyzed by other scientists.

#### Molecular Structure of Chemical X



Analysis showed that the chemical was composed of long chains of repeated copies of  $\text{CH}_2$  molecules.

#### A.4.1.1

9. A researcher noticed that a similar  $\text{CH}_2$  molecular structure was also located in the plasma membrane of an animal cell. This  $\text{CH}_2$  molecular structure contained a negatively charged phosphate group. Which statement **best** describes the primary function of the  $\text{CH}_2$  and phosphate molecular structure located in the plasma membrane?
- It contains the genetic information needed for protein production.
  - It catalyzes specific chemical reactions in the cytoplasm of a cell.
  - It stores the energy that a cell needs to perform various life processes.
  - It allows a cell to regulate the movement of materials into and out of a cell. \*

- The molecule described does not indicate it is DNA, and it would not be located in the plasma membrane.
- The molecule described does not indicate it is an enzyme, and it would not be located in the plasma membrane.
- The molecule described does not indicate it is an ATP molecule, and it would not be located in the plasma membrane.
- Key: The molecule described is a phospholipid located in the plasma membrane that helps regulate the movement of materials into and out of a cell.

## A.2.2.3

10. Which type of organic molecule was **most likely** formed by the scientist in the laboratory?
- A. lipid \*
  - B. protein
  - C. nucleic acid
  - D. carbohydrate

- A. *Key: Most lipid molecules have long hydrocarbon chains as the main component of their structures. The molecule described has a long hydrocarbon chain with a phosphate group, which is a phospholipid.*
- B. *Protein molecules are made of amino acids.*
- C. *Nucleic acid molecules are made of nucleotides.*
- D. *Carbohydrate molecules are made of carbon, oxygen, and hydrogen atoms in a specific ratio.*

**CONSTRUCTED-RESPONSE QUESTION****A.2.2.3**

11. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

**Part A:** Describe the general composition of a protein molecule.

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**Part B:** Describe how the structures of proteins differ from the structures of carbohydrates.

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**Go to the next page to finish question 11.**





11. **Continued.** Please refer to the previous page for task explanation.

**Part C:** Describe how the functions of proteins differ from the functions of carbohydrates.

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## ITEM-SPECIFIC SCORING GUIDELINE

### ITEM # 11

This item is reported under A.2.2.3

#### Assessment Anchor:

A.2.2– Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules).

#### Specific Eligible Content addressed by this item:

A.2.2.3– Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.

#### Scoring Guide:

Part A: Describe the general composition of a protein molecule.

Part B: Describe how the structures of proteins differ from the structures of carbohydrates.

Part C: Describe how the functions of proteins differ from the functions of carbohydrates.

Score	Student Response Descriptions
3	The response demonstrates a <i>thorough</i> understanding of the structures and functions of carbohydrates and proteins by describing each of the following: <ul style="list-style-type: none"> <li>the general composition of a protein molecule, <b>and</b></li> <li>how the structures of proteins differ from carbohydrates, <b>and</b></li> <li>how the functions of proteins differ from carbohydrates.</li> </ul> The response is clear, complete, and correct.
2	The response demonstrates a <i>partial</i> understanding of the structures and functions of carbohydrates and proteins by describing any <b>two</b> of the following: <ul style="list-style-type: none"> <li>the general composition of a protein molecule,</li> <li>how the structures of proteins differ from carbohydrates,</li> <li>how the functions of proteins differ from carbohydrates.</li> </ul> The response may contain some work that is incomplete or unclear.
1	The response demonstrates a <i>minimal</i> understanding of the structures and functions of carbohydrates and proteins by describing any <b>one</b> of the following: <ul style="list-style-type: none"> <li>the general composition of a protein molecule,</li> <li>how the structures of proteins differ from carbohydrates,</li> <li>how the functions of proteins differ from carbohydrates.</li> </ul> The response may contain some work that is incomplete or unclear.
0	The response provides <i>insufficient</i> evidence to demonstrate any understanding of the concept being tested.

**Note: No deductions should be taken for misspelled words or grammatical errors.**

**Possible responses that will receive credit:****Part A (1 point):**

- Proteins are composed of amino acid molecules linked together by peptide bonds. C, H, N, S, and O are typical atoms that compose amino acids.

**Part B (1 point):**

- The amino acids contain amino and carboxyl groups. Primary, secondary, tertiary, and quaternary structures of a protein molecule are necessary for the protein to function correctly. Interactions occur between amino and carboxyl groups of amino acids. Carbohydrates are composed of C, H, and O. Monosaccharides are the building blocks of carbohydrates. Two monosaccharides form a disaccharide. Many monosaccharides form a polysaccharide, such as starch, cellulose, or chitin.

