pennsylvania
DEPARTMENT OF EDUCATION

PENNSYLVANIA
KEYSTONE EXAMS

Biology

Item and Scoring Sampler

2022–2023

Pennsylvania Department of Education Bureau of Curriculum, Assessment and Instruction—August 2022

TABLE OF CONTENTS

INTRODUCTION

The Pennsylvania Department of Education (PDE) provides districts and schools with tools to assist in delivering focused instructional programs aligned to 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 2022 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 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. 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 can then use the sampler as a guide to score the responses either independently or together with colleagues.

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.

INFORMATION ABOUT BIOLOGY

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 minute 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 actual 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. Which characteristic is shared by **all** prokaryotic and eukaryotic organisms?

A. contain genetic material

B. contain membrane-bound organelles

C. use the same method of reproduction

D. use the same method of obtaining nutrition

Item Information	
Alignment	BIO.A.1.1.1
Answer Key	A
Depth of Knowledge	2
p-value A	56% (correct answer)
p-value B	23%
p-value C	12%
p-value D	9%
Option Annotations	A. Key: Prokaryotes and eukaryotes both have genetic material, but it is present in different forms among these groups. B. Membrane-bound organelles are absent in prokaryotes but present in eukaryotes. C. Prokaryotes divide by binary fission; eukaryotes divide through the process of mitosis. D. Prokaryotes and eukaryotes both require energy, but the methods used to obtain nutrients are not the same for all organisms.

2. Which conclusion is **best** supported by the presence of ribosomes in prokaryotes and eukaryotes?

A. Ribosomes have different functions in prokaryotes and eukaryotes.

B. Both prokaryotes and eukaryotes store energy to power life functions.

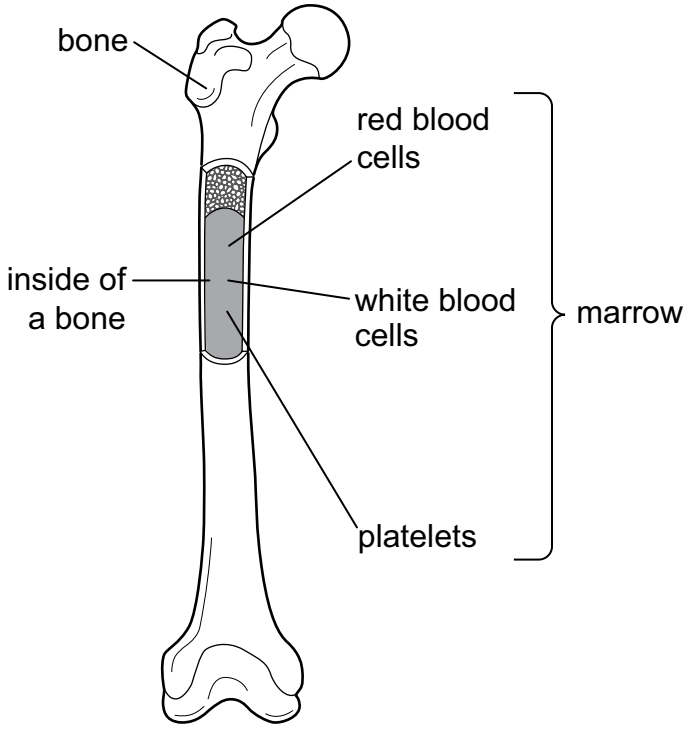
C. Ribosomes developed independently inside prokaryotes and eukaryotes.

D. Both prokaryotes and eukaryotes make proteins to perform life functions.

Item Information	
Alignment	BIO.A.1.1.1
Answer Key	D
Depth of Knowledge	2
p-value A	16%
p-value B	17%
p-value C	12%
p-value D	55% (correct answer)
Option Annotations	A. The function of a ribosome is to serve as the site of protein synthesis in both eukaryotic and prokaryotic cells. B. Energy in a cell is stored within the bonds of ATP, not ribosomes. C. Ribosomes are the site of protein synthesis, so their development does not explain why they are found in both prokaryotic and eukaryotic cells. D. Key: Ribosomes serve as the site of protein synthesis; eukaryotes and prokaryotes are able to make proteins for cell growth and repair.

3. Use the diagram below to answer the question.

Some Components of a Bone



The diagram shows a bone and some of its components. Which statement **best** describes a relationship among some of these components?

A. Marrow is an organ in the skeletal system.

B. Marrow is a tissue that contains different types of cells.

C. Red blood cells, white blood cells, and platelets perform the same function.

D. Red blood cells, white blood cells, and platelets together form an organ system.

Item Information	
Alignment	BIO.A.1.2.2
Answer Key	B
Depth of Knowledge	2
p-value A	7%
p-value B	62% (correct answer)
p-value C	10%
p-value D	21%
Option Annotations	A. Bone marrow is a tissue in bones, and bones are the organs in the skeletal system. B. Key: Bone marrow is a tissue in bone (an organ) and is made up of specialized cells. C. These different cell types have specialized forms and functions. D. Red blood cells, white blood cells, and platelets are found in blood and do not make up an organ system.

4. Which statement **best** describes how amino acids become polymers?

A. Water is added as amino acids link to form proteins.

B. Water is released as amino acids break apart to form proteins.

C. Peptide bonds link amino acids together as proteins form.

D. Peptide bonds break between amino acids as proteins form.

Item Information	
Alignment	BIO.A.2.2.2
Answer Key	C
Depth of Knowledge	2
p-value A	11%
p-value B	13%
p-value C	67% (correct answer)
p-value D	9%
Option Annotations	A. To link amino acid monomers with peptide bonds, dehydration synthesis releases water. B. Hydrolysis can break peptide bonds, but this produces monomers, not polymers. C. Key: Amino acids become protein polymers through a condensation (dehydration synthesis) reaction. D. Amino acids are the monomers that link to form protein polymers.

5. DNA replication in a eukaryotic cell occurs in the presence of the enzyme DNA polymerase. Which effect is **most likely** caused by a pH change in the cell nucleus?

A. The rate of DNA replication will decrease.

B. The energy required to initiate DNA replication will decrease.

C. DNA replication will occur in the absence of certain nucleic acids.

D. DNA replication will move to the cytoplasm and be completed by other enzymes.

Item Information	
Alignment	BIO.A.2.3.2
Answer Key	A
Depth of Knowledge	2
p-value A	42% (correct answer)
p-value B	25%
p-value C	18%
p-value D	14%
Option Annotations	A. Key: Enzymes function at a specific pH; any change above or below this optimum pH will result in decreased activity of the enzyme. B. One function of an enzyme is to decrease activation energy, but if the enzyme involved in the reaction is compromised, then the energy to initiate a reaction will increase. C. DNA is a nucleic acid and stores the genetic material. D. DNA synthesis occurs in the nucleus of a eukaryotic cell, not the cytoplasm.

6. Which statement **best** describes the role of ATP in a living system?

A. ATP senses and adjusts the pH in the cellular environment.

B. ATP identifies and repairs weak components of cells and tissues.

C. ATP measures and provides heat to increase reaction rates in cells.

D. ATP captures and transfers energy released by the breakdown of glucose.

Item Information	
Alignment	BIO.A.3.2.2
Answer Key	D
Depth of Knowledge	2
p-value A	6%
p-value B	7%
p-value C	9%
p-value D	79% (correct answer)
Option Annotations	A. As a molecule, ATP is an energy carrier, and it does not have sensory capabilities. B. As a molecule, ATP is an energy carrier, and it provides the energy for repairs to be performed. C. ATP does not monitor conditions in the cellular environment. D. Key: Chemical energy is stored in the bonds of the ATP molecule, particularly the bonds between the phosphate groups.

7. An organism carries out both photosynthesis and cellular respiration. Which statement describes a difference between these two processes?

A. Only cellular respiration creates chemical energy.

B. The processes occur in different types of animal cells.

C. Only photosynthesis changes light energy into chemical energy.

D. The processes occur at different times during the animal's life cycle.

Item Information	
Alignment	BIO.A.3.2.1
Answer Key	C
Depth of Knowledge	2
p-value A	10%
p-value B	7%
p-value C	76% (correct answer)
p-value D	8%
Option Annotations	A. Photosynthesis and cellular respiration transform chemical energy. B. Photosynthesis occurs in plant cells, not animal cells. C. Key: Photosynthesis uses radiant energy from the Sun and converts it into chemical energy in the form of glucose. D. Photosynthesis occurs in plant cells, not animal cells.

8. Which statement **best** describes both mitochondria and chloroplasts?

A. They both contain their own RNA and are involved in transcription.

B. They both contain their own DNA and are involved in energy conversions.

C. They both contain their own DNA and are involved in controlling the activities of a cell.

D. They both contain their own RNA and are involved in storage of nuclear genetic material.

Item Information	
Alignment	BIO.A.3.1.1
Answer Key	B
Depth of Knowledge	2
p-value A	12%
p-value B	59% (correct answer)
p-value C	18%
p-value D	11%
Option Annotations	A. They both contain RNA, but chloroplasts are involved in photosynthesis and mitochondria produce cell energy in cellular respiration. B. Key: Mitochondria and chloroplasts both contain DNA and both form ATP. C. The nucleus controls the activities of a cell. D. The nucleus of the cell stores the genetic material.

9. A molecule is produced within a ribosome in a cell. What **most likely** happens to the newly formed molecule once it is inside the Golgi apparatus of the cell?

