**OKLAHOMA SCHOOL TESTING PROGRAM**

**OKLAHOMA CORE CURRICULUM TESTS**

# TEST AND ITEM SPECIFICATIONS

End-of-Instruction
ACE Biology I

Oklahoma State Department of Education
Oklahoma City, Oklahoma

Revised
August 2014

# OKLAHOMA CORE CURRICULUM TESTS TEST AND ITEM SPECIFICATIONS

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## Purpose

The purpose of this test is to measure Oklahoma students' level of proficiency at the End-of-Instruction in Biology I. Students are required to respond to a variety of items linked to the Biology I standards identified in the Oklahoma Academic Standards observing and measuring, classifying, experimenting, interpreting and communicating, and modeling. Students are also required to use a variety of science objectives within each standard. Items also measure content knowledge in the areas of the cell, the molecular basis of heredity, biological diversity, the interdependence of organisms, matter/energy/ organization in living systems, and the behavior of organisms. Each test item will measure one of the process/inquiry objectives and one of the content objectives below, with the exception of items in process objective 3.5, which are process/inquiry only. All Biology I test forms will assess the identified process/inquiry and content standards and objectives listed below. The following standards and objectives are intended to summarize the knowledge as identified in Oklahoma Academic Standards.

| **Oklahoma Academic Standards<br>Biology I<br>Process/Inquiry Standards and Objectives** |
|---|
| **Observe and Measure (P1.0)**<br>• Qualitative/quantitative observations and changes (1.1)<br>• Use appropriate System International (SI) units and tools (1.2 & 1.3) |
| **Classify (P2.0)**<br>• Use observable properties to classify (2.1)<br>• Identify properties of a classification system (2.2) |
| **Experimental Design (P3.0)**<br>• Evaluate the design of investigations (3.1)<br>• Identify a testable hypothesis, controlled variables, and experimental controls in an experiment (3.2 & 3.4)<br>• Use mathematics to show relationships (3.3)<br>• Identify potential hazards and practice safety procedures in all science activities (3.5) |
| **Interpret and Communicate (P4.0)**<br>• Select predictions based on observed patterns of evidence (4.1)<br>• Interpret line, bar, trend, and circle graphs (4.3)<br>• Accept or reject a hypothesis (4.4)<br>• Make logical conclusions based on experimental data (4.5)<br>• Identify an appropriate graph or chart (4.8) |
| **Model (P5.0)**<br>• Interpret a model which explains a given set of observations (5.1)<br>• Select predictions based on models using mathematics when appropriate (5.2) |

| Oklahoma Academic Standards<br>Biology I<br>Content Standards and Objectives |
|---|
| **The Cell (1.0)**<br>• Cell structures and functions (1.1)<br>• Differentiation of cells (1.2)<br>• Specialized cells (1.3) |
| **The Molecular Basis of Heredity (2.0)**<br>• DNA structure and function in heredity (2.1)<br>• Sorting and recombination of genes (2.2) |
| **Biological Diversity (3.0)**<br>• Variation among organisms (3.1)<br>• Natural selection and biological adaptations (3.2)<br>• Behavior patterns can be used to ensure reproductive success (3.3) |
| **The Interdependence of Organisms (4.0)**<br>• Organisms both cooperate and compete (4.1)<br>• Population dynamics (4.2) |
| **Matter/Energy/Organization in Living Systems (5.0)**<br>• Complexity and organization used for survival (5.1)<br>• Matter and energy flow in living and nonliving systems (5.2)<br>• Earth cycles including abiotic and biotic factors (5.3) |

## Test Structure, Format, and Scoring

The test consists of 60 operational multiple-choice items and 15 field test items, which are written at a reading level about two grade levels below an EOI Biology I audience and includes four responses: the correct answer and three distractors. The total 75 items will be divided into two test sections to be administered in one day or consecutive days.

Each multiple-choice item is scored as correct or incorrect. Only operational multiple- choice items contribute to the total test score. Thus, for example, if a test contained 60 operational items, only those 60 items (not the 15 field test) would contribute to a student's scaled score on the test.

The student's raw score is converted to a scaled score using the number correct scoring method.

## Test Alignment with Oklahoma Academic Standards

| Criteria for Aligning the Test with the Oklahoma Academic Standards and Objectives |
|---|
| **1. Categorical Concurrence**<br>The test is constructed so that there are at least six items measuring each Oklahoma Academic Standard. The number of items, six, is based on estimating the number of items that could produce a reasonably reliable estimate of a student's mastery of the content measured. |
| **2. Range-of-Knowledge Correspondence**<br>The test is constructed so that at least 75 percent of the objectives for an Oklahoma Academic Standard have at least one corresponding assessment item. |
| **3. Balance of Representation***<br>The test construction shall yield a balance of representation with an index value of 0.7 or higher of assessed objectives related to a standard. |
| **4. Source of Challenge**<br>Each test item is constructed in such a way that the major cognitive demand comes directly from the targeted Oklahoma Academic Standards or objective being assessed, not from specialized knowledge or cultural background that the test-taker may bring to the testing situation. |

*When new Oklahoma Academic Standards and objectives are implemented, there is a transition period before the criteria for test alignment with Oklahoma Academic Standards can be completely met. During this transition time, items are developed and field tested in order to meet the criteria for alignment to the Oklahoma Academic Standards and objectives.

**Blueprint**

The blueprint describes the content and structure of an assessment and defines the ideal number of test items by standard and objective of the Priority Academic Student Skills/Oklahoma Academic Standards (PASS-2011/OAS).

## ACE Biology I EOI
## School Years 2014–2015 and 2015–2016

| Process/Inquiry Standards and Objectives | Ideal Number of Items | Ideal Percentage of Items |
|---|---|---|
| **P1.0 Observe and Measure** | **6** | **10%** |
| 1.1 Qualitative/Quantitative Observations/Changes | 4 | |
| 1.2 Appropriate Tools and<br>1.3 Use Appropriate System International SI (metric) Units | 2 | |
| **P2.0 Classify** | **7–8** | **12%–13%** |
| 2.1 Use Observable Properties to Classify | 4 | |
| 2.2 Identify Properties of a Classification System | 3–4 | |
| **P3.0 Experimental Design** | **16–19** | **27%–32%** |
| 3.1 Evaluate the Design of Investigations | 4–5 | |
| 3.2 Identify Controlled Variables and Experimental Controls in an Experiment and<br>3.4 Identify a Testable Hypothesis in a Biology Investigation | 5–6 | |
| 3.3 Use Mathematics to Show Relationships | 4–6 | |
| 3.5 Identify Potential Hazards and Practice Safety Procedures in all Science Activities | 3 | |
| **P4.0 Interpret and Communicate** | **20–24** | **33%–40%** |
| 4.1 Select Predictions Based on Observed Patterns of Evidence | 4–5 | |
| 4.3 Interpret Line, Bar, Trend, and Circle Graphs | 4–5 | |
| 4.4 Accept or Reject a Hypothesis | 4–5 | |
| 4.5 Make Logical Conclusions Based on Experimental Data | 4–5 | |
| 4.8 Identify an Appropriate Graph or Chart | 4 | |
| **P5.0 Model** | **8** | **13%** |
| 5.1 Interpret a Model which Explains a Given Set of Observations | 4 | |
| 5.2 Select Predictions Based on Models, Using Mathematics When Appropriate | 4 | |
| **Total Test** | **60** | **100%** |

*(Please note this blueprint does not include items that may be field-tested.)*

- A minimum of 6 items is required to report a standard, and a minimum of 4 items is required to report results for an objective.

**Continued**

| Content Standards and Objectives | Ideal Number of Items | Ideal Percentage of Items |
|---|---|---|
| **C1.0 The Cell** | **12–15** | **21%–27%** |
| 1.1 Cell Structures and Functions | 4–6 | |
| 1.2 Differentiation of Cells | 4–6 | |
| 1.2 Specialized Cells | 4 | |
| **C2.0 The Molecular Basis of Heredity** | **12–15** | **21%–27%** |
| 2.1 DNA Structure and Function in Heredity | 6–8 | |
| 2.2 Sorting and Recombination of Genes | 6–7 | |
| **C3.0 Biological Diversity** | **12–15** | **21%–27%** |
| 3.1 Variation Among Organisms | 4–6 | |
| 3.2 Natural Selection and Biological Adaptations | 4–6 | |
| 3.3 Behavior Patterns Can Be Used To Ensure Reproductive Success | 4 | |
| **C4.0 The Interdependence of Organisms** | **8–10** | **14%–18%** |
| 4.1 Organisms Both Cooperate and Compete | 4–6 | |
| 4.2 Population Dynamics | 4–6 | |
| **C5.0 Matter/Energy/Organization in Living Systems** | **12** | **21%** |
| 5.1 Complexity and Organization Used For Survival | 4 | |
| 5.2 Matter and Energy Flow in Living and Nonliving Systems | 4 | |
| 5.3 Earth Cycles Including Abiotic and Biotic Factors | 4 | |
| **Total Test** | **57[1]** | **100%** |

*(Please note this blueprint does not include items that may be field-tested.)*

[1]Each test item aligns to both a Process Standard/Objective and a Content Standard/Objective, except for Safety Items which only align to P3.5.

**Depth-of-Knowledge Assessed by Test Items**

The test will approximately reflect the following "depth-of-knowledge" distribution of items:[1]

| Depth-of-Knowledge | Percent of Items |
|---|---|
| Level 1—Recall and Reproduction | 10–15% |
| Level 2—Skills and Concepts | 50–60% |
| Level 3—Strategic and Extended Thinking | 30–40% |

**Level 1** is the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a **simple** science process or procedure. Level 1 only requires students to demonstrate a rote response, use a well-known formula, follow a set procedure (like a recipe), or perform a clearly defined series of steps. A "simple" procedure is well-defined and typically involves only **one step**. Verbs such as "identify," "recall," "recognize," "use," "calculate," and "measure" generally represent cognitive work at the recall and reproduction level. Simple word problems that can be directly translated into and solved by a formula are considered Level 1. Verbs such as "describe" and "explain" could be classified at different depth-of-knowledge levels, depending on the complexity of what is to be described and explained.

A student answering a Level 1 item either knows the answer or does not: that is, the answer does not need to be "figured out" or "solved." In other words, if the knowledge necessary to answer an item automatically provides the answer to the item, then the item is at Level 1. If the knowledge necessary to answer the items does not automatically provide the answer, the item is at least at Level 2. Some examples that represent but do not constitute all of Level 1 performance are:

- Recall or recognize a fact, term, or property.
- Represent in words or diagrams a scientific concept or relationship.
- Provide or recognize a standard scientific representation for simple phenomenon.
- Perform a routine procedure such as measuring length.



[1] This is the ideal depth-of-knowledge distribution of items. There may be slight differences in the actual distribution of the upcoming testing session.

**Level 2** includes the engagement of some mental processing beyond recalling or reproducing a response. The content knowledge or process involved is **more complex** than in Level 1. Items require students to make some decisions as to how to approach the question or problem. Keywords that generally distinguish a Level 2 item include "classify," "organize," "estimate," "make observations," "collect and display data," and "compare data." These actions imply **more than one** step. For example, to compare data requires first identifying characteristics of the objects or phenomenon and then grouping or ordering the objects. Level 2 activities include making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

Some action verbs, such as "explain," "describe," or interpret," could be classified at different depth-of-knowledge levels, depending on the complexity of the action. For example, interpreting information from a simple graph, requiring reading information from the graph, is a Level 2. An item that requires interpretation from a complex graph, such as making decisions regarding features of the graph that need to be considered and how information from the graph can be aggregated, is at Level 3.

Some examples that represent, but do not constitute all of Level 2 performance, are:

- Specify and explain the relationship between facts, terms, properties, or variables.
- Describe and explain examples and non-examples of science concepts.
- Select a procedure according to specified criteria and perform it.
- Formulate a routine problem given data and conditions.
- Organize, represent and interpret data.

**Level 3** requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. The cognitive demands of a Level 3 are **complex and abstract**. The complexity does not result only from the fact that there could be multiple answers, a possibility for both Levels 1 and 2, but because the multi-step task requires **more demanding reasoning**. In most instances, requiring students to explain their thinking is at Level 3; requiring a very simple explanation or a word or two should be at Level 2. An activity that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Experimental designs in Level 3 typically involve more than one dependent variable. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve non-routine problems. Some examples that represent, but do not constitute all of Level 3 performance, are:

- Identify research questions and design investigations for a scientific problem.
- Solve non-routine problems.
- Develop a scientific model for a complex situation.
- Form conclusions from experimental data.

Level 4 questions are generally used for extended student responses and are most appropriate for classroom assessments. There are no Level 4 items on any state level core curriculum tests in Biology I.

**Level 4** has **high cognitive demands** and is **very complex**. Students are required to make several connections—relate ideas *within* the content area and *among* content areas and select or devise one approach among many alternatives on how the situation can be solved. Many on-demand assessment instruments will not include any assessment activities that could be classified as Level 4. However, standards, goals, and objectives can be stated in such a way as to expect students to perform extended thinking. Many, but not all, performance assessments and open-ended assessment activities requiring significant thought will be Level 4.

Level 4 requires complex reasoning, experimental design and planning, and **probably will require an extended period of time,** either for the science investigation required by an objective or for carrying out the multiple steps of an assessment item. However, the extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and higher-order thinking. For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2 activity. However, if the student conducts a river study that requires taking into consideration a number of variables, this would be a Level 4. Some examples that represent but do not constitute all of a Level 4 performance are:

- Based on provided data from a complex experiment that is novel to the student, deduct the fundamental relationship between several controlled variables.
- Conduct an investigation, from specifying a problem to designing and carrying out an experiment, to analyzing its data and forming conclusions.

**Note:** These descriptions are adapted from Review Background Information and Instructions, Standards and Assessment Alignment Analysis, CCSSO TILSA Alignment Study, May 21–24, 2001, Version 2.0. For an extended description of each depth-of- knowledge level, see the student assessment Web site at http://ok.gov/sde/test-support-teachers-and-administrators.

## Universal Design Considerations

Universal Design, as applied to assessments, is a concept that allows the widest possible range of students to participate in assessments and may even reduce the need for accommodations and alternative assessments by expanding access to the tests themselves. In the Oklahoma End-of-Instruction tests, modifications have been made to some items that simplify and clarify instructions, and provide maximum readability, comprehensibility, and legibility. This includes such things as reducing the language load in content areas other than Language Arts, increasing the font size, displaying fewer items per page, and boxing the items to assist visual focus. These modifications are evident in the sample items included in this document.

## Testing Schedule

Each End-of-Instruction test is meant to be administered in two sections within one day or consecutive days. Estimated time for scheduling purposes is given in the table below.

| **Biology I Online Test Time Schedule** | |
|---|---|
| Distributing login information | Approximately 5 minutes |
| Section 1: Test instructions/tutorial and reviewing sample items | Approximately 15 minutes |
| Total: | Approximately 20 minutes |
| Distributing login information | Approximately 5 minutes |
| Administering Section 2 of the Biology I Online Test | Approximately 55 minutes |
| Total: | Approximately 60 minutes |
| Distributing login information | Approximately 5 minutes |
| Administering Section 3 of the Biology I Online Test | Approximately 55 minutes |
| Total: | Approximately 60 minutes |

**Multiple-Choice Item Rules**

- All items must clearly indicate what is expected in a response and direct students to focus on their responses.
- Each multiple-choice item will have a stem (question or incomplete statement) and four answer (or completion) options, only one of which is correct. Items may contain graphical elements and/or text extracts.
- Multiple-choice item stems will present a complete problem so that students will know what to do before looking at the answer choices. Students should not need to read all answer choices before knowing what is expected.