**Part C (1 point):**

- Proteins function as enzymes, antibodies, and structural components. Carbohydrates function in short-term energy storage (starch, glycogen) or structural components (chitin, cellulose, glycogen).

**A.2.2.3 Response Score: 3 points**

11. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

**Part A:** Describe the general composition of a protein molecule.

Proteins are made of carbon, hydrogen, oxygen, nitrogen and some have sulfur. These elements form amino acids. Amino acids form proteins.

**Part B:** Describe how the structures of proteins differ from the structures of

Carbohydrates are in long chains formed by sugars that are bonded together. Proteins can be in sheets or folded shapes. Carbohydrates only have carbon, hydrogen and oxygen in them.

**Go to the next page to finish question 11.**

11. **Continued.** Please refer to the previous page for task explanation.

**Part C:** Describe how the functions of proteins differ from the functions of carbohydrates.

Proteins make up the enzymes that speed up the reactions in living things. Proteins also make antibodies. Carbohydrates give us energy (starch) and make plant cell walls (cellulose).

*The student response correctly describes the general composition of proteins by listing the elements that form proteins and identifying the building blocks of proteins, correctly describes the main differences in protein and carbohydrate structures, and correctly describes the functions of both molecules. All three parts of the answer are correct and complete; the response is given 3 points.*

**A.2.2.3 Response Score: 2 points**

11. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

**Part A:** Describe the general composition of a protein molecule.

Proteins are made of amino acids and have carbon, hydrogen, oxygen and nitrogen.

**Part B:** Describe how the structures of proteins differ from the structures of carbohydrates.

Proteins have a lot of shapes like sheets or bundles that fold back on themselves. Carbohydrates are chains of carbon, hydrogen and oxygen.

**Go to the next page to finish question 11.**

11. **Continued.** Please refer to the previous page for task explanation.

**Part C:** Describe how the functions of proteins differ from the functions of carbohydrates.

*Both things are needed for life.*

*The student response correctly describes the general composition of proteins and correctly describes the main differences in protein and carbohydrate structures, but it does not correctly describe the function of each molecule. Two of the three parts of the answer are correct; the response is given 2 points.*

**A.2.2.3 Response Score: 1 point**

11. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

**Part A:** Describe the general composition of a protein molecule.

Proteins have 4 elements in them:  
C, H, O, and N and are made of  
building blocks called amino acids.

**Part B:** Describe how the structures of proteins differ from the structures of carbohydrates.

Proteins are made of amino acids,  
carbohydrates are not.

**Go to the next page to finish question 11.**



11. **Continued.** Please refer to the previous page for task explanation.

**Part C:** Describe how the functions of proteins differ from the functions of carbohydrates.

More foods have Carbohydrate than protein. Meat has protein.

*The student response correctly describes the general composition of proteins, but it does not correctly differentiate between the structures of proteins and carbohydrates or describe the function of either type of molecule. The response is given 1 point.*

**A.2.2.3 Response Score: 0**

11. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

**Part A:** Describe the general composition of a protein molecule.

Proteins are big molecules .

**Part B:** Describe how the structures of proteins differ from the structures of carbohydrates.

There are more parts to a carbohydrate than a protein because carbohydrates are bigger than proteins .

**Go to the next page to finish question 11.**

11. **Continued.** Please refer to the previous page for task explanation.

**Part C:** Describe how the functions of proteins differ from the functions of carbohydrates.

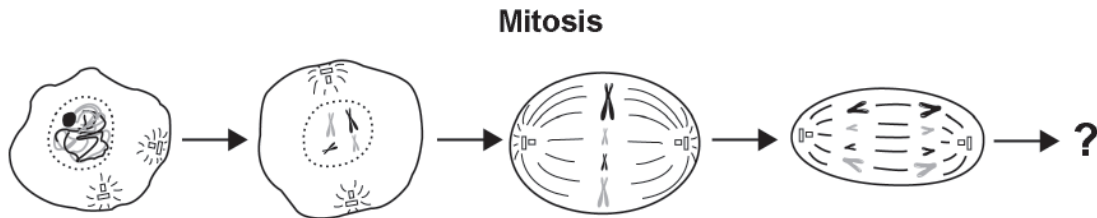
Proteins help you grow but carbohydrates  
make you fat

*The student response fails to describe the general composition of proteins and fails to compare the structures or functions of proteins and carbohydrates. The response is given no credit.*

## MULTIPLE-CHOICE QUESTIONS

## B.1.1.1

Use the diagram below to answer question 1.



