pennsylvania
DEPARTMENT OF EDUCATION

PENNSYLVANIA
KEYSTONE EXAMS

Biology

Item and Scoring Sampler

2023–2024

Pennsylvania Department of Education Bureau of Curriculum, Assessment and Instruction—August 2023

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INTRODUCTION

General Introduction

The Pennsylvania Department of Education (PDE) provides districts and schools with tools to assist in delivering focused instructional programs aligned with the Pennsylvania Standards (PS). These tools include the standards, Assessment Anchor documents, Keystone Exams Test Definition, Classroom Diagnostic Tool, Standards Aligned System, and content-based item and scoring samplers. This 2023 Biology Item and Scoring Sampler is a useful tool for Pennsylvania educators in preparing students for the Keystone Exams by providing samples of test item types and scored student responses. The Item and Scoring Sampler is not designed to be used as a pretest, a curriculum, or any other benchmark for operational testing.

This Item and Scoring Sampler contains released operational multiple-choice and constructed-response items that have appeared on previously administered Keystone Exams. These items will not appear on any future Keystone Exams. Released items provide an idea of the types of items that have appeared on operational exams and that will appear on future operational Keystone Exams. Each item has been through a rigorous review process to ensure alignment with the Assessment Anchors and Eligible Content (AAEC). This sampler includes items that measure a variety of Assessment Anchor and Eligible Content statements, but it does not include sample items for all Assessment Anchor and Eligible Content statements.

The items in this sampler may be used[1] as samples of item types that students will encounter in operational testing. Classroom teachers may find it beneficial to have students respond to the constructed-response items in this sampler. Educators may then use the sampler as a guide to score the responses either independently or together with colleagues within a school or district.

This Item and Scoring Sampler is available in Braille format. For more information regarding Braille, call (717)-901-2238.

ABOUT THE KEYSTONE EXAMS

The Keystone Exams are end-of-course assessments currently designed to assess proficiencies in Algebra I, Biology, and Literature. 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 website at http://www.education.pa.gov.

[1] The permission to copy and/or use these materials does not extend to commercial purposes.

Alignment

The Biology Keystone Exam consists of questions grouped into **two modules**: Module 1—Cells and Cell Processes and Module 2—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 items 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 items 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 items 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 items or stems can come from the Eligible Content, Anchor Descriptor, or Assessment Anchor statements.

Depth of Knowledge

Webb's Depth of Knowledge (DOK) was created by Dr. Norman Webb of the Wisconsin Center for Education Research. Webb's definition of DOK is the cognitive expectation demanded by standards, curricular activities, and assessment tasks. Webb's DOK includes four levels, from the lowest (recall) level to the highest (extended thinking) level.

Depth of Knowledge	
Level 1	Recall
Level 2	Basic Application of Skill/Concept
Level 3	Strategic Thinking
Level 4	Extended Thinking

Each Keystone item has been through a rigorous review process and is assigned a DOK level. For additional information about DOK, please visit the PDE website at http://static.pdesas.org/content/documents/Keystone_Exams_Understanding_Depth_of_Knowledge_and_Cognitive_Complexity.pdf.

Exam Format

The Keystone Exams are delivered in a paper-and-pencil format as well as in a computer-based online format. The multiple-choice items require students to select the best answer from four possible answer options and record their answers in the spaces provided. The correct answer for each multiple-choice item is worth one point. The constructed-response items require students to develop and write (or construct) their responses. Constructed-response items in Biology are scored using item-specific scoring guidelines based on a 0–3-point scale. Each multiple-choice item is designed to take about one to one and a half minutes to complete. Each constructed-response item is designed to take about eight minutes to complete. The estimated time to respond to a test question is the same for both test formats. During an official exam administration, students are given additional time as necessary to complete the exam.

ITEM AND SCORING SAMPLER FORMAT

This sampler includes the test directions and scoring guidelines that appear in the Keystone Exams. Each sample multiple-choice item is followed by a table that includes the alignment, the answer key, the DOK, the percentage[2] of students who chose each answer option, and a brief answer option analysis or rationale. Each constructed-response item is followed by a table that includes the item alignment, the DOK, and the mean student score. Additionally, each of the included item-specific scoring guidelines is combined with sample student responses representing each score point to form a practical item-specific scoring guide. The *General Description of Scoring Guidelines for Biology* used to develop the item-specific scoring guidelines should be used if any additional item-specific scoring guidelines are created for use within local instructional programs. The student responses in this item and scoring sampler are actual student responses; however, the handwriting has been changed to protect the students' identities and to make the item and scoring sampler accessible to as many people as possible.

Example Multiple-Choice Item Information Table

Item Information	
Alignment	Assigned AAEC
Answer Key	Correct Answer
Depth of Knowledge	Assigned DOK
p-value A	Percentage of students who selected option A
p-value B	Percentage of students who selected option B
p-value C	Percentage of students who selected option C
p-value D	Percentage of students who selected option D
Option Annotations	Brief answer option analysis or rationale

Example Constructed-Response Item Information Table

Alignment	Assigned AAEC	**Depth of Knowledge**	Assigned DOK	**Mean Score**	Average Score

[2] All *p*-value percentages listed in the item information tables have been rounded.

BIOLOGY EXAM DIRECTIONS

Directions:

Below are the exam directions available to students. These directions may be used to help students navigate through the exam.

There are two types of questions in this module.

Multiple-Choice Questions:

These questions will ask you to select an answer from among four choices.

- Read each question, and choose the correct answer.
- Only one of the answers provided is correct.
- Record your answer in the Biology answer booklet.

Constructed-Response Questions:

These questions will require you to write your response.

- Be sure to read the directions carefully.
- You cannot receive the highest score for a constructed-response question without following all directions.
- If the question asks you to do multiple tasks, be sure to complete all tasks.
- If the question asks you to explain, be sure to explain. If the question asks you to analyze, describe, or compare, be sure to analyze, describe, or compare.
- All responses must be written in the appropriate location within the response box in the Biology answer booklet. If you use scratch paper to write your draft, be sure to transfer your final response to the Biology answer booklet.

In addition, a module may also include scenarios. A scenario contains text, graphics, charts, and/or tables describing a biological concept, an experiment, or other scientific research. You can use the information contained in a scenario to answer certain exam questions. Before responding to any scenario questions, be sure to study the entire scenario and follow the directions for the scenario. You may refer back to the scenario at any time when answering the scenario questions.

If you finish early, you may check your work in Module 1 [or Module 2] only.

- Do not look ahead at the questions in Module 2 [or back at the questions in Module 1] of your exam materials.
- After you have checked your work, close your exam materials.

You may refer to this page at any time during this portion of the exam.

GENERAL DESCRIPTION OF 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 as 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.

BIOLOGY MODULE 1

MULTIPLE-CHOICE ITEMS

1. Some prokaryotic bacteria and certain eukaryotic microorganisms can survive in extremely salty environments. Which characteristic do these organisms **most likely** have in common?

A. the presence of a nervous system

B. the ability to maintain homeostasis

C. the ability to perform photosynthesis

D. the presence of a nuclear membrane

Item Information	
Alignment	BIO.A.1.1.1
Answer Key	B
Depth of Knowledge	2
p-value A	8%
p-value B	64% (correct answer)
p-value C	14%
p-value D	14%
Option Annotations	A. Prokaryotes do not have nervous systems. B. Key: Both eukaryotes and prokaryotes can regulate cellular processes to maintain homeostasis. C. Prokaryotes do not have the cellular machinery to perform photosynthesis. D. Prokaryotes do not have nuclei.

2. Which statement **best** compares the plasma membrane in prokaryotes and eukaryotes?

A. The plasma membrane is a single layer of lipids in prokaryotes, but it is a bilayer in eukaryotes.

B. The plasma membrane in both prokaryotes and eukaryotes separates the cell from the external environment.

C. The plasma membrane is lined with ribosomes in prokaryotes, but it is lined with lipids in eukaryotes.

D. The plasma membrane in both prokaryotes and eukaryotes contains chloroplasts for starch storage.

Item Information	
Alignment	BIO.A.1.2.1
Answer Key	B
Depth of Knowledge	2
p-value A	27%
p-value B	49% (correct answer)
p-value C	14%
p-value D	10%
Option Annotations	A. The plasma membrane is comprised of a double layer of lipids in both eukaryotic and prokaryotic cells. B. Key: The plasma membrane provides a barrier from the external environment for both prokaryotic and eukaryotic cells. C. The plasma membrane is composed of lipids in both prokaryotes and eukaryotes. Ribosomes are located within the cytoplasm of prokaryotic cells. D. The plasma membrane is composed of lipids in both prokaryotes and eukaryotes. Prokaryotes do not contain chloroplasts, and not all eukaryotes contain chloroplasts.

3. Use the chart below to answer the question.

Properties of Carbon

Property	Value
number of neutrons	6
number of protons	6
number of electrons	6
atomic masses of stable isotopes	12, 13

The chart shows some properties of the element carbon. Which property is **most** responsible for carbon's ability to form complex biological macromolecules?

A. number of neutrons

B. number of protons

C. number of electrons

D. atomic masses of stable isotopes

Item Information	
Alignment	BIO.A.2.2.1
Answer Key	C
Depth of Knowledge	2
p-value A	9%
p-value B	12%
p-value C	41% (correct answer)
p-value D	38%
Option Annotations	A. The number of neutrons in the nucleus does not affect carbon's ability to form compounds. B. The number of protons in the nucleus determines carbon's chemical identity but does not directly affect carbon's ability to form compounds. C. Key: The number of electrons in carbon's outer valence shell determines the number and type of chemical bonds that carbon can form with other atoms. D. The atomic masses of carbon isotopes do not determine whether carbon can bond with other atoms.

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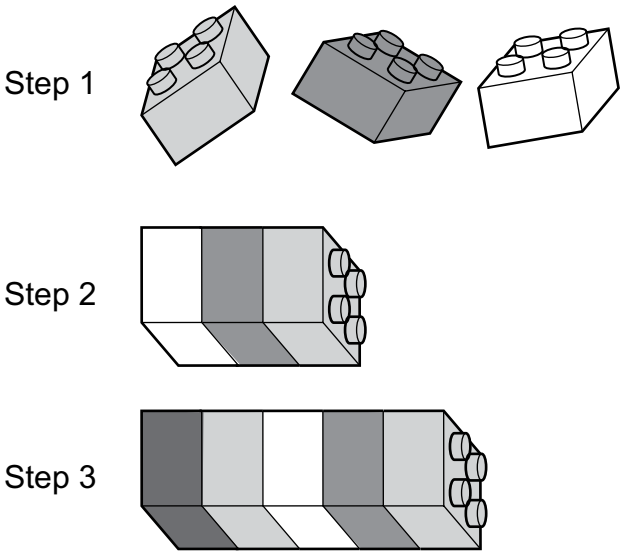
4. Use the model below to answer the question.

Protein Formation Model



A teacher demonstrated protein formation to a science class. The model shows three steps the teacher used in the demonstration. How can the steps in the model **best** be described?

A. In Step 1, amino acid monomers are present. In Step 2, the monomers are attached together to form a protein polymer. In Step 3, more amino acid monomers are added to the chain, making a larger protein.

B. In Step 1, nucleotide monomers are present. In Step 2, the monomers are attached together to form a protein polymer. In Step 3, more nucleotide monomers are added to the chain, making a larger protein.

C. In Step 1, amino acid polymers are present. In Step 2, the polymers are attached together to form a protein monomer. In Step 3, more amino acid polymers are added to the chain, making a larger protein.

D. In Step 1, nucleotide polymers are present. In Step 2, the polymers are attached together to form a protein monomer. In Step 3, more nucleotide polymers are added to the chain, making a larger protein.

Item Information	
Alignment	BIO.A.2.2.2
Answer Key	A
Depth of Knowledge	2
p-value A	63% (correct answer)
p-value B	12%
p-value C	17%
p-value D	8%
Option Annotations	A. Key: Amino acids are the monomers, or subunits, that assemble into a protein polymer, which becomes a larger protein with the addition of more amino acid monomers. B. Nucleotides are the monomers of nucleic acids. C. Monomers are the smaller subunits that assemble into a larger polymer. D. Nucleotides are the monomers of nucleic acids, and monomers are the smaller subunits that assemble into a larger polymer.

5. Use the information below to answer the question.

> Student's Claim: Carbohydrates are complex compounds made of monosaccharides that function as data-storage molecules.

A student made the claim shown. Which statement **best** explains whether the student's claim is correct?

A. The student's claim is correct because carbohydrates form DNA.

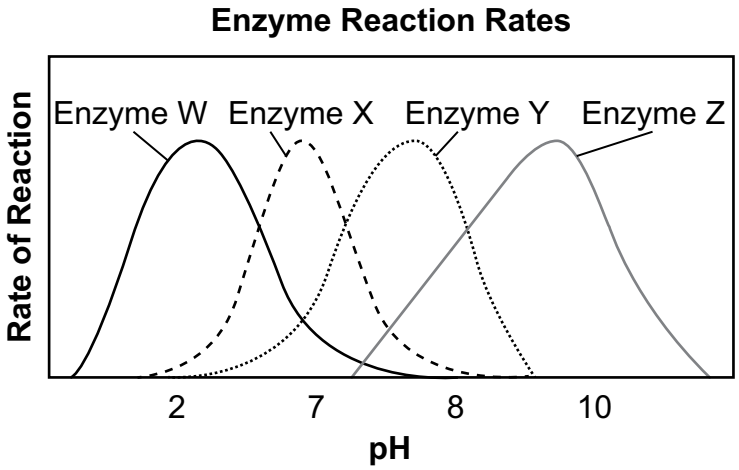
B. The student's claim is correct because all complex molecules store data.

