<table>
<thead>
<tr>
<th>Question No.*</th>
<th>Item Type</th>
<th>Content Strand</th>
<th>Content Statement</th>
<th>Answer Key</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Multiple Choice</td>
<td>Cells</td>
<td>Cellular Processes</td>
<td>B</td>
<td>1 point</td>
</tr>
<tr>
<td>3</td>
<td>Multiple Choice</td>
<td>Cells</td>
<td>Cell Structure and Function</td>
<td>A</td>
<td>1 point</td>
</tr>
<tr>
<td>5</td>
<td>Graphic Response</td>
<td>Heredity</td>
<td>Structure and Function of DNA in Cells</td>
<td>---</td>
<td>1 point</td>
</tr>
<tr>
<td>7</td>
<td>Multiple Choice</td>
<td>Diversity and Interdependence of Life</td>
<td>Ecosystems</td>
<td>D</td>
<td>1 point</td>
</tr>
<tr>
<td>8</td>
<td>Multi-Interaction</td>
<td>Heredity</td>
<td>Structure and Function of DNA in Cells</td>
<td>B; D</td>
<td>1 point</td>
</tr>
<tr>
<td>9</td>
<td>Graphic Response</td>
<td>Evolution</td>
<td>Mechanisms</td>
<td>---</td>
<td>1 point</td>
</tr>
<tr>
<td>10</td>
<td>Multiple Choice</td>
<td>Evolution</td>
<td>Mechanisms</td>
<td>C</td>
<td>1 point</td>
</tr>
<tr>
<td>11</td>
<td>Graphic Response</td>
<td>Evolution</td>
<td>Diversity of Life</td>
<td>---</td>
<td>2 points</td>
</tr>
<tr>
<td>12</td>
<td>Graphic Response</td>
<td>Heredity</td>
<td>Genetic Mechanisms and Inheritance</td>
<td>---</td>
<td>1 point</td>
</tr>
</tbody>
</table>

* The question number matches the item number in the Item Level Report in the Online Reporting System. The items are numbered sequentially in the practice site.
### Biology
#### Spring 2018 Item Release
#### Content Summary and Answer Key

<table>
<thead>
<tr>
<th>Question No.*</th>
<th>Item Type</th>
<th>Content Strand</th>
<th>Content Statement</th>
<th>Answer Key</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Graphic Response</td>
<td>Diversity and Interdependence of Life</td>
<td>Classification systems are frameworks created by scientists for describing the vast diversity of organisms, indicating the degree of relatedness between organisms.</td>
<td>---</td>
<td>1 point</td>
</tr>
<tr>
<td>14</td>
<td>Multiple Choice</td>
<td>Diversity and Interdependence of Life</td>
<td>Ecosystems</td>
<td>D</td>
<td>1 point</td>
</tr>
<tr>
<td>15</td>
<td>Graphic Response</td>
<td>Cells</td>
<td>Cellular Processes</td>
<td>---</td>
<td>2 points</td>
</tr>
<tr>
<td>16</td>
<td>Multi-Interaction</td>
<td>Heredity</td>
<td>Cellular Genetics</td>
<td>D; B</td>
<td>2 points</td>
</tr>
<tr>
<td>22</td>
<td>Multiple Choice</td>
<td>Heredity</td>
<td>Structure and Function of DNA in Cells</td>
<td>A</td>
<td>1 point</td>
</tr>
<tr>
<td>23</td>
<td>Graphic Response</td>
<td>Evolution</td>
<td>Mechanisms</td>
<td>---</td>
<td>2 points</td>
</tr>
<tr>
<td>24</td>
<td>Multi-Interaction</td>
<td>Diversity and Interdependence of Life</td>
<td>Classification systems are frameworks created by scientists for describing the vast diversity of organisms, indicating the degree of relatedness between organisms.</td>
<td>C; B,D</td>
<td>2 points</td>
</tr>
</tbody>
</table>

*The question number matches the item number in the Item Level Report in the Online Reporting System. The items are numbered sequentially in the practice site.*
### Biology
**Spring 2018 Item Release**
**Content Summary and Answer Key**

<table>
<thead>
<tr>
<th>Question No.*</th>
<th>Item Type</th>
<th>Content Strand</th>
<th>Content Statement</th>
<th>Answer Key</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>Table Item</td>
<td>Diversity and Interdependence of Life</td>
<td>Ecosystems</td>
<td>---</td>
<td>1 point</td>
</tr>
<tr>
<td>46</td>
<td>Multiple Choice</td>
<td>Heredity</td>
<td>Genetic Mechanisms and Inheritance</td>
<td>A</td>
<td>1 point</td>
</tr>
</tbody>
</table>

* The question number matches the item number in the Item Level Report in the Online Reporting System. The items are numbered sequentially in the practice site.
Biology
Spring 2018 Item Release

Question 2

Question and Scoring Guidelines
**Question 2**

How is chemosynthesis different from photosynthesis?

- **A** Chemosynthesis does not require enzymes.
- **B** Chemosynthesis can occur in environments without sunlight.
- **C** Chemosynthesis does not require reactants from outside the cell.
- **D** Chemosynthesis produces sugars that organisms use as an energy source.

**Points Possible:** 1

See Alignment for more detail.

**Scoring Guidelines**

**Rationale for Option A:** This is incorrect. Both of these metabolic processes require a multitude of enzymes.

**Rationale for Option B:** Key – Chemosynthesis harvests the energy from inorganic compounds to make organic, energy-rich compounds like sugar, and does not require sunlight.

**Rationale for Option C:** This is incorrect. Chemosynthesis requires inorganic compounds from the environment as sources of energy.

**Rationale for Option D:** This is incorrect. Both of these processes produce sugars.
**Alignment**
Content Strand
Cells

**Content Statement**
Cellular Processes

**Content Elaboration**
The cell is a system that conducts a variety of functions associated with life. Details of cellular processes such as photosynthesis, chemosynthesis, cellular respiration, cell division and differentiation are studied at this grade level.

**Cognitive Demand**
Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students’ knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

**Explanation of the Item**
This item requires the student to recall the difference between chemosynthesis and photosynthesis. Both chemosynthesis and photosynthesis use inorganic compounds found in the environment as reactants. Enzymes are utilized to control the reactions that produce the sugars needed to produce energy. The difference between the two processes is chemosynthesis can take place in environments completely absent of sunlight.
Sample Response: 1 point

How is chemosynthesis different from photosynthesis?

A. Chemosynthesis does not require enzymes.
B. Chemosynthesis can occur in environments without sunlight.
C. Chemosynthesis does not require reactants from outside the cell.
D. Chemosynthesis produces sugars that organisms use as an energy source.
Question 3

Chief cells are found in the glands that line the inside of the stomach. These cells secrete large amounts of enzymes to aid in food digestion.

Which cellular structure will be more abundant in chief cells because of their high rate of enzyme secretion?

A) endoplasmic reticulum
B) nuclear envelope
C) cytoskeleton
D) cell wall

Points Possible: 1
See Alignment for more detail.

Scoring Guidelines

Rationale for Option A: **Key** – Cells that produce and secrete large amounts of enzymes (and other proteins) will have higher than normal amounts of endoplasmic reticulum, the organelle set where those proteins are produced and packaged for distribution.

Rationale for Option B: This is incorrect. The nuclear envelope surrounds the nucleus, and is not involved in enzyme secretion.

Rationale for Option C: This is incorrect. The cytoskeleton provides support and structure to the cell and is not directly involved in enzyme secretion.

Rationale for Option D: This is incorrect. Animal cells do not have cell walls, and cell walls do not contribute to increased enzyme secretion.
Alignment
Content Strand
Cells

Content Statement
Cell Structure and Function

Content Elaboration
Within the cell are specialized parts for the transport of materials, energy transformation, protein building, waste disposal, information feedback and movement. In addition to these basic cellular functions, most cells in multicellular organisms perform some specific functions that others do not.

Cognitive Demand
Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

Explanation of the Item
This item requires the student to determine the function of cell organelles. Chief cells located in the stomach release enzymes required for food digestion. This requirement for increased enzyme production would necessitate the cell to have an abundance of endoplasmic reticulum. The endoplasmic reticulum is responsible for the folding of protein molecules and the transport of synthesized proteins. The other three selections that include nuclear envelope, cytoskeleton, and cell wall, have other functions and are not involved in enzyme production.
Sample Response: 1 point

Chief cells are found in the glands that line the inside of the stomach. These cells secrete large amounts of enzymes to aid in food digestion.

Which cellular structure will be more abundant in chief cells because of their high rate of enzyme secretion?

- endoplasmic reticulum
- nuclear envelope
- cytoskeleton
- cell wall
Biology
Spring 2018 Item Release

Question 5

Question and Scoring Guidelines
Question 5

The diagram shows the nucleus and the cytoplasm of a cell.

Identify the nucleic acid most commonly found in the nucleus, the nucleic acid that carries information from the nucleus into the cytoplasm, and the nucleic acid that carries amino acids in the cytoplasm.

Place a nucleic acid label into each of the three blank boxes.

- Place only one label in each blank box.
- You may use each label more than once.

Points Possible: 1

See Alignment for more detail.