A. It will be used to form new genetic material.

B. It will be stored for the cell's future energy needs.

C. It will be modified before it is packaged for transport.

D. It will be broken down so its components can be reused.

Item Information	
Alignment	BIO.A.4.1.3
Answer Key	C
Depth of Knowledge	2
p-value A	12%
p-value B	17%
p-value C	60% (correct answer)
p-value D	11%
Option Annotations	A. The Golgi apparatus does not replicate DNA for new genetic material. B. The Golgi apparatus does not have the ability to store cell materials or energy molecules. C. Key: The Golgi apparatus functions to process proteins and sort them for transport. D. The Golgi apparatus does not have the ability to break down molecules; this is the role of lysosomes.

10. In the human body, the steroid aldosterone is released by the adrenal glands to help regulate sodium and potassium levels. This regulation helps control blood pressure and the balance of fluids in blood. Which statement **best** describes this process of regulation within the body?

A. It is a feedback system that maintains homeostasis.

B. It is a response that is only a result of medical intervention.

C. It is a response by the body that is used only in extreme situations.

D. It is a feedback system that moves the body further from equilibrium.

Item Information	
Alignment	BIO.A.4.2.1
Answer Key	A
Depth of Knowledge	2
p-value A	72% (correct answer)
p-value B	7%
p-value C	13%
p-value D	8%
Option Annotations	A. Key: The hormone aldosterone helps regulate blood volume as part of the negative feedback loop for water balance (homeostasis) in the human body. B. This regulation is a natural response by the body involving interaction between the endocrine, circulatory, and excretory systems. C. Human body systems are constantly monitoring and responding to changing environmental conditions, which means that this response is part of the normal homeostatic process. D. Positive feedback loops are less common in types of homeostasis because they reinforce changes that push a variable further from the steady state.

11. Which statement **best** explains why most biological macromolecules contain carbon?

A. The long chains formed by carbon can be combusted with oxygen as a source of energy.

B. Carbon exists across the universe and is produced in the interior of stars during their life cycles.

C. Carbon can share electrons with up to four different atoms and form three types of bonding patterns.

D. The chemical and physical characteristics of carbon-containing molecules change as they move through the carbon cycle.

Item Information	
Alignment	BIO.A.2.2.1
Answer Key	C
Depth of Knowledge	2
p-value A	12%
p-value B	5%
p-value C	71% (correct answer)
p-value D	12%
Option Annotations	A. Hydrocarbon chains are just one of many forms carbon can take, and hydrogen is one of many atoms with which carbon can bond. B. Carbon's continual formation as stars evolve makes it universally available to be incorporated into different molecules as a function of its chemical characteristics. C. Key: This ability to bond with many different atoms in different forms and structures gives carbon the unique role of being present in many molecules. D. This characteristic allows carbon to be present in various forms on Earth.

Directions: Use the information presented on page 18 to answer questions 12 and 13.

Arsenic-Loving Bacteria or Not

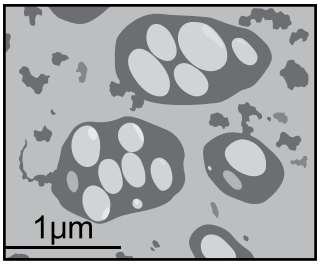
For many years, scientists thought that carbon (C), hydrogen (H), nitrogen (N), oxygen (O), sulfur (S), and phosphorus (P) were necessary building blocks for all living things. These elements are required to make many biological molecules. Recently, a scientist working for the National Aeronautics and Space Administration (NASA) claimed to have discovered a bacterium that could use arsenate (AsO_4^{3-}) instead of phosphate (PO_4^{3-}) as a building block for biological molecules. This bacterium, GFAJ-1, lives in Mono Lake, a briny body of water located in central California.

Chemical Composition of Mono Lake

Element	Concentration (g/L)	Element	Concentration (g/L)
Sodium	39.3	Phosphate	0.088
Chloride	23.0	Fluoride	0.065
Sulfate	13.1	Magnesium	0.044
Potassium	1.8	Silica	0.028
Boron	0.474	Arsenic	0.017

The NASA scientist collected mud from Mono Lake and added it to a container of salt medium. This medium did not have PO_4^{3-} but did have a high concentration of AsO_4^{3-}. After diluting the mud sample several times and adding more AsO_4^{3-}, the scientist thought PO_4^{3-} levels were too low for any microbe to use. However, the scientist discovered one type of microbe, the bacterium GFAJ-1, in the mud mixture that seemed to thrive when other microbes struggled to survive.

GFAJ-1



Further tests on GFAJ-1 seemed to confirm that the AsO_4^{3-} had taken the place of PO_4^{3-} in some biological molecules, such as DNA, RNA, proteins, lipids, and carbohydrates. Other scientists were unable to reproduce the NASA scientist's results. They thought the samples used by the NASA scientist likely contained PO_4^{3-} contaminants that could still support GFAJ-1 growth. Finally, the scientists determined the bacterium used a special protein to discriminate between PO_4^{3-} and AsO_4^{3-}. This protein allowed the bacterium to reject the arsenate and accept the phosphate even when the arsenate molecules outnumbered the phosphate molecules 4,500 to 1. Thus GFAJ-1 turned out to be a bacterium that was highly resistant to AsO_4^{3-} and not an arsenic-loving bacterium.

12. Which statement **best** explains how a property of water influences the chemical composition of Mono Lake?

A. The nonpolar nature of water molecules allows water to neutralize ions.

B. The nonpolar nature of water molecules allows water to engulf the salts.

C. The polar nature of water molecules allows water to repel different salts.

D. The polar nature of water molecules allows water to form bonds with ions.

Item Information	
Alignment	BIO.A.2.1.1
Answer Key	D
Depth of Knowledge	2
p-value A	16%
p-value B	15%
p-value C	18%
p-value D	51% (correct answer)
Option Annotations	A. Water molecules are polar and do not dissolve ions by undergoing an acid-base reaction with them. B. Water molecules are polar and tend to form hydrogen bonds with each other to form cages around small, nonpolar molecules, not salts. C. Water molecules are polar, but they attract ions in salts, forming covalent bonds with metal ions and hydrogen bonds with negative ions. D. Key: Water is polar and dissolves the compounds in the water.

13. Based on the final conclusion scientists reached about GFAJ-1, what would happen to energy production by the bacterium when given an arsenate-rich, phosphate-free medium?

A. Neither ADP nor ATP would be produced because the bacterium can only use PO_4^{3-}, and this would cause energy production to stop.

B. ADP and P_i would continue to be converted into ATP using AsO_4^{3-} instead of PO_4^{3-}, and this conversion would maintain energy production.

C. Neither ADP nor ATP would be produced because the bacterium has no mitochondria to produce PO_4^{3-}, and this would cause energy production to stop.

D. ADP and P_i would continue to be converted into ATP using PO_4^{3-} produced by the mitochondria, and this conversion would maintain energy production.

Item Information	
Alignment	BIO.A.3.2.2
Answer Key	A
Depth of Knowledge	2
p-value A	41% (correct answer)
p-value B	27%
p-value C	15%
p-value D	17%
Option Annotations	A. Key: In the absence of phosphate, the bacterium would be unable to produce energy. B. The absence of phosphate and the toxicity of the arsenate would prevent any synthesis of ADP, P_i, or ATP. C. GFAJ-1 has no mitochondria and absorbs PO_4^{3-} from the environment. D. Bacteria do not have mitochondria, and mitochondria do not produce PO_4^{3-}.

CONSTRUCTED-RESPONSE ITEM

14. Use the chart below to answer the question.

Observed Cell Features

Cell 1	Cell 2
• nucleoid • cytoplasm • plasma membrane	• mitochondria • cytoplasm • plasma membrane

Using a microscope, a scientist observed two cells and recorded several features observed for each cell.

Part A: The scientist recorded a limited number of observations for each cell. Based on the information, classify each cell as either a prokaryote or a eukaryote.

Cell 1: _____

Cell 2: _____

Part B: Identify another cell structure that would be observed in both cells but is not on the chart and describe the function of this cell structure.

Cell Structure: _____

Function: _____

_____

_____

_____

SCORING GUIDE

#14 Item Information

Alignment	BIO.A.1.2.1	**Depth of Knowledge**	3	**Mean Score**	1.41

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of comparing and contrasting cellular structures and their functions in prokaryotic and eukaryotic cells by • classifying each of two cells as prokaryote or eukaryote, based on a chart of observations for each cell, **AND** • identifying another cell structure that would be observed in both cells but is not on the chart, **AND** • describing the function of this cell structure. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of comparing and contrasting cellular structures and their functions in prokaryotic and eukaryotic cells 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 comparing and contrasting cellular structures and their functions in prokaryotic and eukaryotic cells by fulfilling **one** of the bullets listed 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):

- Cell 1 is a prokaryote and Cell 2 is a eukaryote

Part B (2 points total; 1 point for identifying the structure, 1 point for its function):

- Structure: DNA
  OR
- Structure: ribosomes
  OR
- Structure: cell wall
  OR
- Structure: flagellum

- Function of DNA: carries the genetic information for the cell
  OR
- Function of DNA: carries the instructions for the cell
  OR
- Function of DNA: carries the genes that the cell needs

- Function of ribosomes: build proteins
  OR
- Function of ribosomes: perform translation

- Function of cell wall: provides cell structure
  OR
- Function of cell wall: protects the cell
  OR
- Function of cell wall: prevents the cell from bursting

- Function of flagellum: helps the cell move; cell motility

Background Information:

- Not all eukaryotic cells have a cell wall or flagellum, but many do.