C. The student's claim is incorrect because carbohydrates are simple compounds, not complex ones.

D. The student's claim is incorrect because nucleic acids, not carbohydrates, are the data-storage molecules.

Item Information	
Alignment	BIO.A.2.2.3
Answer Key	D
Depth of Knowledge	2
p-value A	8%
p-value B	12%
p-value C	20%
p-value D	60% (correct answer)
Option Annotations	A. DNA is formed by nucleotides. B. Not all complex molecules store data. C. Carbohydrates exist as simple compounds as well as complex compounds. D. Key: Nucleic acids store data encoded in the sequence of nucleotides.

6. Use the graph below to answer the question.



Which enzyme would **most likely** reach its maximum reaction rate in pure water?

A. Enzyme W

B. Enzyme X

C. Enzyme Y

D. Enzyme Z

Item Information	
Alignment	BIO.A.2.3.2
Answer Key	B
Depth of Knowledge	2
p-value A	19%
p-value B	47% (correct answer)
p-value C	12%
p-value D	22%
Option Annotations	A. The maximum reaction rate for enzyme W is near pH 2, which is too acidic for pure water. B. Key: The maximum reaction rate for enzyme X is near pH 7, which is the pH of pure water. C. The maximum reaction rate for enzyme Y is near pH 8, which is too basic for pure water. D. The maximum reaction rate for enzyme Z is near pH 10, which is too basic for pure water.

7. Genetic mutations can cause chloroplasts in leaf cells to lack pigment and appear pale yellow. Which statement describes how a plant is **most** immediately affected by the presence of these genetic mutations?

A. The ability to absorb minerals is reduced.

B. The rate of ATP production by mitochondria increases.

C. The sensitivity to changes in air temperature increases.

D. The amount of light energy transformed into chemical energy is reduced.

Item Information	
Alignment	BIO.A.3.1.1
Answer Key	D
Depth of Knowledge	2
p-value A	15%
p-value B	8%
p-value C	11%
p-value D	66% (correct answer)
Option Annotations	A. Minerals are primarily absorbed through a plant's root system. B. The rate of ATP production would decrease due to decreased light energy transfer. C. Sensitivity to air temperature would not be the immediate effect of the mutations. D. Key: Chloroplasts that lack pigment would be unable to capture and convert light energy, and the process of photosynthesis would yield reduced results.

8. Muscle cells have a comparatively large number of mitochondria. Which action does this characteristic allow muscle cells to accomplish?

A. rapidly release chemical energy for use

B. rapidly convert carbohydrates into lipids

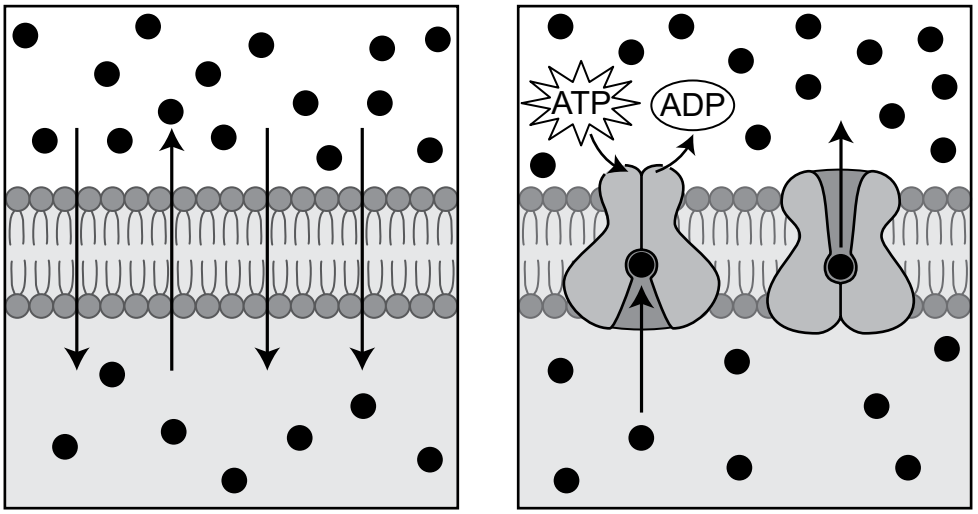
C. reduce oxygen demand when releasing stored energy

D. reduce carbon dioxide production when releasing stored energy

Item Information	
Alignment	BIO.A.3.1.1
Answer Key	A
Depth of Knowledge	2
p-value A	55% (correct answer)
p-value B	15%
p-value C	19%
p-value D	11%
Option Annotations	A. Key: Mitochondria transfer energy stored in glucose molecules to molecules of ATP. Having more mitochondria in a muscle cell enables the cell to generate ATP more quickly. B. Mitochondria do not convert carbohydrate energy into lipids in muscle cells. C. Muscle cells have a higher demand for oxygen when releasing stored energy during cellular respiration. D. Muscle cells produce more carbon dioxide when releasing stored energy during cellular respiration.

9. Use the diagram below to answer the question.

Two Types of Cell Transport



type 1 type 2

The diagram shows two types of cell transport. Which pair of statements **best** compares the two types of cell transport?

A. Type 1 does not require energy and molecules move with their concentration gradient. Type 2 requires energy and molecules can move against their concentration gradient.

B. Type 1 does not require energy and molecules can move against their concentration gradient. Type 2 requires energy and molecules move with their concentration gradient.

C. Type 1 requires energy and molecules move with their concentration gradient. Type 2 requires energy and molecules can move against their concentration gradient.

D. Type 1 does not require energy and molecules move with their concentration gradient. Type 2 does not require energy and molecules can move against their concentration gradient.

Item Information	
Alignment	BIO.A.4.1.2
Answer Key	A
Depth of Knowledge	2
p-value A	55% (correct answer)
p-value B	26%
p-value C	12%
p-value D	7%
Option Annotations	A. Key: Type 1 is a passive transport process that does not require energy to move particles with their concentration gradient. Type 2 is an active transport process that does require energy from ATP to move particles against their concentration gradient. B. In type 1, particles are moving with their concentration gradient. In type 2, particles are moving against their concentration gradient. C. In type 1, particles do not require energy to move with their concentration gradient. D. In type 2, particles require energy to move against their concentration gradient.

10. Which statement **best** describes the role of the Golgi apparatus within the cell?

A. It is the site where glucose is oxidized to produce energy.

B. It is the site where lipids and proteins are translated and folded.

C. It is the site where DNA and RNA are stored, maintained, and controlled.

D. It is the site where proteins are sorted, packaged, processed, and modified.

Item Information	
Alignment	BIO.A.4.1.3
Answer Key	D
Depth of Knowledge	2
p-value A	7%
p-value B	13%
p-value C	11%
p-value D	69% (correct answer)
Option Annotations	A. The oxidation of glucose occurs in the cytoplasm. B. Lipids and proteins are translated and folded in the endoplasmic reticulum. C. DNA is stored in the nucleus. D. Key: Proteins receive final processing in the Golgi apparatus.

11. Which reaction helps maintain homeostasis when the body becomes dehydrated?

A. The skin starts to sweat.

B. The muscles contract rapidly.

C. The lungs exhale more frequently.

D. The kidneys produce concentrated urine.

Item Information	
Alignment	BIO.A.4.2.1
Answer Key	D
Depth of Knowledge	2
p-value A	33%
p-value B	14%
p-value C	13%
p-value D	40% (correct answer)
Option Annotations	A. Sweating is a homeostatic method of decreasing body temperature. B. Muscle contraction is a homeostatic method of increasing body temperature. C. Increased breathing rate is a homeostatic method of regulating gas exchange. D. Key: When the body is dehydrated, the kidneys will retain water by producing urine with a higher concentration of solutes and a lower concentration of water.

Directions: Use the information presented on page 20 to answer questions 12 and 13.

Thermophilic Bacteria of Yellowstone National Park

Yellowstone National Park has over 10,000 hydrothermal features, such as hot springs and geysers. Volcanic activity below Yellowstone provides the heat for these features. The hydrothermal features of Yellowstone include environments of extremes: high temperatures, high and low pHs, and high sulfur content.

Microorganisms in Yellowstone's hot springs were first discovered in 1966. These microorganisms are called thermophiles. The presence of thermophiles in Yellowstone's hydrothermal features can be observed by the features' bright colors and strong odors.

Almost all hot springs and geysers in Yellowstone host bacteria. Cyanobacteria exist in some of Yellowstone's hot springs. Cyanobacteria were the first photosynthesizers, more than 3 billion years ago, providing oxygen to Earth's early atmosphere. Other bacteria chemosynthesize, changing hydrogen or sulfur into forms other thermophiles can use. One product of chemosynthesis is a gas that smells like rotten eggs.

The table below shows some characteristics of three types of bacteria living in Yellowstone's hydrothermal features.

Characteristics of Three Thermophilic Bacteria in Yellowstone National Park

Type of Bacterium	Ideal pH Range	Ideal Temperature Range	Metabolism
Hydrogenobaculum	3 to 5.5	55°C to 72°C (131°F to 162°F)	chemosynthesis using hydrogen, hydrogen sulfide, and carbon dioxide as energy sources; can use arsenic in place of hydrogen sulfide
Phormidium	6 to 8	35°C to 57°C (95°F to 135°F)	photosynthesis
Synechococcus	7 to 9	52°C to 74°C (126°F to 165°F)	photosynthesis by day; fermentation by night

12. According to the theory of endosymbiosis, free-living cyanobacteria moved into some eukaryote cells millions of years ago and evolved into the chloroplasts of plant cells. Which statement correctly compares a cyanobacterium and a chloroplast?

A. Both have a cell wall.

B. Both contain a nucleus.

C. Both perform photosynthesis.

D. Both are single-celled organisms.

Item Information	
Alignment	BIO.A.1.2.2
Answer Key	C
Depth of Knowledge	2
p-value A	12%
p-value B	12%
p-value C	62% (correct answer)
p-value D	14%
Option Annotations	A. A chloroplast is a membrane-bound organelle and does not have a cell wall. B. Plastids do not contain nuclei, and cyanobacteria are prokaryotes, which also do not contain nuclei. C. Key: Both cyanobacteria and chloroplasts in plant cells undergo photosynthesis for energy production. D. Chloroplasts are not organisms.

13. Which statement **best** contrasts the role of enzymes in thermophilic bacteria and the plants living in Yellowstone National Park?

A. Enzymes of thermophilic bacteria store energy at higher sulfur concentrations than enzymes of plants do.

B. Enzymes of thermophilic bacteria catalyze biochemical reactions at higher temperatures than enzymes of plants do.

C. Enzymes of thermophilic bacteria control DNA replication in the nucleus at higher sulfur concentrations than enzymes of plants do.

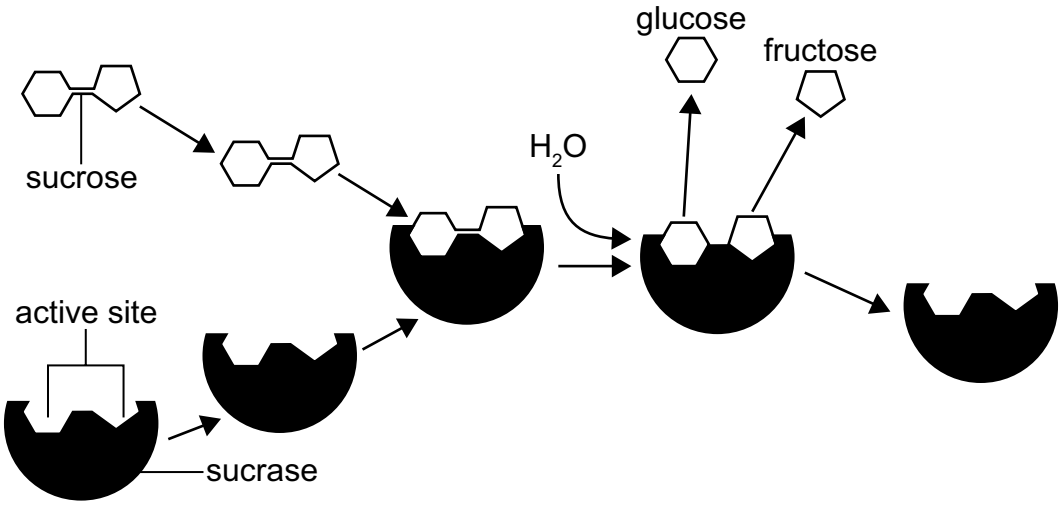
D. Enzymes of thermophilic bacteria control the water moving into and out of the cell at higher temperatures than enzymes of plants do.

Item Information	
Alignment	BIO.A.2.3.1
Answer Key	B
Depth of Knowledge	2
p-value A	19%
p-value B	57% (correct answer)
p-value C	13%
p-value D	11%
Option Annotations	A. Enzymes do not store energy. B. Key: Thermophilic bacteria can survive in extreme geothermal environments because their enzymes function as biochemical catalysts at higher temperatures than the enzymes of plants do. C. Bacteria do not have nuclei. D. Regulating water movement across cell membranes is not a primary role of enzymes.

CONSTRUCTED-RESPONSE ITEM

14. The model shows a biochemical reaction utilizing sucrase.

Sucrase Reaction



Part A: Explain the role of sucrase in the reaction shown.

Part B: Identify **one** factor that can affect how sucrase functions, and explain what effect this factor has on the reaction.

Factor:

Effect:

SCORING GUIDE

#14 Item Information

Alignment	BIO.A.2.3.2	**Depth of Knowledge**	2	**Mean Score**	1.16

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of how factors such as pH, temperature, and concentration levels can affect enzyme function by • explaining the role of sucrase in a chemical reaction, **AND** • identifying one factor that can affect how sucrase functions, **AND** • explaining the effect the identified factor has on the indicated reaction. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of how factors such as pH, temperature, and concentration levels can affect enzyme function by completing two of the three tasks described above. The response may contain some work that is incomplete or unclear.
1	The response demonstrates a *minimal* understanding of how factors such as pH, temperature, and concentration levels can affect enzyme function by completing only one of the three tasks described above. The response may contain some work that is incomplete or unclear.
0	The response provides *insufficient* evidence to demonstrate any understanding of the concept being tested.