Scoring Guidelines

For this item, a full-credit response includes:

- “DNA” placed in the top box;
  AND
- “mRNA” placed in the center box;
  AND
- “tRNA” placed in the bottom box (1 point).
Content Strand
Heredity

Content Statement
Structure and Function of DNA in Cells

Content Elaboration
Life is specified by genomes. Each organism has a genome that contains all of the biological information needed to build and maintain a living example of that organism. The biological information contained in a genome is encoded in its deoxyribonucleic acid (DNA) and is divided into discrete units called genes.

Cognitive Demand
Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

Explanation of the Item
This item requires the student to accurately place where deoxyribonucleic acid (DNA) and the different forms of ribonucleic acid (RNA) reside in a graphical representation of a cell. In all eukaryotic cells, the nucleus contains the DNA. During the process of transcription, messenger RNA (mRNA) copies the genetic instructions from DNA in the nucleus. The mRNA is transferred out of the cell’s nucleus where it is decoded by transfer RNA (tRNA) in the cytoplasm during a process called translation. Translation occurs in the ribosomes located in the cytoplasm.
Notes on Scoring

This response earns full credit (1 point) because it correctly completes the diagram illustrating the locations of DNA, mRNA, and tRNA in the cell. It correctly places DNA in the top box located in the nucleus, places mRNA in the center box located on the nuclear membrane since it transfers out of the nucleus, and places tRNA in the bottom box located in the cytoplasm.
Sample Response: 0 points

The diagram shows the nucleus and the cytoplasm of a cell.

Identify the nucleic acid most commonly found in the nucleus, the nucleic acid that carries information from the nucleus into the cytoplasm, and the nucleic acid that carries amino acids in the cytoplasm.

Place a nucleic acid label into each of the three blank boxes.
- Place only one label in each blank box.
- You may use each label more than once.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly places tRNA in the top box located in the nucleus and places DNA in the bottom box located in the cytoplasm.
Sample Response: 0 points

The diagram shows the nucleus and the cytoplasm of a cell.

Identify the nucleic acid most commonly found in the nucleus, the nucleic acid that carries information from the nucleus into the cytoplasm, and the nucleic acid that carries amino acids in the cytoplasm.

Place a nucleic acid label into each of the three blank boxes.

- Place only one label in each blank box.
- You may use each label more than once.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly places tRNA in the top box located in the nucleus, DNA in the center box located on the nuclear membrane, and mRNA in the bottom box located in the cytoplasm.
Biology
Spring 2018 Item Release
Question 7
Question and Scoring Guidelines
Question 7

The diagram shows part of a prairie food web.

Which species in the food web would be subject to the greatest biomagnification of pesticides applied to the grasses?

A  deer
B  grasses
C  grasshoppers
D  hawks

Points Possible: 1

See Alignment for more detail.
Scoring Guidelines

Rationale for Option A: This is incorrect. The deer do not consume as many types of organisms as hawks, whose prey consume the toxins.

Rationale for Option B: This is incorrect. The grasses have the toxins; it does not biomagnify in them.

Rationale for Option C: This is incorrect. Grasshoppers are exposed to the toxins, but at lower levels than hawks.

Rationale for Option D: Key – Hawks consume the greatest number of organisms exposed to the toxins.

Alignment

Content Strand
Diversity and Interdependence of Life

Content Statement
Ecosystems

Content Elaboration
Organisms transform energy (flow of energy) and matter (cycles of matter) as they survive and reproduce. The cycling of matter and flow of energy occurs at all levels of biological organization, from molecules to ecosystems. At the high school level, the concept of energy flow as unidirectional in ecosystems is explored.

Cognitive Demand
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

Explanation of the Item
This item requires the student to evaluate a food web to determine the potential outcome of introduced pesticides in an ecosystem on the organisms that live there. Biomagnification affects organisms at the top of the food web greater than those organisms at lower trophic levels. When an herbivore eats a
producer contaminated by a fat-soluble substance in the environment, such as a pesticide or herbicide, the contaminant is retained in the herbivore’s cells. When that herbivore is then consumed by a carnivore or omnivore, the contaminants are retained and increase in concentration within the tissues of the consumer. This process is known as biomagnification. When the apex predator, the hawk for this item, eats these consumers, it is affected by these contaminants in concentrations greater than the consumers at the lower trophic levels.

Sample Response: 1 point

The diagram shows part of a prairie food web.

Which species in the food web would be subject to the greatest biomagnification of pesticides applied to the grasses?

A  deer
B  grasses
C  grasshoppers
D  hawks
Biology
Spring 2018 Item Release

Question 8

Question and Scoring Guidelines
Question 8

The following question has two parts. First, answer part A. Then, answer part B.

Part A

A scientist examines a fruit fly gene involved in the regulation of body development. A section of the DNA sequence for the gene is shown.

Fruit Fly DNA Sequence

...TGG-AAC-CAA...

Amino Acid Codon Chart

<table>
<thead>
<tr>
<th>Second Position</th>
<th>U</th>
<th>C</th>
<th>A</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>Phe</td>
<td>Ser</td>
<td>Tyr</td>
<td>Cys</td>
</tr>
<tr>
<td>C</td>
<td>Leu</td>
<td>Pro</td>
<td>His</td>
<td>Arg</td>
</tr>
<tr>
<td>A</td>
<td>Ile</td>
<td>Thr</td>
<td>Asn</td>
<td>Ser</td>
</tr>
<tr>
<td>G</td>
<td>Val</td>
<td>Ala</td>
<td>Asp</td>
<td>Gly</td>
</tr>
</tbody>
</table>

First Position (5' end)

<table>
<thead>
<tr>
<th>C</th>
<th>U</th>
<th>C</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>Leu</td>
<td>Pro</td>
<td>His</td>
</tr>
<tr>
<td>C</td>
<td>Leu</td>
<td>Pro</td>
<td>His</td>
</tr>
<tr>
<td>A</td>
<td>Ile</td>
<td>Thr</td>
<td>Asn</td>
</tr>
<tr>
<td>G</td>
<td>Val</td>
<td>Ala</td>
<td>Asp</td>
</tr>
</tbody>
</table>

Third Position (3' end)

<table>
<thead>
<tr>
<th>U</th>
<th>C</th>
<th>A</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>C</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>C</td>
<td>U</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

Which amino acid sequence would be produced from this DNA?

A  Gly-Pro-Ser
B  Thr-Leu-Val
C  Gln-Gly-Trp
D  Trp-Asn-Gln

Part B

Which mRNA sequence was used to create the amino acid sequence you selected in part A?

A  UCC-TTC-GTT
B  ACC-TTG-GTT
C  CAA-GGT-TGG
D  ACC-UUG-GUU

Points Possible: 1

See Alignment for more detail.
Scoring Guidelines

**Part A**
Rationale for Option A: This is incorrect. The correct sequence is Thr-Leu-Val.

Rationale for Option B: **Key** – The correct sequence is Thr-Leu-Val.

Rationale for Option C: This is incorrect. The correct sequence is Thr-Leu-Val.

Rationale for Option D: This is incorrect. The correct sequence is Thr-Leu-Val.

**Part B**
Rationale for Option A: This is incorrect. The correct sequence is ACC-UUG-GUU.

Rationale for Option B: This is incorrect. Thymine is not present in mRNA. The correct sequence is ACC-UUG-GUU.

Rationale for Option C: This is incorrect. The correct sequence is ACC-UUG-GUU.

Rationale for Option D: **Key** – The correct sequence is ACC-UUG-GUU.

Alignment

**Content Strand**
Heredity

**Content Statement**
Structure and Function of DNA in Cells

**Content Elaboration**
Life is specified by genomes. Each organism has a genome that contains all of the biological information needed to build and maintain a living example of that organism. The biological information contained in a genome is encoded in its deoxyribonucleic acid (DNA) and is divided into discrete units called genes. Genes are segments of DNA molecules. Genes code for protein. The sequence of DNA bases in a chromosome determines the sequence of amino acids in a protein.

**Cognitive Demand**
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-
appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

**Explanation of the Item**
This item requires the student to analyze a DNA sequence using a codon chart to determine the amino acid sequence coded for by a specific strand of DNA and to identify the mRNA strand that the DNA strand coded for during transcription resulting in the amino acid sequence chosen in Part A.

In Part A, the student first determines what mRNA strand is transcribed by the DNA strand. The compliment of DNA’s thymine is RNA’s uracil. Therefore, the DNA sequence …TGG-AAC-CAA… goes through the process of transcription to produce the mRNA strand …ACC-UUG-GUU…. The student uses the provided codon chart to determine which mRNA codon translates to which amino acid: the codon ACC translates to the amino acid threonine (Thr); the codon UUG translates to the amino acid leucine (Leu); and the codon GUU translates to the amino acid valine (Val). The resulting amino sequence is Thr-Leu-Val.

In Part B, …ACC-UUG-GUU… is the mRNA sequence used to create the correct amino acid sequence in Part A.
Sample Response: 1 point

The following question has two parts. First, answer part A. Then, answer part B.

Part A

A scientist examines a fruit fly gene involved in the regulation of body development. A section of the DNA sequence for the gene is shown.

![Amino Acid Codon Chart](chart.png)

**Fruit Fly DNA Sequence**

...TGG-AAC-CAA...

Which amino acid sequence would be produced from this DNA?

- (A) Gly-Pro-Ser
- (B) Thr-Leu-Val
- (C) Gln-Gly-Trp
- (D) Trp-Asn-Gln

Part B

Which mRNA sequence was used to create the amino acid sequence you selected in part A?