STUDENT RESPONSE

Response Score: 3 points

14. Use the chart below to answer the question.

Observed Cell Features

Cell 1	Cell 2
• nucleoid • cytoplasm • plasma membrane	• mitochondria • cytoplasm • plasma membrane

Using a microscope, a scientist observed two cells and recorded several features observed for each cell.

Part A: The scientist recorded a limited number of observations for each cell. Based on the information, classify each cell as either a prokaryote or a eukaryote.

Cell 1: prokaryote

Cell 2: eukaryote

Part B: Identify another cell structure that would be observed in both cells but is not on the chart and describe the function of this cell structure.

Cell Structure: Flagella

Function: The function is to help move the cell around.

The response demonstrates a thorough understanding of comparing and contrasting cellular structures and their functions in prokaryotic and eukaryotic cells. In Part A, the response correctly classifies each of the two cells as prokaryote or eukaryote (Cell 1: *prokaryote*; Cell 2: *eukaryote*). In Part B, the response correctly identifies another cell structure that would be observed in both cells but is not on the chart (Cell Structure: *Flagella*) and correctly describes the function of this cell structure (Function: *help move the cell around*). The response is clear, complete, and correct.

STUDENT RESPONSE

Response Score: 2 points

14. Use the chart below to answer the question.

Observed Cell Features

Cell 1	Cell 2
• nucleoid • cytoplasm • plasma membrane	• mitochondria • cytoplasm • plasma membrane

Using a microscope, a scientist observed two cells and recorded several features observed for each cell.

Part A: The scientist recorded a limited number of observations for each cell. Based on the information, classify each cell as either a prokaryote or a eukaryote.

Cell 1: Prokaryote

Cell 2: Eukaryote

Part B: Identify another cell structure that would be observed in both cells but is not on the chart and describe the function of this cell structure.

Cell Structure: The cell membrane

Function: It controls what enters and leaves a cell.

The response demonstrates a partial understanding of comparing and contrasting cellular structures and their functions in prokaryotic and eukaryotic cells. In Part A, the response correctly classifies each of the two cells as prokaryote or eukaryote (Cell 1: *Prokaryote*; Cell 2: *Eukaryote*). In Part B, the response incorrectly identifies another cell structure that would be observed in both cells but is not on the chart (Cell Structure: *cell membrane*); cell (plasma) membrane is included on the chart, so it does not receive credit. However, the response does correctly describe the function of this cell structure (Function: *controls what enters and leaves a cell*).

STUDENT RESPONSE

Response Score: 1 point

14. Use the chart below to answer the question.

Observed Cell Features

Cell 1	Cell 2
• nucleoid • cytoplasm • plasma membrane	• mitochondria • cytoplasm • plasma membrane

Using a microscope, a scientist observed two cells and recorded several features observed for each cell.

Part A: The scientist recorded a limited number of observations for each cell. Based on the information, classify each cell as either a prokaryote or a eukaryote.

Cell 1: eukaryote

Cell 2: prokaryote

Part B: Identify another cell structure that would be observed in both cells but is not on the chart and describe the function of this cell structure.

Cell Structure: Rhobosome

Function: Rhobosomes store water and energy in the cell.

The response demonstrates a minimal understanding of comparing and contrasting cellular structures and their functions in prokaryotic and eukaryotic cells. In Part A, the response incorrectly classifies both cells as prokaryote or eukaryote (Cell 1: *eukaryote*; Cell 2: *prokaryote*) and does not receive any credit. In Part B, the response correctly identifies another cell structure that would be observed in both cells but is not on the chart (Cell Structure: *Rhobosome*). However, the response incorrectly describes the function of ribosomes (*store water and energy in the cell*), and the function description does not receive any credit.

STUDENT RESPONSE

Response Score: 0 points

14. Use the chart below to answer the question.

Observed Cell Features

Cell 1	Cell 2
• nucleoid • cytoplasm • plasma membrane	• mitochondria • cytoplasm • plasma membrane

Using a microscope, a scientist observed two cells and recorded several features observed for each cell.

Part A: The scientist recorded a limited number of observations for each cell. Based on the information, classify each cell as either a prokaryote or a eukaryote.

Cell 1: eukaryote

Cell 2: prokaryote

Part B: Identify another cell structure that would be observed in both cells but is not on the chart and describe the function of this cell structure.

Cell Structure: Exocytosis

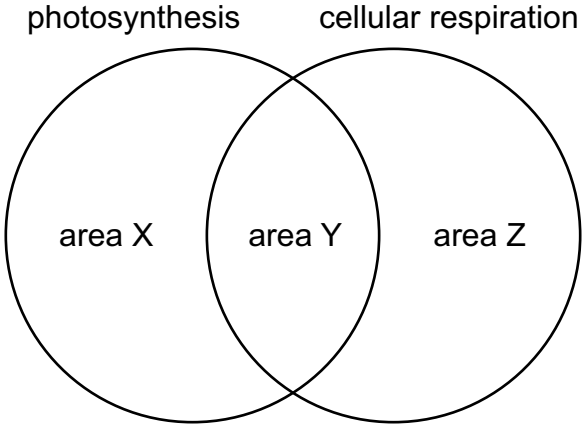
Function: used to move materials out of the cell.

The response provides insufficient evidence to demonstrate any understanding of comparing and contrasting cellular structures and their functions in prokaryotic and eukaryotic cells. In Part A, the response incorrectly classifies both cells as prokaryote or eukaryote (Cell 1: *eukaryote*; Cell 2: *prokaryote*) and does not receive any credit. In Part B, the response incorrectly identifies another cell structure that would be observed in both cells but is not on the chart (Cell Structure: *Exocytosis*). Exocytosis is not a cellular structure; the accompanying description of the function (*used to move materials out of the cell*) does not receive any credit.

CONSTRUCTED-RESPONSE ITEM

15. Use the diagram below to answer the question.

Two Cellular Processes



A student draws a Venn diagram to compare and contrast two cellular processes.

Part A: Select two areas from the Venn diagram and describe a characteristic that could be placed into each of the areas.

Area: _____

Characteristic: _____

_____

_____

Area: _____

Characteristic: _____

_____

_____

Go to the next page to finish question 15.

GO ON

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

Part B: Explain why some organisms would need to perform both cellular respiration and photosynthesis.

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.3.2.1	**Depth of Knowledge**	3	**Mean Score**	1.39

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of comparing and contrasting the basic transformation of energy during photosynthesis and cellular respiration by • describing a characteristic of one of three areas on a Venn diagram that shows overlap between the processes of photosynthesis and cellular respiration, **AND** • describing a characteristic of a second of three areas on a Venn diagram that shows overlap between the processes of photosynthesis and cellular respiration, **AND** • explaining why some organisms would need to perform both cellular respiration and photosynthesis. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of comparing and contrasting the basic transformation of energy during photosynthesis and cellular respiration 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 comparing and contrasting the basic transformation of energy during photosynthesis and cellular respiration by fulfilling **one** of the bullets listed 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 (2 points total; 1 point for each area with a characteristic):

Area X Characteristics:

- occurs only in plants, algae, and some bacteria
- happens in chloroplasts/chlorophyll
- uses sunlight energy
- generates oxygen
- makes sugars and other organic molecules/chemical energy
- includes the light-dependent reactions and/or the Calvin cycle
- fixes carbon
- uses carbon dioxide
- has two stages

Area Y Characteristics:

- both use an electron transport chain
- both use a cycle of enzymes
- both generate and use a proton-motive force (proton gradient)
- both make ATP
- both occur inside an organelle/a cell
- both use an organelle that probably originated as an endosymbiont
- both have multiple stages
- both use ATP synthase
- both use each other's products as input

Area Z Characteristics:

- breaks down sugars or other organic molecules
- generates water
- has one stage that occurs in the cytosol
- occurs in the mitochondria
- includes glycolysis and/or the citric acid cycle
- requires oxygen
- has three/four stages
- generates carbon dioxide

Part B (1 point):

- Plants need to perform photosynthesis to make organic molecules as raw material for growth, and they need to perform cellular respiration to make ATP to power the energy-requiring processes in the cell.
  OR
- Plants need to perform photosynthesis so they have molecules for growth and sugars that can be broken down by cellular respiration to provide the energy for cellular work.
  OR
- Cellular respiration makes ATP to power cell work; photosynthesis is how the organism uses sunlight energy to make the organic molecules it needs.
  OR
- Since plants don't eat, they get their organic molecules from photosynthesis; they get the energy for cellular work from cellular respiration.

Background Information:

- Photosynthesis includes two stages. The first is called the light reactions or the light-dependent reactions. It uses sunlight energy to make ATP and NADPH, which requires an electron transport chain to make a proton gradient. Then the proton gradient powers an ATP synthase. This first stage uses water and generates oxygen. The second stage is called the Calvin cycle or the light-independent reactions. It uses the energy stored in ATP and NADPH to fix carbon, or add inorganic carbon dioxide to an organic molecule, eventually making PGAL (aka G3P). Two PGAL molecules make one glucose.
- In cellular respiration, the citric acid cycle is also called the Krebs cycle or the TCA cycle.
- In cellular respiration, there are four stages: glycolysis, an unnamed stage that is often called the junction stage, the citric acid cycle, and oxidative phosphorylation. Oxidative phosphorylation includes an electron transport chain (to generate a proton gradient) and chemiosmosis (using the proton gradient to make ATP via ATP synthase).
- Photosynthesis makes ATP, but that ATP must stay in the chloroplast and be used to drive the Calvin cycle; it is not available to do cellular work.
- A proton is also a hydrogen ion, or H^+.