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

Responses That Will Receive Credit

Part A (1 point):

- Sucrase is an enzyme that reduces the amount of energy (activation energy) needed to break down sucrose, a disaccharide, into glucose and fructose, two monosaccharides.

Part B (1 point for the factor, 1 point for the effect):

- Factor: temperature
- Effect: High temperatures can degrade enzymes (proteins), which makes them less efficient in the process of breaking down other molecules. If the temperature is increased enough, sucrase is completely denatured and will not function at all, stopping or decreasing the rate of the reaction.

- Factor: acidity (pH)
- Effect: The reaction rate will increase as the pH increases until the optimal pH is reached. Once optimal pH is exceeded, the enzyme becomes denatured or the substrate is degraded to the point where it cannot bind with the enzyme and the reaction rate will decrease.

- Factor: concentration of enzyme
- Effect: As the concentration of the enzyme increases, the reaction rate will increase until the substrate is used up. Then the reaction rate will level off.

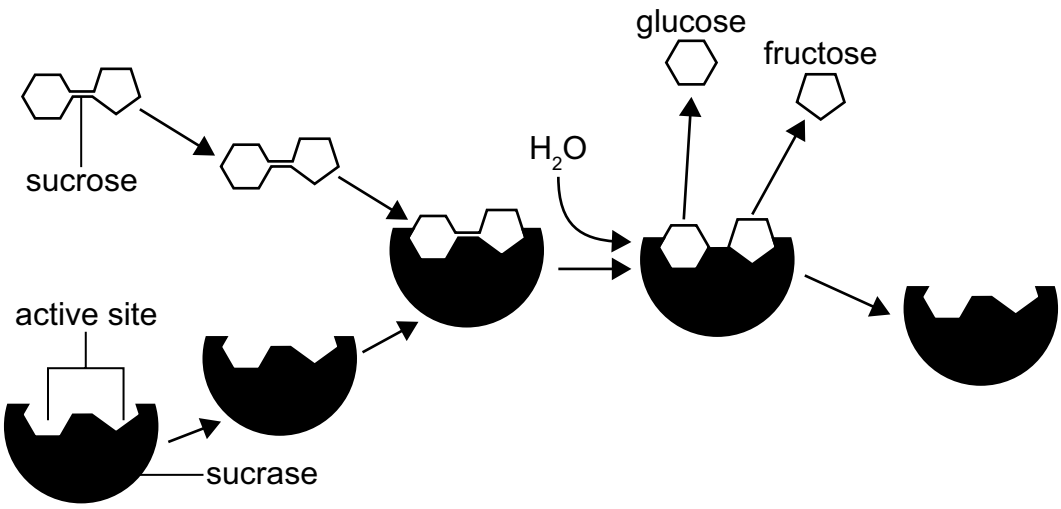
- Factor: concentration of substrate
- Effect: As the concentration of the substrate increases, the reaction rate will increase to a maximum where all the enzyme is being used (the reaction rate will level off beyond this point).

STUDENT RESPONSE

Response Score: 3 points

14. The model shows a biochemical reaction utilizing sucrase.

Sucrase Reaction



Part A: Explain the role of sucrase in the reaction shown.

The role of sucrase in the reaction shown is to lessen the activation energy needed to break sucrose down into glucose and fructose.

Part B: Identify **one** factor that can affect how sucrase functions, and explain what effect this factor has on the reaction.

Factor: Temperature is one factor that can affect how sucrase functions.

Effect: The effect temperature has on the reaction is it will denature the sucrase and stop the reaction.

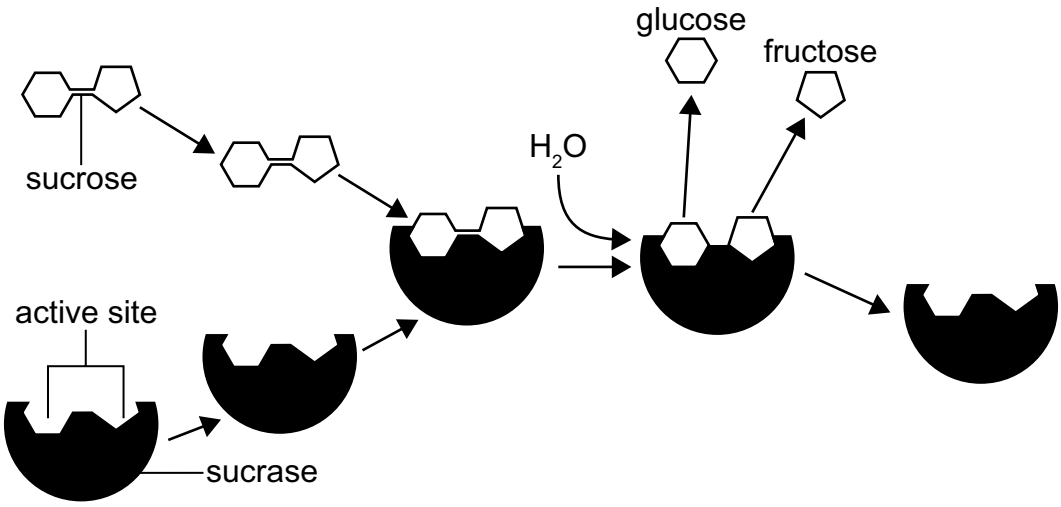
The response demonstrates a thorough understanding of how factors such as pH, temperature, and concentration levels can affect enzyme function. In Part A, the response correctly explains the role of sucrase in the reaction (*to lessen the activation energy needed to break sucrose down into glucose and fructose*). In Part B, the response correctly identifies one factor that can affect how sucrase functions (*Temperature*) and correctly explains what effect this factor has on the reaction (*it will denature the sucrase and stop the reaction*). The response is clear, complete, and correct.

STUDENT RESPONSE

Response Score: 2 points

14. The model shows a biochemical reaction utilizing sucrase.

Sucrase Reaction



Part A: Explain the role of sucrase in the reaction shown.

Sucrase is the active site in the reaction

Part B: Identify **one** factor that can affect how sucrase functions, and explain what effect this factor has on the reaction.

Factor: Temperature

Effect: Temperate can denature sucrase, causing it to not be able to react.

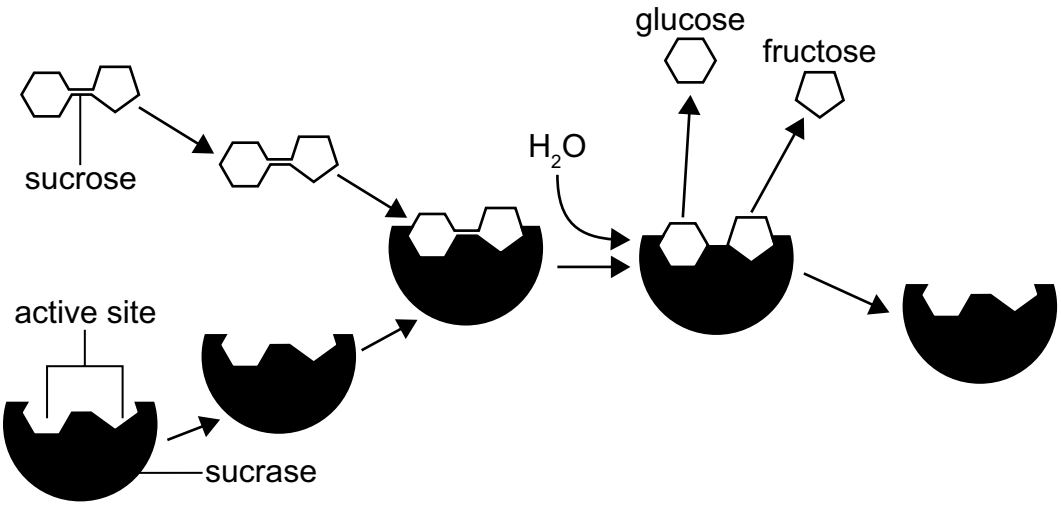
The response demonstrates a partial understanding of how factors such as pH, temperature, and concentration levels can affect enzyme function. In Part A, the response incorrectly explains the role of sucrase in the reaction (*Sucrase is the active site in the reaction*) and does not receive any credit. In Part B, the response correctly identifies one factor that can affect how sucrase functions (*Temperature*) and correctly explains what effect this factor has on the reaction (*causing it to not be able to react*).

STUDENT RESPONSE

Response Score: 1 point

14. The model shows a biochemical reaction utilizing sucrase.

Sucrase Reaction



Part A: Explain the role of sucrase in the reaction shown.

Sucrase in the reaction serves as a substrate. It will take in the "enzyme" and break it down.

Part B: Identify **one** factor that can affect how sucrase functions, and explain what effect this factor has on the reaction.

Factor: The tempturature can effect how sucrase functions.

Effect: If there is a tempture change the active site can change form/shape.

The response demonstrates a minimal understanding of how factors such as pH, temperature, and concentration levels can affect enzyme function. In Part A, the response incorrectly explains the role of sucrase in the reaction (*sucrase in the reaction serves as a substrate*) and does not receive any credit. In Part B, the response correctly identifies one factor that can affect how sucrase functions (*The tempturature can effect how sucrase functions.*). However, the response incorrectly explains what effect this has on the reaction (*the active site can change form/shape*), and the effect explanation does not receive any credit.

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STUDENT RESPONSE

Response Score: 0 points

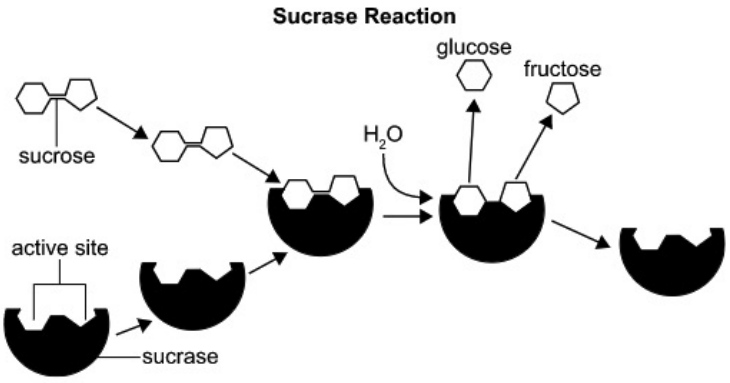
PART A

Question 14
Page 1 of 2

Line Guide

Item ID

The model shows a biochemical reaction utilizing sucrase.



Part A: Explain the role of sucrase in the reaction shown.

Sucrase joins an enzyme at the active site and gets proken down into glucose and fructose

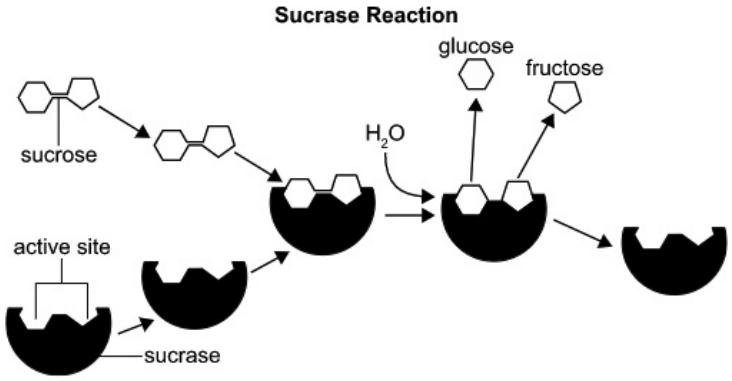
89 / 1000

Review/End Test | Pause | Flag | Options | Next

PART B

Question 14
Page 2 of 2

The model shows a biochemical reaction utilizing sucrase.



Part B: Identify **one** factor that can affect how sucrase functions, and explain what effect this factor has on the reaction.

Factor:

provides energy

15 / 1000

Effect:

when broken down sucrose turns into fructose adn glucose which is an energy source

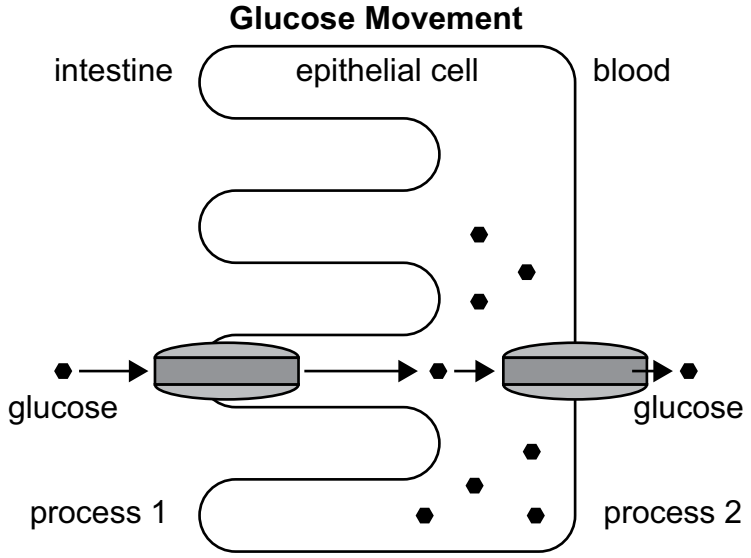
82 / 1000

Review/End Test | Pause | Flag | Options | Back | Next

This response demonstrates a complete understanding of how inherited structures or behaviors help organisms survive and reproduce in different environments. In Part A, the response correctly identifies one advantage dark-gray peppered moths had over the lighter-colored moths after the industrial revolution (*easier for dark-grey moths to hid from its pretodors* [predators]). In Part B, the response correctly predicts what will most likely happen to the coloration of peppered moths as pollution control measures increase in England (*there will most likely be less dark-grey moths*). The response is clear, complete, and correct.