- (A) UCC-TTC-GTT
- (B) ACC-TTG-GTT
- (C) CAA-GGT-TGG
- (D) ACC-UUG-GUU
Stimulus for Questions 9 - 11
Stimulus for Questions 9 - 11

The map shows the geographic distribution of salamander subpopulations that descended from the common ancestor *E. e. oregonensis*. Over millions of years, the salamanders moved south from what is now Oregon and northern California into areas to the east and west of California’s Central Valley.

The salamanders were initially separated by a large lake, and later by the unsuitable habitat of the Central Valley itself. Because of this geographic barrier, gene flow among some of these subpopulations is extremely limited, and in some cases has led to reproductive isolation.
Question 9

Based on the salamander distribution data shown on the map, choose two salamander subpopulations between which gene flow can occur. Move two Salamander Subpopulation labels into the blank boxes.

- Move only one salamander label into each blank box.
- There may be more than one correct answer.

**Points Possible:** 1

See Alignment for more detail.

**Scoring Guidelines**

For this item, a full-credit response includes:

- “L” and “N” placed individually in the boxes (1 point);
  OR
- “M” and “O” placed individually in the boxes (1 point);
  OR
- “O” and “P” placed individually in the boxes (1 point).
Populations evolve over time. Evolution is the consequence of the interactions of:

1. the potential for a population to increase its numbers;
2. the genetic variability of offspring due to mutation and recombination of genes;
3. a finite supply of the resources required for life; and
4. the differential survival and reproduction of individuals with the specific phenotype.

Mutations are described in the content elaboration for heredity. Apply the knowledge of mutation and genetic drift to real-world examples.

Recent molecular-sequence data generally, but not always, support earlier hypotheses regarding lineages of organisms based upon morphological comparisons.

Heritable characteristics influence how likely an organism is to survive and reproduce in a particular environment. When an environment changes, the survival value of inherited characteristics may change. This may or may not cause a change in species that inhabit the environment. Formulate and revise explanations for gene flow and sexual selection based on real-world problems.

**Cognitive Demand**
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

**Explanation of the Item**
This item requires the student to determine how the environment affects the mechanism of gene flow, the transfer of genes between populations. For gene flow to occur between the salamander subpopulations, there must be a means
for members of the subpopulations to reproduce. The species originally were separated by a large lake, and then later by the Central Valley. Therefore, with the geographical barrier that the lake and later the valley created, it is not possible for the subpopulations L or N to have gene flow with subpopulations M, O, or P. Also, due to distance and the presence of subpopulation O, subpopulations M and P do not have an opportunity for interbreeding. Only subpopulations L and N, M and O, and O and P have an opportunity for gene flow to occur along the common terrain joining their subpopulations.
Biology
Spring 2018 Item Release

Question 9

Sample Responses
Sample Response: 1 point

Based on the salamander distribution data shown on the map, choose two salamander subpopulations between which gene flow can occur. Move two Salamander Subpopulation labels into the blank boxes.

- Move only one salamander label into each blank box.
- There may be more than one correct answer.

Notes on Scoring

This response earns full credit (1 point) because it correctly identifies subpopulations L and N as potentially experiencing gene flow.
Sample Response: 0 points

Based on the salamander distribution data shown on the map, choose two salamander subpopulations between which gene flow can occur. Move two Salamander Subpopulation labels into the blank boxes.

- Move only one salamander label into each blank box.
- There may be more than one correct answer.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies subpopulations L and P as potentially experiencing gene flow. Subpopulations L and P are separated by the Central Valley. This geographical barrier prohibits gene flow since there is no means for the two subpopulations to reproduce.
Sample Response: 0 points

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies subpopulations O and N as potentially experiencing gene flow. Subpopulations O and N are separated by the Central Valley. This geographical barrier prohibits gene flow since there is no means for the two subpopulations to reproduce.
Biology
Spring 2018 Item Release

Question 10

Question and Scoring Guidelines
**Question 10**

Which two salamander subpopulations would be least likely to reproduce successfully if brought together?

- A  Salamanders L and M
- B  Salamanders L and N
- C  Salamanders P and N
- D  Salamanders P and O

**Points Possible: 1**

See **Alignment** for more detail.

**Scoring Guidelines**

**Rationale for Option A:** This is incorrect. These two salamanders are not as geographically isolated or as evolutionarily divergent as P and N.

**Rationale for Option B:** This is incorrect. These two salamanders can experience gene flow and are likely to be able to reproduce successfully.

**Rationale for Option C:** Key – These two species are geographically isolated and have been diverging for the longest time, from two already unique subpopulations.

**Rationale for Option D:** This is incorrect. These two salamanders can experience gene flow and are likely to be able to reproduce successfully.
Alignment
Content Strand
Evolution

Content Statement
Mechanisms

Content Elaboration
Heritable characteristics influence how likely an organism is to survive and reproduce in a particular environment. When an environment changes, the survival value of inherited characteristics may change. This may or may not cause a change in species that inhabit the environment. Formulate and revise explanations for gene flow and sexual selection based on real-world problems.

Cognitive Demand
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

Explanation of the Item
This item requires the student to determine how the environment affects the mechanism of gene flow, the transfer of genes between populations. For gene flow to occur between the salamander subpopulations, there must be a means for members of the subpopulations to interbreed. The species originally were separated by a large lake, and later by the Central Valley. The subpopulations P and N are not only separated by the geographical barrier, but they have also been diverging and genetically isolated for the longest period.

Sample Response: 1 point

Which two salamander subpopulations would be least likely to reproduce successfully if brought together?

A. Salamanders L and M
B. Salamanders L and N
C. Salamanders P and N
D. Salamanders P and O
Biology
Spring 2018 Item Release

Question 11

Question and Scoring Guidelines
**Question 11**

Complete the blank cladogram using the information in the salamander distribution map and accompanying explanatory text. Place the correct salamander into each of the blank boxes.

- You should use all of the salamanders.
- There may be more than one correct answer.

**Points Possible:** 2

See **Alignment** for more detail.

**Scoring Guidelines**

For this item, a full-credit response includes:

From **LEFT** to **RIGHT**:

- “L” and “N” placed in the first and second boxes OR “N” and “L” placed in the first and second boxes (1 point);
  AND
- “O” and “P” placed in the third and fourth boxes OR “P” and “O” placed in the third and fourth boxes AND “M” placed in the fifth box (1 point).
Alignment
Content Strand
Evolution

Content Statement
Diversity of Life

Content Elaboration
Biological evolution explains the natural origins for the diversity of life. Emphasis shifts from thinking in terms of selection of individuals with a particular trait to changing proportions of a trait in populations. The study of evolution must include Modern Synthesis, the unification of genetics and evolution and historical perspectives of evolutionary theory. The study of evolution must include gene flow, mutation, speciation, natural selection, genetic drift, sexual selection and Hardy Weinberg’s law.

The basic concept of biological evolution is that the Earth’s present-day species descended from earlier, common ancestral species. At the high school level, the term natural selection is used to describe the process by which traits become more or less common in a population due to consistent environmental effects upon the survival or reproduction of the individual with the trait. Mathematical reasoning must be applied to solve problems, (e.g., use Hardy Weinberg’s law to explain gene frequency patterns in a population).

Cognitive Demand
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

Explanation of the Item
This item requires the student to determine how geographical isolation and gene flow affect the evolution of a species. The unlabeled salamander subpopulation is provided in the last box on the right. From the left, the cladogram has boxes 1 and 2 that represent closely-related sister groups, boxes 3 and 4 that represent closely-related sister groups, and box 5 that is the outgroup to sister groups represented by boxes 3 and 4.
Looking at the map of California in the stimulus, the two salamander subpopulations L and N in the western part of the state are closely related as they diverged and were separated from the others by the Central Valley. Therefore, salamander subspecies L and N are entered in boxes 1 and 2, in either order.

On the eastern side of the state, there are salamander subspecies M, O, and P. Salamander subspecies M has the larger geographic area and was the first to diverge. Therefore, salamander subspecies M is entered in box 5. Salamander subspecies O and P diverged from salamander subspecies M and are entered in boxes 3 and 4 in either order to complete the cladogram.
Biology
Spring 2018 Item Release

Question 11

Sample Responses
Sample Response: 2 points

Complete the blank cladogram using the information in the salamander distribution map and accompanying explanatory text. Place the correct salamander into each of the blank boxes.

- You should use all of the salamanders.
- There may be more than one correct answer.

Notes on Scoring

This response earns full credit (2 points) because the order of the salamander subpopulations in the cladogram demonstrates the correct evolutionary relationships among the subpopulations.
Sample Response: 1 point

Complete the blank cladogram using the information in the salamander distribution map and accompanying explanatory text.
Place the correct salamander into each of the blank boxes.

- You should use all of the salamanders.
- There may be more than one correct answer.

Notes on Scoring

This response earns partial credit (1 point) because it correctly enters subpopulations L and N in boxes 1 and 2. However, it incorrectly enters subpopulations P and M in boxes 3 and 4, and subpopulation O in box 5. This is incorrect because salamander subpopulations O and P diverged from salamander subpopulation M. Salamander subpopulations P and M did not diverge from subpopulation O as this response reflects.
Sample Response: 1 point

Complete the blank cladogram using the information in the salamander distribution map and accompanying explanatory text. Place the correct salamander into each of the blank boxes.

- You should use all of the salamanders.
- There may be more than one correct answer.