In summary, biology test items will assess whether students understand scientific methods and biological concepts.

**Item Types**

Each multiple-choice item will have four responses—the correct answer and three distractors. Distractors will be developed based on the types of errors students are most likely to make.

For item review committee purposes, information regarding the Oklahoma Academic Standards and objectives addressed and the correct answer key will accompany each item.

Each item begins with a stem that asks a question or poses a clear problem. A stem will seldom include an incomplete sentence.

All stems will be positively worded—avoiding the use of the word not. If a negative is required, the format will be "All of the following . . . except."

A stimulus that gives information must precede a question or a set of questions.

**Stimulus Materials**

Stimulus materials are the tables, charts, graphs, science passages, and illustrations students must use in order to respond to items. The following characteristics are necessary for stimulus materials:

1. When students are given data or an experiment set-up to evaluate, they should know the research question and the purpose of the research.
2. Tables, graphs, science passages, and illustrations will provide sufficient information for possible assessment of multiple standards.
3. Stimulus materials for a set of items may be a combination of multiple stimuli.
4. Information in stimulus materials will be real examples of scientific concepts and principles as described by the Oklahoma Academic Standards.

5. Science passages should be limited to relevant information only, with a maximum of 50 to 150 words.
6. There will be a balance of graphic and textual stimulus materials within a test form. At least 50 percent of the items will have appropriate pictorial or graphical representations. Graphs, tables, or figures will be clearly associated with their intended items. Graphics will appear either on the same page as the stimulus or on the facing page.
7. There will be approximately 2–3 items for each field-test stimulus.

**Online Administration**

Test questions will be presented one at a time.

Answers may be selected by using either the mouse or the keyboard.

Navigation buttons appear at the bottom of the page for each question. For longer items, a scroll bar will appear on the right-hand side of the window to allow scrolling through the answer choices.

Tools (including a scientific calculator on the ACE Algebra I, Biology I and ACE Geometry assessments and a graphing calculator for the ACE Algebra II assessment) appear at the top of the screen/page to aid in answering questions.

Students will be able to use scratch paper for all online multiple-choice assessments. This paper must be taken up and destroyed by the test administrator immediately following the test. The test administrator must not look at what the student has written on the scratch paper.

The stimulus and question will appear on the screen at the same time.

**Item Specifications**

It is necessary to create test items that are reliable, fair, and targeted to the Oklahoma Academic Standards listed on the following pages. There are some general considerations and procedures for effective item development. These considerations include, but are not limited to, the following:

1. Each test form contains items assessing all process/inquiry and content standards, with the exception of process/inquiry standard 6.0 which must be assessed by the local school district.
2. Test items attempt to focus on authentic content that End-of-Instruction level students can relate to and understand.
3. Test items are worded precisely and clearly. The better focused an item, the more reliable and fair it is likely to be, and the more likely all students will understand what is required of them.
4. All items are reviewed to eliminate language that shows bias or is otherwise likely to disadvantage a particular group of students. That is, items do not display unfair representations of gender, race, disability, culture, or religion; nor do items contain elements that are offensive to any such groups.

5. All multiple-choice answer choices—keys and distractors—are similar in length, syntax, or structure. Students should not be able to rule out a wrong answer or identify a correct answer response solely by its appearance. Distractors are created so that students must reason their way to the correct answer rather than simply identifying incorrect responses because of a distractor's obviously inappropriate nature. Distractors should always be plausible (but incorrect) in the context of the item stem. Correct responses will be approximately equally distributed among answer choices.

**General Considerations—Oklahoma Core Curriculum Tests**

1. Items deal with issues and details that are of consequence in the stimulus and central to students' understanding and interpretation of the stimulus.
2. Test items are varied and address all Oklahoma Academic Standards and objectives listed in the Test Blueprint.
3. To the greatest extent possible, no item or response choice clues the answer to any other item.
4. All items reviewed and approved by the Oklahoma Item Review Committee are assigned an Oklahoma Academic Standard and/or objective. The Test Blueprints and score reports reflect the degree to which each Oklahoma Academic Standard and/or objective is represented on the test.
5. Test items are tied closely and particularly to the stimuli from which they derive, so that the impact of outside (prior) knowledge, while never wholly avoidable, is minimized.
6. Each multiple-choice item contains a question and four answer options, only one of which is correct. Correct answers will be approximately equally distributed among As, Bs, Cs, and Ds.
7. The four choices are approximately the same length, have the same format, and are syntactically and semantically parallel; students should not be able to rule out a wrong answer or identify a correct response simply by virtue of its looking or sounding different.
8. Distractors adopt the language and sense of the material in the stimuli so that students must think their way to the correct answer rather than simply identify incorrect responses by virtue of a distractor's obviously inappropriate nature.
9. Distractors should always be plausible (but, of course, incorrect) in the context of the stimulus.
10. Order of presentation of item types is dictated by logic (chronologically, spatially, etc.).
11. Items are worded precisely and clearly. The better focused an item, the more reliable and fair it is certain to be, and the more likely all students will understand it in the same way.
12. It is not possible to measure every Oklahoma Academic Standard objective on the test. However, at least 50% of the objectives from each Oklahoma Academic Standard (except Process Standard 6) are included on the test.
13. The range of items measuring an Oklahoma Academic objective consisting of more than one skill will provide a balanced representation of those skills.
14. Items should be focused on what all students should know and be able to do as they complete their End-of-Instruction coursework.
15. The responses "Both of the above," "All of the above," "None of the above," and "Neither of the above" will not be used.

16. The material presented is balanced, culturally diverse, well written, and of interest to End-of-Instruction level students. The stimuli and items are fairly presented in order to gain a true picture of students' skills.
17. Across all forms, a balance of gender and active/passive roles by gender is maintained.
18. Forms attempt to represent the ethnic diversity of Oklahoma students.
19. No resource materials may be used by students during the test. Use of scratch paper is allowed on the test but should be taken up and destroyed at the end of the test.
20. The stimuli avoid subject matter that might prompt emotional distress on the part of the students.
21. In addition to the 60 operational items, there will be 15 field-test items per form.
22. Permission to use stimuli from copyrighted material is obtained as necessary by CTB/McGraw-Hill.
23. Items will emphasize student-designed, classroom-conducted investigations, and may also include research-based investigations that are stated in language appropriate for students.
24. Note of explanation: i.e. (*id est*—that is) only items mentioned may be assessed. e.g. (*exempli gratia*—for example, for instance) item related to the content may be assessed.

All items developed using these specifications are reviewed annually by Oklahoma educators and approved by the Oklahoma State Department of Education. The distribution of newly developed items is based on dual alignment, difficulty, cognitive ability, percentage of art/graphics, and by grade-level appropriateness as determined by an annual Item Development Plan approved by the Oklahoma State Department of Education.

## OVERVIEW OF ITEM SPECIFICATIONS

For each Oklahoma Academic Standard (OAS), item specifications are organized under the following headings:

- OAS Standard
- OAS Objective
- Item Specifications
    a. Emphasis
    b. Stimulus Attributes
    c. Format
    d. Item Content Limits
    e. Content/Process Objectives May Include
    f. Distractor Domain
    g. Sample Test Items

The headings "OAS Standard" and "OAS Objective" state the standard and objective being measured as found in the Biology I section of the OAS document.

The heading "Item Specifications" highlights important points about the items' emphasis, stimulus attributes, format, content limits, depth-of-knowledge, process/content objective combinations, distractor domain, and sample test items. All items will measure one process objective and one content objective, with the exception of items for process objective 3.5 which measures safety only.

**Note: With the exception of content limits, the Item Specifications offer suggestions of what might be included and does not provide an exhaustive list of what can be included.**

**The sample test items are not intended to be definitive in nature or construction—the stimuli and the test items that follow them may differ from test form to test form, as may their presentations.**

**Oklahoma Academic Standards**
**BIOLOGY I**

**Process and Inquiry Standards and Objectives**

The Oklahoma Academic Standards should be taught by investigating content, concepts, and principles of major themes in the Biological Sciences.

Asterisks (*) have been used to identify objectives that must be assessed by the local school district. All other objectives will be assessed by the Oklahoma School Testing Program (OSTP).

**Process Standard 1: Observe and Measure—Observing is the first action taken by the learner to acquire new information about an organism or event. Opportunities for observation are developed through the use of a variety of scientific tools, allowing the student to distinguish between observation and inference. Measurement allows observations to be quantified. The student will accomplish these objectives to meet this process standard.**

1. Identify qualitative and quantitative changes in cells, organisms, populations, and ecosystems given conditions (e.g., temperature, mass, volume, time, position, length, quantity) before, during, and after an event.
2. Use appropriate tools with accuracy and precision (e.g., microscope, pipette, metric ruler, graduated cylinder, thermometer, balance, stopwatch) when measuring cells, organisms, populations, and ecosystems.
3. Use appropriate International System of Units (SI) (i.e., grams, meters, liters, degrees Celsius, and seconds) and SI prefixes (i.e., micro-, milli-, centi-, and kilo-) when measuring objects and/or events.

**Process Standard 2: Classify—Classifying establishes order. Organisms and events are classified based on similarities, differences, and interrelationships. The student will accomplish these objectives to meet this process standard.**

1. Using observable properties, place cells, organisms, and/or events into a biological classification system (e.g., dichotomous keys, taxonomy charts, cladograms).
2. Identify the properties by which a biological classification system is based.

**Process Standard 3: Experimental Design—Understanding experimental design requires that students recognize the components of a valid experiment. The student will accomplish these objectives to meet this process standard.**

1. Evaluate the design of a biology laboratory experiment.
2. Identify the independent variables, dependent variables, controlled variables, and control set-up in an experiment.
3. Use mathematics to show relationships within a given set of observations (e.g., population studies, biomass, probability).
4. Identify a hypothesis for a given problem in biology investigations.
5. Recognize potential hazards and practice safety procedures in all biology activities.

**Process Standard 4: Interpret and Communicate—Interpreting is the process of recognizing patterns in collected data by making inferences, predictions, or conclusions. Communicating is the process of describing, recording, and reporting experimental procedures and results to others. Communication may be oral, written, or mathematical and includes organizing ideas, using appropriate vocabulary, graphs, other visual representations, and mathematical equations. The student will accomplish these objectives to meet this process standard.**

1. Select appropriate predictions based on previously observed patterns of evidence.

*2. Report and display data using appropriate-technology and other media.

3. Interpret data tables, line, bar, trend, and/or circle graphs from existing science research or student experiments.
4. Determine if results of biological science investigations support or do not support hypotheses.
5. Evaluate experimental data to draw the conclusion that is best supported by the evidence.

*6. Routinely prepare a written report describing the sequence, results, and interpretation of a biological investigation or event.

   a. Establish and maintain a formal style and objective tone.
   b. When appropriate or possible, utilize technology to produce, publish, or revise writing products.
   c. Gather relevant information from multiple authoritative print and digital sources and follow a standard format for citation, avoiding plagiarism.

*7. Communicate or defend scientific thinking that results in conclusions.

   a. Read, comprehend, and present evidence from a range of sources (e.g., texts, experiments, or simulations) to support conclusions.
   b. Recognize bias in observation/research.

8. Identify and/or create an appropriate graph or chart from collected data, tables, or written description (e.g., population studies, plant growth, heart rate).

   a. Translate quantitative information expressed in words into visual form (e.g., a table or chart).
   b. Translate information expressed visually or mathematically (e.g., a table, chart or equation) into words.

**Process Standard 5: Model—Modeling is the active process of forming a mental or physical representation from data, patterns, or relationships to facilitate understanding and enhance prediction. The student will accomplish these objectives to meet this process standard.**

1. Interpret a biological model which explains a given set of observations.
2. Select predictions based on models (e.g., pedigrees, life cycles), and when appropriate, apply mathematical reasoning to make accurate predictions.

*3. Compare a given model to the living world.

**Process Standard 6: Inquiry—Inquiry can be defined as the skills necessary to carry out the process of scientific or systemic thinking. In order for inquiry to occur students must have the opportunity to make observation, pose questions, formulate testable hypotheses, carry out experiments, and make conclusions based on evidence. The student will accomplish these objectives to meet this process standard.**

*1. Ask a scientific question, formulate a testable hypothesis, and design an appropriate experiment relating to the living world.

*2. Design and conduct biological investigations in which variables are identified and controlled.

*3. Use a variety of technologies (e.g., probes, handheld digital devices, electrophoresis equipment, digital cameras, software, calculators, digital balances, microscopes, measuring instruments, and computers) to collect, analyze and display data.

*4. Inquiries should lead to the formulation of explanations or models (physical, conceptual, and mathematical). In answering questions, students should engage in research and discussions (based on scientific knowledge, the use of logic, and evidence from the investigation) and arguments that encourage the revision of their explanations, leading to further inquiry.

## Content Standards and Objectives

**Standard 1: The Cell—Cells are the fundamental unit of life, composed of a variety of structures that perform functions necessary to maintain life. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:**

1. Cells are composed of a variety of structures such as the nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.
    a. The cell/plasma membrane functions (i.e., active transport, passive transport, diffusion, osmosis, and surface area to volume ratio) to maintain homeostasis.
    b. Differentiate among hypotonic, hypertonic, and isotonic conditions.
    c. Compare and contrast prokaryotic and eukaryotic cells.
2. In multicellular organisms, cells have levels of organization (i.e., cells, tissues, organs, organ systems, organisms).
3. Specialized cells enable organisms to monitor what is going on in the world around them (e.g., detect light, sound, specific chemicals, gravity, plant tropism, sense organs, homeostasis).

**Standard 2: The Molecular Basis of Heredity—DNA determines the characteristics of organisms. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:**

1. Cells function according to the information contained in the master code of DNA (i.e., cell cycle, DNA replication and transcription). Transfer RNA and protein synthesis will be taught in life science courses with rigor greater than Biology I.
2. A sorting and recombination of genes during sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents (i.e., Punnett squares and pedigrees). Students will understand concepts in a single trait cross (e.g., alleles, dominant trait, recessive trait, phenotype, genotype, homozygous, heterozygous, incomplete dominance, and sex-linked traits).

**Standard 3: Biological Diversity—Diversity of species is developed through gradual processes over many generations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:**

1. Different species might look dissimilar, but the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry (e.g., homologous and analogous structures, embryology, fossil record, genetic data).
2. Characteristics of populations change through the mechanism of natural selection. These biological adaptations, including changes in structures, behaviors, and/or physiology, may enhance or limit survival and reproductive success within a particular environment.
3. Broad patterns of behavior exhibited by animals have changed over time to ensure reproductive success. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses can be either innate or learned.

**Standard 4: The Interdependence of Organisms—Interdependence of organisms in an environment includes the interrelationships and interactions between and among organisms. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:**

1. Organisms both cooperate and compete in ecosystems (e.g., symbiotic relationships).
2. Living organisms have the capacity to produce populations of infinite size, but environments and resources limit population size (e.g., carrying capacity, limiting factors, ecological succession).