CONSTRUCTED-RESPONSE ITEM

15. Digestion of food releases glucose into the intestine. Epithelial cells lining the intestine move glucose between the intestine and the blood. Moving glucose from the intestine into the epithelial cell uses active transport (process 1), but moving glucose into the blood uses passive transport (process 2).



Part A: Describe a similarity between process 1 and process 2.

Go to the next page to finish question 15.

GO ON

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

Part B: Describe **two** differences between process 1 and process 2.

Difference 1: _____

_____

_____

_____

Difference 2: _____

_____

_____

_____

AFTER YOU HAVE CHECKED YOUR WORK, CLOSE YOUR ANSWER BOOKLET AND TEST BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

STOP

SCORING GUIDE

#15 Item Information

Alignment	BIO.A.4.1.2	**Depth of Knowledge**	3	**Mean Score**	1.55

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of the mechanisms that transport materials across the plasma membrane (i.e., passive transport—diffusion, osmosis, facilitated diffusion; and active transport—pumps, endocytosis, exocytosis) by • describing one similarity between active transport and passive transport, **AND** • describing two differences between active transport and passive transport. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of the mechanisms that transport materials across the plasma membrane (i.e., passive transport—diffusion, osmosis, facilitated diffusion; and active transport—pumps, endocytosis, exocytosis) by • describing one similarity between active transport and passive transport **AND** • describing one difference between active transport and passive transport **OR** • describing two differences between active transport and passive transport. The response may contain some work that is incomplete or unclear.
1	The response demonstrates a *minimal* understanding of the mechanisms that transport materials across the plasma membrane (i.e., passive transport—diffusion, osmosis, facilitated diffusion; and active transport—pumps, endocytosis, exocytosis) by • describing one similarity between active transport and passive transport **OR** • describing one difference between active transport and passive transport. The response may contain some work that is incomplete or unclear.
0	The response provides *insufficient* evidence to demonstrate any understanding of the concept being tested.

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

Responses That Will Receive Credit

Part A (1 point):

- Both processes move materials from one side of a cell membrane to another.
- Both processes use channels to move ions across a cell membrane.
- Both processes involve ion movement.
- Both processes help a cell maintain homeostasis.

Part B (2 points):

- Active transport (process 1) uses energy (ATP), but passive transport (process 2) does not use energy.
- Passive transport moves materials from an area of high concentration to an area of low concentration (with the gradient), while active transport moves materials from an area of low concentration to an area of high concentration (against the gradient).
- Passive transport uses diffusion, osmosis, and facilitated diffusion, but active transport uses pumps, endocytosis, and exocytosis.
- Process 1 is transporting glucose from the intestine into the epithelial cell, while process 2 is transporting glucose from the epithelial cell into the blood.

STUDENT RESPONSE

Response Score: 3 points

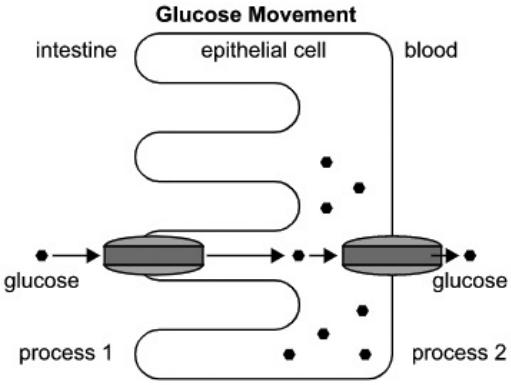
PART A

Question 15
Page 1 of 2

Line Guide

Item ID

Digestion of food releases glucose into the intestine. Epithelial cells lining the intestine move glucose between the intestine and the blood. Moving glucose from the intestine into the epithelial cell uses active transport (process 1), but moving glucose into the blood uses passive transport (process 2).



Part A: Describe a similarity between process 1 and process 2.

Both processes use a protein channel to transport glucose.

58 / 1000

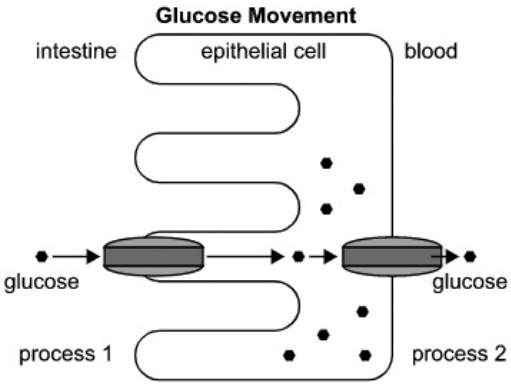
Review/End Test | Pause | Flag | Options | Next

PART B

Question 15
Page 2 of 2

Line Guide | Item ID | ?

Digestion of food releases glucose into the intestine. Epithelial cells lining the intestine move glucose between the intestine and the blood. Moving glucose from the intestine into the epithelial cell uses active transport (process 1), but moving glucose into the blood uses passive transport (process 2).



Part B: Describe **two** differences between process 1 and process 2.

Difference 1:

Process 1 is active transport and requires ATP while process 2 is passive and does not require ATP.

99 / 1000

Difference 2:

Process 1 brings glucose into an area of high concentration while process 2 brings it into an area of lower concentration.

122 / 1000

Review/End Test | Pause | Flag | Options | Back | Next

The response demonstrates a thorough understanding of the mechanisms that transport materials across the plasma membrane. In Part A, the response correctly describes a similarity between process 1 and process 2 (*Both processes use a protein channel to transport glucose.*). In Part B, the response correctly describes two differences between process 1 and process 2 (*Process 1 . . . requires ATP while process 2 . . . does not require ATP*; *Process 1 brings glucose into an area of high concentration while process 2 brings it into an area of lower concentration.*). The response is clear, complete, and correct.

STUDENT RESPONSE

Response Score: 2 points

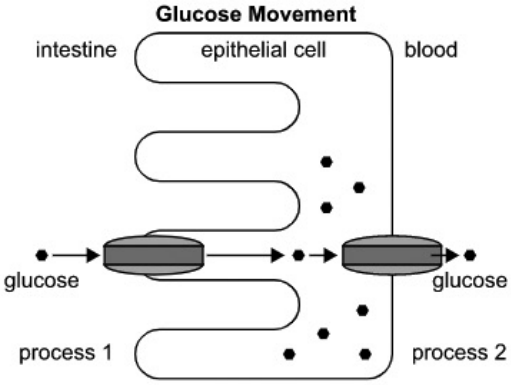
PART A

Question 15
Page 1 of 2

Line Guide

Item ID

Digestion of food releases glucose into the intestine. Epithelial cells lining the intestine move glucose between the intestine and the blood. Moving glucose from the intestine into the epithelial cell uses active transport (process 1), but moving glucose into the blood uses passive transport (process 2).



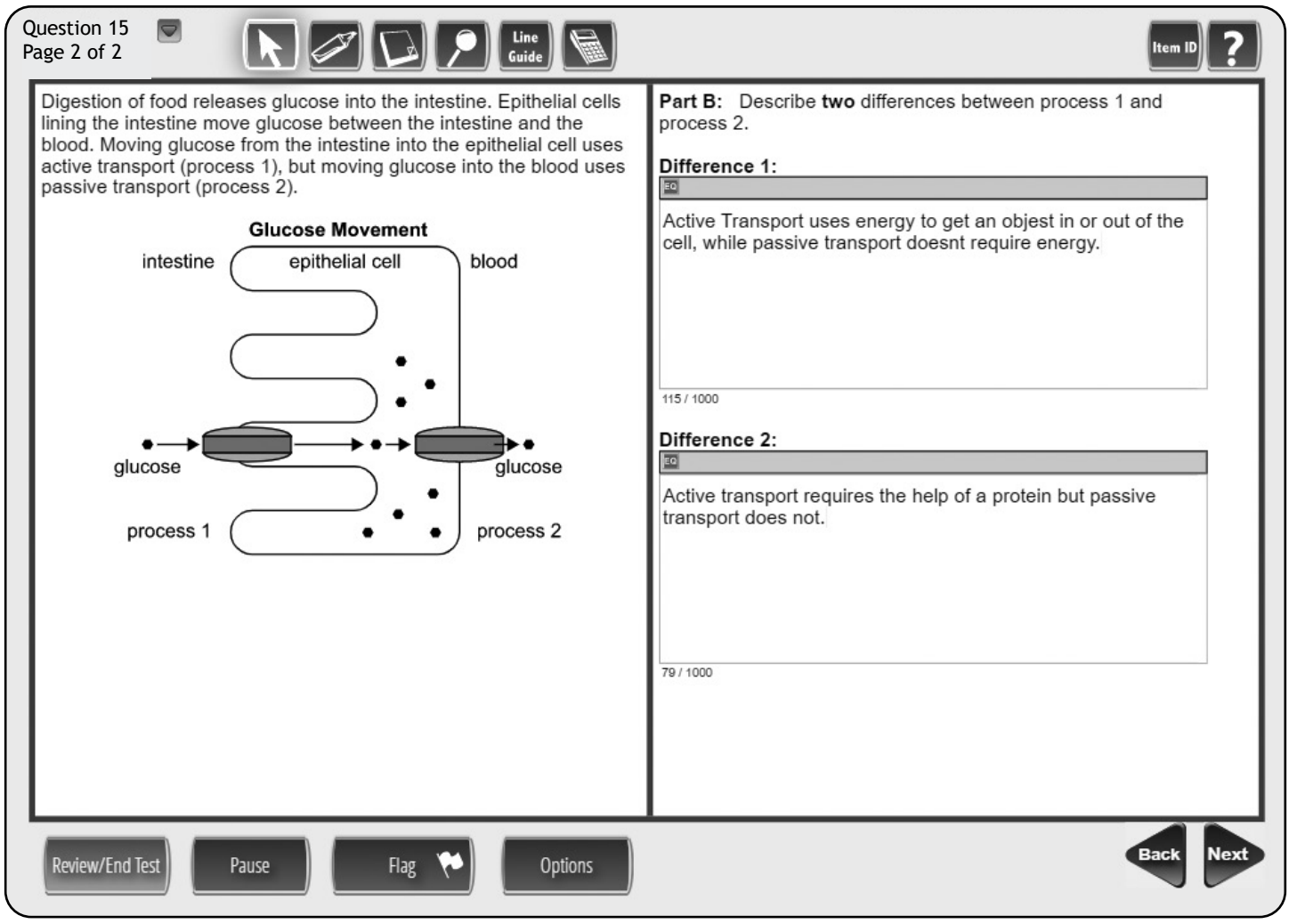
Part A: Describe a similarity between process 1 and process 2.

Active transport and passive transport both are used to get things in or out of a cell.

87 / 1000

Review/End Test | Pause | Flag | Options | Next

PART B

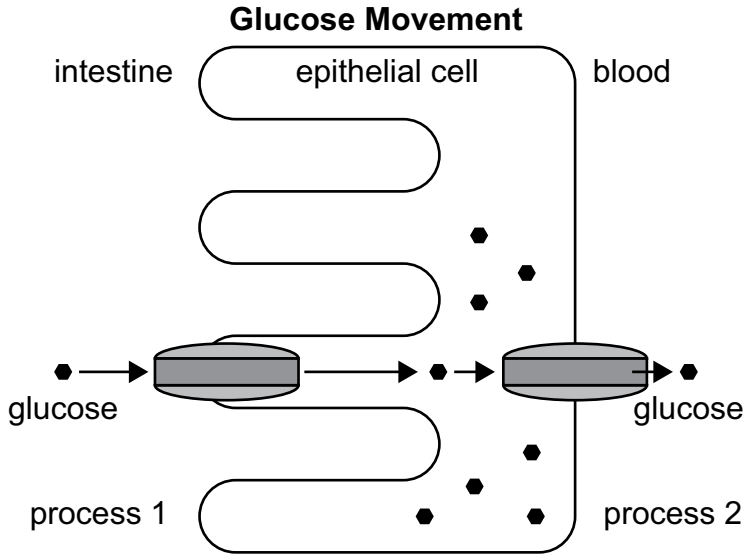


The response demonstrates a partial understanding of the mechanisms that transport materials across the plasma membrane. In Part A, the response correctly describes a similarity between process 1 and process 2 (*Active transport and passive transport both are used to get things in or out of a cell.*). In Part B, the response correctly describes only one difference between process 1 and process 2 (*Active Transport uses energy to get an objest in or out of the cell, while passive transport doesnt require energy.*). The second response provided incorrectly describes a difference between process 1 and process 2 (*Active transport requires the help of a protein but passive transport does not.*) and does not receive any credit.

STUDENT RESPONSE

Response Score: 1 point

15. Digestion of food releases glucose into the intestine. Epithelial cells lining the intestine move glucose between the intestine and the blood. Moving glucose from the intestine into the epithelial cell uses active transport (process 1), but moving glucose into the blood uses passive transport (process 2).



Part A: Describe a similarity between process 1 and process 2.

They both move glucose.

Go to the next page to finish question 15.

GO ON

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

Part B: Describe **two** differences between process 1 and process 2.

Difference 1: Process 1 uses active transport.