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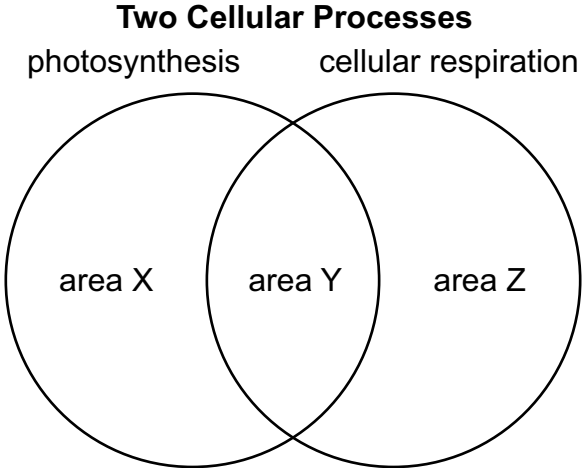
STUDENT RESPONSE

Response Score: 3 points

15. Use the diagram below to answer the question.



A student draws a Venn diagram to compare and contrast two cellular processes.

Part A: Select two areas from the Venn diagram and describe a characteristic that could be placed into each of the areas.

Area: X

Characteristic: Converts light energy from the sun into chemical energy in the form of glucose.

Area: Z

Characteristic: occurs in the mitochondria of eukaryotic cells

Go to the next page to finish question 15.

GO ON

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

Part B: Explain why some organisms would need to perform both cellular respiration and photosynthesis.

Some organisms would need to perform both cellular respiration and photosynthesis because photosynthesis is the only way those organisms could obtain glucose, which is broken down during cellular respiration in order to make ATP, which is necessary for all cells and is not created in great enough quantities during photosynthesis to be useful.

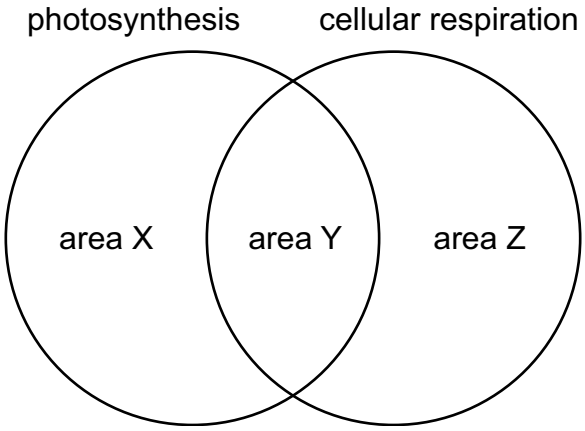
The response demonstrates a thorough understanding of comparing and contrasting the basic transformation of energy during photosynthesis and cellular respiration. In Part A, the response selects two areas from the Venn diagram and correctly describes a characteristic that could be placed into the selected areas (Area: *X*, Characteristic: *Converts light energy . . . into chemical energy in the form of glucose*; Area: *Z*, Characteristic: *Occurs in the mitochondria*). In Part B, the response correctly explains why some organisms would need to perform both cellular respiration and photosynthesis (*photosynthesis is the only way those organisms could obtain glucose, which is broken down during cellular respiration in order to make ATP*). The response is clear, complete, and correct.

STUDENT RESPONSE

Response Score: 2 points

15. Use the diagram below to answer the question.

Two Cellular Processes



A student draws a Venn diagram to compare and contrast two cellular processes.

Part A: Select two areas from the Venn diagram and describe a characteristic that could be placed into each of the areas.

Area: X

Characteristic: requires sunlight and can only occur in plants.

Area: Y

Characteristic: Both photosynthesis and cellular respiration are proccess's that are used to obtain energy.

Go to the next page to finish question 15.

GO ON

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

Part B: Explain why some organisms would need to perform both cellular respiration and photosynthesis.

An organism might not have all the resources it needs to do one of the process's so it does both. For example, if a plant can't complete photosynthesis because of a lack of sunlight, it might finish off by using cellular respiration.

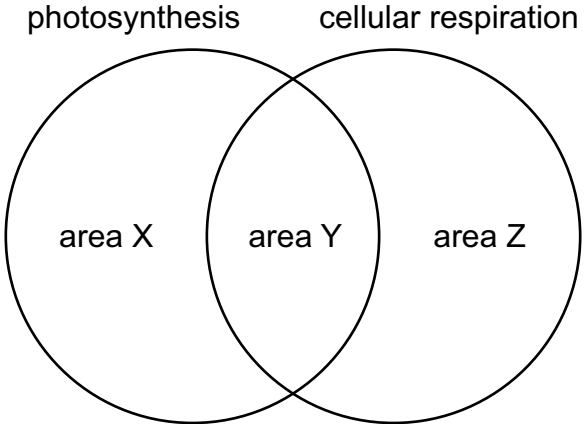
The response demonstrates a partial understanding of comparing and contrasting the basic transformation of energy during photosynthesis and cellular respiration. In Part A, the response selects two areas from the Venn diagram and correctly describes a characteristic that could be placed into the selected areas (Area: *X*, Characteristic: *requires sunlight* OR *can only occur in plants*; Area: *Y*, Characteristic: *Both . . . are used to obtain energy*). In Part B, the response incorrectly explains why some organisms would need to perform both cellular respiration and photosynthesis (*lack of sunlight*) and does not receive any credit.

STUDENT RESPONSE

Response Score: 1 point

15. Use the diagram below to answer the question.

Two Cellular Processes



A student draws a Venn diagram to compare and contrast two cellular processes.

Part A: Select two areas from the Venn diagram and describe a characteristic that could be placed into each of the areas.

Area: x

Characteristic: Photosynthesis occurs in the mitochondria.

Area: Y

Characteristic: Both photosynthesis and cellular respiration involve light energy, CO_2, H_2O, ATP, O_2, and 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: Explain why some organisms would need to perform both cellular respiration and photosynthesis.

Some organisms need to perform cellular respiration and photosynthesis because they need different types of energy and nutrients. To acquire certain nutrients like glucose, organisms need to photosynthesize. Then to make ATP, those organisms would use that glucose as one of the reactants in cellular respiration.

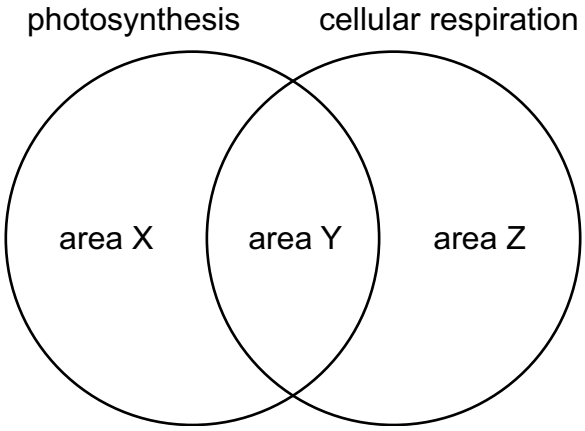
The response demonstrates a minimal understanding of comparing and contrasting the basic transformation of energy during photosynthesis and cellular respiration. In Part A, the response selects two areas from the Venn diagram and incorrectly describes a characteristic that could be placed into the selected areas (Area: *X*, Characteristic: *occurs in the mitochondria*; Area: *Y*, Characteristic: *Both . . . involve light energy*), so it does not receive any credit. In Part B, the response correctly explains why some organisms would need to perform both cellular respiration and photosynthesis (*To acquire certain nutrients like glucose, organisms need to photosynthesize. Then to make ATP, those organisms would use that glucose as one of the reactants in cellular respiration*).

STUDENT RESPONSE

Response Score: 0 points

15. Use the diagram below to answer the question.

Two Cellular Processes



A student draws a Venn diagram to compare and contrast two cellular processes.

Part A: Select two areas from the Venn diagram and describe a characteristic that could be placed into each of the areas.

Area: Y

Characteristic: Require light to take place

Area: X

Characteristic: Plants only way of producing energy

Go to the next page to finish question 15.

GO ON

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

Part B: Explain why some organisms would need to perform both cellular respiration and photosynthesis.

Some organisms perform both because they need the extra energy to survive in maybe a harsher climate/ environment.