**Standard 5: Matter, Energy, and Organization in Living Systems—Living systems require a continuous input of energy to maintain their chemical and physical organizations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:**

1. The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism (i.e., photosynthesis and cellular respiration).
2. As matter and energy flow through different levels of organization of living systems and between living systems and the physical environment, chemical elements are recombined in different ways by different structures. Matter and energy are conserved in each change (i.e., water cycle, carbon cycle, nitrogen cycle, food webs, and energy pyramids).
3. Matter on earth cycles among the living (biotic) and nonliving (abiotic) components of the biosphere.

**OAS Standard:**

Process Standard 1: Observe and Measure—Observing is the first action taken by the learner to acquire new information about an organism or event. Opportunities for observation are developed through the use of a variety of scientific tools, allowing the student to distinguish between observation and inference. Measurement allows observations to be quantified. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 1: Identify qualitative and quantitative changes in cells,organisms, populations, and ecosystems given conditions (e.g., temperature, mass, volume, time, position, length, quantity) before, during, and after an event.

**Item Specifications:**

Emphasis:

Make qualitative and quantitative observations. Identify the change that occurs over time or determine the cause of the change.

Stimulus Attributes:

Test items may include illustrations, charts, graphs, and tables.

Format:

Assessable content includes:

1. Students will apply observation skills in biological contexts.
2. Students will identify and differentiate qualitative and quantitative data or measurements collected within a research plan or experiment.
3. Students will determine which data (qualitative or quantitative) would be most appropriate to collect in order to test a hypothesis.
4. Students will identify and describe information collected from observation and measurement.
5. Students will distinguish observation from inference.
6. Students will recognize bias in observation/research.
7. Students will identify observations and measurements which are precise, accurate, and reliable.

Item Content Limits:

Non-assessable content includes:

1. Items with measurements not listed in Process Standard 1.3.

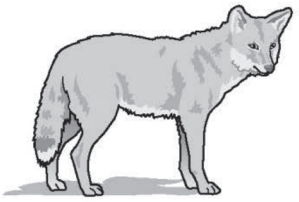
Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

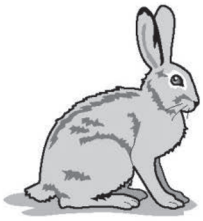
Incorrect qualitative or quantitative observations

Sample Test Item:
**Process Objective: 1.1**
Content Objective: 5.2
Depth-of-Knowledge: 1
Correct Response: B



Coyote

Grass



Rabbit

**Which statement correctly describes how energy flows among the above organisms in a prairie food chain?**

**A** Energy flows from the coyote to the rabbit to the grass.

**B** Energy flows from the grass to the rabbit to the coyote.

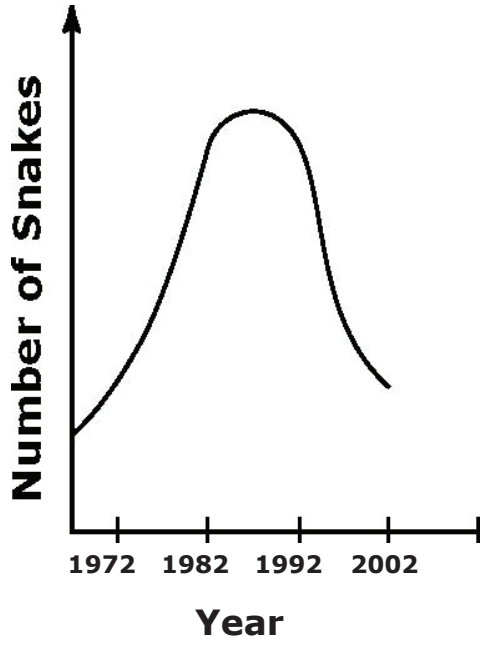
**C** Energy flows from the rabbit to both the coyote and grass.

**D** Energy flows from both the grass and the coyote to the rabbit.

Sample Test Item:
**Process Objective: 1.1**
Content Objective: 4.2
Depth-of-Knowledge: 2
Correct Response: B

**Scientists studied a rattlesnake population from 1972 through 2002. No snakes moved into or out of the population during this time.**

**Rattlesnake Population Between 1972 and 2002**




**What <u>most likely</u> happened between 1992 and 2002?**

**A** The birth rate was greater than the death rate.

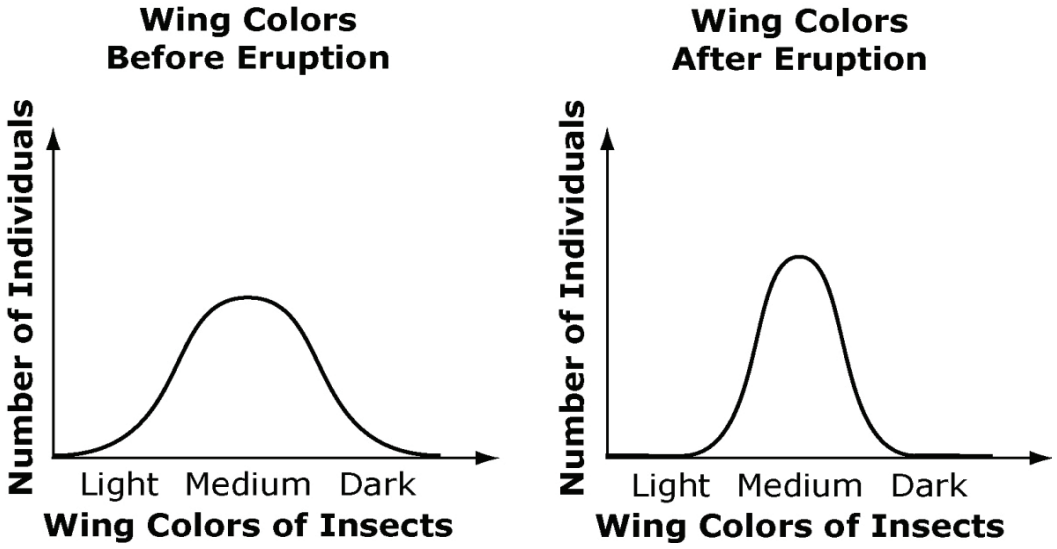
**B** The birth rate was less than the death rate.

**C** The death rate was equal to the birth rate.

**D** The death rate and birth rate remained constant.

Sample Test Item:
**Process Objective: 1.1**
Content Objective: 3.2
Depth-of-Knowledge: 3
Correct Response: D

**A scientist was studying a species of insect that lives on an island. The wing colors of individual insects varied from very light gray to dark gray. The graphs show the distribution of wing colors in the population before and after a volcano erupted on the island.**




**Which of these <u>best</u> explains the change in the insect population after the volcano erupted?**

**A** The light gray and dark gray insects migrated from the island.

**B** The light gray and dark gray insects changed color to become medium gray.

**C** The volcanic ash changed the color of the medium gray insects to light gray or dark gray.

**D** The volcanic ash resulted in medium gray insects that were better camouflaged from predators.

**OAS Standard:**

Process Standard 1: Observe and Measure—Observing is the first action taken by the learner to acquire new information about an organism or event. 'Opportunities for observation are developed through the use of a variety of scientific tools, allowing the student to distinguish between observation and inference. Measurement allows observations to be quantified. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 2: Use appropriate tools with accuracy and precision (e.g., microscope, pipette, metric ruler, graduated cylinder, thermometer, balance, stopwatch) when measuring cells, organisms, populations, and ecosystems.

**Item Specifications:**

Emphasis:

Recognize and select appropriate tools when investigating cells, organisms, populations, and ecosystems.

Stimulus Attributes:

Test items may include illustrations and descriptions.

Format:

Assessable content includes:

1. Students will apply knowledge of tools commonly used in high school biology classrooms.
2. Students will identify correct methods for using measurement tools.
3. Students will use appropriate tools to make precise, accurate, and reliable measurements.

Item Content Limits:

Non-assessable content includes:

1. Items referencing measurement tools designed for use at the university or professional research level.

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

1. Inappropriate tools for measurement
2. Incorrect methods for using tools

Sample Test Item:
**Process Objective: 1.2**
Content Objective: 1.1
Depth-of-Knowledge: 1
Correct Response: C

**Which method should a scientist use to view the site of photosynthesis in a plant cell?**

**A** use a magnifying glass to view the chloroplasts

**B** use a magnifying glass to view the mitochondria

**C** use a microscope to view the chloroplasts

**D** use a microscope to view the mitochondria

Sample Test Item:
**Process Objective: 1.2**
Content Objective: 4.2
Depth-of-Knowledge: 2
Correct Response: C

**A biologist is studying the effect of a sugar solution on the growth rate of yeast. She will add different amounts of the sugar solution to four test tubes containing yeast.**

**Sugar Solution per Test Tube**

| Test Tube | Sugar Solution (in milliliters) |
|---|---|
| A | 0.7 |
| B | 1.0 |
| C | 1.3 |
| D | 1.6 |

**What tool should the biologist use to add the sugar solution to the yeast population and what effect will the solution have on the yeast population?**

**A** flask; promotes growth

**B** beaker; limits growth

**C** pipette; promotes growth

**D** graduated cylinder; limits growth

**OAS Standard:**

Process Standard 1: Observe and Measure—Observing is the first action taken by the learner to acquire new information about an organism or event. Opportunities for observation are developed through the use of a variety of scientific tools, allowing the student to distinguish between observation and inference. Measurement allows observations to be quantified. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 3: Use appropriate International System of Units (SI) (i.e., grams, meters, liters, degrees Celsius, and seconds) and SI prefixes (i.e., micro-, milli-, centi-, and kilo-) when measuring objects and/or events.

**Item Specifications:**

Emphasis:

Recognize and select appropriate units when investigating cells, organisms, populations, and ecosystems.

Stimulus Attributes:

Test items may include illustrations and descriptions.

Format:

Assessable content includes:

1. Students will apply knowledge of International System of Units in biological contexts.
2. Students will determine which unit of measurement would be most appropriate to use in data collection.
3. Students will identify derived units for quantities found in biological context (i.e., population density, surface area/volume, rate, concentration).

Item Content Limits:

Non-Assessable content includes:

1. Items referencing units or prefixes other than SI.
2. Items with derived units other than those listed in #3 above.

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

Inappropriate SI units and prefixes

Sample Test Item:
**Process Objective: 1.3**
Content Objective: 5.1
Depth-of-Knowledge: 2
Correct Response: B

**A scientist wants to measure how much gas is released by a plant to estimate how fast it is photosynthesizing.**

**Which measurement should the scientist take?**

**A** meters of carbon dioxide

**B** milliliters of oxygen

**C** grams of carbon dioxide

**D** centimeters of oxygen

Sample Test Item:
**Process Objective: 1.3**
Content Objective: 1.2
Depth-of-Knowledge: 2
Correct Response: D

**Which measurement units best describe the size relationship of cells to organs?**

**A** centimeters to meters

**B** meters to millimeters

**C** millimeters to micrometers

**D** micrometers to centimeters

Sample Test Item:
**Process Objective: 1.3**
Content Objective: 5.2
Depth-of-Knowledge: 2
Correct Response: B

**An ecologist wants to estimate the biomass of the producers in a lake. Which measurement should be taken?**

**A** milligrams of fish

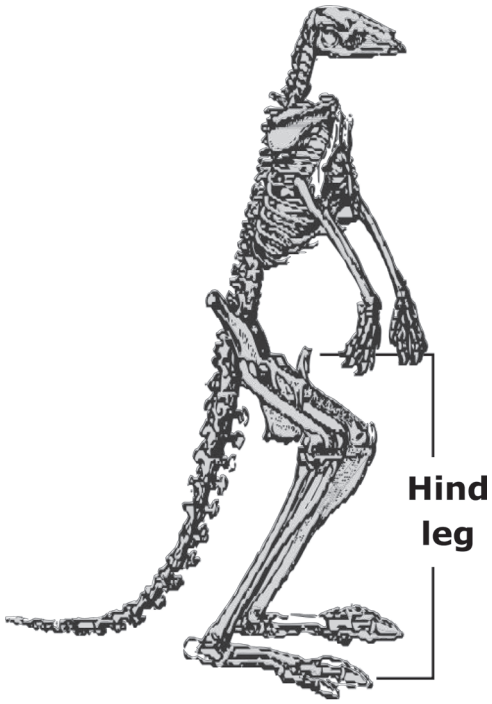
**B** kilograms of water plants

**C** cubic centimeters of oxygen

**D** cubic meters of carbon dioxide

Sample Test Item:
**Process Objective: 1.3**
Content Objective: 3.1
Depth-of-Knowledge: 2
Correct Response: C

**The diagram shows a kangaroo skeleton.**




**Kangaroo**

**Which hind leg measurement is <u>most likely</u> from an adult animal with a hind leg that is homologous to the kangaroo hind leg?**

**A** a crab leg 50 millimeters long

**B** a rabbit leg 8 millimeters long

**C** a bullfrog leg 30 centimeters long

**D** a grasshopper leg 2 centimeters long

**OAS Standard:**

Process Standard 2: Classify—Classifying establishes order. Organisms and events are classified based on similarities, differences, and interrelationships. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 1: Using observable properties, place cells, organisms, and/or events into a biological classification system (e.g., dichotomous keys, taxonomy charts, cladograms).

**Item Specifications:**

Emphasis:

Apply classification skills based on observations using a variety of classification systems.

Stimulus Attributes:

Items may include illustrations, classification keys, including dichotomous keys, data tables, behavioral checklists, flowcharts, life cycles, Venn diagrams, and cladograms.

Format:

Assessable content includes:

1. Students will use observable characteristics to apply classification skills in biological contexts.
2. Students will accurately utilize a variety of classification systems (e.g., dichotomous keys, taxonomy charts, cladograms).

Item Content Limits:

Non-assessable content includes:

1. Obscure classification systems.
2. Items requiring identification of the best classification system based on a given set of properties.