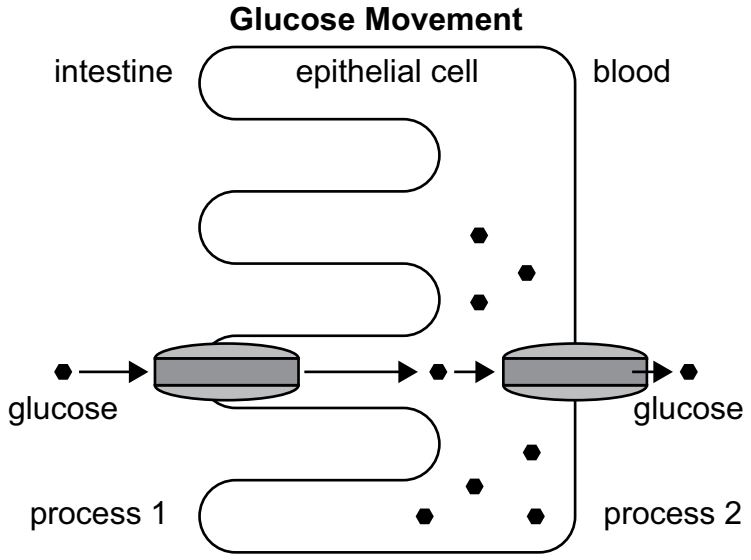
Difference 2: Process 2 uses passive transport.

The response demonstrates a minimal understanding of the mechanisms that transport materials across the plasma membrane. In Part A, the response correctly describes a similarity between process 1 and process 2 (*They both move glucose.*). In Part B, the response incorrectly describes only one difference between process 1 and process 2 (*Process 1 uses active transport. . . . Process 2 uses passive transport.*) and does not receive any credit. A second difference is not provided.

STUDENT RESPONSE

Response Score: 0 points

15. Digestion of food releases glucose into the intestine. Epithelial cells lining the intestine move glucose between the intestine and the blood. Moving glucose from the intestine into the epithelial cell uses active transport (process 1), but moving glucose into the blood uses passive transport (process 2).



Part A: Describe a similarity between process 1 and process 2.

They both have energy and they use ATP

Go to the next page to finish question 15.

GO ON

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

Part B: Describe **two** differences between process 1 and process 2.

Difference 1: process 2 stores them while process 1 does not.

Difference 2: process 1 lets them go

The response provides insufficient evidence to demonstrate any understanding of the mechanisms that transport materials across the plasma membrane. In Part A, the response incorrectly describes a similarity between process 1 and process 2 (*They both have energy and they use ATP*) and does not receive any credit. In Part B, the student incorrectly describes only one difference between process 1 and process 2 (*process 2 stores them while process 1 does not.*). The second response for Part B (*process 1 lets them go*) is not a comparison and does not receive any credit.

BIOLOGY MODULE 1—SUMMARY DATA

MULTIPLE-CHOICE

Sample Number	Alignment	Answer Key	Depth of Knowledge	*p*-value A	*p*-value B	*p*-value C	*p*-value D
1	BIO.A.1.1.1	B	2	8	64	14	14
2	BIO.A.1.2.1	B	2	27	49	14	10
3	BIO.A.2.2.1	C	2	9	12	41	38
4	BIO.A.2.2.2	A	2	63	12	17	8
5	BIO.A.2.2.3	D	2	8	12	20	60
6	BIO.A.2.3.2	B	2	19	47	12	22
7	BIO.A.3.1.1	D	2	15	8	11	66
8	BIO.A.3.1.1	A	2	55	15	19	11
9	BIO.A.4.1.2	A	2	55	26	12	7
10	BIO.A.4.1.3	D	2	7	13	11	69
11	BIO.A.4.2.1	D	2	33	14	13	40
12	BIO.A.1.2.2	C	2	12	12	62	14
13	BIO.A.2.3.1	B	2	19	57	13	11

CONSTRUCTED-RESPONSE

Sample Number	Alignment	Points	Depth of Knowledge	Mean Score
14	BIO.A.2.3.2	3	2	1.16
15	BIO.A.4.1.2	3	3	1.55

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BIOLOGY MODULE 2

MULTIPLE-CHOICE ITEMS

1. Which statement **best** describes how DNA replication results in the conservation of genetic information?

A. Enzymes associated with DNA replication are used over and over by the cell.

B. Each strand of DNA serves as a template for a new strand during DNA replication.

C. Nucleic acids linked to sugars twist in a specific pattern following DNA replication.

D. Random shuffling of DNA base pairs during DNA replication maintains the base pair ratios.

Item Information	
Alignment	BIO.B.1.2.1
Answer Key	B
Depth of Knowledge	2
p-value A	14%
p-value B	68% (correct answer)
p-value C	10%
p-value D	8%
Option Annotations	A. The recycling of enzyme molecules during DNA replication is not responsible for conserving the sequence of nucleotides in a DNA molecule. B. Key: Each strand of DNA serves as a template, and the base-pairing rule ensures that each exposed nucleotide on a DNA strand will be paired with the correct nucleotide, conserving the original sequence of genetic information. C. The genetic sequence is not conserved by nucleic acids linking to sugars and twisting into a specific pattern after the process of DNA replication occurs. D. DNA base pairs are not randomly shuffled during DNA replication.

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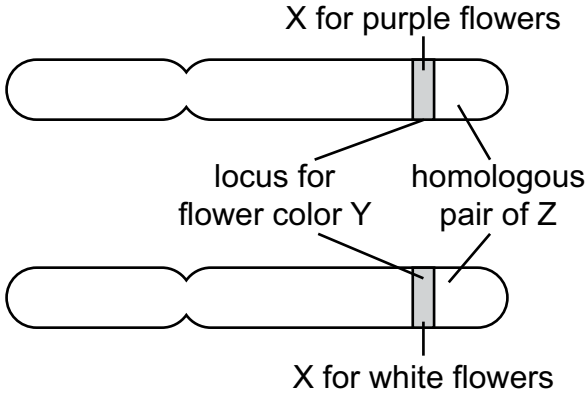
2. Use the diagram below to answer the question.

Genetic Information Controlling Flower Color



The diagram shows structures that help determine the color of a certain flower. Which list **best** identifies the structures labeled X, Y, and Z in the diagram?

A. X: allele
Y: flower color gene
Z: chromosome

B. X: gene
Y: flower color allele
Z: chromosome

C. X: allele
Y: flower color chromosome
Z: strand of DNA

D. X: gene
Y: flower color allele
Z: strand of DNA

Item Information	
Alignment	BIO.B.1.2.2
Answer Key	A
Depth of Knowledge	2
p-value A	50% (correct answer)
p-value B	24%
p-value C	13%
p-value D	13%
Option Annotations	A. Key: Alleles are variations of a gene and are responsible for determining flower color. The flower color gene is a particular segment of DNA at a specific location on a chromosome. The chromosome is the entire DNA molecule when it is condensed. B. X is an allele; Y is the gene. C. Y is not a chromosome, and a whole chromosome is not responsible for a single trait. D. X is an allele; Y is the gene. The whole strand of DNA is best identified as a chromosome.

3. An individual of a plant species shows a certain physical characteristic that requires two copies of the same allele to be expressed. Based on this information, how would the allele for the characteristic **most likely** be classified?

A. recessive

B. dominant

C. sex-linked

D. polygenic

Item Information	
Alignment	BIO.B.2.1.1
Answer Key	A
Depth of Knowledge	2
p-value A	53% (correct answer)
p-value B	26%
p-value C	11%
p-value D	10%
Option Annotations	A. Key: A trait that can only be expressed when two copies of the same allele are present is most likely a recessive trait, which cannot be expressed if a dominant allele for the gene is also present. B. A dominant trait can be expressed with one copy of the allele. C. Sex-linked traits are the result of genes located on a sex chromosome and can be dominant or recessive. D. Polygenic traits are the result of multiple genes being expressed simultaneously.

4. What is one important result of chromosomal crossing-over during meiosis?

A. an increase in the likelihood of having gametes in offspring that are genetically the same as their parents

B. an increase in the amount of genetic variation within a population that can improve its ability to survive

C. a decrease in the number of chromosome pairs that can be passed from each parent to its offspring

D. a decrease in the frequency of genetic mutations and a limit to the diversity of traits within a species

Item Information	
Alignment	BIO.B.2.1.2
Answer Key	B
Depth of Knowledge	2
p-value A	17%
p-value B	59% (correct answer)
p-value C	13%
p-value D	11%
Option Annotations	A. Crossing-over results in new combinations of genes in the unique gametes produced at the end of meiosis. B. Key: Increased genetic variation improves the likelihood that a population can survive changing environmental conditions. C. Crossing-over does not affect the number of chromosomes that are passed from parent to offspring. D. Crossing-over does not affect the frequency of random changes to the DNA sequence and does not limit the diversity of traits that are expressed within a species.

5. Antibiotics are medicines that slow the growth of disease-causing bacteria. One of the ways that antibiotics work is by interfering with the normal functioning of bacterial ribosomes. How does this interference reduce the rate of bacterial reproduction?

A. by preventing the bacterial cell from synthesizing essential proteins

B. by increasing the rate at which bacterial cells go through the cell cycle

C. by blocking the bacterial cell's access to nutrients from the host organism

D. by allowing harmful substances to enter the bacterial cell through its cell membrane

Item Information	
Alignment	BIO.B.2.2.2
Answer Key	A
Depth of Knowledge	2
p-value A	56% (correct answer)
p-value B	9%
p-value C	25%
p-value D	10%
Option Annotations	A. Key: Ribosomes are responsible for synthesizing proteins. B. Ribosomes do not control the rate of the cell cycle. C. Ribosomes are not involved with accessing or limiting cellular nutrients. D. Ribosomes do not regulate the movement of substances across a cellular membrane.

6. Use the diagram below to answer the question.

Normal Cell DNA

CAT CCC AAC GGA CCT

Mutated Cell DNA

CAT CCC CAA CGG ACC T

Which genetic mutation is shown in the diagram?

A. a point mutation caused by a base deletion

B. a point mutation caused by a base substitution

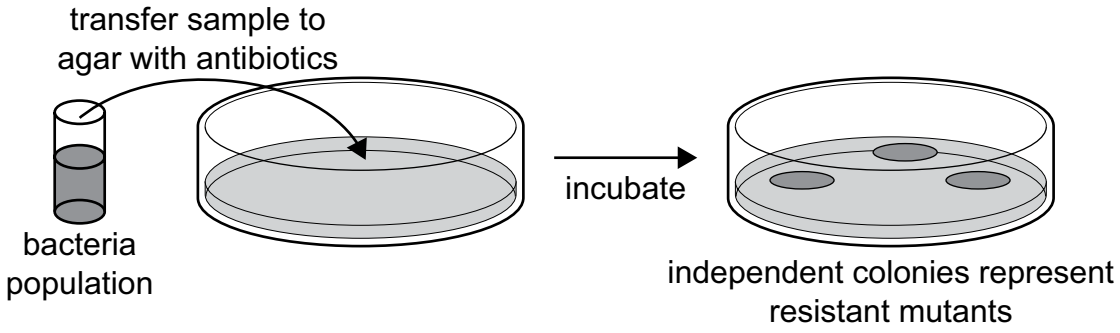
C. a frameshift mutation caused by a base insertion

D. a frameshift mutation caused by a base substitution

Item Information	
Alignment	BIO.B.2.3.1
Answer Key	C
Depth of Knowledge	2
p-value A	6%
p-value B	13%
p-value C	65% (correct answer)
p-value D	16%
Option Annotations	A. A deletion mutation would result in a shorter sequence of bases, not a longer sequence. B. A substitution mutation does not change the number of nitrogen bases. C. Key: An additional C nitrogenous base was inserted before the third codon, causing the reading frame to shift over by one base. D. The number of bases increased by one, which is the result of an insertion.

7. Use the diagram below to answer the question.

Results of a Genetic Mutation



The diagram shows several bacterial colonies that resulted when individual bacteria experienced a mutation. Which statement **best** describes how these colonies could change the genotypic makeup of future generations?

A. They could teach offspring to develop antibiotic resistance.

B. They could prey upon bacteria that are not antibiotic resistant.

C. They could pass on genes for antibiotic resistance to offspring.

D. They could be consumed by bacteria that are not antibiotic resistant.

Item Information	
Alignment	BIO.B.3.1.3
Answer Key	C
Depth of Knowledge	2
p-value A	13%
p-value B	8%
p-value C	71% (correct answer)
p-value D	8%
Option Annotations	A. Antibiotic resistance is an inherited trait, not a learned behavior. B. Preying upon other bacteria does not change the genotypic makeup of the bacterial offspring. C. Key: The independent colonies of mutant bacteria are resistant to the antibiotic in the agar, so they can survive and reproduce, passing on their resistant genes to their offspring. D. Organisms that are not antibiotic resistant would die. Organisms that are eaten are unable to produce future generations.

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8. Use the drawing below to answer the question.

Archaeopteryx

This drawing is a reconstruction of the extinct dinosaur *Archaeopteryx*, based on fossil evidence. *Archaeopteryx* had many birdlike structures, including wings and feathers. Which principle of evolution does this reconstruction of *Archaeopteryx* support?

A. New types of organisms develop in stages from earlier organisms.

B. Similar selection pressures will eventually yield similar adaptations.

C. New types of organisms cannot develop until earlier organisms become extinct.

D. All possible adaptations appear repeatedly by chance over a long enough timeline.

Item Information	
Alignment	BIO.B.3.2.1
Answer Key	A
Depth of Knowledge	2
p-value A	52% (correct answer)
p-value B	22%
p-value C	6%
p-value D	20%
Option Annotations	A. Key: The evolutionary development of birds from dinosaurs occurred in small incremental changes over time, as evidenced by *Archaeopteryx*'s adaptation of wings and feathers. B. Similar selection pressures do not result in similar mutations, resulting in advantageous traits in organisms. C. Sequential development of new species can occur without the extinction of previous species. D. The expression of advantageous traits is not cyclical and depends on random mutations.

9. Use the chart below to answer the question.

Students' Statements

Student	Statement
W	If a cell is placed in a saltwater solution, the cell will shrink.
X	Cells placed in water with red dye turned red after several hours.
Y	If a cell is placed in distilled water without ions, the cell will swell.
Z	Cells are the basic unit of structure in all organisms and the basic unit of reproduction.