The response provides insufficient evidence to demonstrate any understanding of comparing and contrasting the basic transformation of energy during photosynthesis and cellular respiration. In Part A, the response selects two areas from the Venn diagram and incorrectly describes a characteristic that could be placed into the selected areas (Area: *Y*, Characteristic: *Require light*; Area: *X*, Characteristic: *Plants only way of producing energy*), so it does not receive any credit. In Part B, the response incorrectly explains why some organisms would need to perform both cellular respiration and photosynthesis (*need energy to survive in a harsh climate/environment*) 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	A	2	56%	23%	12%	9%
2	BIO.A.1.1.1	D	2	16%	17%	12%	55%
3	BIO.A.1.2.2	B	2	7%	62%	10%	21%
4	BIO.A.2.2.2	C	2	11%	13%	67%	9%
5	BIO.A.2.3.2	A	2	42%	25%	18%	14%
6	BIO.A.3.2.2	D	2	6%	7%	9%	79%
7	BIO.A.3.2.1	C	2	10%	7%	76%	8%
8	BIO.A.3.1.1	B	2	12%	59%	18%	11%
9	BIO.A.4.1.3	C	2	12%	17%	60%	11%
10	BIO.A.4.2.1	A	2	72%	7%	13%	8%
11	BIO.A.2.2.1	C	2	12%	5%	71%	12%
12 (P)	BIO.A.2.1.1	D	2	16%	15%	18%	51%
13 (P)	BIO.A.3.2.2	A	2	41%	27%	15%	17%

CONSTRUCTED-RESPONSE

Sample Number	Alignment	Points	Depth of Knowledge	Mean Score
14	BIO.A.1.2.1	3	3	1.41
15	BIO.A.3.2.1	3	3	1.39

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BIOLOGY MODULE 2

MULTIPLE-CHOICE ITEMS

1. Which event describes cellular activities that would be observed during cytokinesis in an animal cell?

A. The cytoplasm of the parent cell divides following the division of the nucleus.

B. The chromosomes line up at the equator of the spindle in their most tightly condensed form.

C. The DNA and proteins condense and the centrioles move toward the opposite ends of the cell to form a spindle.

D. The spindle fibers, attached to the two sister chromatids of each chromosome, contract and separate as the chromosomes move to opposite poles of the cell.

Item Information	
Alignment	BIO.B.1.1.1
Answer Key	A
Depth of Knowledge	2
p-value A	50% (correct answer)
p-value B	11%
p-value C	17%
p-value D	22%
Option Annotations	A. Key: This is what happens during cytokinesis. B. This activity occurs during metaphase. C. These activities occur during prophase. D. These activities occur during anaphase.

2. A scientist wants to make a change to a genetic code that will lead to the removal of one amino acid from the sequence of a protein. Which genetic material should the scientist remove?

A. three genes

B. three alleles

C. three nucleotides

D. three chromosomes

Item Information	
Alignment	BIO.B.1.2.2
Answer Key	C
Depth of Knowledge	3
p-value A	15%
p-value B	21%
p-value C	53% (correct answer)
p-value D	11%
Option Annotations	A. A gene is a segment of DNA. B. An allele is a version of a gene. C. Key: Removing three nucleotides would remove one amino acid because a single amino acid is determined by a codon, and a codon is three adjacent nucleotides. D. A chromosome is a long DNA molecule.

3. A specific genetic disorder is caused by nondisjunction. Which statement describes how the genetic disorder occurs?

A. A problem with RNA replication leads to gametes with extra chromosomes.

B. A problem with chromosome separation leads to gametes with damaged chromosomes.

C. Incomplete DNA replication leads to gametes with half the usual number of chromosomes.

D. Incomplete chromosome separation leads to gametes with an abnormal number of chromosomes.

Item Information	
Alignment	BIO.B.2.1.2
Answer Key	D
Depth of Knowledge	2
p-value A	18%
p-value B	17%
p-value C	19%
p-value D	45% (correct answer)
Option Annotations	A. Nondisjunction occurs when the chromosomes fail to separate. B. Nondisjunction results in an abnormal number of chromosomes, not damaged chromosomes. C. Incomplete DNA replication is not involved in nondisjunction; instead, the chromosomes fail to separate. D. Key: Nondisjunction occurs when the chromosomes fail to separate, and the resulting daughter cells have an abnormal number of chromosomes.

4. Which sequence of events correctly describes the process of protein synthesis?

A. DNA ⟶ transcription ⟶ mRNA ⟶ translation ⟶ proteins produced

B. DNA ⟶ translation ⟶ mRNA ⟶ transcription ⟶ proteins produced

C. mRNA ⟶ transcription ⟶ polypeptides form ⟶ translation ⟶ proteins produced

D. mRNA ⟶ translation ⟶ polypeptides form ⟶ transcription ⟶ proteins produced

Item Information	
Alignment	BIO.B.2.2.1
Answer Key	A
Depth of Knowledge	2
p-value A	45% (correct answer)
p-value B	29%
p-value C	14%
p-value D	12%
Option Annotations	A. Key: The process of protein synthesis includes DNA being transcribed into mRNA, which is translated into proteins. B. Transcription occurs before translation in the production of proteins within the cell. C. Transcription produces mRNA, which is then translated to form polypeptide chains. D. Transcription occurs when DNA is used to make mRNA, before translation occurs.

5. A mutation present in a parent's genetic code impacts offspring. Which statement **most likely** describes the mutation?

A. The mutation can be recognized and repaired by enzymes.

B. The mutation is observed in the somatic cells of the parent.

C. The mutation changes a base without changing an amino acid.

D. The mutation alters the function of the protein made by the gene.

Item Information	
Alignment	BIO.B.3.1.3
Answer Key	D
Depth of Knowledge	2
p-value A	10%
p-value B	18%
p-value C	17%
p-value D	56% (correct answer)
Option Annotations	A. If a repair enzyme were involved, then the mutation would not be observed in the offspring. B. Mutations in somatic cells are not passed to offspring. C. If the mutation changes a base without changing an amino acid, then the mutation is silent and would not affect the offspring. D. Key: The mutation changes the sequence of bases and prevents the protein from working properly.

6. Use the list below to answer the question.

Scientific Evidence

1. Some genes from the bacterium *E. coli* have sequences that are similar to genes found in humans.
2. In the 1940s, infections by the bacterium *Staphylococcus aureus* could be treated successfully with penicillin. Today, populations exist that are completely resistant to natural penicillin.
3. Whales have tiny bones inside the rear portion of their bodies that are very similar to the bones found in vertebrate legs.
4. Human embryos have gill slits similar to those observed in fish embryos.

Four pieces of evidence collected by scientists are listed. How did the scientists **most likely** use these pieces of evidence?

A. to support the cell theory

B. to support the theory of evolution

C. to explain the process of DNA replication

D. to explain the process of genetic mutations

Item Information	
Alignment	BIO.B.3.2.1
Answer Key	B
Depth of Knowledge	3
p-value A	8%
p-value B	72% (correct answer)
p-value C	6%
p-value D	13%
Option Annotations	A. Cell theory would be supported with evidence of living things being made of cells. B. Key: Genetic code, natural selection, and anatomical and embryological similarities are all evidence for the theory of evolution. C. Genetic code, natural selection, and anatomical and embryological similarities are all evidence for the theory of evolution and do not explain how DNA molecules are copied. D. Genetic code, natural selection, and anatomical and embryological similarities are all evidence for the theory of evolution and do not explain how permanent changes to DNA occur.

7. A scientist determined that the average air temperature in an area increased during an observed period of time. The area included several small ponds. Which change to the water cycle **most likely** occurred in the area during the observed period of time?

A. runoff decreased

B. evaporation increased

C. precipitation decreased

D. condensation increased

Item Information	
Alignment	BIO.B.4.2.3
Answer Key	B
Depth of Knowledge	2
p-value A	7%
p-value B	61% (correct answer)
p-value C	19%
p-value D	14%
Option Annotations	A. A decrease in runoff cannot be determined without measuring precipitation amounts. B. Key: Evaporation most likely increased because the temperature increase caused an increase in the kinetic energy of the water molecules. C. There is no evidence presented to suggest a change in the amount of precipitation. D. The humidity of the air is not described, so condensation amounts cannot be determined.

8. A student made an observation about a plant. Which statement is an observation that the student **most likely** made?

A. Plants benefit from tilting their leaves toward the Sun.

B. At 10 A.M. the plant's leaves were tilted toward the Sun.

C. Plants that do not tilt their leaves toward the Sun will not survive.

D. The tilting of plant leaves toward the Sun evolved over a long period of time.

Item Information	
Alignment	BIO.B.3.3.1
Answer Key	B
Depth of Knowledge	2
p-value A	28%
p-value B	54% (correct answer)
p-value C	8%
p-value D	9%
Option Annotations	A. This is an inference the student could make based on multiple observations of plants; it is not an observation. B. Key: The student can use the sense of sight to see that the plant is tilted at a specific time. C. This is a hypothesis that could be tested; it is not information that is directly noticed by the senses. D. This is a theory, which relies on a set of scientific principles to explain a phenomena and cannot be formed from a single observation.

9. Oak treehoppers are parasites of trees. Which statement describes the relationship between an oak treehopper and a tree?

A. Both the oak treehopper and the tree are harmed by one another.

B. The oak treehopper benefits from the tree, while the tree is unaffected.

C. The tree benefits from the oak treehopper, while the oak treehopper is unaffected.

D. The oak treehopper benefits from the tree, while the tree is harmed by the oak treehopper.

Item Information	
Alignment	BIO.B.4.2.2
Answer Key	D
Depth of Knowledge	2
p-value A	5%
p-value B	14%
p-value C	7%
p-value D	74% (correct answer)
Option Annotations	A. This describes a mutually negative relationship and not a parasitic relationship, in which one organism benefits and the other organism is harmed. B. This describes commensalism, a relationship in which one organism benefits and the other organism is unaffected. C. This describes commensalism, a relationship in which one organism benefits and the other organism is unaffected. D. Key: In a parasitic relationship, one organism is harmed by another organism, the parasite, which benefits.