Notes on Scoring

This response earns partial credit (1 point) because it correctly enters subpopulations L and N in boxes 1 and 2. However, it incorrectly enters subpopulations M and O in boxes 3 and 4, and subpopulation P is in box 5. This is incorrect because salamander subpopulations O and P diverged from salamander subpopulation M. Salamander subpopulations M and O did not diverge from subpopulation P as this response reflects.
Sample Response: 0 points

Complete the blank cladogram using the information in the salamander distribution map and accompanying explanatory text. Place the correct salamander into each of the blank boxes.

- You should use all of the salamanders.
- There may be more than one correct answer.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly enters subpopulations M, N and P into the cladogram showing the incorrect order of subpopulations.
Sample Response: 0 points

Complete the blank cladogram using the information in the salamander distribution map and accompanying explanatory text. Place the correct salamander into each of the blank boxes.

- You should use all of the salamanders.
- There may be more than one correct answer.

Notes on Scoring

This response earns no credit (0 points) because the order of the species in the cladogram is incorrect and does not demonstrate an accurate evolutionary relationship among the salamander subpopulations.
Biology
Spring 2018 Item Release

Question 12

Question and Scoring Guidelines
Question 12

In Labrador retriever dogs, the black coat color allele (B) is dominant over the chocolate coat color allele (b). However, some litters produce dogs that have a yellow coat color. Scientists have determined this is because of a second gene that can influence coat color. If this eumelanin gene is recessive for both alleles (e), the dog’s coat will be yellow regardless of the alleles for the other coat color gene.

A dog breeder sets up a cross between a dog that is homozygous dominant for coat color (BB) and heterozygous for eumelanin (Ee) with a dog that is homozygous recessive for coat color (bb) and heterozygous for eumelanin (Ee).

Place the dogs in the Punnett square to show the coat color phenotypes that would result from this cross.

- You may use each dog more than once.
- You should fill all the blank boxes in the Punnett square.

**Points Possible: 1**

See Alignment for more detail.

Scoring Guidelines

For this item, a full-credit response includes:

Where top-left cell is A1, and bottom-right cell is D4:

- “Black” placed in cells A1, A2, A3, A4, B1, B3, C1, C2, C3, C4, D1, D3;
  AND
- “Yellow” placed in cells B2, B4, D2, D4 (1 point).
**Alignment**

Content Strand  
Heredity

Content Statement  
Genetic Mechanisms and Inheritance

Content Elaboration  
The gene interactions described in middle school were limited primarily to dominance and co-dominance traits. In high school, genetic mechanisms, both classical and modern including incomplete dominance, sex-linked traits, goodness of fit test (Chi-square) and dihybrid crosses are investigated through real-world examples. Dihybrid crosses can be used to explore linkage groups. Gene interactions and phenotypic effects can be introduced using real-world examples (e.g., polygenic inheritance, epistasis, and pleiotropy).

Cognitive Demand  
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

Explanation of the Item  
This item requires the student to perform a dihybrid cross between two Labrador retriever dogs to determine the coat color of the offspring. The parent alleles are provided on the Punnett square, so the student performs the steps for a dihybrid cross to determine the coat color of the offspring as shown:

```
BE   Be   BE   Be  
BBEE  BBee  BBEE  BBee  
BbEE  BbEe  BbEE  BbEe  
bbEE  bbEe  bbEE  bbEe  
```

The black coat allele (B) is dominant. All of the dogs should have the potential of having a black coat, however scientists found an exception caused by the eumelanin gene. When the eumelanin gene is recessive for both alleles (ee), a yellow coat is produced regardless of the other coat color gene. Therefore, the potential for the dogs to exhibit a black coat phenotype remains with the dogs
with the genotypes, BBEE, BBEe, BbEE or BbEe. The dogs with genotypes BBee and Bbee express the yellow coat phenotype.
Biology
Spring 2018 Item Release
Question 12
Sample Responses
Sample Response: 1 point

In Labrador retriever dogs, the black coat color allele (B) is dominant over the chocolate coat color allele (b). However, some litters produce dogs that have a yellow coat color. Scientists have determined this is because of a second gene that can influence coat color. If this eumelanin gene is recessive for both alleles (e), the dog’s coat will be yellow regardless of the alleles for the other coat color gene.

A dog breeder sets up a cross between a dog that is homozygous dominant for coat color (BB) and heterozygous for eumelanin (Ee) with a dog that is homozygous recessive for coat color (bb) and heterozygous for eumelanin (Ee).

Place the dogs in the Punnett square to show the coat color phenotypes that would result from this cross.

- You may use each dog more than once.
- You should fill all the blank boxes in the Punnett square.

Notes on Scoring

This response earns full credit (1 point) because it correctly identifies the phenotypes of the Labrador retrievers.
Sample Response: 0 points

In Labrador retriever dogs, the black coat color allele (B) is dominant over the chocolate coat color allele (b). However, some litters produce dogs that have a yellow coat color. Scientists have determined this is because of a second gene that can influence coat color. If this eumelanin gene is recessive for both alleles (e), the dog’s coat will be yellow regardless of the alleles for the other coat color gene.

A dog breeder sets up a cross between a dog that is homozygous dominant for coat color (BB) and heterozygous for eumelanin (Ee) with a dog that is homozygous recessive for coat color (bb) and heterozygous for eumelanin (Ee).

Place the dogs in the Punnett square to show the coat color phenotypes that would result from this cross.

- You may use each dog more than once.
- You should fill all the blank boxes in the Punnett square.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies the phenotypes of the Labrador retrievers. It enters the dogs incorrectly as chocolate in cells B2, B4, D2, and D4. However, the retrievers in those cells have a genotype of BBee, Bbee, BBee, and Bbee, respectively, giving a phenotype of a yellow coat color.
Sample Response: 0 points

In Labrador retriever dogs, the black coat color allele (B) is dominant over the chocolate coat color allele (b). However, some litters produce dogs that have a yellow coat color. Scientists have determined this is because of a second gene that can influence coat color. If this eumelanin gene is recessive for both alleles (E), the dog’s coat will be yellow regardless of the alleles for the other coat color gene.

A dog breeder sets up a cross between a dog that is homozygous dominant for coat color (BB) and heterozygous for eumelanin (Ee) with a dog that is homozygous recessive for coat color (bb) and heterozygous for eumelanin (Ee).

Place the dogs in the Punnett square to show the coat color phenotypes that would result from this cross.

- You may use each dog more than once.
- You should fill all the blank boxes in the Punnett square.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies the phenotypes of the Labrador retrievers. It enters the dogs incorrectly as having a chocolate coat color in cells B2 and D2. However, the retrievers in those cells have a genotype of BBee, giving a phenotype of a yellow coat color.
Question 13

The cladogram shows the evolutionary relationships among four species. One of the species in the cladogram is labeled as Species X.

Click on the blank box or boxes to select the species that are members of the smallest clade that includes Species X.

Points Possible: 1

See Alignment for more detail.

Scoring Guidelines

For this item, a full-credit response includes:

- The bottom two boxes selected (1 point).
**Alignment**

**Content Strand**
Diversity and Interdependence of Life

**Content Statement**
Classification systems are frameworks created by scientists for describing the vast diversity of organisms, indicating the degree of relatedness between organisms.

**Content Elaboration**
Classification systems are frameworks developed by scientists for describing the diversity of organisms, indicating the degree of relatedness between organisms. Recent molecular-sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons. Both morphological comparisons and molecular evidence must be used to describe biodiversity (cladograms can be used to address this).

**Cognitive Demand**
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

**Explanation of the Item**
This item requires the student to interpret the evolutionary relationships between four species using a cladogram. A clade includes an ancestor and all descendants of that ancestor. To select the box or boxes within the cladogram that identify the clade that would include species X, they would have to be more recent. Since the root species would be located at the top, the bottom two boxes are selected in this cladogram.
Biology
Spring 2018 Item Release

Question 13

Sample Responses
Sample Response: 1 point

The cladogram shows the evolutionary relationships among four species. One of the species in the cladogram is labeled as Species X.

Click on the blank box or boxes to select the species that are members of the smallest clade that includes Species X.

Notes on Scoring

This response earns full credit (1 point) because it correctly identifies the more recent members of the clade (that includes species X) at the bottom since the root species in this cladogram is at the top.
Sample Response: 0 points

The cladogram shows the evolutionary relationships among four species. One of the species in the cladogram is labeled as Species X.

Click on the blank box or boxes to select the species that are members of the smallest clade that includes Species X.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies a less recent species on the cladogram that is located closer to the root species than species X. This response also excludes the most recent member of the clade that includes species X located at the bottom of the cladogram, farthest from the root species.
Sample Response: 0 points

The cladogram shows the evolutionary relationships among four species. One of the species in the cladogram is labeled as Species X.

Click on the blank box or boxes to select the species that are members of the smallest clade that includes Species X.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies a less recent species on the cladogram that is located closer to the root species than species X. This response also excludes a member of the clade that includes species X.
Question and Scoring Guidelines
Question 14

Scientists collect data on the size and number of worms that three bird species prefer to eat. The feeding preference data of the three bird species are shown.

Which statement is supported by the data?

A. No competition for food exists within any of the three bird species.
B. At least three different species of worms are eaten by the three bird species.
C. Selection pressure from the three bird species will result in a worm population with only small and large worms.
D. Less competition between the three bird species will be observed if a range of differently sized worms is available.