Students presented the statements shown in the chart. Which student's statement would **best** be characterized as a scientific theory?

A. student W

B. student X

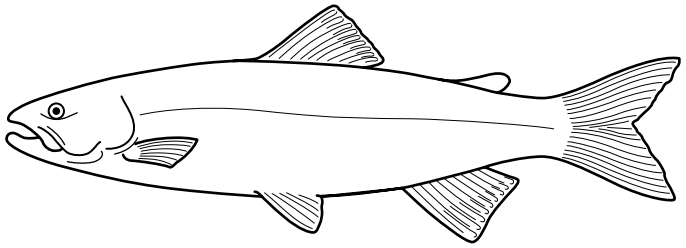
C. student Y

D. student Z

Item Information	
Alignment	BIO.B.3.3.1
Answer Key	D
Depth of Knowledge	2
p-value A	16%
p-value B	14%
p-value C	18%
p-value D	52% (correct answer)
Option Annotations	A. Student W's statement is best characterized as a testable hypothesis. B. Student X's statement is best characterized as an observation. C. Student Y's statement is best characterized as a testable hypothesis. D. Key: Student Z's statement is best characterized as a scientific theory because it is an accepted explanation of a key principle of life that has been repeatedly tested and validated.

10. Use the illustration below to answer the question.

Lake Trout



A researcher is studying relationships within a lake. A disease is killing off lake trout. The researcher wants to find out how this event will affect the lake trout's predators. Which statement **best** describes the researcher's work in terms of ecological organization?

A. The researcher is studying how change in an ecosystem will affect the biome.

B. The researcher is studying how change in a community will affect the organism.

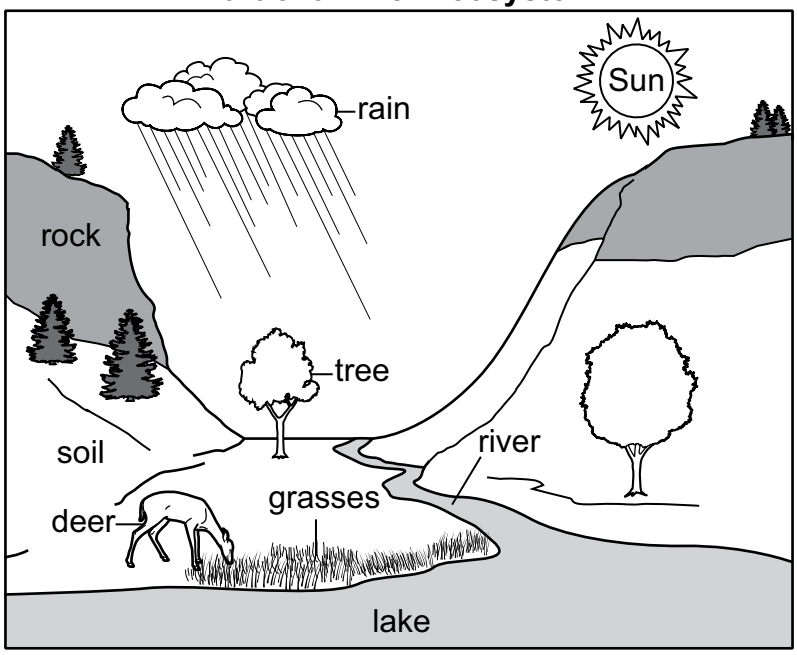
C. The researcher is studying how change in an organism will affect the population.

D. The researcher is studying how change in a population will affect the community.

Item Information	
Alignment	BIO.B.4.1.1
Answer Key	D
Depth of Knowledge	2
p-value A	10%
p-value B	11%
p-value C	24%
p-value D	55% (correct answer)
Option Annotations	A. The researcher is not studying abiotic factors. B. The change is to the population of lake trout, not all the interacting populations in the ecosystem, and the effect impacts more than an individual organism. C. The change being studied is in more than a single lake trout, and the measured effect is on the predator population, not the lake trout population. D. Key: The researcher is studying how a change in organisms of the same species (lake trout population) will affect organisms of another species (predator population). A community is the ecological level of organization characterized by the interactions of different species.

11. Use the diagram below to answer the question.

Part of a River Ecosystem



The diagram shows part of a river ecosystem. Which statement **best** describes a relationship between a biotic part and an abiotic part of this ecosystem?

A. The rain erodes the rock.

B. The river moves water into the lake.

C. The grasses use energy from the Sun to grow.

D. The grasses provide a food source for the deer.

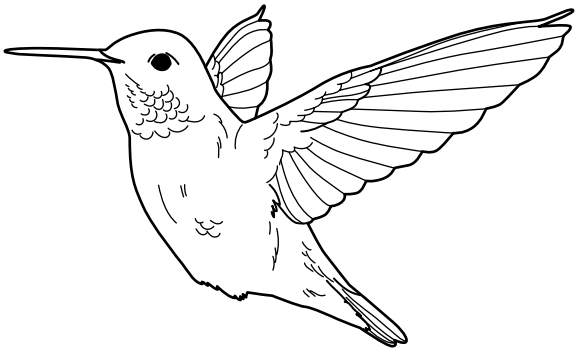
Item Information	
Alignment	BIO.B.4.1.2
Answer Key	C
Depth of Knowledge	2
p-value A	9%
p-value B	5%
p-value C	60% (correct answer)
p-value D	26%
Option Annotations	A. Rain and rocks are both abiotic. B. The water in the river and in the lake is abiotic. C. Key: Grasses are plants, which are biotic, and the Sun is an abiotic part of the ecosystem. D. Grasses and deer are both biotic.

Directions: Use the information presented on page 62 to answer questions 12 and 13.

Hummingbirds

Hummingbirds are the smallest warm-blooded animals on Earth. They get their name from the sound made by flapping their wings, which they can do 10 to 80 times per second. Hummingbirds are the only birds that can hover and fly backward. Nectar from flowers and small flying insects are their primary sources of food. Their nests are often preyed upon by larger birds, snakes, and mammals, while adult hummingbirds are prey to cats, larger birds, frogs, spiders, and praying mantises.

Hummingbird



Hummingbirds have the highest metabolic rate of any vertebrate and the highest rate of energy consumption of any animal. Their hearts can beat 1,200 times per minute. Hummingbirds have to constantly eat due to their high energy requirements. Many hummingbirds go into torpor, a hibernation-like sleep, at night so they do not starve. During torpor, their heart rate drops to between 50 and 180 beats per minute.

Today, hummingbirds live only in North and South America. The oldest hummingbird fossils that have been found are from southern Germany in Europe. The fossils are about 30 million years old. Based on fossil evidence, it is thought that hummingbirds diverged from a related group of small-sized birds that lived in Europe and Asia about 42 million years ago. About 22 million years ago, the common ancestor of hummingbirds migrated to North and South America. Today, there are 338 hummingbird species, which are divided into nine groups, based on differences in size, shape, habitat, and feeding method. Different hummingbird species utilize different niches. Bright-colored feathers, body decorations, courtship displays, and complex calls are evidence that sexual selection has played a part in hummingbird evolution. Hummingbirds are still developing into new species. One scientist hypothesizes that the number of hummingbird species could double in the next several million years.

12. Which factor would **most likely** contribute to the development of new hummingbird species?

A. having the ability to hover

B. having a common ancestor

C. having a high rate of metabolism

D. having different courtship displays

Item Information	
Alignment	BIO.B.3.1.2
Answer Key	D
Depth of Knowledge	2
p-value A	8%
p-value B	30%
p-value C	15%
p-value D	47% (correct answer)
Option Annotations	A. All hummingbird species can already hover, so that trait is unlikely to contribute to the development of a new hummingbird species. B. Having a common ancestor does not contribute to the development of a new hummingbird species. C. An increased rate of metabolism is unlikely to affect reproductive outcomes in such a way as to introduce a reproductively isolated group of hummingbirds. D. Key: Different courtship displays are behavioral differences that could affect which individuals mate and the frequency of certain traits being passed to offspring. Over a long period of time, small changes could accumulate until a separate group of hummingbirds becomes reproductively isolated, potentially leading to speciation.

13. Which food chain **best** describes how energy flows in an urban ecosystem that includes hummingbirds?

A. cats → hummingbirds → insects → plants

B. cats → insects → hummingbirds → plants

C. plants → insects → hummingbirds → cats

D. plants → cats → hummingbirds → insects

Item Information	
Alignment	BIO.B.4.2.1
Answer Key	C
Depth of Knowledge	2
p-value A	18%
p-value B	4%
p-value C	75% (correct answer)
p-value D	3%
Option Annotations	A. This food chain is reversed and shows energy flowing from consumers to producers. B. Cats are not the source of energy, and plants are not consumers. C. Key: Energy in this urban ecosystem flows from plants (producers) to insects (primary consumers) to hummingbirds (secondary consumers) to cats (tertiary consumers). D. Hummingbirds do not consume cats.

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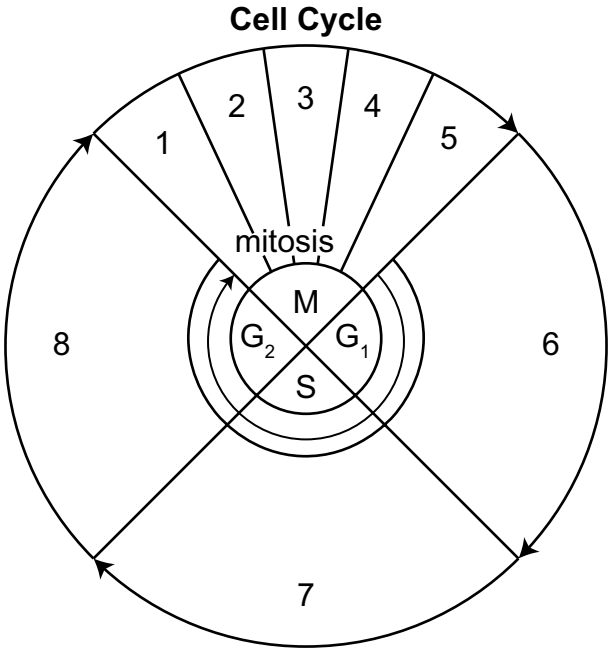
CONSTRUCTED-RESPONSE ITEM

14. A student is observing a cell under a microscope. The cell is growing, but its genetic material has not begun to replicate nor is the cell preparing for division. The student is referencing a model of the cell cycle while observing the cell.



Part A: Identify the numbered area of the model that represents the student's observations.

_____

Go to the next page to finish question 14.

GO ON

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

Part B: Describe **two** events that must take place during interphase before the cell can enter mitosis.

Event 1: _____

_____

_____

Event 2: _____

_____

_____

SCORING GUIDE

#14 Item Information

Alignment	BIO.B.1.1.1	**Depth of Knowledge**	3	**Mean Score**	1.34

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of key events that occur during the cell cycle by • identifying the part of the cell cycle that represents a cell growing but not replicating or preparing for cell division **AND** • describing two events that take place during interphase before the cell can enter mitosis. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of key events that occur during the cell cycle by • identifying the part of the cell cycle that represents a cell growing but not replicating or preparing for cell division **AND** • describing one event that takes place during interphase before the cell can enter mitosis **OR** • describing two events that take place during interphase before the cell can enter mitosis. The response may contain some work that is incomplete or unclear.
1	The response demonstrates a *minimal* understanding of key events that occur during the cell cycle by • identifying the part of the cell cycle that represents a cell growing but not replicating or preparing for cell division **OR** • describing one event that takes place during interphase before the cell can enter mitosis. The response may contain some work that is incomplete or unclear.
0	The response provides *insufficient* evidence to demonstrate any understanding of the concept being tested.

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

Responses That Will Receive Credit

Part A (1 point): A response indicating that area 6 (G_1) represents the time when a cell is growing but not replicating or dividing.

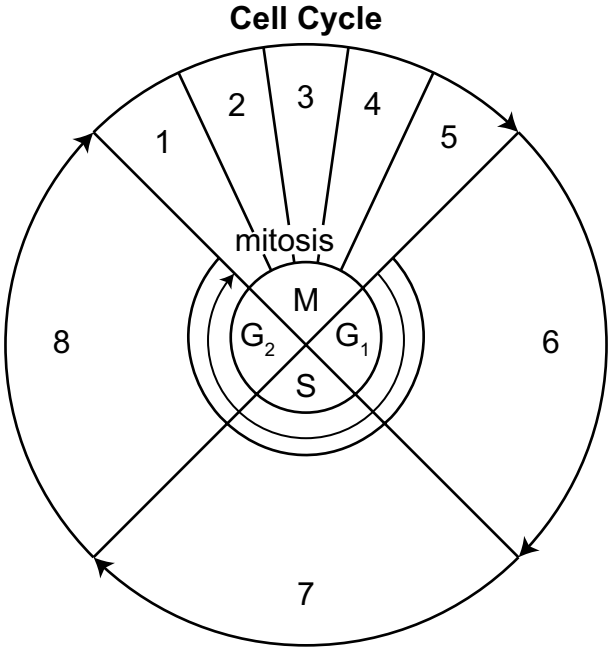
Part B (2 points): Any two events that take place during interphase before the cell can enter mitosis. Each event is worth 1 point.

- DNA replication occurs (DNA synthesis, DNA duplication, chromosomes become chromatids).
- Cell growth occurs.
- New organelles are made.
- Protein synthesis occurs.
- The cell cycle process goes through checkpoints to make sure everything is working properly.

STUDENT RESPONSE

Response Score: 3 points

14. A student is observing a cell under a microscope. The cell is growing, but its genetic material has not begun to replicate nor is the cell preparing for division. The student is referencing a model of the cell cycle while observing the cell.