10. Some scientists believe that a gradual but steady atmospheric warming has led to changes in the reproductive rates of several moth and butterfly species in a region. These species are producing multiple generations in one year, rather than the single generation per year they have historically produced. Which statement describes the **most likely** impact of the additional generations on the ecosystem in this region?

A. Insects will have less ability to develop genetic resistance to insecticides.

B. Insect predator populations will increase due to increased availability of prey.

C. Plants pollinated by insects will have less of a chance of producing offspring.

D. Plant and animal diversity will increase as more insects are produced each year.

Item Information	
Alignment	BIO.B.4.2.4
Answer Key	B
Depth of Knowledge	2
p-value A	10%
p-value B	59% (correct answer)
p-value C	9%
p-value D	22%
Option Annotations	A. Genetic resistance would increase only if a beneficial gene for resistance were passed on to offspring. B. Key: The insect population will increase, which will make a food resource more readily available for predators and result in an increase in the predator population. C. Plants that benefit from the pollinators would experience increased pollination because of the increase in the insect population. D. Plant and animal diversity depends on natural selection, not on an increase in the number of insects.

11. Photosynthesis is a process that helps cycle matter through the environment. Which statement **best** explains the role of photosynthesis in the carbon cycle?

A. Carbon dioxide is absorbed from the air, and carbohydrates are produced.

B. Carbon dioxide is released into the air, and carbohydrates are broken down.

C. Carbon and nitrogen are absorbed into the soil, and carbohydrates are produced.

D. Carbon and nitrogen are released from the soil, and carbohydrates are broken down.

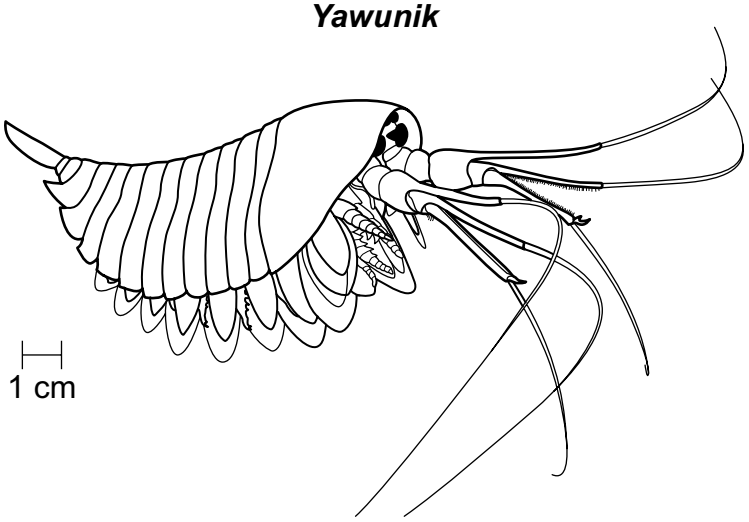
Item Information	
Alignment	BIO.B.4.2.3
Answer Key	A
Depth of Knowledge	2
p-value A	48% (correct answer)
p-value B	26%
p-value C	15%
p-value D	10%
Option Annotations	A. Key: Plants take in carbon dioxide from the air and use sunlight to produce chemical energy, which is stored in the bonds of carbohydrates. B. In photosynthesis, carbon dioxide is absorbed from the air, not released, and carbohydrates are produced, not broken down. C. In photosynthesis, carbon is absorbed as carbon dioxide gas from the air, not from elemental carbon in the soil. D. Elemental carbon and nitrogen are not produced by photosynthesis, and carbohydrates are produced in the form of glucose.

Directions: Use the information presented on page 55 to answer questions 12 and 13.

A New Fossil Discovery

Geologists have recently unearthed fossils of a species that could provide the evolutionary link between arthropods such as insects, spiders, and lobsters. The fossils are in a deposit called the Burgess Shale, in the Canadian Rockies of British Columbia. The Burgess Shale is one of the most abundant fossil deposits in the world, and it provides scientists with information about the middle Cambrian period, which was approximately 508 million years ago.

Yawunik



The fossilized organism, identified as *Yawunik*, was equipped with three long claws, two of which had opposing rows of teeth to better grip prey. These multipurpose appendages, which would have been opened to capture prey, could be pulled in close to the body to reduce drag while swimming. The organism had the features of an arthropod: external skeleton, segmented body, and jointed appendages. However, it did not have the advanced traits present in other similar groups of organisms that have survived until the present day. The discovery of 42 fossil specimens at one location suggests *Yawunik* was common during the deposition of the Burgess Shale.

12. Which statement **best** describes how scientists use the *Yawunik* fossil evidence to support its evolutionary relationship to other arthropods?

A. They interpret the similar anatomy of other arthropods.

B. They identify the DNA of several other similar arthropods.

C. They locate other arthropod fossils in the Burgess Shale area.

D. They compare embryological development to other arthropods.

Item Information	
Alignment	BIO.B.3.2.1
Answer Key	A
Depth of Knowledge	2
p-value A	59% (correct answer)
p-value B	13%
p-value C	13%
p-value D	15%
Option Annotations	A. Key: The scientists compared the anatomical and structural similarities to modern arthropods and other arthropod fossils. B. The scientists used anatomical comparisons and did not demonstrate the use of DNA fingerprinting techniques to compare genetic material. C. Locating other arthropods does not show an evolutionary relationship. D. The scientists used anatomical comparisons and did not demonstrate the use of comparing different embryos of organisms that were similar.

13. Which statement describes how the *Yawunik* **most likely** interacted with other organisms in its environment?

A. It competed with producers for sunlight.

B. It had a mutualistic relationship with phytoplankton.

C. It lived symbiotically with most small aquatic organisms.

D. It was a predator that obtained energy from other consumers.

Item Information	
Alignment	BIO.B.4.2.2
Answer Key	D
Depth of Knowledge	2
p-value A	5%
p-value B	8%
p-value C	25%
p-value D	61% (correct answer)
Option Annotations	A. The arthropod was not a plant, so it did not produce its own energy. B. The evidence of teeth and claws to grip prey demonstrate that it was a predator that consumed organisms. C. The evidence of teeth and claws to grip prey demonstrate that it was a predator that consumed organisms. D. Key: The evidence of teeth and claws to grip prey demonstrate that it was a predator that consumed other consumers and not plants.

CONSTRUCTED-RESPONSE ITEM

14. A group of students went to a local park. When the students returned to their classroom, they were asked to describe what they saw.

Student Statement 1: There were fourteen trees in the park; all were the same species.

Student Statement 2: There were no weeds in the park, so pesticides must have been used.

Student Statement 3: More birds would come to the park if feeding stations were added.

Forms of Scientific Information

- fact
- hypothesis
- inference
- observation
- law
- principle
- theory

Part A: Select two student statements, and classify each of them as one form of scientific information.

Student Statement Number: _____

Classification: _____

Student Statement Number: _____

Classification: _____

Go to the next page to finish question 14.

GO ON

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

Part B: Explain how an observation and a scientific law are related.

SCORING GUIDE

#14 Item Information

Alignment	BIO.B.3.3.1	**Depth of Knowledge**	3	**Mean Score**	1.66

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of how to distinguish among the scientific terms hypothesis, inference, law, theory, principle, fact, and observation by • classifying one statement as a particular type of scientific information, **AND** • classifying a second statement as a particular type of scientific information, **AND** • explaining how an observation and a scientific law are related. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of how to distinguish among the scientific terms hypothesis, inference, law, theory, principle, fact, and observation 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 to distinguish among the scientific terms hypothesis, inference, law, theory, principle, fact, and observation by fulfilling **one** of the bullets listed 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 (2 points total; 1 point for classifying each of two statements):

- Statement 1: observation
  OR
- Statement 1: fact
- Statement 2: inference
- Statement 3: hypothesis

Part B (1 point):

- An observation might lead a scientist to carry out research that, along with the research of many other scientists, discovers and confirms a scientific law.
  OR
- A scientific law might describe or explain a phenomenon that a person can see and about which an observation can be made.
  OR
- A person might make an observation, such as the falling of a dropped object, that can be explained by a scientific law.

Background Information:

- An observation is simply some occurrence that a person notices with senses.
- An inference is a possible explanation for the observation.
- A hypothesis is a tentative answer to a well-framed question or an explanation that can be tested by an experiment. The results of the experiment may either support the hypothesis or disprove it. A hypothesis is a limited explanation of some phenomenon.
- A scientific theory is a well-substantiated explanation of some aspect of the natural world that has been repeatedly tested and confirmed through experimentation.
- A scientific law is an accurate description of a natural phenomenon. A law does not explain the phenomenon; a theory does explain it.
- A scientific principle is considered by most to be the same as a scientific law.

STUDENT RESPONSE

Response Score: 3 points

14. A group of students went to a local park. When the students returned to their classroom, they were asked to describe what they saw.

Student Statement 1: There were fourteen trees in the park; all were the same species.

Student Statement 2: There were no weeds in the park, so pesticides must have been used.

Student Statement 3: More birds would come to the park if feeding stations were added.

Forms of Scientific Information

- fact
- hypothesis
- inference
- observation
- law
- principle
- theory

Part A: Select two student statements, and classify each of them as one form of scientific information.

Student Statement Number: 1

Classification: observation

Student Statement Number: 2

Classification: inference

Go to the next page to finish question 14.