1. Which event **most likely** occurs next in mitosis?

- A. The chromatin condenses.
- B. The nuclear envelope dissolves.
- C. The chromosomes double in number.
- D. The cell membrane pinches inward to divide the cytoplasm. \*

- A. *The condensing of the chromatin occurs during prophase at the beginning of mitosis.*
- B. *The nuclear envelope dissolves after the chromatin condenses into chromosomes during prophase.*
- C. *The chromosomes double in number during the S phase, not during mitosis.*
- D. *Key: The next event would show telophase, when the cell begins to separate into two daughter cells.*

## B.1.1.2

2. Mitosis and meiosis are processes by which animal and plant cells divide. Which statement **best** describes a difference between mitosis and meiosis?
- A. Meiosis is a multi-step process.
  - B. Mitosis occurs only in eukaryotic cells.
  - C. Meiosis is used in the repair of an organism.
  - D. Mitosis produces genetically identical daughter cells. \*

- A. *Both meiosis and mitosis are multi-step processes.*
- B. *Mitosis also takes place in prokaryotic cells.*
- C. *Meiosis generates gametes used in sexual reproduction.*
- D. *Key: Cells produced through mitosis contain DNA identical to the parent cells, whereas meiosis produces cells that are haploid and often genetically different.*

## B.2.1.1

3. A scientist observes that a certain trait is determined by a single allele. An organism inherited one version of the trait from one parent and another version from the other parent. Both versions of the trait are expressed in the phenotype of the offspring. Which pattern of inheritance **best** classifies the observed trait?
- A. dominance
  - B. sex-linkage
  - C. co-dominance \*
  - D. incomplete dominance

- A. *The pattern of inheritance does not reflect that one allele is dominant and the other is recessive since both traits are expressed in the individual.*
- B. *The information given does not provide enough evidence for a sex-linkage pattern of inheritance.*
- C. *Key: The pattern of inheritance is best described as co-dominance because both traits are fully expressed in the phenotype of the individual.*
- D. *Since both versions of the trait are expressed without a modification of the phenotype expressed, the pattern of inheritance is not incomplete dominance.*

## B.2.2.1

4. The bacterium *Acetobacter aceti* is found in acidic environments and has an acidic cytoplasm. For this reason, most of its proteins are able to function in acidic conditions. This property distinguishes *Acetobacter aceti* proteins from those of most other organisms. Which characteristic does *Acetobacter aceti* **most likely** share with other organisms?
- A. the method that the organism uses to reproduce itself
  - B. the physical and chemical responses to environmental changes
  - C. the type of organelle used to produce energy for cellular functions
  - D. the process used to form proteins by transcription and translation \*

- A. *Bacteria are prokaryotes and reproduce by binary fission; most organisms that are eukaryotes reproduce by mitosis and meiosis.*
- B. *Bacteria are prokaryotes, lacking membrane-bound organelles, which respond to changes in their environment differently than eukaryotic cells.*
- C. *Bacteria are prokaryotes and do not have membrane-bound organelles, such as mitochondria that produce energy for eukaryotic cells.*
- D. *Key: Prokaryotes and eukaryotes both have ribosomes that synthesize proteins.*

## B.2.3.1

5. A mutation occurs at the midpoint of a gene, altering all amino acids encoded after the point of mutation. Which mutation could have produced this change?
- A. deletion of two nucleotides \*
  - B. deletion of three nucleotides
  - C. insertion of six nucleotides
  - D. insertion of twelve nucleotides

- A. *Key: A deletion of two nucleotides will most likely cause a shift in the codon sequence that codes for an amino acid. This could cause a change in the sequence of amino acids attached after the point of the mutation.*
- B. *A deletion of three nucleotides will cause a deletion of the original amino acid in the protein but will not cause a change in the rest of the amino-acid sequence.*
- C. *An insertion of six nucleotides will add two additional amino acids to the protein but will not cause a change in the rest of the amino-acid sequence.*
- D. *An insertion of twelve nucleotides will add four additional amino acids to the protein but will not cause a change in the rest of the amino-acid sequence.*

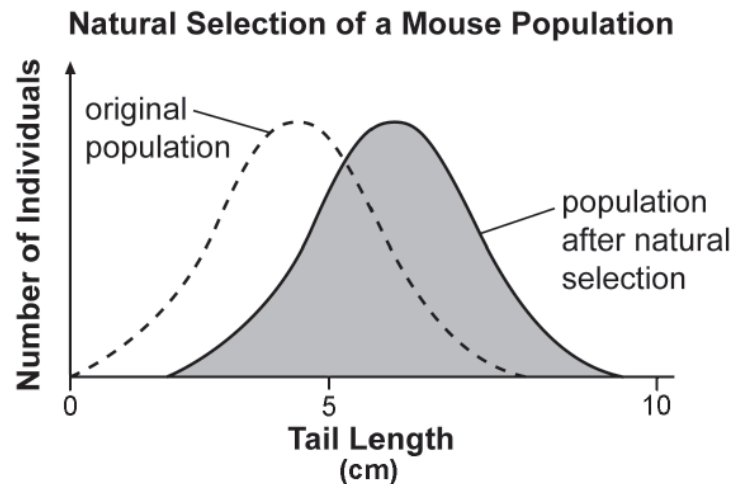
## B.3.1.1

6. The frequency of an allele in a fly population changes from 89% to 20% after three generations. Which other events **most likely** occurred during the same time period?
- A. an environmental change and a fly population increase
  - B. an environmental change and a fly population decrease \*
  - C. interbreeding of flies with an invasive species and fly population speciation
  - D. interbreeding of flies with an established local species and fly population speciation