Part A: Identify the numbered area of the model that represents the student's observations.

The cell he is observing is in phase 6

Go to the next page to finish question 14.

GO ON

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

Part B: Describe **two** events that must take place during interphase before the cell can enter mitosis.

Event 1: First, the cell has to replicate its DNA so it has another set after it splits

Event 2: Then, the cell has to make extra organells so each new cell will have a set.

The response demonstrates a thorough understanding of key events that occur during the cell cycle. In Part A, the response correctly identifies the numbered area of the model that represents the student's observations (*The cell he is observing is in phase 6*). In Part B, the response correctly describes two events that must take place during interphase before the cell can enter mitosis (*the cell has to replicate its DNA*; *the cell has to make extra organells*). The response is clear, complete, and correct.

STUDENT RESPONSE

Response Score: 2 points

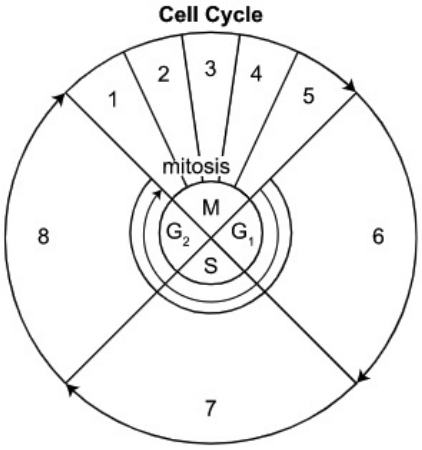
PART A

Question 14
Page 1 of 2

Line Guide

Item ID

A student is observing a cell under a microscope. The cell is growing, but its genetic material has not begun to replicate nor is the cell preparing for division. The student is referencing a model of the cell cycle while observing the cell.



Part A: Identify the numbered area of the model that represents the student's observations.

EQ

8 represents the student's observations.

40 / 50

Review/End Test | Pause | Flag | Options | Next

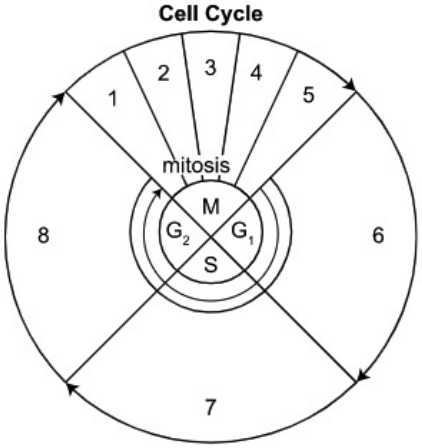
PART B

Question 14
Page 2 of 2

Line Guide

Item ID

A student is observing a cell under a microscope. The cell is growing, but its genetic material has not begun to replicate nor is the cell preparing for division. The student is referencing a model of the cell cycle while observing the cell.



Part B: Describe **two** events that must take place during interphase before the cell can enter mitosis.

Event 1:

The cell must grow to the point where it is able to replicate itself.

69 / 500

Event 2:

The cell must copy the DNA to prepare for division to that when the cell divides during mitosis, the DNA is transported to the replicated cell.

143 / 500

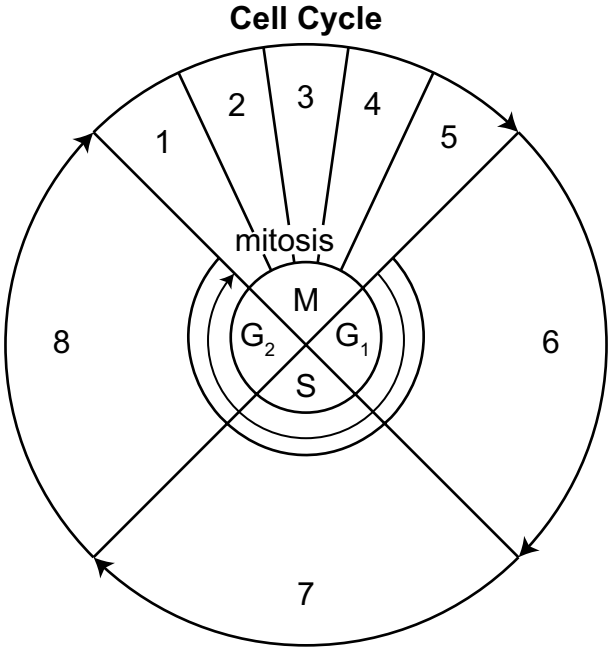
Review/End Test | Pause | Flag | Options | Back | Next

The response demonstrates a partial understanding of key events that occur during the cell cycle. In Part A, the response incorrectly identifies the numbered area of the model that represents the student's observations (*8 represents the student's observations.*) and does not receive any credit. In Part B, the response correctly identifies two events that must take place during interphase before the cell can enter mitosis (*The cell must grow*; *The cell must copy the DNA*).

STUDENT RESPONSE

Response Score: 1 point

14. A student is observing a cell under a microscope. The cell is growing, but its genetic material has not begun to replicate nor is the cell preparing for division. The student is referencing a model of the cell cycle while observing the cell.



Part A: Identify the numbered area of the model that represents the student's observations.

1

Go to the next page to finish question 14.

GO ON

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

Part B: Describe **two** events that must take place during interphase before the cell can enter mitosis.

Event 1: The cell must disolve the nuclear envelope.

Event 2: The cell must replicate its DNA.

The response demonstrates a minimal understanding of key events that occur during the cell cycle. In Part A, the response incorrectly identifies the numbered area of the model that represents the student's observations (*1*) and does not receive any credit. In Part B, the response correctly identifies only one event that must take place during interphase before the cell can enter mitosis (*The cell must replicate its DNA.*). The other response provided incorrectly identifies an event that must take place during interphase before the cell can enter mitosis (*The cell must disolve the nuclear envelope.*) and does not receive any credit.

STUDENT RESPONSE

Response Score: 0 points

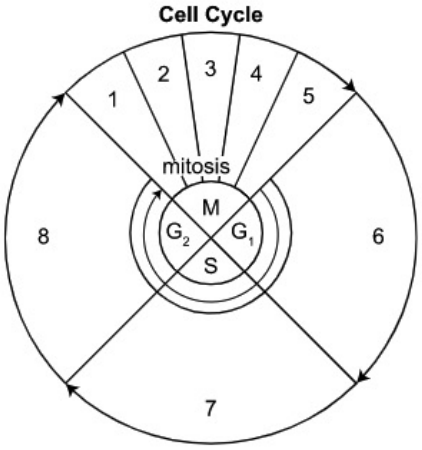
PART A

Question 14
Page 1 of 2

Line Guide

Item ID

A student is observing a cell under a microscope. The cell is growing, but its genetic material has not begun to replicate nor is the cell preparing for division. The student is referencing a model of the cell cycle while observing the cell.



Part A: Identify the numbered area of the model that represents the student's observations.

EQ

1-5 are steps in mitosis and the rest are G1 G2 S

49 / 50

Review/End Test | Pause | Flag | Options | Next

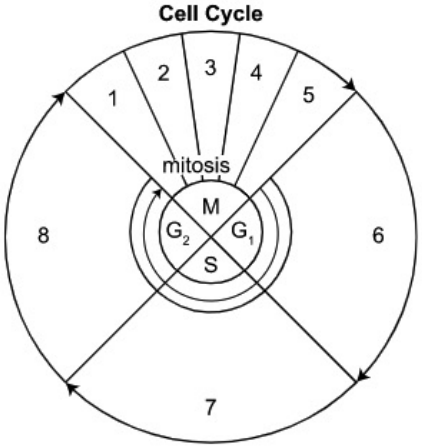
PART B

Question 14
Page 2 of 2

Line Guide

Item ID

A student is observing a cell under a microscope. The cell is growing, but its genetic material has not begun to replicate nor is the cell preparing for division. The student is referencing a model of the cell cycle while observing the cell.



Part B: Describe **two** events that must take place during interphase before the cell can enter mitosis.

Event 1:

One event that mut happen is interphase before mitosis is the cells need to split apart into 2.

95 / 500

Event 2:

Another event that must happen in interphase before mitosis is the cells need to clone.

87 / 500

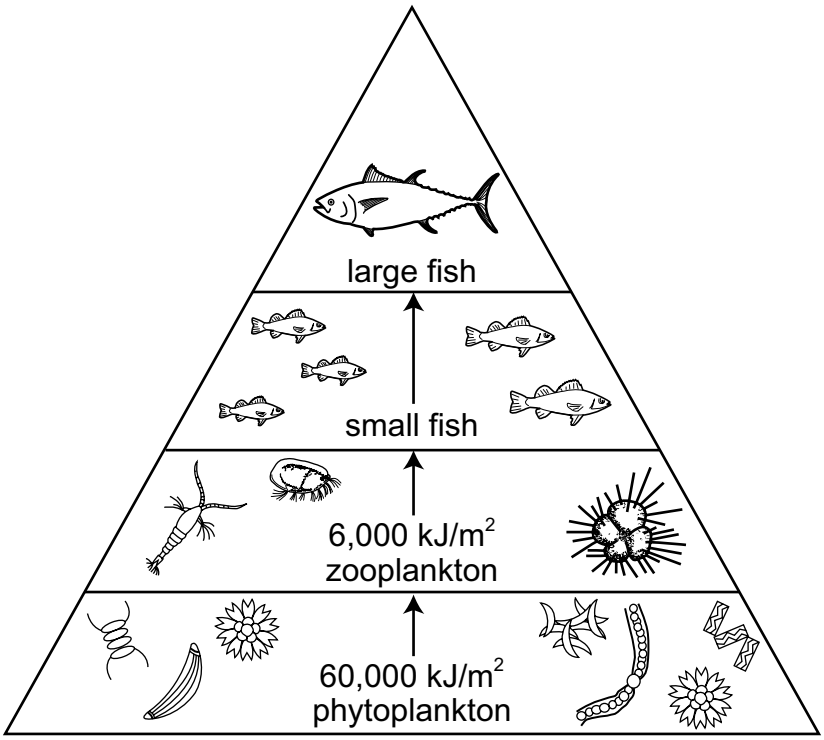
Review/End Test | Pause | Flag | Options | Back | Next

The response provides insufficient evidence to demonstrate any understanding of key events that occur during the cell cycle. In Part A, the response incorrectly identifies the numbered area of the model that represents the student's observations (*1-5 are steps in mitosis*) and does not receive any credit. In Part B, the response incorrectly identifies two events that must take place during interphase before the cell can enter mitosis (*the cells need to split apart into 2*; *the cells need to clone*) and does not receive any credit.

CONSTRUCTED-RESPONSE ITEM

15. A simplified aquatic energy pyramid is shown. It shows the flow of energy transferred in over a year within an aquatic community.

Energy Pyramid for an Aquatic Community



Part A: Identify the primary consumer in this community.

_____

Part B: The amount of energy transferred from the phytoplankton to the zooplankton is shown to be 6,000 kJ/m^2. Determine the amount of energy that will end up as biomass in the body of the large fish.

_____

Go to the next page to finish question 15.

GO ON

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

Part C: Describe what may have happened to the 54,000 kJ/m^2 of energy that was **not** transferred from the phytoplankton to the bodies of the zooplankton.

AFTER YOU HAVE CHECKED YOUR WORK, CLOSE YOUR ANSWER BOOKLET AND TEST BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

STOP

SCORING GUIDE

#15 Item Information

Alignment	BIO.B.4.2.1	**Depth of Knowledge**	3	**Mean Score**	1.49

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of how energy flows through an ecosystem by • identifying the primary consumer in the given energy pyramid, **AND** • determining the amount of energy that will be converted into the biomass of the large fish in the energy pyramid, **AND** • describing what happened to the energy not transferred from the phytoplankton to the zooplankton in the energy pyramid. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of how energy flows through an ecosystem by fulfilling **two** of the bullets under the 3-point response. The response may contain some work that is incomplete or unclear.
1	The response demonstrates a *minimal* understanding of how energy flows through an ecosystem by fulfilling **one** of the bullets under the 3-point response. The response may contain some work that is incomplete or unclear.
0	The response provides *insufficient* evidence to demonstrate any understanding of the concept being tested.

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

Responses That Will Receive Credit

Part A (1 point): One point for identifying zooplankton as the primary consumer in this community.

Part B (1 point): One point for determining that the amount of energy that will end up as biomass in the body of the large fish is 60 kJ/m^2.

Part C (1 point): Any one of the following:

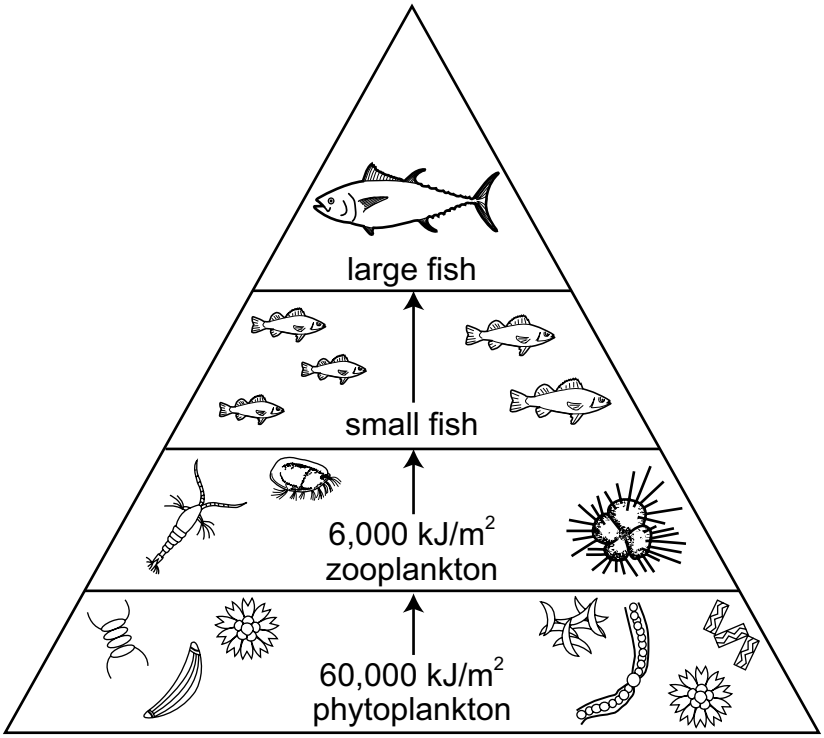
- The energy was lost in respiration.
- It was lost as waste.
- It was lost as heat.
- It was used by the organism.