GO ON

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

Part B: Explain how an observation and a scientific law are related.

Observations support a scientific law and further prove that it is correct. Observations made by a scientist may lead them to a hypothesis and experiments that create a scientific law.

The response demonstrates a thorough understanding of how to distinguish among the scientific terms hypothesis, inference, law, theory, principle, fact, and observation. In Part A, the response correctly classifies two selected statements as particular types of scientific information (Student Statement Number: *1*, Classification: *observation*; Student Statement Number: *2*, Classification: *inference*). In Part B, the response correctly explains how an observation and a scientific law are related (*Observations support a scientific law and further prove that it is correct*). The response also correctly phrased this relationship a second way (*Observations . . . may lead them to a hypothesis and experiments that create a scientific law*). The response is clear, complete, and correct.

STUDENT RESPONSE

Response Score: 2 points

14. A group of students went to a local park. When the students returned to their classroom, they were asked to describe what they saw.

Student Statement 1: There were fourteen trees in the park; all were the same species.

Student Statement 2: There were no weeds in the park, so pesticides must have been used.

Student Statement 3: More birds would come to the park if feeding stations were added.

Forms of Scientific Information

- fact
- hypothesis
- inference
- observation
- law
- principle
- theory

Part A: Select two student statements, and classify each of them as one form of scientific information.

Student Statement Number: 1

Classification: fact

Student Statement Number: 3

Classification: law

Go to the next page to finish question 14.

GO ON

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

Part B: Explain how an observation and a scientific law are related.

An observation then leads to a hypothesis and research leads to a law.

The response demonstrates a partial understanding of how to distinguish among the scientific terms hypothesis, inference, law, theory, principle, fact, and observation. In Part A, the response correctly classifies only one selected statement as a particular type of scientific information (Student Statement Number: *1*, Classification: *fact*). The second chosen statement and classification (Student Statement Number: *3*, Classification: *law*) is incorrect and does not receive any credit. In Part B, the response correctly explains how an observation and a scientific law are related (*An observation then leads to a hypothesis and research leads to a law*).

STUDENT RESPONSE

Response Score: 1 point

14. A group of students went to a local park. When the students returned to their classroom, they were asked to describe what they saw.

Student Statement 1: There were fourteen trees in the park; all were the same species.

Student Statement 2: There were no weeds in the park, so pesticides must have been used.

Student Statement 3: More birds would come to the park if feeding stations were added.

Forms of Scientific Information

- fact
- hypothesis
- inference
- observation
- law
- principle
- theory

Part A: Select two student statements, and classify each of them as one form of scientific information.

Student Statement Number: 2

Classification: hypothesis

Student Statement Number: 3

Classification: observation

Go to the next page to finish question 14.

GO ON

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

Part B: Explain how an observation and a scientific law are related.

A scientific law is a hypothesis that was proven true through steps such as observation.

The response demonstrates a minimal understanding of how to distinguish among the scientific terms hypothesis, inference, law, theory, principle, fact, and observation. In Part A, the response incorrectly classifies two selected statements as particular types of scientific information (Student Statement Number: *2*, Classification: *hypothesis*; Student Statement Number: *3*, Classification: *observation*) and does not receive any credit. In Part B, the response correctly explains how an observation and a scientific law are related (*scientific law . . . was proven true through steps such as observation*).

STUDENT RESPONSE

Response Score: 0 points

14. A group of students went to a local park. When the students returned to their classroom, they were asked to describe what they saw.

Student Statement 1: There were fourteen trees in the park; all were the same species.

Student Statement 2: There were no weeds in the park, so pesticides must have been used.

Student Statement 3: More birds would come to the park if feeding stations were added.

Forms of Scientific Information

- fact
- hypothesis
- inference
- observation
- law
- principle
- theory

Part A: Select two student statements, and classify each of them as one form of scientific information.

Student Statement Number: 3

Classification: observation

Student Statement Number: 2

Classification: hypothesis

Go to the next page to finish question 14.

GO ON

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

Part B: Explain how an observation and a scientific law are related.

They are related because they both have information that needs to be viewed over and over also it's based off of a outcome

The response provides insufficient evidence to demonstrate any understanding of how to distinguish among the scientific terms hypothesis, inference, law, theory, principle, fact, and observation. In Part A, the response incorrectly classifies two selected statements as particular types of scientific information (Student Statement Number: *3*, Classification: *observation*; Student Statement Number: *2*, Classification: *hypothesis*) and does not receive any credit. In Part B, the response incorrectly explains how an observation and a scientific law are related (*both have information that needs to be viewed over and over*) and does not receive any credit.

CONSTRUCTED-RESPONSE ITEM

15. Use the chart below to answer the question.

RNA Codon Chart

Second Position

First Position	U	C	A	G	Third Position
U	UUU, UUC — Phe UUA, UUG — Leu	UCU, UCC, UCA, UCG — Ser	UAU, UAC — Tyr UAA — stop UAG — stop	UGU, UGC — Cys UGA — stop UGG — Trp	**U** **C** **A** **G**
C	CUU, CUC, CUA, CUG — Leu	CCU, CCC, CCA, CCG — Pro	CAU, CAC — His CAA, CAG — Gln	CGU, CGC, CGA, CGG — Arg	**U** **C** **A** **G**
A	AUU, AUC, AUA — Ile AUG — Met	ACU, ACC, ACA, ACG — Thr	AAU, AAC — Asn AAA, AAG — Lys	AGU, AGC — Ser AGA, AGG — Arg	**U** **C** **A** **G**
G	GUU, GUC, GUA, GUG — Val	GCU, GCC, GCA, GCG — Ala	GAU, GAC — Asp GAA, GAG — Glu	GGU, GGC, GGA, GGG — Gly	**U** **C** **A** **G**

A scientist was studying a long protein in a cell. The amino acid leucine (Leu) was observed in the middle of the protein. Further testing revealed that the codon UUA codes for the leucine.

Go to the next page to finish question 15.

GO ON

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

Part A: Provide an example of a mutation to the leucine codon in the cell that would **not** result in a phenotypic change to the cell.

Part B: Provide an example of a mutation to a single nucleotide of the leucine codon in the cell that would cause a stop codon to be inserted into the middle of the protein.

Part C: Explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein.

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

SCORING GUIDE

#15 Item Information

Alignment	BIO.B.2.3.1	**Depth of Knowledge**	3	**Mean Score**	1.37

Item-Specific Scoring Guideline

Score	Description
3	The response demonstrates a *thorough* understanding of how genetic mutations alter the DNA sequence and may or may not affect phenotype by • providing an example of a mutation to a codon that would not result in a phenotypic change to the cell, **AND** • providing an example of a mutation to a UUA codon that would create a stop codon, **AND** • explaining what effect a single base deletion would have on the encoded protein. The response is clear, complete, and correct.
2	The response demonstrates a *partial* understanding of how genetic mutations alter the DNA sequence and may or may not affect phenotype 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 genetic mutations alter the DNA sequence and may or may not affect phenotype by fulfilling **one** of the bullets listed 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):

- If the UUA leucine codon were changed to UUG, this would not cause a phenotypic change.
  OR
- If the UUA leucine codon were changed to CUU, CUC, CUA, or CUG, this would not cause a phenotypic change.

Part B (1 point):

- If the UUA leucine codon were changed to UGA, this would create a stop codon in the middle of the gene.
  OR
- If the UUA leucine codon were changed to UAA, this would create a stop codon in the middle of the gene.

Part C (1 point):

- Deleting a single base from a gene would result in all the codons after the deletion being different, so the protein would have the wrong amino acid sequence and would not function.
  OR
- Deleting a single base from a gene is a frameshift mutation; the reading frame is shifted, and the encoded protein would not function.
  OR
- If a single base is deleted from a gene, then every amino acid after that deletion would be wrong and there might be a stop codon created, so the protein would not work.

Background Information:

- For Part A, these mutations cause no phenotypic change because the new codons still code for leucine.

STUDENT RESPONSE

Response Score: 3 points

15. Use the chart below to answer the question.

RNA Codon Chart

Second Position

First Position	U	C	A	G	Third Position
U	UUU, UUC — Phe UUA, UUG — Leu	UCU, UCC, UCA, UCG — Ser	UAU, UAC — Tyr UAA — stop UAG — stop	UGU, UGC — Cys UGA — stop UGG — Trp	**U** **C** **A** **G**
C	CUU, CUC, CUA, CUG — Leu	CCU, CCC, CCA, CCG — Pro	CAU, CAC — His CAA, CAG — Gln	CGU, CGC, CGA, CGG — Arg	**U** **C** **A** **G**
A	AUU, AUC, AUA — Ile AUG — Met	ACU, ACC, ACA, ACG — Thr	AAU, AAC — Asn AAA, AAG — Lys	AGU, AGC — Ser AGA, AGG — Arg	**U** **C** **A** **G**
G	GUU, GUC, GUA, GUG — Val	GCU, GCC, GCA, GCG — Ala	GAU, GAC — Asp GAA, GAG — Glu	GGU, GGC, GGA, GGG — Gly	**U** **C** **A** **G**

A scientist was studying a long protein in a cell. The amino acid leucine (Leu) was observed in the middle of the protein. Further testing revealed that the codon UUA codes for the leucine.

Go to the next page to finish question 15.

GO ON

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

Part A: Provide an example of a mutation to the leucine codon in the cell that would **not** result in a phenotypic change to the cell.