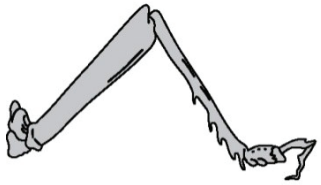
Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

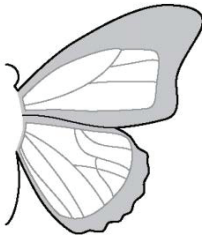
Inappropriate classifications

Sample Test Item:
**Process Objective: 2.1**
Content Objective: 3.1
Depth-of-Knowledge: 1
Correct Response: D

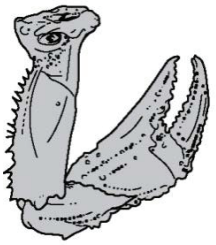


**Grasshopper**

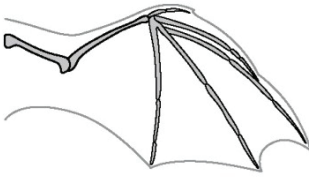
**Which body part is analogous to the grasshopper structure shown?**



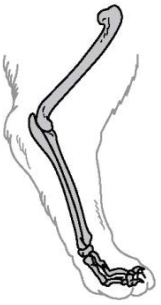
**Butterfly**
**A**



**Crab**
**B**



**Bat**
**C**



**Cat**
**D**

Sample Test Item:
**Process Objective: 2.1**
Content Objective: 4.1
Depth-of-Knowledge: 2
Correct Response: D

## Classification System

| Type of Relationship | Description of Relationship |
|---|---|
| Commensalism | One species benefits, and the other species is neither benefitted nor harmed. |
| Mutualism | Both species benefit. |
| Parasitism | One species benefits, and the other species is harmed. |
| Competition | Both species are harmed. |

**A student is researching three examples of animal relationships:**

- **Worms in a sheep's liver feeding on the sheep's tissue and products of the sheep's digestion.**
- **Wasps laying their eggs on caterpillars so the wasp larvae can feed on the caterpillar.**
- **Small "cleaning" shrimp eating parasites off the bodies of fish.**

**The table shows the classification system the student uses to classify these examples of animal relationships.**

**Which statement accurately classifies an animal relationship using the classification system?**

**A** The wasps and caterpillars are an example of mutualism.

**B** The worms and sheep are an example of commensalism.

**C** The wasps and caterpillars are an example of competition.

**D** The shrimp and fish are an example of mutualism.

Sample Test Item:
**Process Objective: 2.1**
Content Objective: 3.1
Depth-of-Knowledge: 3
Correct Response: D

**A student studying four different organisms recorded this data.**
**Characteristics of Four Organisms**

| Organism | Food | Habitat | Same Segment of DNA | Time Most Active |
|---|---|---|---|---|
| 1 | Small animals | Rivers and lakes | AAA CGG TAC AAA | Day |
| 2 | Grasses and leaves | Meadow | ATT GCG TAA AAA | Day and night |
| 3 | Grasses | Forest | AAA CGG TAA AAA | Night |
| 4 | Insects and plants | Forest | ATA GGG TAC AAA | Day |

**Which organisms are most closely related?**

**A** Organisms 3 and 4
**B** Organisms 2 and 3
**C** Organisms 1 and 4
**D** Organisms 1 and 3

**OAS Standard:**

Process Standard 2: Classify—Classifying establishes order. Organisms and events are classified based on similarities, differences, and interrelationships. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 2: Identify the properties by which a biological classification system is based.

**Item Specifications:**

Emphasis:

Understand a classification system and identify the observable properties used for classifying.

Stimulus Attributes:

Items may include illustrations, Venn diagrams, classification keys, including dichotomous keys, data tables, behavioral checklists, and cladograms.

Format:

Assessable content includes:

1. Students will apply classification skills in biological contexts.
2. Students will identify and apply understanding of properties that are relevant to particular classification systems common to biological sciences (e.g. behavior, structural similarities/ differences, and genetics).

Item Content Limits:

Non-Assessable content includes:

1. Classification based on Gram positive/negative
2. Information outside the contextual level of Biology I

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

Properties that are inappropriate for the given classification system

Sample Test Item:
**Process Objective: 2.2**
Content Objective: 5.2
Depth-of-Knowledge: 1
Correct Response: C

**Which characteristic determines whether an organism is a producer, a consumer, or a decomposer?**

**A** how it moves

**B** how it reproduces

**C** how it obtains energy

**D** how it maintains homeostasis

Sample Test Item:
**Process Objective: 2.2**
Content Objective: 3.1
Depth-of-Knowledge: 2
Correct Response: B

**Characteristics of Four Organisms**

| Organism | Native Range | Number of Toes | Number of Neck Vertebrae | Number of Bony Horns | Most Active Day or Night? |
|---|---|---|---|---|---|
| Mountain Goat | North America | 2 | 7 | 2 | Day |
| Grevy's Zebra | Africa | 1 | 7 | 0 | Day |
| Reticulated Giraffe | Africa | 2 | 7 | 2 | Day |
| Asian Elephant | Asia | 3 to 5 | 7 | 0 | Day |

**Scientists have classified the reticulated giraffe and the mountain goat as the most closely related animals in the table.**

**What two properties best support the classification of the reticulated giraffe and the mountain goat?**

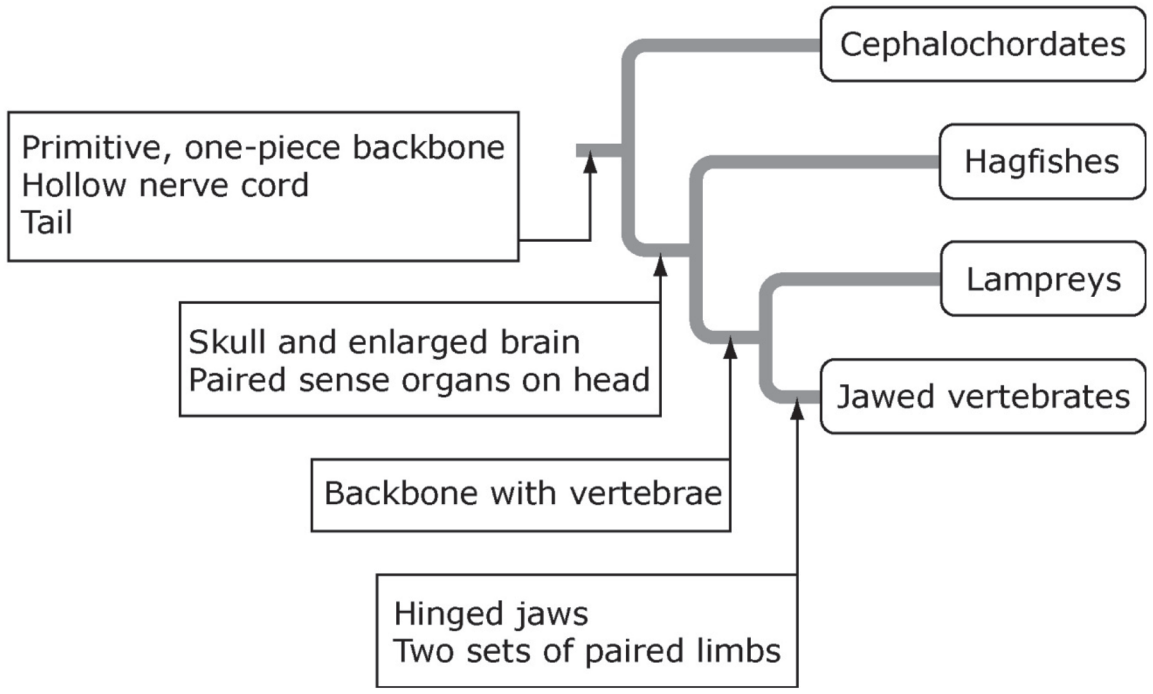
**A** the number of neck vertebrae and the number of bony horns

**B** the number of toes and the number of bony horns

**C** the time they are most active and the native range

**D** the number of neck vertebrae and the number of toes

Sample Test Item:
**Process Objective: 2.2**
Content Objective: 3.1
Depth-of-Knowledge: 3
Correct Response: B




**A scientist is studying a fossil organism. The organism did not have any limbs and was shaped like an eel. Its skull and backbone were made of cartilage. Its backbone was all one piece instead of being composed of vertebrae. The organism did not have jaws or teeth.**

**Based on the description, to what group is the organism <u>most closely</u> related?**

**A** Cephalochordates

**B** Hagfishes

**C** Lampreys

**D** Jawed vertebrates

**OAS Standard:**

Process Standard 3: Experimental Design—Understanding experimental design requires that students recognize the components of a valid experiment. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 1: Evaluate the design of a biology laboratory experiment.

**Item Specifications:**

Emphasis:

Sequence steps in logical progression and determine what steps are not needed or have been left out; identify correct and incorrect scientific procedures.

Stimulus Attributes:

Items will include a scenario of an experimental design and may include one or more illustrations, tables, and/or graphs.

Format:

Assessable content includes:

1. Students will be able to critique a research plan and/or experiment.
2. Students will determine which data (qualitative or quantitative) would be most appropriate to collect for a research plan or experiment.
3. Students will determine which data (qualitative or quantitative) would be most appropriate to collect in order to test a hypothesis.
4. Students will determine the appropriate tools in experimental protocol that will generate valid data.
5. Students will make judgments from collected data to identify appropriate revisions of experimental protocols.
6. Students will distinguish observation from inference.
7. Students will identify investigatable/non-investigatable questions in relation to experimental design.
8. Students will understand how to insure accuracy, precision and reliability in a science experiment. (e.g. multiple trials, repeatability, internal consistency, sampling size)

Item Content Limits:

Non-assessable content includes:

1. Null hypothesis
2. Identifying bias

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

1. Steps listed in an incorrect order
2. Steps not needed in an experiment
3. Necessary steps for an experiment
4. Inappropriate experiment procedures

Sample Test Item:
**Process Objective: 3.1**
Content Objective: 5.2
Depth-of-Knowledge: 1
Correct Response: D

**A class designed an experiment to test the effects of nitrogen fertilizer on grass growth. The steps for the experiment are shown below but are out of order.**

1. **Place both trays in sunlight for one week.**
2. **Spray 100 mL of 100% fertilizer solution over tray A. Spray 100 mL of 50% fertilizer solution over tray B.**
3. **Measure the biomass of the grass. Record observations in a data table.**
4. **Fill two trays with soil, plant an equal number of grass seeds, and add the same amount of water.**

**In which order should the class perform these steps?**

**A** 2 – 1 – 3 – 4

**B** 2 – 4 – 3 – 1

**C** 4 – 1 – 2 – 3

**D** 4 – 2 – 1 – 3

Sample Test Item:
**Process Objective: 3.1**
Content Objective: 3.3
Depth-of-Knowledge: 2
Correct Response: C

**Anita is studying the factors that affect seed germination. She wants to test whether soaking seeds in water affects the sprouting process.**

**Which should Anita measure to get the most useful results?**

**A** germination of 100 soaked seeds at a given temperature

**B** germination of 100 regular seeds at different temperatures

**C** germination of 50 soaked seeds and 50 regular seeds at a given temperature

**D** germination of 50 soaked seeds and 50 regular seeds at different temperatures

Sample Test Item:
**Process Objective: 3.1**
Content Objective: 4.1
Depth-of-Knowledge: 3
Correct Response: C

**A biology class is studying the effect of competition between two species of insects, Species A and Species B. Species A and B eat the same type of food. The experimental design is summarized in the table below.**

**Experimental Design**

| Aquarium | Species A (Number of Individuals) | Species B (Number of Individuals) | Amount of Food Added Each Day (grams) |
|---|---|---|---|
| 1 | 10 | 10 | 2 |
| 2 | 5 | 15 | 2 |
| 3 | 15 | 5 | 2 |

**Which of these would be the best way to set up a fourth aquarium to test the effect of competition on Species A?**

**A** Place in the aquarium 10 individuals of Species A and 10 individuals of Species B, and provide them with 1 gram of food per day.

**B** Place in the aquarium 5 individuals of Species A and 5 individuals of Species B, and provide them with 2 grams of food per day.

**C** Place in the aquarium 20 individuals of Species A and provide them with 2 grams of food per day.

**D** Place in the aquarium 20 individuals of Species B and provide them with 1 gram of food per day.

**OAS Standard:**

Process Standard 3: Experimental Design—Understanding experimental design requires that students recognize the components of a valid experiment. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 2: Identify the independent variables, dependent variables, controlled variables, and control set-up in an experiment.

**Item Specifications:**

Emphasis:

Know the terms and be able to identify them in an experimental design: independent variable, dependent variable, control group, and controlled variables.

Stimulus Attributes:

Items will include a scenario of an experimental design and may include illustrations, tables, and graphs.

Format:

Assessable content includes:

1. Students will identify the independent variable, dependent variable, and control variables within a controlled experiment.
2. Students will select the independent variable, dependent variable, and control variables appropriate for a given set of data.
3. Students will select the most appropriate independent variable or dependent variable or control variable for use within a given controlled experiment.

Item Content Limits:

Non-assessable content includes:

1. Multiple independent variables

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

Irrelevant variables and wrong types of variables and inconsistent constants

Sample Test Item:
**Process Objective: 3.2**
Content Objective: 5.1
Depth-of-Knowledge: 2
Correct Response: A

**A student designed an experiment to show the relationship between photosynthesis and cellular respiration. Four test tubes, as described below, were sealed and left under lamp light for 24 hours.**

## Experimental Design

| Test Tube 1 | Test Tube 2 | Test Tube 3 | Test Tube 4 |
|---|---|---|---|
| Water<br>Bromothymol blue<br>Plant<br>Snail | Water<br>Bromothymol blue<br>Plant | Water<br>Bromothymol blue<br>Snail | Water<br>Bromothymol blue |

Note: Bromothymol blue changes color in the presence of carbon dioxide.

**In this experiment, what was the role of Test Tube 4 and what was being observed by the student?**

**A** It was a control set-up because there were no organisms to use or release carbon dioxide.

**B** It was a controlled variable because the amount of oxygen remains the same.

**C** It was the dependent variable because Test Tube 4 showed that organisms released oxygen.

**D** It was the independent variable because Test Tube 4 showed that organisms released carbon dioxide.

Sample Test Item:
**Process Objective: 3.2**
Content Objective: 5.1
Depth-of-Knowledge: 2
Correct Response: C

**A scientist wanted to determine the best level of light intensity for photosynthesis in an aquatic plant. He varied the light intensity and measured the amount of a gas produced by the plant at each level of light intensity.**

**Which is the dependent variable in this experiment?**

**A** the type of plant

**B** the light intensity

**C** the amount of oxygen produced

**D** the amount of carbon dioxide produced

Sample Test Item:
**Process Objective: 3.2**
Content Objective: 3.2
Depth-of-Knowledge: 2
Correct Response: A

**Scientists are conducting an experiment to see how antibiotic resistance develops in bacterial populations. They hypothesized that if a population of bacteria is exposed to an antibiotic once every 24 hours, then the bacteria would develop resistance faster than bacteria exposed to the antibiotic once every 12 hours. The scientists treat 50 dishes of bacteria with the antibiotic once every 24 hours, and 50 dishes of bacteria with the antibiotic once every 12 hours.**

**What would be the best control set-up for this experiment?**

**A** 50 dishes of bacteria that are never treated

**B** 50 dishes of bacteria that are treated every 6 hours

**C** 50 dishes of bacteria that are treated every 48 hours

**D** 50 dishes that do not contain bacteria and are never treated

**OAS Standard:**

Process Standard 3: Experimental Design—Understanding experimental design requires that students recognize the components of a valid experiment. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 3: Use mathematics to show relationships within a given set of observations (e.g., population studies, biomass, probability).

**Item Specifications:**

Emphasis:

Apply mathematics to describe observations, infer relationships, and make predictions.

Stimulus Attributes:

Items may include descriptions, illustrations, data tables, graphs, and diagrams.

Format:

Assessable content includes:

1. Students will apply mathematics in biological contexts.
2. Students will apply mathematics in order to collect data and report data.
3. Students will correctly apply appropriate mathematical reasoning to explain science concepts: density (population density including exponential growth), percentage of growth increase/decrease, ratios (surface area/volume), rate of change, biomass, probability, percentages, fractions/decimals, genetic crosses (Punnett squares), calculating averages, and predicting energy flow in pyramids.
4. Students will select from a variety of data tables, line, bar, trend, and/or circle graphs the correct representation of data based upon mathematical calculations.

Item Content Limits:

Non-Assessable content includes:

1. Conversions from English standard units of measurement to SI units of measurement and vice versa.
2. Mathematics beyond the Algebra 1 level.