STUDENT RESPONSE

Response Score: 3 points

15. A simplified aquatic energy pyramid is shown. It shows the flow of energy transferred in over a year within an aquatic community.

Energy Pyramid for an Aquatic Community



Part A: Identify the primary consumer in this community.

Zooplankton

Part B: The amount of energy transferred from the phytoplankton to the zooplankton is shown to be 6,000 kJ/m^2. Determine the amount of energy that will end up as biomass in the body of the large fish.

60 KJ/m^2

Go to the next page to finish question 15.

GO ON

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

Part C: Describe what may have happened to the 54,000 kJ/m^2 of energy that was **not** transferred from the phytoplankton to the bodies of the zooplankton.

It would be the waste

The response demonstrates a thorough understanding of how energy flows through an ecosystem. In Part A, the response correctly identifies the primary consumer in the energy pyramid (*Zooplankton*). In Part B, the response correctly determines the amount of energy that will be converted into the biomass in the large fish in the energy pyramid (*60 KJ/m^2*). In Part C, the response correctly describes what may have happened to the 54,000 kJ/m^2 that was not transferred from the phytoplankton to the bodies of the zooplankton (*It would be the waste*). The response is clear, complete, and correct.

AFTER YOU HAVE CHECKED YOUR WORK, CLOSE YOUR ANSWER BOOKLET AND TEST BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

STUDENT RESPONSE

Response Score: 2 points

PARTS A and B

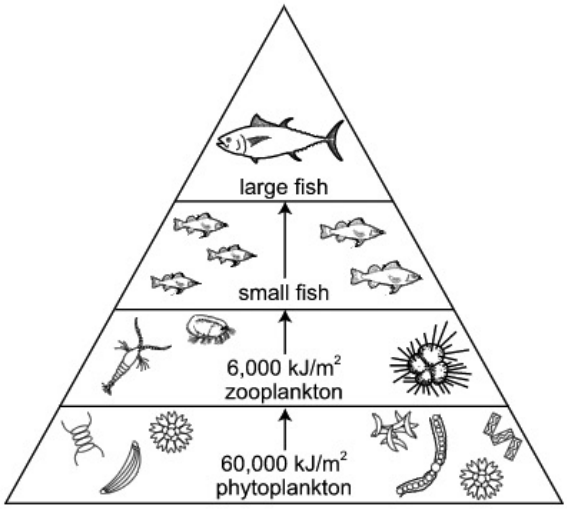
Question 15
Page 1 of 2

Line Guide

Item ID

A simplified aquatic energy pyramid is shown. It shows the flow of energy transferred in over a year within an aquatic community.

Energy Pyramid for an Aquatic Community



Part A: Identify the primary consumer in this community.

EQ

the Large Fish

14 / 1000

Part B: The amount of energy transferred from the phytoplankton to the zooplankton is shown to be 6,000 kJ/m^2. Determine the amount of energy that will end up as biomass in the body of the large fish.

EQ

60 kj/m^2

9 / 1000

Review/End Test | Pause | Flag | Options | Next

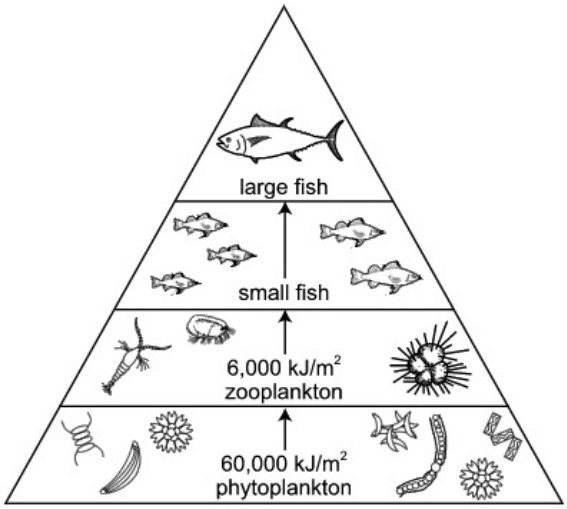
PART C

Question 15
Page 2 of 2

Line Guide | Item ID | ?

A simplified aquatic energy pyramid is shown. It shows the flow of energy transferred in over a year within an aquatic community.

Energy Pyramid for an Aquatic Community



Part C: Describe what may have happened to the 54,000 kJ/m^2 of energy that was **not** transferred from the phytoplankton to the bodies of the zooplankton.

EQ

The energy was lost in heat.

28 / 1000

Review/End Test | Pause | Flag | Options | Back | Next

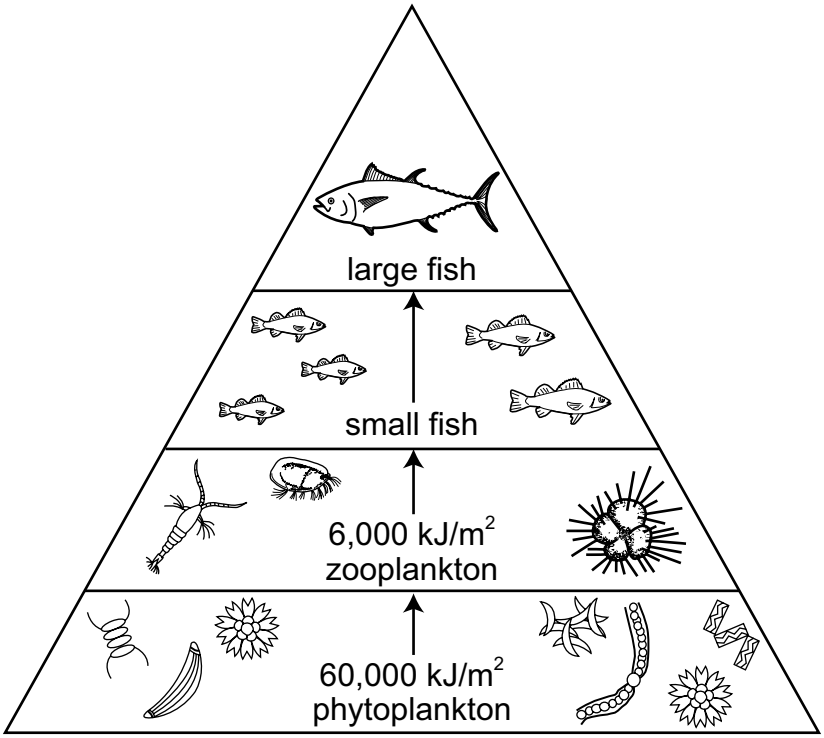
The response demonstrates a partial understanding of how energy flows through an ecosystem. In Part A, the response incorrectly identifies the primary consumer in the energy pyramid (*the Large Fish*) and does not receive any credit. In Part B, the response correctly determines the amount of energy that will be converted into the biomass in the large fish in the energy pyramid (*60 kj/m^2*). In Part C, the response correctly describes what may have happened to the 54,000 kJ/m^2 that was not transferred from the phytoplankton to the bodies of the zooplankton (*The energy was lost in heat.*).

STUDENT RESPONSE

Response Score: 1 point

15. A simplified aquatic energy pyramid is shown. It shows the flow of energy transferred in over a year within an aquatic community.

Energy Pyramid for an Aquatic Community



Part A: Identify the primary consumer in this community.

Large fish

Part B: The amount of energy transferred from the phytoplankton to the zooplankton is shown to be 6,000 kJ/m^2. Determine the amount of energy that will end up as biomass in the body of the large fish.

60

Go to the next page to finish question 15.

GO ON

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

Part C: Describe what may have happened to the 54,000 kJ/m^2 of energy that was **not** transferred from the phytoplankton to the bodies of the zooplankton.

It was consumed by the organims higher in the pyramid.

The response demonstrates a minimal understanding of how energy flows through an ecosystem. In Part A, the response incorrectly identifies the primary consumer in the energy pyramid (*Large fish*) and does not receive any credit. In Part B, the response correctly determines the amount of energy that will be converted into the biomass in the large fish in the energy pyramid (*60*). In Part C, the response incorrectly describes what may have happened to the 54,000 kJ/m^2 that was not transferred from the phytoplankton to the bodies of the zooplankton (*It was consumed by the organims higher in the pyramid.*) and does not receive any credit.

AFTER YOU HAVE CHECKED YOUR WORK, CLOSE YOUR ANSWER BOOKLET AND TEST BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

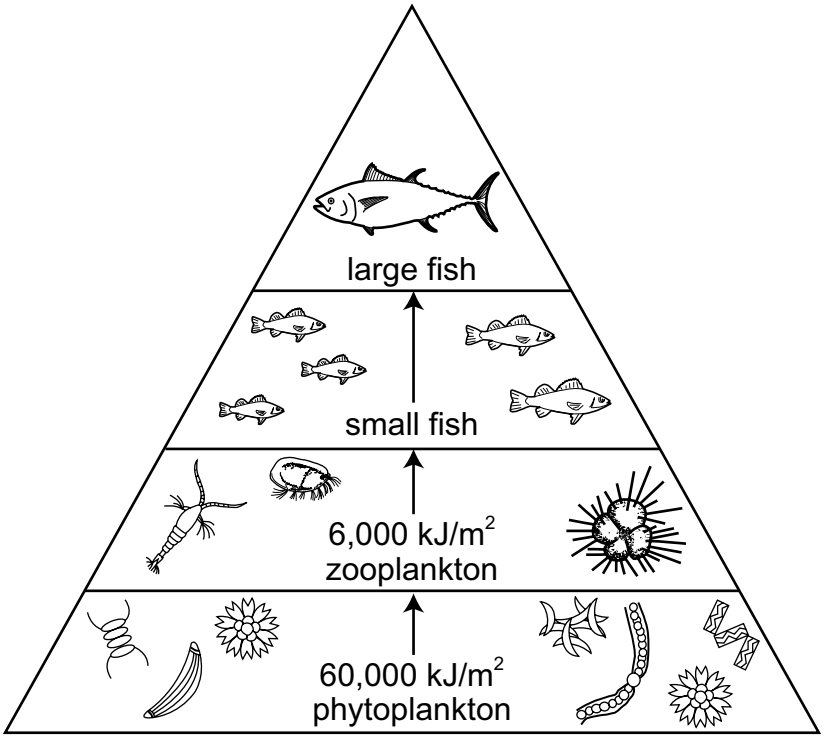
STOP

STUDENT RESPONSE

Response Score: 0 points

15. A simplified aquatic energy pyramid is shown. It shows the flow of energy transferred in over a year within an aquatic community.

Energy Pyramid for an Aquatic Community



Part A: Identify the primary consumer in this community.

Large fish

Part B: The amount of energy transferred from the phytoplankton to the zooplankton is shown to be 6,000 kJ/m^2. Determine the amount of energy that will end up as biomass in the body of the large fish.

600 KJ/M^2

Go to the next page to finish question 15.

GO ON

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

Part C: Describe what may have happened to the 54,000 kJ/m^2 of energy that was **not** transferred from the phytoplankton to the bodies of the zooplankton.

The zooplankton does not need as much energy as the phytoplankton.

The response provides insufficient evidence to demonstrate any understanding about how energy flows through an ecosystem. In Part A, the response incorrectly identifies the primary consumer in the energy pyramid (*Large fish*) and does not receive any credit. In Part B, the response incorrectly determines the amount of energy that will be converted into the biomass in the large fish in the energy pyramid (*600 KJ/M^2*) and does not receive any credit. In Part C, the response incorrectly describes what may have happened to the 54,000 kJ/m^2 that was not transferred from the phytoplankton to the bodies of the zooplankton (*The zooplankton does not need as much energy as the phytoplankton.*) and does not receive any credit.

AFTER YOU HAVE CHECKED YOUR WORK, CLOSE YOUR ANSWER BOOKLET AND TEST BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

BIOLOGY MODULE 2—SUMMARY DATA

MULTIPLE-CHOICE

Sample Number	Alignment	Answer Key	Depth of Knowledge	*p*-value A	*p*-value B	*p*-value C	*p*-value D
1	BIO.B.1.2.1	B	2	14	68	10	8
2	BIO.B.1.2.2	A	2	50	24	13	13
3	BIO.B.2.1.1	A	2	53	26	11	10
4	BIO.B.2.1.2	B	2	17	59	13	11
5	BIO.B.2.2.2	A	2	56	9	25	10
6	BIO.B.2.3.1	C	2	6	13	65	16
7	BIO.B.3.1.3	C	2	13	8	71	8
8	BIO.B.3.2.1	A	2	52	22	6	20
9	BIO.B.3.3.1	D	2	16	14	18	52
10	BIO.B.4.1.1	D	2	10	11	24	55
11	BIO.B.4.1.2	C	2	9	5	60	26
12	BIO.B.3.1.2	D	2	8	30	15	47
13	BIO.B.4.2.1	C	2	18	4	75	3

CONSTRUCTED-RESPONSE

Sample Number	Alignment	Points	Depth of Knowledge	Mean Score
14	BIO.B.1.1.1	3	3	1.34
15	BIO.B.4.2.1	3	3	1.49

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Keystone Exams
Biology

Item and Scoring Sampler 2023