Points Possible: 1
See Alignment for more detail.
**Scoring Guidelines**

**Rationale for Option A**: This is incorrect. The data do not support any inferences about the level of competition within any of the three bird species.

**Rationale for Option B**: This is incorrect. Even though the bird preference for worm size shows three distinct size ranges, this does not mean the worms are of different species.

**Rationale for Option C**: This is incorrect. Since worms at all three ranges are equally targeted by the birds, there is no evidence to show that small and large worms will become more frequent in the population.

**Rationale for Option D**: **Key** - If worms of all size ranges are available, birds will eat the worms they prefer and won’t compete with each other over worms in other size ranges.

**Alignment**

**Content Strand**
Diversity and Interdependence of Life

**Content Statement**
Ecosystems

**Content Elaboration**
The great diversity of organisms and ecological niches they occupy result from more than 3.5 billion years of evolution. Some ecosystems can be reasonably persistent over hundreds or thousands of years. Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change as geological or biological conditions vary. Misconceptions about population growth capacity, interspecies and intra-species competition for resources, and what occurs when a species immigrates to or emigrates from ecosystems are included in this topic. Technology must be used to access real-time/authentic data to study population changes and growth in specific locations.

**Cognitive Demand**
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical
knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

**Explanation of the Item**

This item requires the student to evaluate a graph showing inter-species competition. The graph depicts three different bird species that prey on worms of different sizes. There is some overlap of worm size preference, but only at the extreme margins. If there is a significant population in a range of sizes, inter-species competition will be minimal. Only if a specific worm size becomes unavailable, will the affected species seek a different size worm, creating an inter-species competition issue.

**Sample Response: 1 point**

![Graph of Bird Feeding Preferences](image)

Scientists collect data on the size and number of worms that three bird species prefer to eat. The feeding preference data of the three bird species are shown.

Which statement is supported by the data?

A. No competition for food exists within any of the three bird species.

B. At least three different species of worms are eaten by the three bird species.

C. Selection pressure from the three bird species will result in a worm population with only small and large worms.

D. Less competition between the three bird species will be observed if a range of differently sized worms is available.
Biology
Spring 2018 Item Release

Question 15

Question and Scoring Guidelines
Question 15

Three identical red blood cells, in side view, are placed in three different salt water solutions, as shown in the diagram. Predict the net flow of water ($H_2O$) into or out of each cell. Then predict the effects of this water movement on the structure of each cell. Assume the volume pictured inside the red blood cell is the same as the volume pictured outside the cell.

A. Place the correct picture in each blank box to show the net flow of water into or out of each cell.

B. Place the correct picture in each blank box to show what will happen to the structure of each cell after the water movement occurs.

• Place only one picture in each box.

Points Possible: 2

See Alignment for more detail.

Scoring Guidelines

For this item, a full-credit response includes:

• Part A, labels placed Left to Right: “H$_2$O out,” “H$_2$O in,” “H$_2$O in/out” (1 point);
  AND

• Part B, labels placed Left to Right: “Shrink,” “Burst,” “No Effect” (1 point).
Every cell is covered by a membrane that controls what can enter and leave the cell. In all but quite primitive cells, a complex network of proteins provides organization and shape. Within the cell are specialized parts for the transport of materials, energy transformation, protein building, waste disposal, information feedback and movement. In addition to these basic cellular functions, most cells in multicellular organisms perform some specific functions that others do not.

This item requires the student to show the process and result of osmosis, the movement of water across a membrane, on a cell. In Part A, the student identifies the direction of water movement, and then in Part B, shows the effect the movement has on the red blood cell. The red blood cell on the left has a lower concentration of solute (salt), therefore a higher concentration of water than its environment. Water moves (high to low) out of the cell into the environment causing the cell to shrivel. The red blood cell in the center has a higher concentration of solute (salt), therefore a lower concentration of water than its environment. Water moves (high to low) into the cell from the environment causing the cell to expand and burst. The red blood cell on the right has an equal concentration of solute (salt) and water as its environment. Water moves in and out of the cell at an equal rate into the environment having no effect on the cell.
Sample Response: 2 points

Three identical red blood cells, in side view, are placed in three different salt water solutions, as shown in the diagram. Predict the net flow of water (H₂O) into or out of each cell. Then predict the effects of this water movement on the structure of each cell. Assume the volume pictured inside the red blood cell is the same as the volume pictured outside the cell.

A. Place the correct picture in each blank box to show the net flow of water into or out of each cell.

B. Place the correct picture in each blank box to show what will happen to the structure of each cell after the water movement occurs.

* Place only one picture in each box.

Notes on Scoring

This response earns full credit (2 points) because it correctly identifies the movement of water in Part A and the correct effect on the red blood cell in Part B.
Sample Response: 1 point

Three identical red blood cells, in side view, are placed in three different salt water solutions, as shown in the diagram. Predict the net flow of water (H₂O) into or out of each cell. Then predict the effects of this water movement on the structure of each cell. Assume the volume pictured inside the red blood cell is the same as the volume pictured outside the cell.

A. Place the correct picture in each blank box to show the net flow of water into or out of each cell.

B. Place the correct picture in each blank box to show what will happen to the structure of each cell after the water movement occurs.

- Place only one picture in each box.

Notes on Scoring

This response earns partial credit (1 point) because it correctly identifies the movement of water in Part A in each example, but it incorrectly labels the effect on the red blood cell in Part B in each example.
Sample Response: 1 point

Three identical red blood cells, in side view, are placed in three different salt water solutions, as shown in the diagram. Predict the net flow of water (H₂O) into or out of each cell. Then predict the effects of this water movement on the structure of each cell. Assume the volume pictured inside the red blood cell is the same as the volume pictured outside the cell.

A. Place the correct picture in each blank box to show the net flow of water into or out of each cell.

B. Place the correct picture in each blank box to show what will happen to the structure of each cell after the water movement occurs.

• Place only one picture in each box.

Notes on Scoring

This response earns partial credit (1 point) because it incorrectly identifies the movement of water in Part A, but it correctly labels the effect on the red blood cell in Part B.
Three identical red blood cells, in side view, are placed in three different salt water solutions, as shown in the diagram. Predict the net flow of water (H₂O) into or out of each cell. Then predict the effects of this water movement on the structure of each cell. Assume the volume pictured inside the red blood cell is the same as the volume pictured outside the cell.

A. Place the correct picture in each blank box to show the net flow of water into or out of each cell.

B. Place the correct picture in each blank box to show what will happen to the structure of each cell after the water movement occurs.

• Place only one picture in each box.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies the movement of water in Part A, and it incorrectly labels the effect on the red blood cell in Part B.
Sample Response: 0 points

Three identical red blood cells, in side view, are placed in three different salt water solutions, as shown in the diagram. Predict the net flow of water (H₂O) into or out of each cell. Then predict the effects of this water movement on the structure of each cell. Assume the volume pictured inside the red blood cell is the same as the volume pictured outside the cell.

A. Place the correct picture in each blank box to show the net flow of water into or out of each cell.

B. Place the correct picture in each blank box to show what will happen to the structure of each cell after the water movement occurs.

* Place only one picture in each box.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies the movement of water in Part A for the examples on the left and the right, and it incorrectly labels the effect on the red blood cell in Part B for the examples on the left and the right.
Biology
Spring 2018 Item Release

Question 16

Question and Scoring Guidelines
**Question 16**

The following question has two parts. First, answer part A. Then, answer part B.

<table>
<thead>
<tr>
<th><strong>Part A</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Which statement describes crossing over as it occurs in meiosis?</td>
</tr>
<tr>
<td><strong>A</strong> The alleles of a gene separate.</td>
</tr>
<tr>
<td><strong>B</strong> Spindle fibers pull apart sister chromatids.</td>
</tr>
<tr>
<td><strong>C</strong> Genes move to opposite ends of the chromosomes.</td>
</tr>
<tr>
<td><strong>D</strong> Homologous chromosomes exchange segments of DNA.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Part B</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Which method do scientists use to confirm that crossing over occurs?</td>
</tr>
<tr>
<td><strong>A</strong> cloning</td>
</tr>
<tr>
<td><strong>B</strong> dihybrid crosses</td>
</tr>
<tr>
<td><strong>C</strong> gel electrophoresis</td>
</tr>
<tr>
<td><strong>D</strong> genetic engineering</td>
</tr>
</tbody>
</table>

**Points Possible: 2**

See [Alignment](#) for more detail.
Scoring Guidelines

Part A
Rationale for Option A: This is incorrect. Alleles separate in anaphase after crossing over has occurred.

Rationale for Option B: This is incorrect. Spindle fibers attached to the chromatids pull the chromatids to opposite poles during anaphase, after crossing over has occurred.

Rationale for Option C: This is incorrect. This is how translocation occurs.

Rationale for Option D: Key - Crossing over, or the exchange of DNA, occurs between two chromatids on two different chromosomes that come in contact during prophase.

Part B
Rationale for Option A: This is incorrect. Cloning is the process of producing genetically identical individuals. Producing a genetic copy of an organism does not confirm that crossing over occurs.

Rationale for Option B: Key - Test crosses involving two non-linked traits provide confirmation that alleles located on the same chromosome were inherited independently of one another.

Rationale for Option C: This is incorrect. Scientists use gel electrophoresis to separate and analyze biological molecules based on their relative sizes and charges.