- A. *An environmental change that did not favor the individuals in the population with the allele most likely led to the change in allele frequency; however, since the allele frequency decreased by so much, there would had to have been a decrease in the population within a three-generation period of time.*
- B. *Key: An environmental change that did not favor the individuals in the population with the allele most likely led to the change in allele frequency; since the allele frequency decreased by so much, there would had to have been a decrease in the population within a three-generation period of time.*
- C. *Interbreeding between species is not likely to occur and can produce offspring that are not able to reproduce. Speciation would most likely need more than three generations to occur.*
- D. *Interbreeding between species is not likely to occur and can produce offspring that are not able to reproduce. Speciation would most likely need more than three generations to occur.*

## B.3.1.1

Use the graph below to answer question 7.



7. Tail length in mice varies within a population. Scientists observed change in the distribution of tail lengths in a mouse population over time. At the genetic level, what has **most likely** happened to the allele for the shortest tail lengths?
- The allele changed from being dominant to being recessive.
  - The allele changed from being autosomal to being sex-linked.
  - The allele became less frequent than the alleles for longer tail lengths. \*
  - The allele began to code for long tail lengths instead of the shortest ones.

- Alleles do not have the ability to revert back and forth from dominant to recessive.*
- It is not likely that the alleles changed their chromosome positions to cause the change in the tail-length distribution of the mouse population.*
- Key: Natural selection can cause changes in the allele frequency of a population—mice with short tails were not as successful in reproducing as were mice with longer tails due to environmental influences.*
- A genetic mutation would cause a change in the coding from the allele, not natural selection.*



## B.3.3.1

Use the table below to answer question 8.

Students' Observations of a Pond Ecosystem

Quantitative	Qualitative
37 fish and 3 frogs	Leaves lie on the bottom of the pond.
2 types of aquatic grass	Water insects move along the water's surface.
12 small rocks and 1 medium rock	All 3 frogs are sitting on a pond bank.
sand	

8. A group of students measured a ten-square-meter section of a pond ecosystem and recorded observations. Which statement is a testable hypothesis?
- A. The frogs living in the pond represent a population.
  - B. Water is an abiotic component in the pond ecosystem.
  - C. If the fish are given more food, then they will be happier.
  - D. If the frogs are startled, then they will jump into the water. \*

- A. *This is a statement and does not require testing to validate.*
- B. *This is a statement and does not have a testable framework.*
- C. *The level of happiness in a fish is not measurable.*
- D. *Key: This is a hypothesis because the action can be observed and tested to support or disprove the statement.*

## B.4.1.2

9. A researcher observing an ecosystem describes the amount of sunlight, precipitation, and type of soil present. Which factors is the researcher **most likely** describing?
- A. biotic factors in a forest
  - B. biotic factors in a tundra
  - C. abiotic factors in a prairie \*
  - D. abiotic factors in an ocean

- A. *Sunlight, precipitation, and soil are all abiotic components of a forest ecosystem.*
- B. *Sunlight, precipitation, and soil are all abiotic components of a tundra ecosystem.*
- C. *Key: The examples given are all abiotic components that can be used to describe a prairie ecosystem.*
- D. *Precipitation and soil types are not commonly used to describe aquatic ecosystems.*