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

1. Errors in calculation
2. Misconceptions

## Formula Table

| Formula Name | Symbol | Formula | Example of Units – there may be others that will apply | Content Standard Correlation |
|---|---|---|---|---|
| Average | $\bar{x}$ or Avg. | $\frac{(a_1 + a_2 + \ldots a_n)}{n}$ where n = number in set | integer | Any Content standard/objective |
| Population Density – Area* | $\rho$ | $\frac{\#\ of\ individuals}{Area}$ where N = Population size | $\frac{squirrels}{km^2}$ | C4.2 |
| Percentage | % | $\frac{\#\ of\ favorable}{\#\ of\ possible} \times 100$ or $\frac{part}{total} = \frac{part}{100}$ | % | C2.2 |
| Population Growth Rate* | PGR | $\frac{B - D}{t}$ where $B$ = Birth, $D$ = Death, $t$ = time OR $\frac{final\ population - initial\ population}{initial\ population}$ | | C4.2 |
| Probability (Genetics) | P | $\frac{\#\ of\ favorable\ outcomes}{\#\ of\ possible\ outcomes}$ | $integer \leq 1$ | C2.2 Example: Punnett squares, pedigrees, appearance of traits |
| Rate | Rate | $\frac{any\ unit}{time}$ | $\#\frac{any\ unit}{time}$ | C1.1b Example: fluid flow, movement of living and nonliving components of the biosphere, or animal movement |
| Surface Area – Square | A | $l \times w$ where $l$ = length, w = width | $m^2$ | C 1.1a Example: Plant cell membrane, or a population survey plot |
| Volume – Cube | V | $l \times w \times h$ *or* 1 $cm^3$ = 1 mL where $l$ = length, $w$ – width $h$ = height | $m^3$ | C1.1a and b Example: volume inside a plant cell, ratio of cell membrane to cell volume or a population survey plot |

*Refer to P3.3 on page 47, and C4.2 on page 142 for additional information.

Sample Test Item:
**Process Objective: 3.3**
Content Objective: 5.2
Depth-of-Knowledge: 2
Correct Response: B

**A primary consumer generates 42,500 units of energy in its lifetime.**

**Which is the most likely amount of energy that will be passed to the next level?**

**A** 4,250 units of energy will be transferred to producers.

**B** 4,250 units of energy will be transferred to secondary consumers.

**C** 38,250 units of energy will be transferred to producers.

**D** 38,250 units of energy will be transferred to secondary consumers.

Sample Test Item:
**Process Objective: 3.3**
Content Objective: 2.2
Depth-of-Knowledge: 3
Correct Response: B

**In a certain group of lab mice, black fur is dominant and brown fur is recessive. If two heterozygous mice mate and produce 16 offspring, how many of the offspring will probably have brown fur?**

**A** 0

**B** 4

**C** 8

**D** 12

Sample Test Item:
**Process Objective: 3.3**
Content Objective: 4.2
Depth-of-Knowledge: 3
Correct Response: B

**A biologist is studying deer living in a 100-square-kilometer wildlife area. He determines that the current population of 3000 deer is half the carrying capacity of the wildlife area.**

**What would the deer population density be if the population was at carrying capacity?**

**A** 15 deer per square kilometer

**B** 60 deer per square kilometer

**C** 1500 deer

**D** 6000 deer

**OAS Standard:**

Process Standard 3: Experimental Design—Understanding experimental design requires that students recognize the components of a valid experiment. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 4: Identify a hypothesis for a given problem in biology investigations.

**Item Specifications:**

Emphasis:

Given an experimental design, identify an appropriate hypothesis.

Stimulus Attributes:

Items will include a scenario of a scientific problem or experimental design. Items may include illustrations, tables, and graphs.

Format:

Assessable content includes:

1. Students will identify the best possible solution as the hypothesis in a biological investigation (not limited to if/then statements).

Item Content Limits:

Non-assessable content includes:

1. Null hypothesis.

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

Distractors must be stated as a hypothesis but include incorrect variables.

Sample Test Item:
**Process Objective: 3.4**
Content Objective: 1.3
Depth-of-Knowledge: 1
Correct Response: A

**Juan observes that a potted plant on his desk is bending toward the nearest window.**

**Which hypothesis would be best for Juan to investigate the reason the plant is bending?**

**A** If the plant is placed outside, then it will begin growing straight.

**B** If the plant is tied to a straight stick, then it will begin growing straight.

**C** If the plant had been given more fertilizer, then it would have grown straight.

**D** If the plant had been watered more when it was young, then it would have grown straight.

Sample Test Item:
**Process Objective: 3.4**
Content Objective: 5.3
Depth-of-Knowledge: 3
Correct Response: C

**A student studied the factors that affect the decomposition of vegetable matter by soil microbes. He put four pieces of carrot of equal mass into each of three plastic bags filled with soil. He added different amounts of water to each bag and kept them all at room temperature. Every two days, the carrot pieces were removed from each bag to measure their mass.**

**Which hypothesis was the student most likely testing in his experiment?**

**A** If the temperature is reduced, then there is increased decomposer activity.

**B** If the soil type is changed, then the rate of decomposition will decrease.

**C** If the moisture content of the soil is increased, then there is increased decomposer activity.

**D** If the mass of the decomposing matter is increased, then the rate of decomposition will decrease.

Sample Test Item:
**Process Objective: 3.4**
Content Objective: 5.1
Depth-of-Knowledge: 3
Correct Response: C

**A student placed four equal-sized tomato plants in separate containers. She gave each plant the same amount of light and nutrients, different amounts of water, and frequently measured the amount of oxygen produced by each plant.**

**Which is the hypothesis the student was most likely studying in this experiment?**

**A** If the amount of light is increased, then the rate of photosynthesis will increase.

**B** If the amount of nutrients is increased, then the rate of cellular respiration will increase.

**C** If the amount of water is increased, then the rate of photosynthesis will increase.

**D** If the amount of water is increased, then the rate of cellular respiration will increase.

**OAS Standard:**

Process Standard 3: Experimental Design—Understanding experimental design requires that students recognize the components of a valid experiment. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 5: Recognize potential hazards and practice safety procedures in all biology activities.

**Item Specifications:**

Emphasis:

1. Identify potential hazards in all biology activities.
2. Be aware of unsafe practices and appropriate procedures in all biology-related activities conducted in the laboratory and/or the field.

Stimulus Attributes:

Test items may include illustrations, Safety Data Sheets(SDS), safety symbols, and verbal descriptions.

Format:

Assessable content includes:

1. Students will identify and apply safety regulations in a laboratory setting.
2. Students will recognize commonly used laboratory safety symbols.
3. Students will recognize safety hazards and the procedures in which to make the situation safe.
4. Students will apply crisis management strategies as a reaction to a safety violation.
5. Students will evaluate and critique an experiment for safety consideration.

Item Content Limits:

Non-assessable content includes:

1. Non-standard symbols.
2. Interpretation of the safety diamond.

Content Objectives May Include:

Items for this objective test safety only. They do not assess content knowledge.

Distractor Domain:

1. Wrong safety hazard
2. Not a safety concern
3. Wrong safety procedure
4. Not a safety procedure

Sample Test Item:
**Process Objective: 3.5**
Depth-of-Knowledge: 1
*Safety items do not assess content
Correct Response: A

**In many classrooms, lab exercises are performed by small groups of students. The students are supervised by a teacher who monitors each group's progress periodically.**

**When should you notify your instructor of unsafe conditions in the lab?**

**A** immediately

**B** after the lab period

**C** after your data has been collected

**D** when the instructor comes by your station

Sample Test Item:
**Process Objective: 3.5**
Depth-of-Knowledge: 1
*Safety items do not assess content
Correct Response: A

**Safety Data Sheet**

**1. Product Identification**
**Starch Indicator Solution**

**2. Health Hazard Data**
Toxicity: orl rat LD50: 891 mg/kg for salicylic acid
Primary Route of Entry: ingestion
Carcinogenicity: none
Signs and symptoms of exposure: May be harmful if swallowed.

**3. Emergency First Aid Procedures**
Eye Contact: Flush with water.
Ingestion: Drink water or milk. Consult physician.
Inhalation: N/A
Skin Contact: Flush with water.

**Students are testing water from a nearby stream and must use several chemicals, including starch indicator solution, to measure dissolved oxygen.**

**Which action would be <u>most</u> hazardous to the students?**

**A** Swallowing the starch indicator

**B** Inhaling the fumes from the starch indicator

**C** Getting some of the starch indicator on the skin

**D** Mixing the starch indicator with the wrong chemical

Sample Test Item:
**Process Objective: 3.5**
Depth-of-Knowledge: 2
*Safety items do not assess content
Correct Response: B

**All of the following are examples of biological waste and should be placed in a biological hazard container except**

**A** blood.

**B** chemical reagents.

**C** dissected specimens.

**D** agar plate with bacteria.

**OAS Standard:**

Process Standard 4: Interpret and Communicate—Interpreting is the process of recognizing patterns in collected data by making inferences, predictions, or conclusions. Communicating is the process of describing, recording, and reporting experimental procedures and results to others. Communication may be oral, written, or mathematical and includes organizing ideas, using appropriate vocabulary, graphs, other visual representations, and mathematical equations. The student will accomplish, these objectives to meet this process standard.

**OAS Objective:**

Process Objective 1: Select appropriate predictions based on previously observed patterns of evidence.

**Item Specifications:**

Emphasis:

Make predictions based on patterns of evidence within given data.

Stimulus Attributes:

Data will be presented in tables, graphs, diagrams, illustrations, Venn diagrams, and/or descriptions.

Format:

Assessable content includes:

1. Students will accurately interpret information provided in order to make a prediction.
2. Students will detect patterns in evidence in order to make a prediction in biological contexts.
3. Students will interpolate and/or extrapolate from a given data set.
4. Students will make logical predictions linked to investigative procedures and available data.

Item Content Limits:

Non-assessable content includes:

1. More than three sets of data.
2. Content outside biological contexts.

Content Objectives May Include:

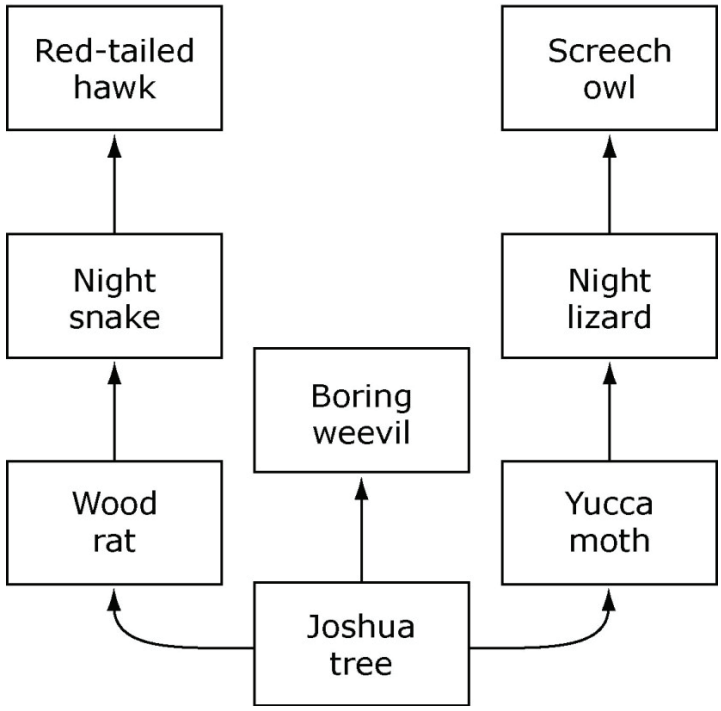
Items may be written to assess any of the content objectives.

Distractor Domain:

1. Wrong predictions
2. Predictions based on incorrect patterns

Sample Test Item:
**Process Objective: 4.1**
Content Objective: 5.2
Depth-of-Knowledge: 2
Correct Response: D

**Desert Food Web**




**A disease has greatly reduced the number of night snakes present in a desert ecosystem.**

**Which population would increase as a direct result of the decrease in the night snake population?**

**A** the red-tailed hawk population

**B** the boring weevil population

**C** the yucca moth population

**D** the wood rat population

Sample Test Item:
**Process Objective: 4.1**
Content Objective: 3.3
Depth-of-Knowledge: 2
Correct Response: B

**Male bowerbirds build and decorate bowers, which are structures used for courtship and mating. Each species of bowerbirds builds a unique type of bower. A researcher raised a male bowerbird in isolation from all other birds. During this time, he observed that the bird built bowers like those of its own species.**

**What would predictably happen if a male bowerbird were raised with bowerbirds of a different species?**

**A** It would not build any bowers.

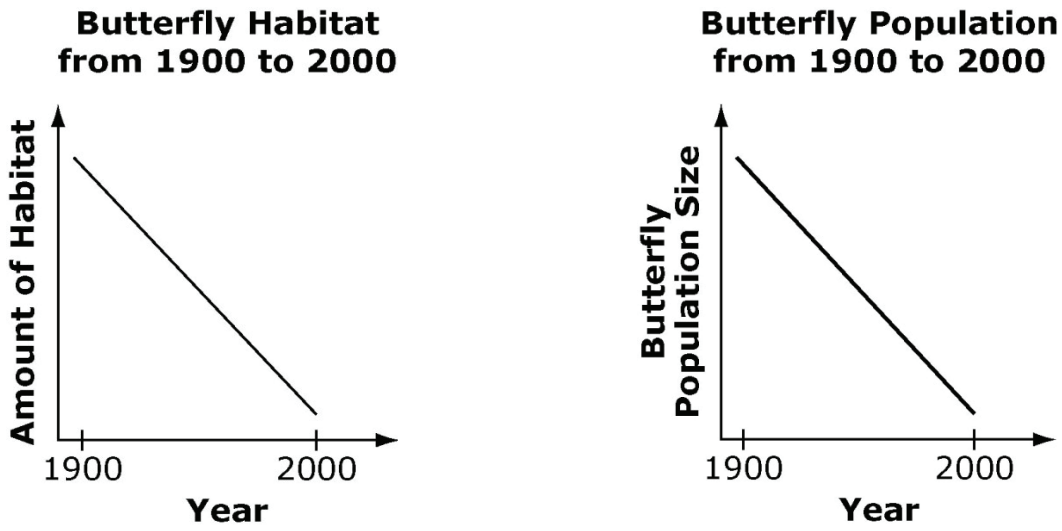
**B** It would build bowers like those of its own species.

**C** It would build bowers like those of the species with which it was raised.

**D** It would build bowers with features from both its own species and the species with which it was raised.

Sample Test Item:
**Process Objective: 4.1**
Content Objective: 3.3
Depth-of-Knowledge: 2
Correct Response: B

**A certain butterfly lives in only one type of habitat. The graphs show changes in the size of this butterfly population and the amount of its habitat during the last century.**




**In 2001, ecologists began restoring areas of the butterfly's habitat. If the habitat restoration continues, which of these will <u>most likely</u> happen to the butterfly population?**

**A** The butterfly population will become extinct.

**B** The butterfly population will increase in size.

**C** The butterfly population will become a new species.

**D** The butterfly population will adapt to a different type of habitat.

**OAS Standard:**

Process Standard 4: Interpret and Communicate—Interpreting is the process of recognizing patterns in collected data by making inferences, predictions, or conclusions. Communicating is the process of describing, recording, and reporting experimental procedures and results to others. Communication may be oral, written, or mathematical and includes organizing ideas, using appropriate vocabulary, graphs, other visual representations, and mathematical equations. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 3: Interpret data tables, line, bar, trend, and/or circle graphs from existing science research or student experiments.