Rationale for Option D: This is incorrect. Genetic engineering is a set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries.
Alignment
Content Strand
Heredity

Content Statement
Cellular Genetics

Content Elaboration
In high school biology, Mendel’s laws of inheritance (introduced in grade 8) are interwoven with current knowledge of DNA and chromosome structure and function to build toward basic knowledge of modern genetics. Sorting and recombination of genes in sexual reproduction and meiosis specifically result in a variance in traits of the offspring of any two parents and explicitly connect the knowledge to evolution.

Cognitive Demand
Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students’ knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

Explanation of the Item
This item requires the student to recall details about crossing over during meiosis. Crossing over during meiosis occurs between two homologous chromosomes when portions of their chromatids are exchanged. Crossing over provides additional genetic variability and is confirmed by conducting a dihybrid cross.
Biology
Spring 2018 Item Release

Question 16

Sample Responses
Sample Response: 2 points

The following question has two parts. First, answer part A. Then, answer part B.

Part A

Which statement describes crossing over as it occurs in meiosis?

A. The alleles of a gene separate.
B. Spindle fibers pull apart sister chromatids.
C. Genes move to opposite ends of the chromosomes.
D. Homologous chromosomes exchange segments of DNA.

Part B

Which method do scientists use to confirm that crossing over occurs?

A. cloning
B. dihybrid crosses
C. gel electrophoresis
D. genetic engineering

Notes on Scoring

This response earns full credit (2 points) because it correctly identifies the statement that crossing over is the exchange of homologous chromosome segments in Part A and it correctly identifies the method that crossing over is verified by conducting a dihybrid cross in Part B.
Sample Response: 1 point

The following question has two parts. First, answer part A. Then, answer part B.

Part A

Which statement describes crossing over as it occurs in meiosis?

A  The alleles of a gene separate.
B  Spindle fibers pull apart sister chromatids.
C  Genes move to opposite ends of the chromosomes.
D  Homologous chromosomes exchange segments of DNA.

Part B

Which method do scientists use to confirm that crossing over occurs?

A  cloning
B  dihybrid crosses
C  gel electrophoresis
D  genetic engineering

Notes on Scoring

This response earns partial credit (1 point) because it correctly identifies the statement that crossing over is the exchange of homologous chromosome segments in Part A. However, it incorrectly selects genetic engineering in Part B as the scientific method used to confirm that crossing over occurs.
Sample Response: 0 points

The following question has two parts. First, answer part A. Then, answer part B.

Part A
Which statement describes crossing over as it occurs in meiosis?

- The alleles of a gene separate.
- Spindle fibers pull apart sister chromatids.
- Genes move to opposite ends of the chromosomes.
- Homologous chromosomes exchange segments of DNA.

Part B
Which method do scientists use to confirm that crossing over occurs?

- cloning
- dihybrid crosses
- gel electrophoresis
- genetic engineering

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies the statement that describes crossing over occurring in meiosis as the alleles of a gene separating in Part A. Also, the response incorrectly selects gel electrophoresis in Part B as the scientific method used to confirm crossing over occurs.
Biology
Spring 2018 Item Release

Question 22

Question and Scoring Guidelines
Question 22

Which molecule was coded for by the longest piece of DNA, assuming that no post-transcriptional RNA processing or splicing has occurred?

A) a protein with 25 amino acids
B) a polysaccharide with 60 sugars
C) an mRNA molecule with 20 codons
D) an mRNA molecule with 45 nucleotides

Points Possible: 1

See Alignment for more detail.

Scoring Guidelines

Rationale for Option A: Key – This protein required a gene with at least 78 bases: 25 codons, one per amino acid, and a stop codon.

Rationale for Option B: This is incorrect. Carbohydrates are not coded for by DNA or RNA.

Rationale for Option C: This is incorrect. An mRNA with 20 codons has 60 bases, less than the 78 bases needed to code for a protein with 25 amino acids.

Rationale for Option D: This is incorrect. An mRNA with 45 nucleotides has 45 bases, less than the 78 bases needed to code for a protein with 25 amino acids.
Alignment
Content Strand
Heredity

Content Statement
Structure and Function of DNA in Cells

Content Elaboration
At the high school level, the explanation of genes is expanded to include the following concepts:

- Life is specified by genomes. Each organism has a genome that contains all of the biological information needed to build and maintain a living example of that organism. The biological information contained in a genome is encoded in its deoxyribonucleic acid (DNA) and is divided into discrete units called genes.
- Genes are segments of DNA molecules. The sequence of DNA bases in a chromosome determines the sequence of amino acids in a protein. Inserting, deleting or substituting segments of DNA molecules can alter genes.

Cognitive Demand
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

Explanation of the Item
This item requires the student to determine how DNA codes for proteins. DNA is used to code for mRNA during a process called transcription. During translation that takes place on ribosomes, each mRNA codon made up of 3 nitrogenous bases attaches to its complimentary tRNA anticodon with its amino acid attached. Therefore, the protein with 25 amino acids would be the longest strand of DNA with 78 bases: 1 start codon (3 bases) and 25 codons (3x25=75 bases).
Sample Response: 1 point

Which molecule was coded for by the longest piece of DNA, assuming that no post-transcriptional RNA processing or splicing has occurred?

- a protein with 25 amino acids
- a polysaccharide with 60 sugars
- an mRNA molecule with 20 codons
- an mRNA molecule with 45 nucleotides
Biology
Spring 2018 Item Release

Question 23

Question and Scoring Guidelines
**Question 23**

An island frog population is made up of two color phenotypes, green and brown, caused by different coloration alleles. The frequency of coloration alleles is shown in the Original Population box in the diagram. Because of changes in the environment, green frogs become more visible to predators and brown frogs are better camouflaged.

A. Place colored symbols into the New Population box to predict the frequency of frog coloration alleles due to the changes in the environment.

B. Select the evolutionary mechanism that would cause this change in allele frequency.

- There may be more than one correct answer.

**Points Possible: 2**

See [Alignment](#) for more detail.

**Scoring Guidelines**

For this item, a full-credit response includes:

- In the “New Population” box, more than 2 brown dots AND less than 8 green dots (1 point);
  
AND

- “Natural selection” selected (1 point).
Biological evolution explains the natural origins for the diversity of life. Emphasis shifts from thinking in terms of selection of individuals with a particular trait to changing proportions of a trait in populations. The study of evolution must include Modern Synthesis, the unification of genetics and evolution and historical perspectives of evolutionary theory. The study of evolution must include gene flow, mutation, speciation, natural selection, genetic drift, sexual selection and Hardy Weinberg’s law.

Cognitive Demand
Demonstrating Science Knowledge (D)

Requires students to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (Slightly altered from National Science Education Standards) Note: Procedural knowledge (knowing how) is included in Recalling/Identifying Accurate Science.

Explanation of the Item
This item requires the student to demonstrate in Part A how phenotype frequencies change due to environmental pressures and in Part B identify the evolutionary mechanism. Due to changes in the environment, the brown frogs become better camouflaged, so the brown phenotype will increase in frequency from the original population (greater than 2) due to less predation caused by better camouflage. The green phenotype will decrease from the original population (less than 8) in frequency due to increased predation caused by being less camouflaged and more visible. In Part B, natural selection is the environmental mechanism evidenced by changes in the environment that gives a survival advantage of one phenotypic trait over another phenotypic trait.
Sample Response: 2 points

An island frog population is made up of two color phenotypes, green and brown, caused by different coloration alleles. The frequency of coloration alleles is shown in the Original Population box in the diagram. Because of changes in the environment, green frogs become more visible to predators and brown frogs are better camouflaged.

A. Place colored symbols into the New Population box to predict the frequency of frog coloration alleles due to the changes in the environment.

B. Select the evolutionary mechanism that would cause this change in allele frequency.

- There may be more than one correct answer.

Notes on Scoring

This response earns full credit (2 points) because it correctly identifies the change in the frog coloration allele frequency in Part A and it correctly identifies the evolutionary mechanism in Part B.
Sample Response: 1 point

An island frog population is made up of two color phenotypes, green and brown, caused by different coloration alleles. The frequency of coloration alleles is shown in the Original Population box in the diagram. Because of changes in the environment, green frogs become more visible to predators and brown frogs are better camouflaged.

A. Place colored symbols into the New Population box to predict the frequency of frog coloration alleles due to the changes in the environment.

B. Select the evolutionary mechanism that would cause this change in allele frequency.

- There may be more than one correct answer.

Notes on Scoring

This response earns partial credit (1 point) because it correctly identifies the change in the frog coloration allele frequencies in Part A. However, this response incorrectly selects “Sexual selection” as the evolutionary mechanism in Part B.
Sample Response: 1 point

An island frog population is made up of two color phenotypes, green and brown, caused by different coloration alleles. The frequency of coloration alleles is shown in the Original Population box in the diagram. Because of changes in the environment, green frogs become more visible to predators and brown frogs are better camouflaged.

A. Place colored symbols into the New Population box to predict the frequency of frog coloration alleles due to the changes in the environment.

B. Select the evolutionary mechanism that would cause this change in allele frequency.
• There may be more than one correct answer.

Notes on Scoring

This response earns partial credit (1 point) because it correctly selects “Natural selection” as the evolutionary mechanism in Part B, but it incorrectly identifies the change in the frog coloration allele frequencies in Part A.
Sample Response: 0 points

An island frog population is made up of two color phenotypes, green and brown, caused by different coloration alleles. The frequency of coloration alleles is shown in the Original Population box in the diagram. Because of changes in the environment, green frogs become more visible to predators and brown frogs are better camouflaged.