## B.4.2.1

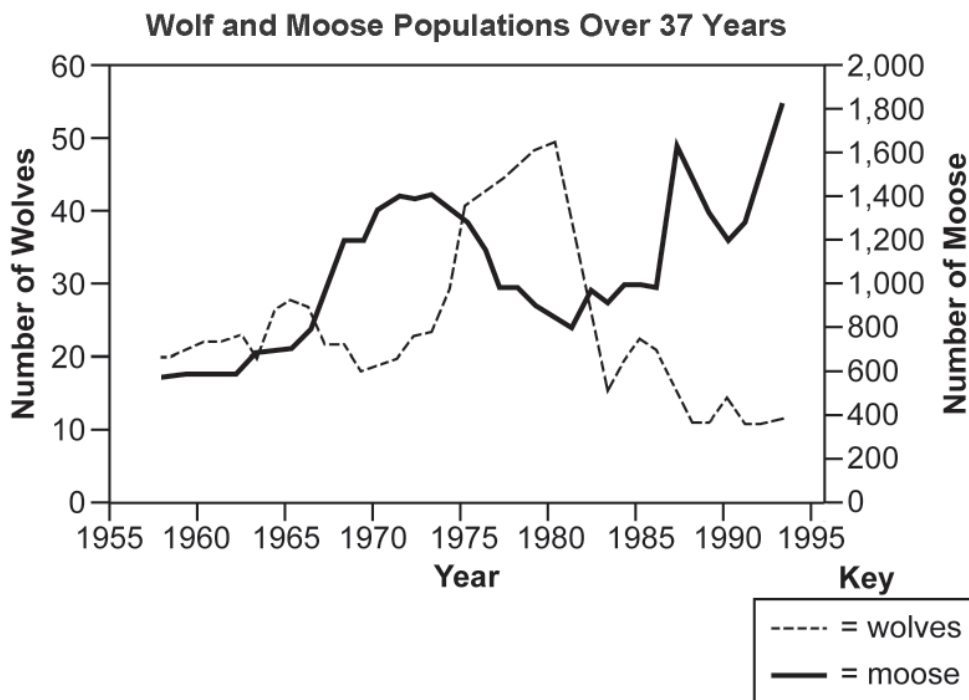
10. Scientists observed that the populations of top-level consumers in a particular ecosystem were rapidly decreasing. Further studies revealed that there was also a decline in producer productivity. Which other changes did the scientists **most likely** observe in the ecosystem?
- A. increased producer diversity
  - B. decreased population size at all levels \*
  - C. decreased primary consumer populations only
  - D. increased primary and secondary consumer diversity

- A. *A decline in producer productivity would most likely result in a decrease in producer diversity.*
- B. *Key: A decline in the producers of an ecosystem will cause a decrease in all other organisms because the producers are responsible for converting sunlight or chemical energy into usable energy for consumers.*
- C. *Primary consumer populations will decrease, but secondary consumer populations will also decrease.*
- D. *A decline in producer productivity would most likely lead to a decrease in diversity in primary and secondary consumers.*

**CONSTRUCTED-RESPONSE QUESTION**

**B.4.2.5**

Use the graph below to answer question 11.



11. Isle Royale is located in Lake Superior. Isle Royale is home to populations of wolves and moose. The interactions between the wolves and moose, as well as the individual population sizes, have been studied since 1958. The graph shows the population sizes over time for both wolves and moose.

**Part A:** Describe one limiting factor for the moose population.

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**Go to the next page to finish question 11.**

11. **Continued.** Please refer to the previous page for task explanation.

**Part B:** Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

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**Part C:** Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.

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## ITEM-SPECIFIC SCORING GUIDELINE

### ITEM # 11

This item is reported under B.4.2.5

#### Assessment Anchor:

B.4.2– Describe interactions and relationships in an ecosystem.

#### Specific Eligible Content addressed by this item:

B.4.2.5– Describe the effects of limiting factors on population dynamics and potential species extinction.

#### Scoring Guide:

Part A: Describe one limiting factor for the moose population.

Part B: Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

Part C: Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.

Score	Student Response Descriptions
3	<p>The response demonstrates a <i>thorough</i> understanding of the effects of limiting factors on population dynamics and potential species extinction by completing all of the following:</p> <ul style="list-style-type: none"> <li>describing one limiting factor for the moose population, <b>and</b></li> <li>explaining a likely reason the wolf population rapidly increased between 1975 and 1980, <b>and</b></li> <li>predicting and explaining the shape of the moose population curve after 1994.</li> </ul> <p>The response is clear, complete, and correct.</p>
2	<p>The response demonstrates a <i>partial</i> understanding of the effects of limiting factors on population dynamics and potential species extinction by completing any <b>two</b> of the following:</p> <ul style="list-style-type: none"> <li>describing one limiting factor for the moose population,</li> <li>explaining a likely reason the wolf population rapidly increased between 1975 and 1980,</li> <li>predicting and explaining the shape of the moose population curve after 1994.</li> </ul> <p>The response may contain some work that is incomplete or unclear.</p>
1	<p>The response demonstrates a <i>minimal</i> understanding of the effects of limiting factors on population dynamics and potential species extinction by completing any <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>describing one limiting factor for the moose population,</li> <li>explaining a likely reason the wolf population rapidly increased between 1975 and 1980,</li> <li>predicting and explaining the shape of the moose population curve after 1994.</li> </ul> <p>The response may contain some work that is incomplete or unclear.</p>
0	<p>The response provides <i>insufficient</i> evidence to demonstrate any understanding of the concept being tested.</p>

**Note: No deductions should be taken for misspelled words or grammatical errors.**

**Possible responses that will receive credit:****Part A (1 point):**

- One limiting factor for the moose population is predation. The moose population will decrease as wolves prey upon moose. Predation would decrease the population.
- OR**
- One limiting factor for the moose population is habitat destruction. Since the moose are on an island, if their habitat is destroyed or affected, their population could decrease.
- OR**
- Other limiting factors could include shelter, natural disturbances, fresh water supply, food supply, and disease. These would all serve to decrease the moose population.