**Item Specifications:**

Emphasis:

Analyze information given in a data table, line, (e.g. broken line graph, multiple line graph, multiple labels on graph), bar, trend, or circle graph.

Stimulus Attributes:

Test items may include data tables, line, bar, trend, and/or circle graphs.

Format:

Assessable content includes:

1. Students will interpret data tables and graphs that communicate biological information.
2. Students will identify and interpret trends in a graph and/or data tables.
3. Students will distinguish relationships between multiple data sets (e.g. direct, inverse, exponential).

Item Content Limits:

Non-assessable content includes:

1. Illustrations other than data tables or graphs.

Content Objectives May Include:

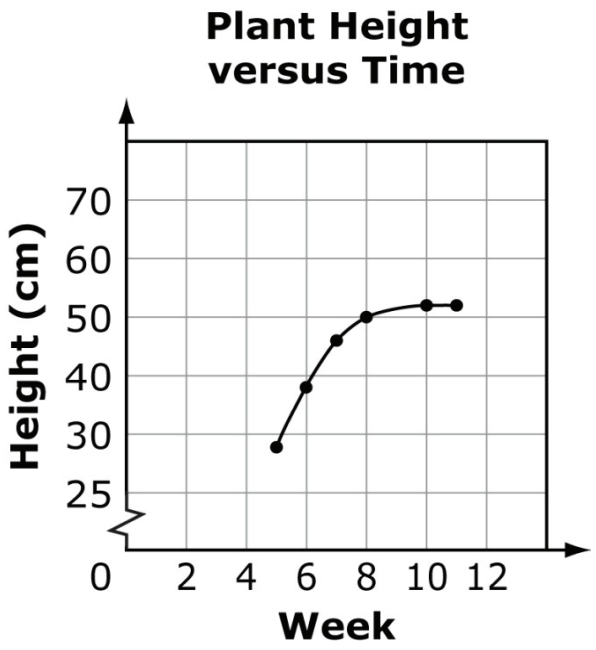
Items may be written to assess any of the content objectives.

Distractor Domain:

1. Quantitative errors due to incorrect interpretations of table or graph
2. Qualitative errors due to incorrect interpretations of table or graph

Sample Test Item:
**Process Objective: 4.3**
Content Objective: 4.2
Depth-of-Knowledge: 2
Correct Response: A

**The graph shown indicates the growth (height) of a bean plant during a period of time.**




**What is the <u>most likely</u> reason for the growth behavior of the plant after week 8?**

**A** limited soil nutrients

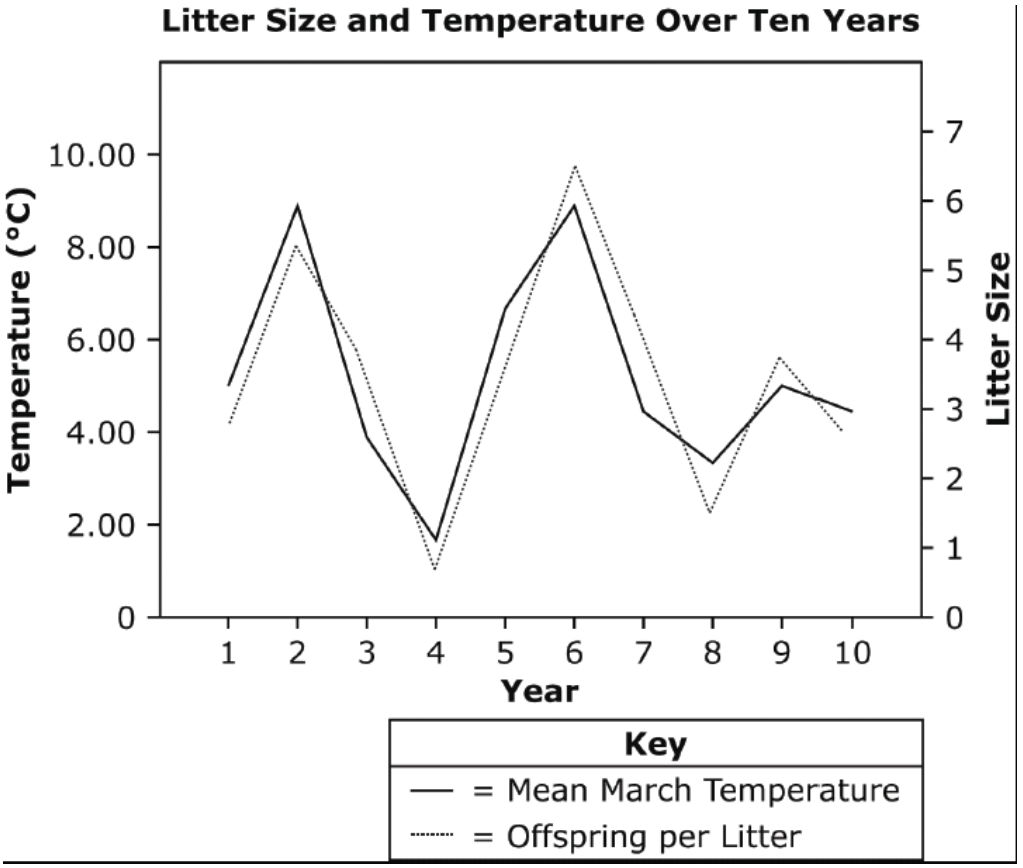
**B** excessive carbon dioxide

**C** the carrying capacity of the plant is reached

**D** the maximum amount of oxygen available to the plant is reached

Sample Test Item:
**Process Objective: 4.3**
Content Objective: 4.2
Depth-of-Knowledge: 2
Correct Response: A

**The graph shows data regarding the mean number of Black-tailed prairie dogs born per litter and the mean March temperature in western Oklahoma over a ten year period.**




**Which <u>best</u> describes the relationship depicted in the graph?**

**A** When the mean temperature decreases, there is a decrease in the number of offspring per litter.

**B** When the mean temperature increases, there is a decrease in the number of offspring per litter.

**C** When the mean temperature decreases, there is an increase in the number of offspring per litter.

**D** There is no clear relationship between the mean temperature and the number of offspring per litter.

Sample Test Item:
**Process Objective: 4.3**
Content Objective: 3.3
Depth-of-Knowledge: 3
Correct Response: D

**A student is studying diet adaptations in caterpillars of the cabbage white butterfly. These caterpillars can eat some plant leaves that contain chemicals that would harm other insects. The student offered different leaves to the caterpillars and recorded whether or not they ate the leaves.**

**Cabbage White Caterpillar Diet Adaptations**

| Plant Species | Leaves Eaten by Caterpillar? | Leaves Contain Cardiac Glycosides? | Leaves Contain Mustard Oils? | Leaves Contain Toxic Milky Sap? |
|---|---|---|---|---|
| 1 | No | Yes | No | Yes |
| 2 | Yes | No | Yes | No |
| 3 | No | Yes | No | Yes |
| 4 | Yes | No | Yes | No |

**Which is the best conclusion about the diet adaptations of cabbage white caterpillars?**

**A** The caterpillars learned to eat cardiac glycosides in order to survive.

**B** The caterpillars learned to eat mustard oils in order to survive.

**C** The caterpillars inherited the ability to eat toxic milky sap.

**D** The caterpillars inherited the ability to eat mustard oils.

**OAS Standard:**

Process Standard 4: Interpret and Communicate—Interpreting is the process of recognizing patterns in collected data by making inferences, predictions, or conclusions. Communicating is the process of describing, recording, and reporting experimental procedures and results to others. Communication may be oral, written, or mathematical and includes organizing ideas, using appropriate vocabulary, graphs, other visual representations, and mathematical equations. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 4: Determine if results of biological science investigations support or do not support hypotheses.

**Item Specifications:**

Emphasis:

Analyze data to accept or reject a hypothesis for a biological investigation.

Stimulus Attributes:

The hypothesis may be stated as an "if, then" statement. Test items may include data in the form of illustrations, descriptions, tables, line, bar, trend, and/or circle graphs. Scenarios describing experimental design may be included.

Format:

Assessable content includes:

1. Students will analyze data or experimental scenarios to accept or reject a hypothesis (the best possible solution, not limited to if/then statements) for a biological investigation.
2. Identify an acceptable hypothesis from a given set of qualitative or quantitative data.
3. Select the data set that supports a given hypothesis.

Content Limits:

Non-assessable content includes:

1. Null hypothesis

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

1. Results that do not support hypothesis
2. Results that do support hypothesis
3. Misconceptions

Sample Test Item:
**Process Objective: 4.4**
Content Objective: 3.2
Depth-of-Knowledge: 2
Correct Response: D

**A study compared the lengths of the ears and feet of rabbits living at different latitudes.**

**Ear and Foot Lengths of Rabbits**

| Latitude | Average Ear Length (cm) | Average Foot Length (cm) |
|---|---|---|
| 30° N | 19 | 10 |
| 35° N | 18 | 12 |
| 45° N | 14 | 13 |
| 70° N | 12 | 15 |

**Note: The Equator is 0° and the North Pole is 90° N.**

**Which hypothesis is best supported by this data?**

**A** If a rabbit lives further north, then its ears and feet will be bigger than those of a rabbit that lives further south.

**B** If a rabbit lives further north, then its ears and feet will be smaller than those of a rabbit that lives further south.

**C** If a rabbit lives further north, then its ears will be bigger but its feet will be smaller than the ears and feet of a rabbit that lives further south.

**D** If a rabbit lives further north, then its ears will be smaller but its feet will be bigger than the ears and feet of a rabbit that lives further south.

Sample Test Item:
**Process Objective: 4.4**
Content Objective: 3.2
Depth-of-Knowledge: 2
Correct Response: A

**A biologist is studying a species of crab. He hypothesized that if a crab has large pincer claws, then it will have greater reproductive success. He placed 50 crabs with small pincers and 50 crabs with large pincers together in an isolated area that closely resembled their natural environment. He observed several generations of the crabs over the next ten years.**

**If the data supported his hypothesis, which result would he most likely observe?**

**A** The percent of crabs with large pincers would increase.

**B** The percent of crabs with small pincers would increase.

**C** The DNA in crabs with small pincers would mutate in order to produce larger pincers.

**D** Crabs born with small pincers would develop larger pincers and pass this trait to their offspring.

Sample Test Item:
**Process Objective: 4.4**
Content Objective: 5.2
Depth-of-Knowledge: 3
Correct Response: C

**Tyler is growing plants in a closed terrarium to study the carbon cycle. He hypothesizes that if plants are grown in a closed environment, then the total amount of carbon in the terrarium will remain constant. He measures the amounts of different gases in the terrarium when he adds the plants, and he will measure again after one month.**

**Which result would best support his hypothesis?**

**A** The amount of oxygen decreased as the plants grew.

**B** The amount of carbon dioxide increased as the plants grew.

**C** The amount of carbon dioxide decreased as the plants grew.

**D** The amount of oxygen became less than the amount of carbon dioxide as the plants grew.

**OAS Standard:**

Process Standard 4: Interpret and Communicate—Interpreting is the process of recognizing patterns in collected data by making inferences, predictions, or conclusions. Communicating is the process of describing, recording, and reporting experimental procedures and results to others. Communication may be oral, written, or mathematical and includes organizing ideas, using appropriate vocabulary, graphs, other visual representations, and mathematical equations. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 5: Evaluate experimental data to draw the conclusion that is best supported by the evidence.

**Item Specifications:**

Emphasis:

Given experimental data, students will analyze relevant data and draw an appropriate conclusion.

Stimulus Attributes:

Test items will include data which may be in the form of complex data tables, line, bar, trend, and/or circle graphs, Venn diagrams, and possibly supported by illustrations. Test items may include irrelevant data.

Format:

Assessable content includes:

1. Students will analyze or evaluate experimental data to draw conclusions.
2. Students will identify a research question based on a stated experimental conclusion.
3. Students will identify relevant data that supports a given conclusion.
4. Students will analyze multiple data sets from one biological investigation to formulate a valid conclusion.

Item Content Limits:

Non-assessable content includes:

1. Analysis of data from more than one biological investigation to formulate a valid conclusion.

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

1. Inappropriate conclusions
2. Use of irrelevant data
3. Misconceptions of biological concepts

Sample Test Item:
**Process Objective: 4.5**
Content Objective: 3.2
Depth-of-Knowledge: 2
Correct Response: B

**A scientist studied factors that affect plant growth in four different biomes.**

**Characteristics of Four Biomes**

| Biome | Average Temperature (°C) | Average Precipitation (cm/yr) | Average Growing Season (days/yr) | Average Plant Biomass ($kg/m^2$) |
|---|---|---|---|---|
| Grasslands | –5 to 20 | 5 to 76 | 150 | 2 |
| Deciduous forest | –5 to 20 | 75 to 150 | 186 | 30 |
| Desert | 2 to 49 | 13 to 25 | 100 | 1 |
| Rainforest | 20 to 34 | 125 to 660 | 365 | 40 |

**Which conclusion is best supported by the results of the study?**

**A** Temperature determines precipitation.

**B** Precipitation increases plant biomass.

**C** Precipitation is determined by growing season.

**D** Plant biomass decreases as temperature decreases.

Sample Test Item:
**Process Objective: 4.5**
Content Objective: 3.2
Depth-of-Knowledge: 2
Correct Response: D

**The leaves of a certain plant produce chemicals that repel insects. A scientist noticed that some individuals of a certain insect species tolerated the chemicals and ate the plant's leaves. Over a period of six years, he monitored how many of these insects ate the plant's leaves. He called individuals that did not eat the leaves "Type 1" and those that ate the leaves "Type 2." The table below shows his data.**

**Percent of Insect Population by Type**

| Year | Type 1 (%) | Type 2 (%) |
|---|---|---|
| 1 | 97 | 3 |
| 2 | 92 | 8 |
| 3 | 66 | 34 |
| 4 | 41 | 59 |
| 5 | 22 | 78 |
| 6 | 12 | 88 |

**Which conclusion is <u>most</u> logical based on the results of the study?**

**A** Type 2 individuals moved out of the region.

**B** Type 1 individuals had more predators than Type 2 individuals.

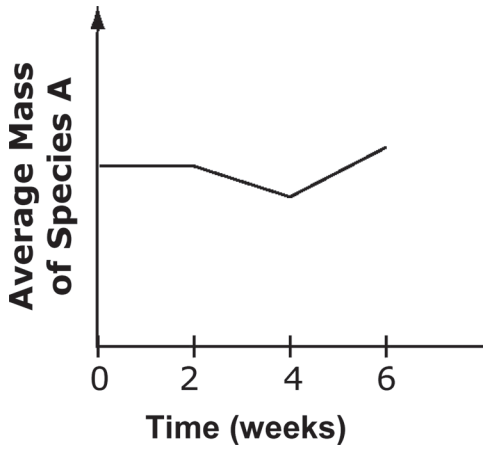
**C** Type 1 individuals out-competed Type 2 individuals for food.