A. Place colored symbols into the New Population box to predict the frequency of frog coloration alleles due to the changes in the environment.

B. Select the evolutionary mechanism that would cause this change in allele frequency.

- There may be more than one correct answer.

Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies the change in the frog coloration allele frequencies in Part A and it incorrectly selects “Founder effect” as the evolutionary mechanism in Part B.
An island frog population is made up of two color phenotypes, green and brown, caused by different coloration alleles. The frequency of coloration alleles is shown in the Original Population box in the diagram. Because of changes in the environment, green frogs become more visible to predators and brown frogs are better camouflaged.

A. Place colored symbols into the New Population box to predict the frequency of frog coloration alleles due to the changes in the environment.

B. Select the evolutionary mechanism that would cause this change in allele frequency.

- There may be more than one correct answer.

---

**Notes on Scoring**

This response earns no credit (0 points) because it incorrectly identifies the change in the frog coloration allele frequencies in Part A and it incorrectly selects “Sexual selection” as the evolutionary mechanism in Part B.
Biology
Spring 2018 Item Release

Question 24

Question and Scoring Guidelines
Question 24

The following question has two parts. First, answer part A. Then, answer part B.

**Part A**

DNA-DNA hybridization is a technique used to determine the relatedness among different species. During hybridization, scientists combine a single strand of DNA from two different species. They heat these combined strands in small increments, and observe the temperatures at which most of the strands in the sample separate. Scientists compare the differences in separation temperatures from single-species DNA strands to hybridized DNA strands, since a greater difference in separation temperature indicates fewer base pair similarities between each organism. The table shows data for six species.

### Differences in DNA Separation Temperature for Six Species

<table>
<thead>
<tr>
<th></th>
<th>Species 1</th>
<th>Species 2</th>
<th>Species 3</th>
<th>Species 4</th>
<th>Species 5</th>
<th>Species 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species 1</td>
<td>X</td>
<td>2.25</td>
<td>4.68</td>
<td>2.27</td>
<td>3.52</td>
<td>2.31</td>
</tr>
<tr>
<td>Species 2</td>
<td>2.25</td>
<td>X</td>
<td>4.75</td>
<td>0.73</td>
<td>3.58</td>
<td>1.60</td>
</tr>
<tr>
<td>Species 3</td>
<td>4.68</td>
<td>4.75</td>
<td>X</td>
<td>4.74</td>
<td>4.87</td>
<td>4.78</td>
</tr>
<tr>
<td>Species 4</td>
<td>2.27</td>
<td>0.73</td>
<td>4.74</td>
<td>X</td>
<td>3.57</td>
<td>1.64</td>
</tr>
<tr>
<td>Species 5</td>
<td>3.52</td>
<td>3.58</td>
<td>4.87</td>
<td>3.57</td>
<td>X</td>
<td>3.61</td>
</tr>
<tr>
<td>Species 6</td>
<td>2.31</td>
<td>1.60</td>
<td>4.78</td>
<td>1.64</td>
<td>3.51</td>
<td>X</td>
</tr>
</tbody>
</table>

Which pair of species is the most closely related?

- **A** species 4 and species 5
- **B** species 5 and species 6
- **C** species 2 and species 4
- **D** species 2 and species 6

**Part B**

Select the two statements that describe evidence to support the determination of the most closely related pair of species.

- [ ] Hybrid DNA will separate easily when two species share more common ancestors.
- [ ] Similar temperatures are needed to separate DNA from species that share more genetic similarities.
- [ ] Higher temperatures are needed to separate hybrid DNA from two species with greater differences in genomes.
- [ ] Species that have diverged from a common ancestor more recently will also share more complementary base pairs.

**Points Possible: 2**

See Alignment for more detail.
Scoring Guidelines

Part A
Rationale for Option A: This is incorrect. These species have one of the greatest differences in hybridization temperatures, and so are two of the least related species.

Rationale for Option B: This is incorrect. These species have a moderate difference in hybridization temperatures, so they are neither the most nor the least closely related.

Rationale for Option C: Key - Species 2 and 4 have the least difference in hybridization temperatures, so their DNA sequences are the most alike and they are the most closely related.

Rationale for Option D: This is incorrect. These species have a moderate difference in hybridization temperatures, so they are neither the most nor the least closely related.

Part B
Rationale for First Option: This is incorrect. Species that share more common ancestors, and are thus more closely related, will have more bonded complementary base pairs, and so higher temperatures will be needed to break more hydrogen bonds.

Rationale for Second Option: Key - Species that are more genetically similar, like species 2 and 4, will have fewer unbonded base pairs when their DNA is hybridized, which is demonstrated by the low differences in the temperatures at which they separate.

Rationale for Third Option: This is incorrect. More differences in base pairs between species that are less closely related decrease the temperatures needed to separate the hybrid DNA strands and cause a greater difference in temperature separation.

Rationale for Fourth Option: Key - A greater number of complementary base pairs between two species suggests they are more closely related; therefore, the amount of heat needed to separate the DNA strands would be similar between hybridized and un-hybridized strands.
**Alignment**

**Content Strand**
Diversity and Interdependence of Life

**Content Statement**
Classification systems are frameworks created by scientists for describing the vast diversity of organisms, indicating the degree of relatedness between organisms.

**Content Elaboration**
Classification systems are frameworks developed by scientists for describing the diversity of organisms, indicating the degree of relatedness between organisms. Recent molecular-sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons. Both morphological comparisons and molecular evidence must be used to describe biodiversity (cladograms can be used to address this).

**Cognitive Demand**
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

**Explanation of the Item**
This item requires the student to evaluate differences in DNA separation temperature that can be used to determine how closely related two species are. DNA hybridization is a technique that measures the degree that two species are genetically similar. This is accomplished by heating the two DNA strands and measuring the temperature in which they separate. The closer the separation temperatures, the greater number of base pair similarities there are and more genetically related the two species are. Therefore, similar temperatures are needed to separate DNA from species that share more genetic information. Also, species that have diverged from a common ancestor more recently will also share more complementary base pairs. Part A requires the student to identify the two species that are closely related based upon the difference in separation temperatures. Part B requires the student to identify the two statements that provide evidence for their selection in Part A.
Question 24

Sample Responses
Sample Response: 2 points

The following question has two parts. First, answer part A. Then, answer part B.

Part A

DNA-DNA hybridization is a technique used to determine the relatedness among different species. During hybridization, scientists combine a single strand of DNA from two different species. They heat these combined strands in small increments, and observe the temperatures at which most of the strands in the sample separate. Scientists compare the differences in separation temperatures from single-species DNA strands to hybridized DNA strands, since a greater difference in separation temperature indicates fewer base pair similarities between each organism. The table shows data for six species.

<table>
<thead>
<tr>
<th>Differences in DNA Separation Temperature for Six Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Species 1</td>
</tr>
<tr>
<td>Species 2</td>
</tr>
<tr>
<td>Species 3</td>
</tr>
<tr>
<td>Species 4</td>
</tr>
<tr>
<td>Species 5</td>
</tr>
<tr>
<td>Species 6</td>
</tr>
</tbody>
</table>

Which pair of species is the **most** closely related?

A) species 4 and species 5  
B) species 5 and species 6  
C) species 2 and species 4  
D) species 2 and species 6

Part B

Select the two statements that describe evidence to support the determination of the **most** closely related pair of species.

☐ Hybrid DNA will separate easily when two species share more common ancestors.  
☑ Similar temperatures are needed to separate DNA from species that share more genetic similarities.  
☐ Higher temperatures are needed to separate hybrid DNA from two species with greater differences in genomes.  
☑ Species that have diverged from a common ancestor more recently will also share more complementary base pairs.

Notes on Scoring

This response earns full credit (2 points) because it correctly identifies the two species that have the lowest difference in DNA separation temperature in Part A, and it correctly identifies the two statements in Part B that provide evidence for the answer selected in Part A.
Sample Response: 1 point

The following question has two parts. First, answer part A. Then, answer part B.

Part A

DNA-DNA hybridization is a technique used to determine the relatedness among different species. During hybridization, scientists combine a single strand of DNA from two different species. They heat these combined strands in small increments, and observe the temperatures at which most of the strands in the sample separate. Scientists compare the differences in separation temperatures from single-species DNA strands to hybridized DNA strands, since a greater difference in separation temperature indicates fewer base pair similarities between each organism. The table shows data for six species.

| Differences in DNA Separation Temperature for Six Species |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Species 1       | Species 2       | Species 3       | Species 4       | Species 5       | Species 6       |
| X               | 2.25            | 4.68            | 2.27            | 3.52            | 2.31            |
| 2.25            | X               | 4.75            | 0.73            | 3.58            | 1.60            |
| 4.68            | 4.75            | X               | 4.74            | 4.87            | 4.78            |
| 2.27            | 0.73            | 4.74            | X               | 3.57            | 1.64            |
| 3.52            | 3.58            | 4.87            | 3.57            | X               | 3.61            |
| 2.31            | 1.60            | 4.78            | 1.64            | 3.51            | X               |

Which pair of species is the **most** closely related?

- species 4 and species 5
- species 5 and species 6
- **species 2 and species 4**
- species 2 and species 6

Part B

Select the **two** statements that describe evidence to support the determination of the **most** closely related pair of species.