**Part B (1 point):**

- The wolf population rapidly increased between 1975 and 1980 because there was an ample food supply. From about 1970–1975, the moose population was at a high level. Because wolves prey upon moose, there was an ample food supply to support a larger population of wolves.

**Part C (1 point):**

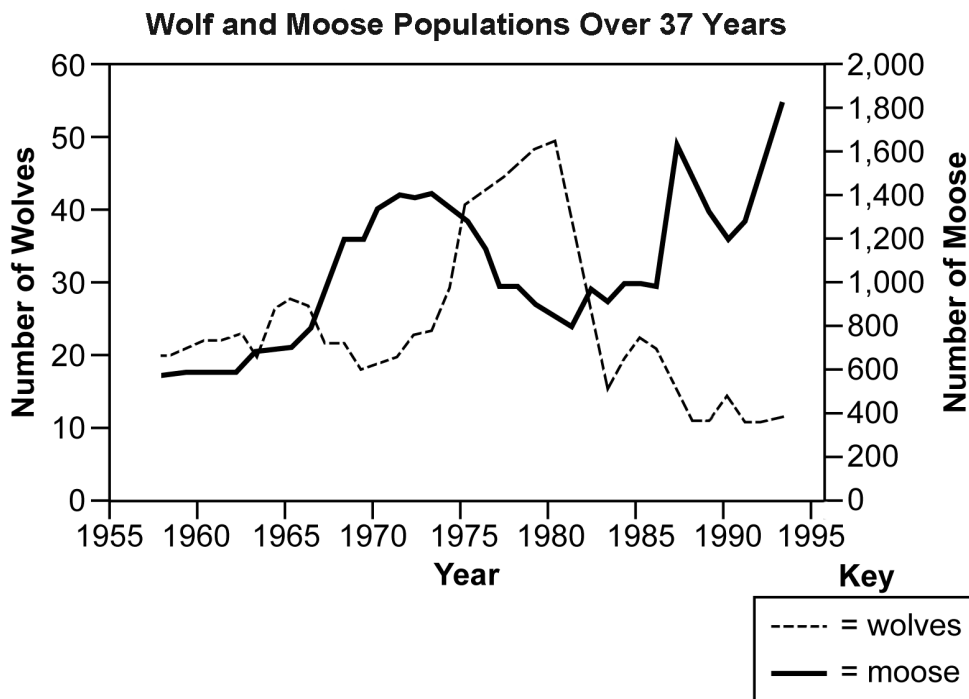
- The moose population curve after 1994 would drop and then level off between 1,400 and 1,200 moose. Because the moose live on an island, there is a limited amount of resources available and the population would stabilize around its carrying capacity.
- OR**
- The moose population curve after 1994 would drop below 1,000 moose if the wolf population increases. The increase of the wolf population would be due to the increased availability of moose, which would result in a decline in the moose population.

**Background information:**

Wolves prey upon moose. Their populations are dependent upon each other. As the wolf population increases, the moose population will decline. As the moose population decreases, the wolf population will decline.

## B.4.2.5 Response Score: 3 points

Use the graph below to answer question 11.



11. Isle Royale is located in Lake Superior. Isle Royale is home to populations of wolves and moose. The interactions between the wolves and moose, as well as the individual population sizes, have been studied since 1958. The graph shows the population sizes over time for both wolves and moose.

**Part A:** Describe one limiting factor for the moose population.

Food supply is a limiting factor on an island because the moose cannot move somewhere else when their food supply runs out. Moose eat plants so there needs to be enough plants for moose to survive

Go to the next page to finish question 11.



11. **Continued.** Please refer to the previous page for task explanation.

**Part B:** Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

The wolf population increased because they had plenty of food. Wolves can eat moose. The moose population increased between 1970-1975 so there was a lot of food for the wolves to eat on the island.