**D** Type 2 individuals had greater reproductive success than Type 1 individuals.

Sample Test Item:
**Process Objective: 4.5**
Content Objective: 4.1
Depth-of-Knowledge: 3
Correct Response: D

**A student wanted to determine the relationship between two types of sea star, Species A and Species B. She set up a large aquarium and added several individuals of each species. She recorded the weight of each Species A sea star over a 6-week period. After the first 2 weeks, she added more Species B sea stars to the aquarium. After 4 weeks, she removed all the Species B sea stars from the aquarium. The results of the experiment are shown below.**

**Species A Raised with and without Species B**




**Which is the best conclusion about the relationship between Species A and Species B based on the student's experiment?**

**A** Species A is a predator of Species B.

**B** Species A is a parasite of Species B.

**C** Species A is not affected by the presence of Species B.

**D** Species A and Species B compete for the same resources.

**OAS Standard:**

Process Standard 4: Interpret and Communicate—Interpreting is the process of recognizing patterns in collected data by making inferences, predictions, or conclusions. Communicating is the process of describing, recording, and reporting experimental procedures and results to others. Communication may be oral, written, or mathematical and includes organizing ideas, using appropriate vocabulary, graphs, other visual representations, and mathematical equations. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 8: Identify and/or create an appropriate graph or chart from collected data, tables, or written description (e.g., population studies, plant growth, heart rate).

**OAS Skill:**

Process Skill 4.8a: Translate quantitative information expressed in words into visual form (e.g., a table or chart).

**Item Specifications:**

Emphasis:

Translate quantitative information expressed in words into visual form (e.g., a table or a chart)

Stimulus Attributes:

Test items may include charts, Venn diagrams, line, bar, trend, and/or circle graphs.

Format:

Assessable content includes:

1. Students will translate quantitative information expressed in words into visual form (e.g., a table or chart)

Content Limits:

Non-assessable content includes:

1. Graphs and diagrams not listed above.
2. Graphs with error bars.

Process Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

1. Incorrect type of graph
2. Data incorrectly represented
3. Selection of incorrect variables
4. Incorrect placement of the independent and dependent variables on the axes.
5. Incorrect units of measure

**OAS Standard:**

Process Standard 4: Interpret and Communicate—Interpreting is the process of recognizing patterns in collected data by making inferences, predictions, or conclusions. Communicating is the process of describing, recording, and reporting experimental procedures and results to others. Communication may be oral, written, or mathematical and includes organizing ideas, using appropriate vocabulary, graphs, other visual representations, and mathematical equations. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 8: Identify and/or create an appropriate graph or chart from collected data, tables, or written description (e.g., population studies, plant growth, heart rate).

**OAS Skill:**

Process Skill 4.8b: Translate information expressed visually or mathematically (e.g., a table, chart or equation) into words.

**Item Specifications:**

Emphasis:

Translate information expressed visually or mathematically (e.g., table, chart, or equation) into words.

Stimulus Attributes:

Test items may include charts, Venn diagrams, line, bar, trend, and/or circle graphs.

Format:

Assessable content includes:

1. Students will translate information expressed visually or mathematically (e.g., table, chart, or equation) into words.

Item Content Limits:

Non-assessable content includes:

1. Graphs and diagrams not listed above.
2. Graphs with error bars.

Content Objectives May Include:

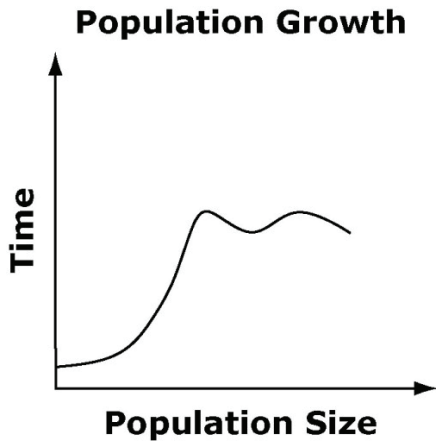
Items may be written to assess any of the content objectives.

Distractor Domain:

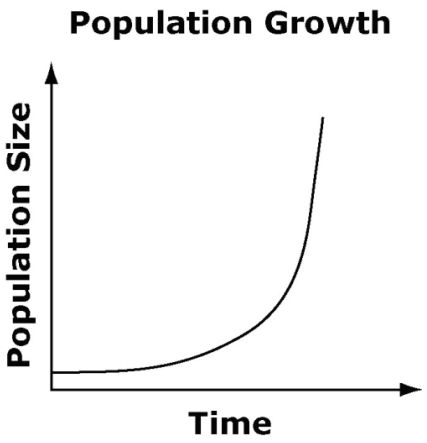
1. Incorrect interpretation of visual information
2. Data incorrectly expressed
3. Selection of incorrect variables
4. Incorrect identification of the independent and dependent variables from visual information
5. Incorrect units of measure

Sample Test Item:
**Process Objective: 4.8a**
Content Objective: 4.2
Depth-of-Knowledge: 2
Correct Response: B

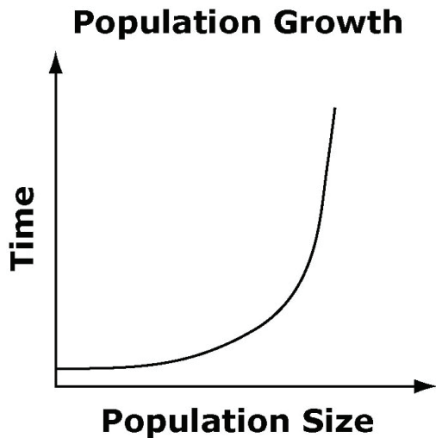
**Which graph correctly illustrates the growth of a population when resources are unlimited?**



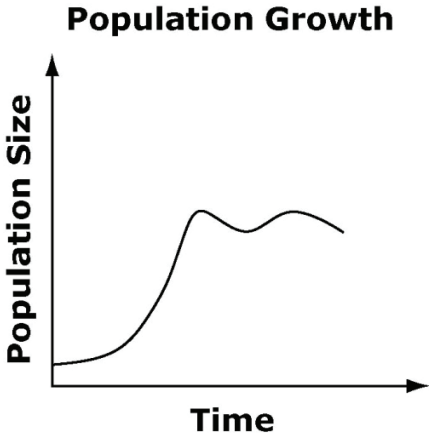

A




B

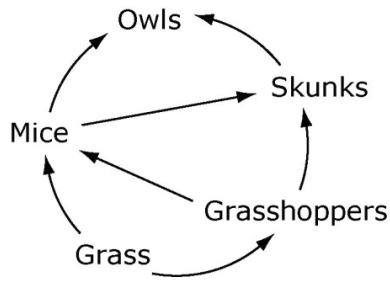



C



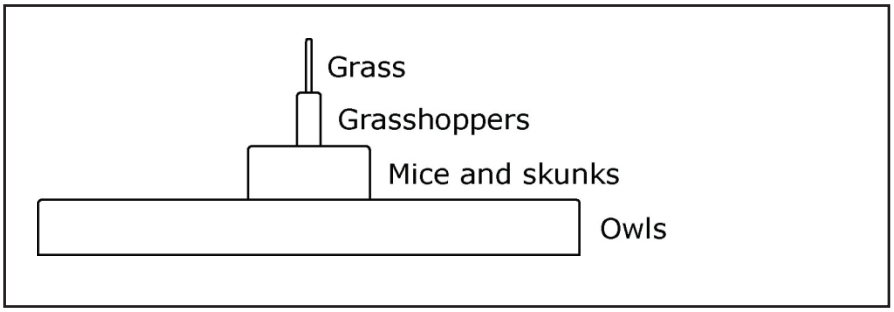

D

Sample Test Item:
**Process Objective: 4.8a**
Content Objective: 5.2
Depth-of-Knowledge: 2
Correct Response: C

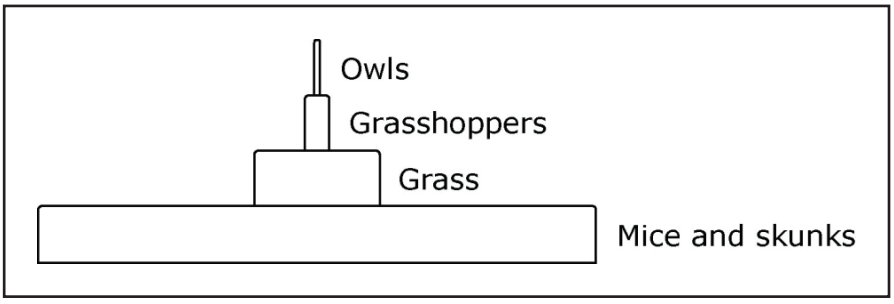



**Which energy pyramid accurately represents the amount of energy at each level of this food web?**

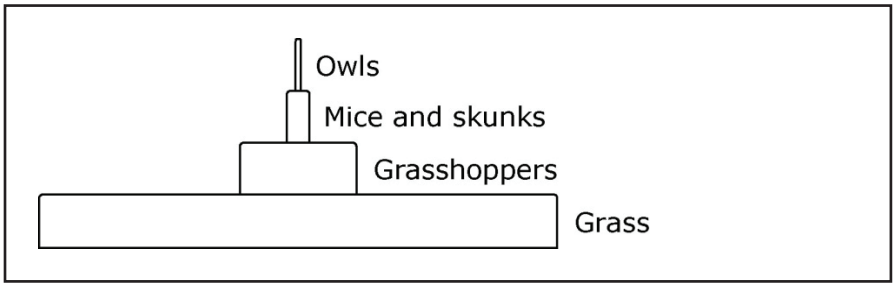
**A**



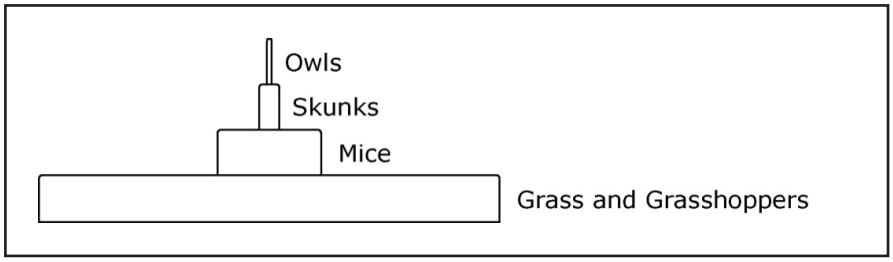

**B**




**C**



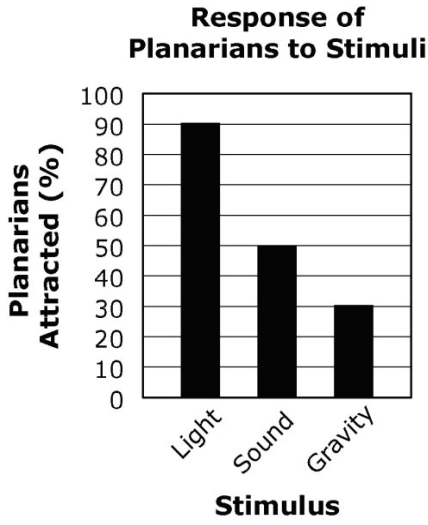

**D**



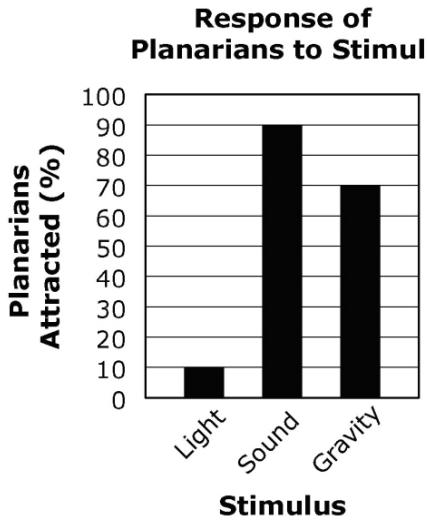
Sample Test Item:
**Process Objective: 4.8a**
Content Objective: 1.3
Depth-of-Knowledge: 2
Correct Response: C

**A planarian is a type of flatworm. A class recorded the responses of 100 planarians to three types of environmental stimuli: light, gravity, and sound. They found that 10% of the planarians preferred light areas and 70% moved in response to gravity. The planarians did not show any clear response to sound.**

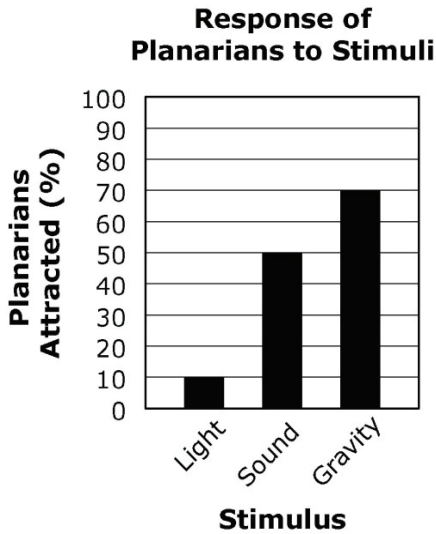
**Which graph best illustrates the results of the planarian experiment?**



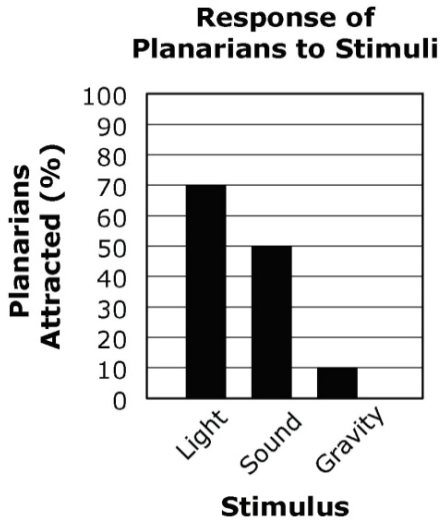

**A**




**B**




**C**




**D**

**OAS Standard:**

Process Standard 5: Model—Modeling is the active process of forming a mental or physical representation from data, patterns, or relationships to facilitate understanding and enhance prediction. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 1: Interpret a biological model which explains a given set of observations.

**Item Specifications:**

Emphasis:

Comprehend a biological model, explain its elements and processes, describe relationships within it, and analyze and evaluate the model.

Stimulus Attributes:

Items will include illustrations of biological systems (e.g. life cycles, biogeochemical cycles, flow charts, food chains, food webs, DNA model, cell cycle, pedigrees, ecological succession).

Format:

Assessable content includes:

1. Students will accurately interpret or evaluate biological models.
2. Students will identify the advantages or limitations of a biological model.
3. Students will identify the best model based on given data.
4. Students will compare a model to the living world.

Item Content Limits:

Non-assessable content includes:

1. The names and events of each stage of mitosis or meiosis and the correct sequence of each.

Content Objectives May Include:

Items may be written to assess any of the content objectives.