- [ ] Hybrid DNA will separate easily when two species share more common ancestors.
- [ ] Similar temperatures are needed to separate DNA from species that share more genetic similarities.
- [ ] Higher temperatures are needed to separate hybrid DNA from two species with greater differences in genomes.
- [x] Species that have diverged from a common ancestor more recently will also share more complementary base pairs.

Notes on Scoring

This response earns partial credit (1 point) because it correctly identifies the two species that have the lowest difference in DNA separation temperature in Part A. However, the response incorrectly identifies one of the two statements in Part B that provides evidence for the answer selected in Part A.
The following question has two parts. First, answer part A. Then, answer part B.

Part A

DNA-DNA hybridization is a technique used to determine the relatedness among different species. During hybridization, scientists combine a single strand of DNA from two different species. They heat these combined strands in small increments, and observe the temperatures at which most of the strands in the sample separate. Scientists compare the differences in separation temperatures from single-species DNA strands to hybridized DNA strands, since a greater difference in separation temperature indicates fewer base pair similarities between each organism. The table shows data for six species.

### Differences in DNA Separation Temperature for Six Species

<table>
<thead>
<tr>
<th>Species</th>
<th>Species 1</th>
<th>Species 2</th>
<th>Species 3</th>
<th>Species 4</th>
<th>Species 5</th>
<th>Species 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species 1</td>
<td>X</td>
<td>2.25</td>
<td>4.68</td>
<td>2.27</td>
<td>3.52</td>
<td>2.31</td>
</tr>
<tr>
<td>Species 2</td>
<td>2.25</td>
<td>X</td>
<td>4.75</td>
<td>0.73</td>
<td>3.58</td>
<td>1.60</td>
</tr>
<tr>
<td>Species 3</td>
<td>4.68</td>
<td>4.75</td>
<td>X</td>
<td>4.74</td>
<td>4.87</td>
<td>4.78</td>
</tr>
<tr>
<td>Species 4</td>
<td>2.27</td>
<td>0.73</td>
<td>4.74</td>
<td>X</td>
<td>3.57</td>
<td>1.64</td>
</tr>
<tr>
<td>Species 5</td>
<td>3.52</td>
<td>3.58</td>
<td>4.87</td>
<td>3.57</td>
<td>X</td>
<td>3.61</td>
</tr>
<tr>
<td>Species 6</td>
<td>2.31</td>
<td>1.60</td>
<td>4.78</td>
<td>1.64</td>
<td>3.51</td>
<td>X</td>
</tr>
</tbody>
</table>

Which pair of species is the most closely related?

- species 4 and species 5
- species 5 and species 6
- species 2 and species 4
- species 2 and species 6

Part B

Select the two statements that describe evidence to support the determination of the most closely related pair of species.

- Hybrid DNA will separate easily when two species share more common ancestors.
- Similar temperatures are needed to separate DNA from species that share more genetic similarities.
- Higher temperatures are needed to separate hybrid DNA from two species with greater differences in genomes.
- Species that have diverged from a common ancestor more recently will also share more complementary base pairs.

### Notes on Scoring

This response earns no credit (0 points) because it incorrectly identifies species 5 and 6 rather than the two species (2 and 4) that have the lowest difference in DNA separation temperature in Part A. Also, the response incorrectly identifies one of the two statements in Part B that provide evidence for the answer selected in Part A.
Biology
Spring 2018 Item Release

Question 38

Question and Scoring Guidelines
Park rangers track the size of a stable deer population in a protected forest preserve. An area of neighboring land is added to the protected forest preserve.

Park rangers plan a survey over a ten year period (B on the graph) to measure how the deer population changes as a result of the territory added to the preserve. They set up the graph as shown.

Select the boxes to predict the population and carrying capacity data that will be recorded by the park rangers.

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>Decrease</th>
<th>At Equilibrium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deer population size during time B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrying capacity of the habitat during time B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrying capacity of the habitat during time C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Points Possible: 1

See Alignment for more detail.
Scoring Guidelines

For this item, a full-credit response includes

- Only “Increase” selected for “Deer population size during time B”;
  AND
- Only “Increase” selected for “Carrying capacity of the habitat during time B”;
  AND
- Only “At Equilibrium” selected for “Carrying capacity of the habitat during time C” (1 point).

Alignment

Content Strand
Diversity and Interdependence of Life

Content Statement
Ecosystems

Content Elaboration
The great diversity of organisms and ecological niches they occupy result from more than 3.5 billion years of evolution. Some ecosystems can be reasonably persistent over hundreds or thousands of years. Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change as geological or biological conditions vary. Misconceptions about population growth capacity, interspecies and intra-species competition for resources, and what occurs when a species immigrates to or emigrates from ecosystems are included in this topic. Technology must be used to access real-time/authentic data to study population changes and growth in specific locations.

Cognitive Demand
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

Explanation of the Item
This item requires the student to evaluate changes in an ecosystem and depict how carrying capacity is affected by available resources. A stable deer
population at carrying capacity and equilibrium is expanded by adding neighboring land to a protected forest preserve. This addition of resources, habitat and food allows the deer population to expand as well as establish a new carrying capacity and equilibrium.

*Sample Response: 1 point*

Park rangers track the size of a stable deer population in a protected forest preserve. An area of neighboring land is added to the protected forest preserve.

Park rangers plan a survey over a ten year period (B on the graph) to measure how the deer population changes as a result of the territory added to the preserve. They set up the graph as shown.

Select the boxes to predict the population and carrying capacity data that will be recorded by the park rangers.

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>Decrease</th>
<th>At Equilibrium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deer population size during time B</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrying capacity of the habitat during time B</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrying capacity of the habitat during time C</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Biology
Spring 2018 Item Release

Question 46

Question and Scoring Guidelines
**Question 46**

A student studying feather color inheritance in a certain species of chickens observes that the chickens have black (homozygous), blue (heterozygous), or white (homozygous) feathers. The student hypothesizes that this feather color trait follows the incomplete dominance inheritance pattern.

Which data table would support the student’s hypothesis?

<table>
<thead>
<tr>
<th>Parent 1 Phenotype</th>
<th>Parent 2 Phenotype</th>
<th>Offspring Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black feathers</td>
<td>White feathers</td>
<td>Blue feathers</td>
</tr>
</tbody>
</table>

- **A**
- **B**
- **C**
- **D**

**Points Possible: 1**

See **Alignment** for more detail.
Scoring Guidelines

Rationale for Option A: Key - The data demonstrate incomplete dominance since the black genotype and white genotype combine to produce the intermediate blue genotype (BW) for the offspring.

Rationale for Option B: This is incorrect. This set of data shows a situation where black feathers would show complete dominance over white feathers to produce offspring with black feathers.

Rationale for Option C: This is incorrect. These results could not be expected based on incomplete dominance and black dominant to white.

Rationale for Option D: This is incorrect. The student would not be able to conclude whether or not the inheritance of chicken feather color is incomplete dominance from these data. More information is needed for the student to make this conclusion. These data could be interpreted as an instance of complete dominance.

Alignment
Content Strand
Heredity

Content Statement
Genetic Mechanisms and Inheritance

Content Elaboration
The gene interactions described in middle school were limited primarily to dominance and co-dominance traits. In high school, genetic mechanisms, both classical and modern including incomplete dominance, sex-linked traits, goodness of fit test (Chi-square) and dihybrid crosses are investigated through real-world examples. Dihybrid crosses can be used to explore linkage groups. Gene interactions and phenotypic effects can be introduced using real-world examples (e.g. polygenic inheritance, epistasis, and pleiotropy).

Cognitive Demand
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical
knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

**Explanation of the Item**
This item requires the student to determine the resulting phenotypes produced by monohybrid crosses based on an example of incomplete dominance. The Punnett square crossing a black homozygous (BB) parent with a white homozygous (bb) parent would be:

<table>
<thead>
<tr>
<th>B</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Bb</td>
</tr>
<tr>
<td>b</td>
<td>Bb</td>
</tr>
</tbody>
</table>

If this were complete dominance, the heterozygous genotype (Bb) offspring would be black; however, with incomplete dominance, neither allele is dominant and both are expressed giving a blending of the traits resulting in an intermediate phenotype. In this item, the heterozygous genotype (Bb) produces a blue phenotype.
A student studying feather color inheritance in a certain species of chickens observes that the chickens have black (homozygous), blue (heterozygous), or white (homozygous) feathers. The student hypothesizes that this feather color trait follows the incomplete dominance inheritance pattern.

Which data table would support the student’s hypothesis?

<table>
<thead>
<tr>
<th>Parent 1 Phenotype</th>
<th>Parent 2 Phenotype</th>
<th>Offspring Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black feathers</td>
<td>White feathers</td>
<td>Blue feathers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parent 1 Phenotype</th>
<th>Parent 2 Phenotype</th>
<th>Offspring Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>White feathers</td>
<td>Black feathers</td>
<td>Black feathers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parent 1 Phenotype</th>
<th>Parent 2 Phenotype</th>
<th>Offspring Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>White feathers</td>
<td>White feathers</td>
<td>Black feathers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parent 1 Phenotype</th>
<th>Parent 2 Phenotype</th>
<th>Offspring Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue feathers</td>
<td>White feathers</td>
<td>Blue feathers</td>
</tr>
</tbody>
</table>
The Ohio Department of Education does not discriminate on the basis of race, color, national origin, sex, religion, age, or disability in employment or the provision of services.

Copyright © 2018 by the Ohio Department of Education. All rights reserved.