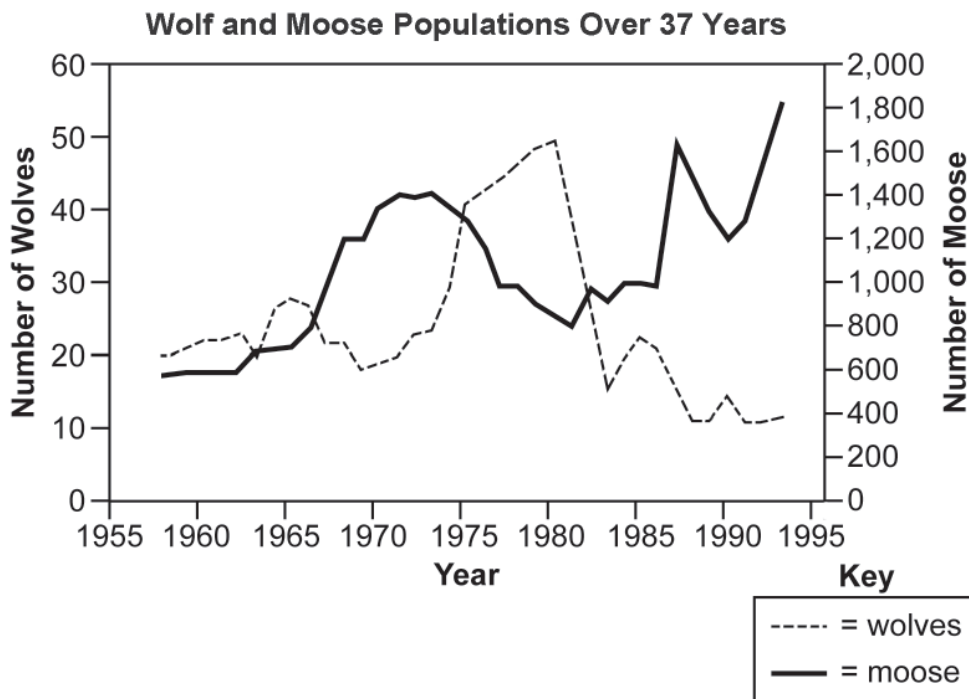
**Part C:** Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.

The moose line could level out and become almost flat. This means the moose have reached carrying capacity for the island. The wolf line would likely level out, too. The moose line cannot continue to go up because the moose will run out of food with too many animals on the island.

*The student response correctly describes one of the limiting factors for moose on the island, logically explains that an increase in wolf population indicates an ample food supply for the wolves, and correctly predicts the shape of the curve and logically explains why the moose population might change after 1994. All three parts of the answer are correct and complete; the response is given 3 points.*

## B.4.2.5 Response Score: 2 points

Use the graph below to answer question 11.



11. Isle Royale is located in Lake Superior. Isle Royale is home to populations of wolves and moose. The interactions between the wolves and moose, as well as the individual population sizes, have been studied since 1958. The graph shows the population sizes over time for both wolves and moose.

**Part A:** Describe one limiting factor for the moose population.

The number of predators on the island is a limiting factor for moose because the moose cannot move somewhere else to avoid predators. More predators need more food which means more moose are eaten.

Go to the next page to finish question 11.

11. **Continued.** Please refer to the previous page for task explanation.

**Part B:** Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

The wolf population increased because they had plenty of moose to eat because the moose population had been increasing for a while.

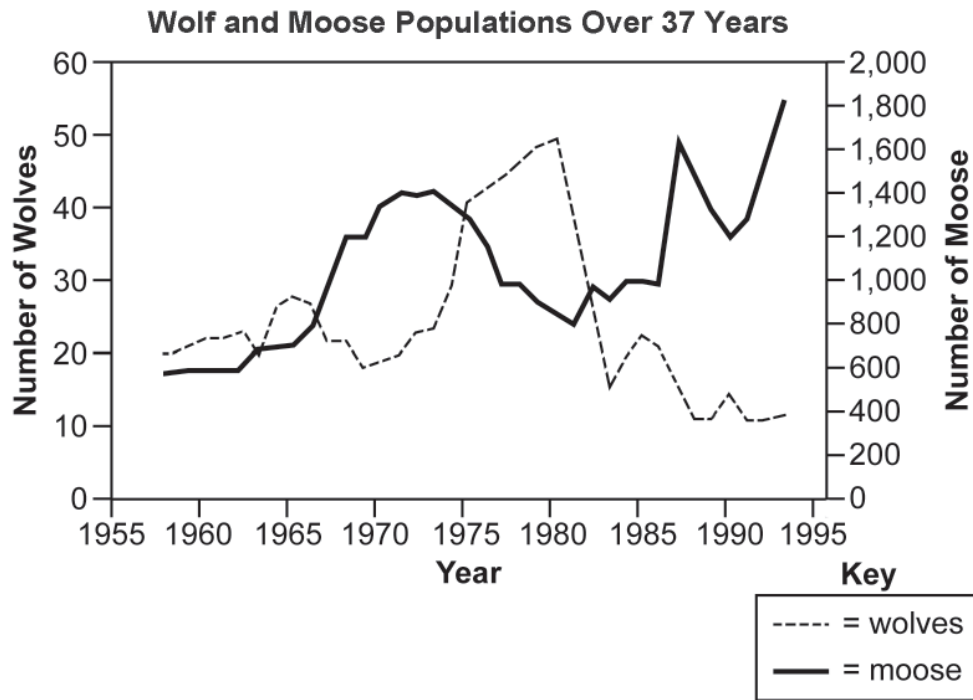
**Part C:** Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.