A point mutation that switches the codon from UUA to UUG would not cause a phenotypic change.

Part B: Provide an example of a mutation to a single nucleotide of the leucine codon in the cell that would cause a stop codon to be inserted into the middle of the protein.

A point mutation that changes UUA to UAA would insert a stop codon.

Part C: Explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein.

Deleting a base would cause a frame-shift mutation and mess up the entire protein. All bases after the deleted one would move over, completely altering the protein's function.

The response demonstrates a thorough understanding of how genetic mutations alter the DNA sequence and how they may or may not affect phenotype. In Part A, the response provides a correct example of a mutation to the leucine codon in the cell that would not result in a phenotype change to the cell (*A point mutation that switches the codon from UUA to UUG*). In Part B, the response provides a correct example of a mutation to a single nucleotide of the leucine codon in the cell that would cause a stop codon to be inserted into the middle of the protein (*A point mutation that changes UUA to UAA*). In Part C, the response correctly explains what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein (*Deleting a base would cause a frame-shift mutation . . . completely altering the protein's function*). The response is clear, complete, and correct.

STUDENT RESPONSE

Response Score: 2 points

15. Use the chart below to answer the question.

RNA Codon Chart

Second Position

First Position	U	C	A	G	Third Position
U	UUU, UUC — Phe UUA, UUG — Leu	UCU, UCC, UCA, UCG — Ser	UAU, UAC — Tyr UAA — stop UAG — stop	UGU, UGC — Cys UGA — stop UGG — Trp	**U** **C** **A** **G**
C	CUU, CUC, CUA, CUG — Leu	CCU, CCC, CCA, CCG — Pro	CAU, CAC — His CAA, CAG — Gln	CGU, CGC, CGA, CGG — Arg	**U** **C** **A** **G**
A	AUU, AUC, AUA — Ile AUG — Met	ACU, ACC, ACA, ACG — Thr	AAU, AAC — Asn AAA, AAG — Lys	AGU, AGC — Ser AGA, AGG — Arg	**U** **C** **A** **G**
G	GUU, GUC, GUA, GUG — Val	GCU, GCC, GCA, GCG — Ala	GAU, GAC — Asp GAA, GAG — Glu	GGU, GGC, GGA, GGG — Gly	**U** **C** **A** **G**

A scientist was studying a long protein in a cell. The amino acid leucine (Leu) was observed in the middle of the protein. Further testing revealed that the codon UUA codes for the leucine.

Go to the next page to finish question 15.

GO ON

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

Part A: Provide an example of a mutation to the leucine codon in the cell that would **not** result in a phenotypic change to the cell.

The codon CUA would not result in a phenotypic change.

Part B: Provide an example of a mutation to a single nucleotide of the leucine codon in the cell that would cause a stop codon to be inserted into the middle of the protein.

An example would be UAA.

Part C: Explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein.

If you deleted a single base from the gene it would cause some changes to that protein.

The response demonstrates a partial understanding of how genetic mutations alter the DNA sequence and how they may or may not affect phenotype. In Part A, the response provides a correct example of a mutation to the leucine codon in the cell that would not result in a phenotype change to the cell (*codon CUA would not result in a phenotypic change*). In Part B, the response provides a correct example of a mutation to a single nucleotide of the leucine codon in the cell that would cause a stop codon to be inserted into the middle of the protein (*UAA*). In Part C, the response does not correctly explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein (*cause some changes to that protein*) and does not receive any credit.

STUDENT RESPONSE

Response Score: 1 point

15. Use the chart below to answer the question.

RNA Codon Chart

Second Position

First Position	U	C	A	G	Third Position
U	UUU, UUC — Phe UUA, UUG — Leu	UCU, UCC, UCA, UCG — Ser	UAU, UAC — Tyr UAA — stop UAG — stop	UGU, UGC — Cys UGA — stop UGG — Trp	**U** **C** **A** **G**
C	CUU, CUC, CUA, CUG — Leu	CCU, CCC, CCA, CCG — Pro	CAU, CAC — His CAA, CAG — Gln	CGU, CGC, CGA, CGG — Arg	**U** **C** **A** **G**
A	AUU, AUC, AUA — Ile AUG — Met	ACU, ACC, ACA, ACG — Thr	AAU, AAC — Asn AAA, AAG — Lys	AGU, AGC — Ser AGA, AGG — Arg	**U** **C** **A** **G**
G	GUU, GUC, GUA, GUG — Val	GCU, GCC, GCA, GCG — Ala	GAU, GAC — Asp GAA, GAG — Glu	GGU, GGC, GGA, GGG — Gly	**U** **C** **A** **G**

A scientist was studying a long protein in a cell. The amino acid leucine (Leu) was observed in the middle of the protein. Further testing revealed that the codon UUA codes for the leucine.

Go to the next page to finish question 15.

GO ON

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

Part A: Provide an example of a mutation to the leucine codon in the cell that would **not** result in a phenotypic change to the cell.

CUC

Part B: Provide an example of a mutation to a single nucleotide of the leucine codon in the cell that would cause a stop codon to be inserted into the middle of the protein.

UAG

Part C: Explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein.

It can completely change the codon.

The response demonstrates a minimal understanding of how genetic mutations alter the DNA sequence and how they may or may not affect phenotype. In Part A, the response provides a correct example of a mutation to the leucine codon in the cell that would not result in a phenotype change to the cell (*CUC*). In Part B, the response does not provide a correct example of a mutation to the leucine codon in the cell that would not result in a phenotype change to the cell (*UAG*) and does not receive any credit. In Part C, the response does not correctly explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein (*completely change the codon*) and does not receive any credit.

STUDENT RESPONSE

Response Score: 0 points

15. Use the chart below to answer the question.

RNA Codon Chart

Second Position

First Position	U	C	A	G	Third Position
U	UUU, UUC — Phe UUA, UUG — Leu	UCU, UCC, UCA, UCG — Ser	UAU, UAC — Tyr UAA — stop UAG — stop	UGU, UGC — Cys UGA — stop UGG — Trp	**U** **C** **A** **G**
C	CUU, CUC, CUA, CUG — Leu	CCU, CCC, CCA, CCG — Pro	CAU, CAC — His CAA, CAG — Gln	CGU, CGC, CGA, CGG — Arg	**U** **C** **A** **G**
A	AUU, AUC, AUA — Ile AUG — Met	ACU, ACC, ACA, ACG — Thr	AAU, AAC — Asn AAA, AAG — Lys	AGU, AGC — Ser AGA, AGG — Arg	**U** **C** **A** **G**
G	GUU, GUC, GUA, GUG — Val	GCU, GCC, GCA, GCG — Ala	GAU, GAC — Asp GAA, GAG — Glu	GGU, GGC, GGA, GGG — Gly	**U** **C** **A** **G**

A scientist was studying a long protein in a cell. The amino acid leucine (Leu) was observed in the middle of the protein. Further testing revealed that the codon UUA codes for the leucine.

Go to the next page to finish question 15.

GO ON

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

Part A: Provide an example of a mutation to the leucine codon in the cell that would **not** result in a phenotypic change to the cell.

A silent mutation would not have any phenotypic change to the cell.

Part B: Provide an example of a mutation to a single nucleotide of the leucine codon in the cell that would cause a stop codon to be inserted into the middle of the protein.

A translation would cause a stop codon to be inserted into the middle of the protein.

Part C: Explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein.

Deleting a single base from the gene that codes the protein would cause a major mutation.

The response provides insufficient evidence to demonstrate any understanding of how genetic mutations alter the DNA sequence and how they may or may not affect phenotype. In Part A, the response does not provide an example of a mutation to the leucine codon in the cell that would not result in a phenotype change to the cell (*A silent mutation would not have any phenotypic change*) and does not receive any credit. In Part B, the response does not provide an example of a mutation to the leucine codon in the cell that would not result in a phenotype change to the cell (*A translation would cause a stop codon*) and does not receive any credit. In Part C, the response does not correctly explain what effect deleting a single base from the gene that codes for the protein would likely have on the function of the protein (*cause a major mutation*) and does not receive any credit.

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.1.1.1	A	2	50%	11%	17%	22%
2	BIO.B.1.2.2	C	3	15%	21%	53%	11%
3	BIO.B.2.1.2	D	2	18%	17%	19%	45%
4	BIO.B.2.2.1	A	2	45%	29%	14%	12%
5	BIO.B.3.1.3	D	2	10%	18%	17%	56%
6	BIO.B.3.2.1	B	3	8%	72%	6%	13%
7	BIO.B.4.2.3	B	2	7%	61%	19%	14%
8	BIO.B.3.3.1	B	2	28%	54%	8%	9%
9	BIO.B.4.2.2	D	2	5%	14%	7%	74%
10	BIO.B.4.2.4	B	2	10%	59%	9%	22%
11	BIO.B.4.2.3	A	2	48%	26%	15%	10%
12 (P)	BIO.B.3.2.1	A	2	59%	13%	13%	15%
13 (P)	BIO.B.4.2.2	D	2	5%	8%	25%	61%

CONSTRUCTED-RESPONSE

Sample Number	Alignment	Points	Depth of Knowledge	Mean Score
14	BIO.B.3.3.1	3	3	1.66
15	BIO.B.2.3.1	3	3	1.37

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Keystone Exams
Biology

Item and Scoring Sampler 2022