The moose population line will continue to increase until all the wolves are gone.

*The student response correctly describes one of the limiting factors for moose on the island, correctly explains that an increase in wolf population indicates that they had plenty of moose to eat, and incorrectly predicts or explains the shape of the moose population curve after 1994. Two of the three parts of the answer are correct; the response is given 2 points.*

B.4.2.5 Response Score: 1 point

Use the graph below to answer question 11.



11. Isle Royale is located in Lake Superior. Isle Royale is home to populations of wolves and moose. The interactions between the wolves and moose, as well as the individual population sizes, have been studied since 1958. The graph shows the population sizes over time for both wolves and moose.

**Part A:** Describe one limiting factor for the moose population.

*Moose need air to live.*

Go to the next page to finish question 11.

11. **Continued.** Please refer to the previous page for task explanation.

**Part B:** Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

There are more wolves because they  
had lots of moose to eat.

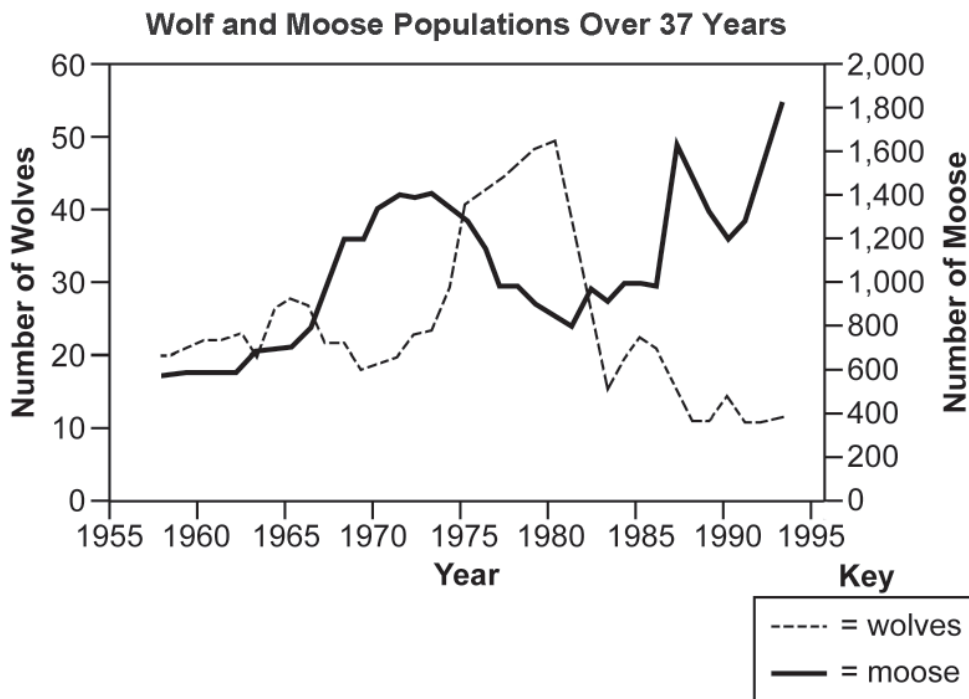
**Part C:** Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.

There will be more and more wolves  
every year.

*The student response incorrectly identifies a limiting factor for moose on the island, correctly explains why the wolf population increased during the indicated years, and incorrectly predicts or explains the shape of the moose population curve after 1994. One of the three parts of the answer is correct; the response is given 1 point.*

B.4.2.5 Response Score: 0

Use the graph below to answer question 11.



11. Isle Royale is located in Lake Superior. Isle Royale is home to populations of wolves and moose. The interactions between the wolves and moose, as well as the individual population sizes, have been studied since 1958. The graph shows the population sizes over time for both wolves and moose.

**Part A:** Describe one limiting factor for the moose population.

Moose are afraid of wolves.

Go to the next page to finish question 11.

11. **Continued.** Please refer to the previous page for task explanation.

**Part B:** Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

Wolves eat moose

**Part C:** Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.

Wolves and moose depend on each other and their lines go the same way.

*The student response fails to correctly describe, explain, or predict any part of the question. The response is given no credit.*

KEYSTONE EXAMS  
BIOLOGY  
2011

ITEM AND SCORING SAMPLER

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