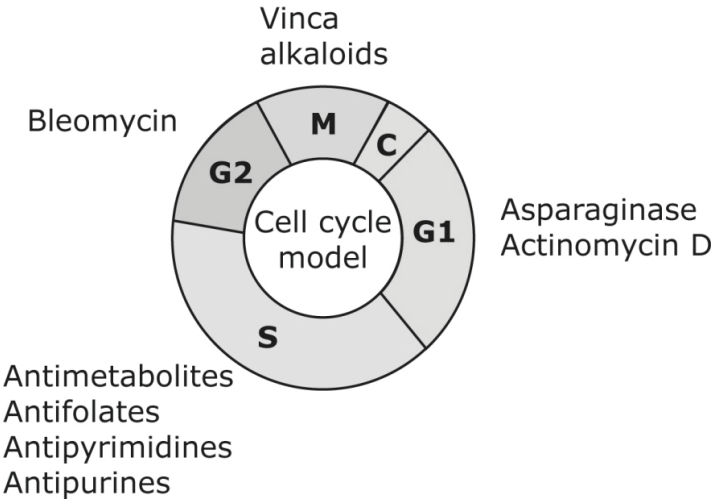
Distractor Domain:

1. Inaccurate interpretations of models
2. Common misconceptions

Sample Test Item:
**Process Objective: 5.1**
Content Objective: 2.1
Depth-of-Knowledge: 2
Correct Response: B

**Some chemicals help stop a certain disease during the cell cycle. The diagram shows where in the cell cycle these chemicals affect the disease.**

**Chemicals That Affect the Cell Cycle**




**Based on the diagram, <u>most</u> of the chemicals affect cells during**

**A** mitosis.

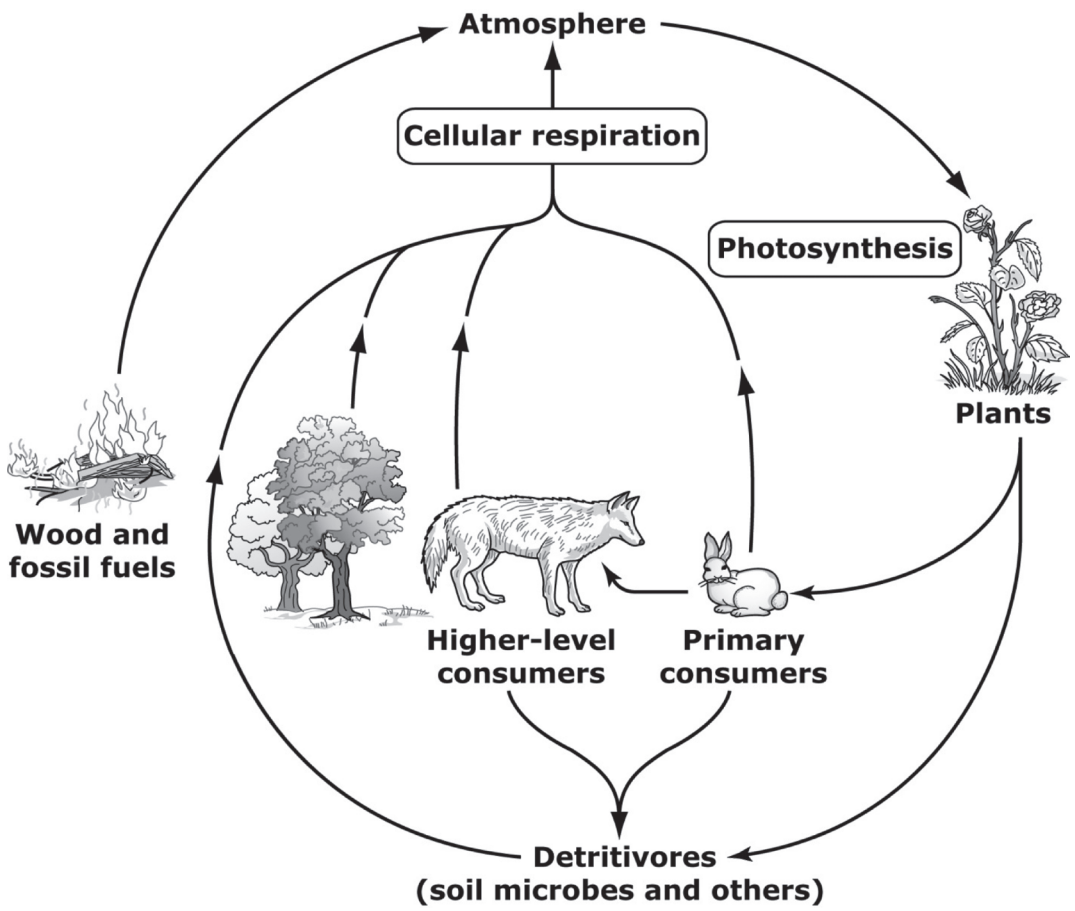
**B** DNA replication.

**C** the growth stage.

**D** the preparation for division.

Sample Test Item:
**Process Objective: 5.1**
Content Objective: 5.2
Depth-of-Knowledge: 2
Correct Response: A

**The model below shows how one substance is recycled in ecosystems.**

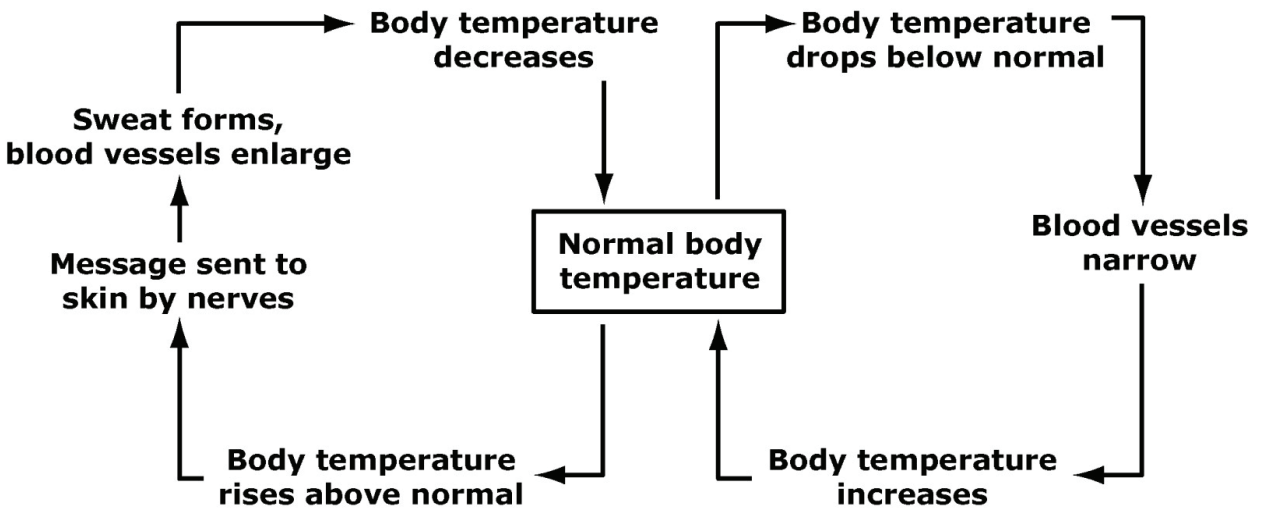



**What is the substance that is being recycled in this model?**

**A** carbon
**B** nitrogen
**C** oxygen
**D** water

Sample Test Item:
**Process Objective: 5.1**
Content Objective: 1.3
Depth-of-Knowledge: 2
Correct Response: A

**The diagram shows body temperature regulation.**




**The <u>most likely</u> response to low air temperature is**

**A** blood vessels narrow.

**B** blood vessels enlarge.

**C** nerve activity decreases.

**D** sweat production increases.

**OAS Standard:**

Process Standard 5: Model—Modeling is the active process of forming a mental or physical representation from data, patterns, or relationships to facilitate understanding and enhance prediction. The student will accomplish these objectives to meet this process standard.

**OAS Objective:**

Process Objective 2: Select predictions based on models (e.g., pedigrees, life cycles) and when appropriate, apply mathematical reasoning to make a prediction.

**Item Specifications:**

Emphasis:

Make predictions based on the analysis of a biological model.

Stimulus Attributes:

Items will include illustrations of biological systems. Items may include life cycles, nutrient cycles, flow charts, food chains, food webs, DNA model, cell cycle, pedigrees, ecological succession, etc.

Format:

Assessable content includes:

1. Students will analyze biological models and make predictions based upon their analyses.
2. Students will correctly apply appropriate mathematical reasoning to make accurate predictions based on a biological model (i.e., density (population density including exponential growth), percentage of growth increase/decrease, ratios (surface area/volume), rate of change, biomass, probability, percentages, fractions/decimals, genetic crosses (Punnett squares), calculating averages, and predicting energy flow in pyramids).
3. Students will predict future outcomes as well as draw conclusions about what most likely happened in the past based on biological models.

Item Content Limits:

Non-assessable content includes:

1. Names and events of each stage of mitosis or meiosis and the correct sequence of each.

Content Objectives May Include:

Items may be written to assess any of the content objectives.

Distractor Domain:

1. Inaccurate predictions
2. Inaccurate calculations
3. Common misconceptions

Sample Test Item:
**Process Objective: 5.2**
Content Objective: 2.2
Depth-of-Knowledge: 2
Correct Response: D

**Feather color in certain chickens is a well-known model of codominance. Black feather color (B) is codominant with white feather color (W). Heterozygous individuals (BW) have both black and white feathers and appear speckled.**

**What possible offspring would result from a cross between two speckled chickens?**

**A** only speckled

**B** white or speckled

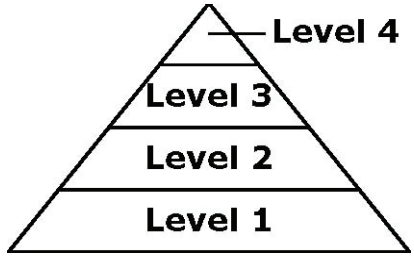
**C** black or speckled

**D** black, white, or speckled

Sample Test Item:
**Process Objective: 5.2**
Content Objective: 5.2
Depth-of-Knowledge: 2
Correct Response: A

**An energy pyramid for an ecosystem is shown.**

**Energy Pyramid**




**The producers in the ecosystem produce 25,000,000 units of energy per year. How much energy is most likely available to the organisms in Level 3 of the pyramid?**

**A** 250,000 units of energy per year

**B** 2,500,000 units of energy per year

**C** 25,000,000 units of energy per year

**D** 250,000,000 units of energy per year

Sample Test Item:
**Process Objective: 5.2**
Content Objective: 2.2
Depth-of-Knowledge: 3
Correct Response: A

**In a certain rodent species, the allele for rough coat (R) is dominant to the allele for smooth coat (r). The Punnett square below shows a cross between rough-coated and smooth-coated individuals.**

| | R | r |
|---|---|---|
| r | Rr | rr |
| r | Rr | rr |

**If a heterozygous offspring from above is crossed with another heterozygous individual, what is the probability that their offspring will have a smooth coat?**

**A** 25%

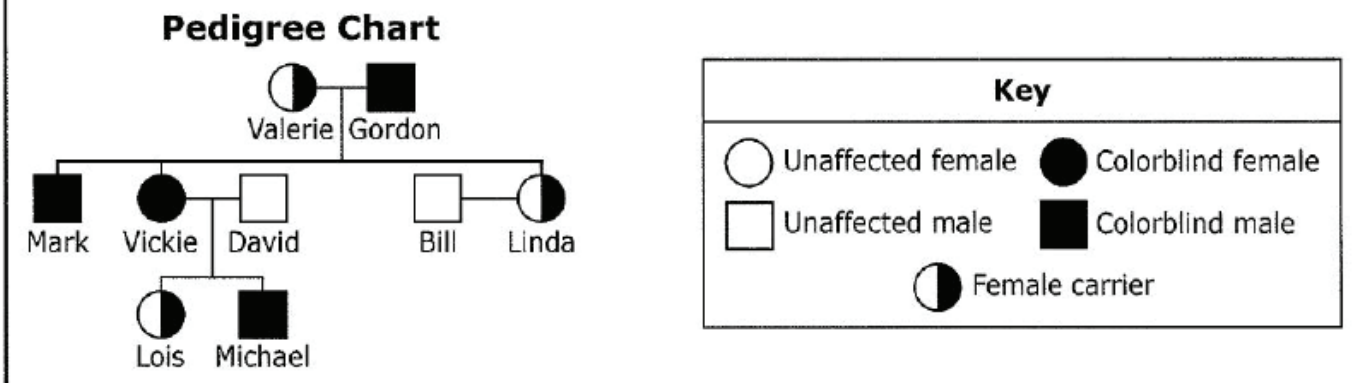
**B** 50%

**C** 75%

**D** 100%

**The information below is used to answer the next two items.**

**Red-green colorblindness occurs in humans when a large piece of one of three genes on the X chromosome is missing. The normal genes are denoted $X^N$ and colorblind vision is denoted $X^n$. A female has two X chromosomes and a male has one X chromosome and a Y chromosome. A female needs two copies of one of the mutated forms of the genes ($X^nX^n$) to be colorblind. A male needs only one copy ($X^nY$) to be colorblind. The pedigree shows the inheritance of red-green colorblindness in a family.**




Sample Test Item:
**Process Objective: 5.2**
Content Objective: 2.2
Depth-of-Knowledge: 2
Correct Response: D

**What is Vickie's phenotype and genotype?**

**A** She has normal vision and carries one copy of the mutated gene.

**B** She has normal vision and carries two copies of the mutated gene.

**C** She is colorblind and carries one copy of the mutated gene.

**D** She is colorblind and carries two copies of the mutated gene.

Sample Test Item:
**Process Objective: 5.2**
Content Objective: 2.2
Depth-of-Knowledge: 2
Correct Response: B

**What is Mark's genotype?**

**A** $X^nX^n$

**B** $X^nY$

**C** $X^NY$

**D** $X^NX^n$

**OAS Standard:**

Content Standard 1: The Cell—Cells are the fundamental unit of life, composed of a variety of structures that perform functions necessary to maintain life. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Standard 1: Cells are composed of a variety of structures such as the nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.

**Item Specifications:**

Emphasis:

Know the function and structure of the nucleus, cell membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.

Stimulus Attributes:

Items may include written descriptions, graphical representations, Venn diagrams and data tables.

Format:

Assessable content includes:

1. Compare and contrast prokaryotic and eukaryotic cells using structural characteristics to differentiate between bacteria, plant, fungal and animal cells (i.e., nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts).
2. Classify cells as plant, animal, fungal or bacterial, based on assessable structures (i.e., nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts).
3. Identify and classify major cell structures in relation to their function, such as: nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.
4. Identify the general function of the following cell structures: nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.
5. Describe the special functions of the cell/plasma membrane including osmosis, diffusion, and surface area to volume ratio of a cell.
6. Differentiate between hypotonic, hypertonic, and isotonic conditions between a cell and its environment.
7. Explain each of the following processes by recognizing and interpreting process/chart/or diagrams related to how materials are exchanged across membranes. i.e., active and passive transport, osmosis, diffusion, and the ratio of surface area to volume in cells).
8. Identify and explain how cell structures help various organisms maintain homeostasis.

9. Interpret diagrams of cells which model how internal balance is maintained.
10. Interpret data and predict trends in homeostatic responses.

Item Content Limits:

Non-assessable content includes:

1. Specific knowledge of these structures: cytoskeleton, lysosome, centrioles, endoplasmic reticulum, golgi apparatus, cytosol, vacuoles, cilia, and flagella.
2. Knowledge related to the specific chemical/molecular structure and/or chemical interaction with other organelles or structures around it that would be above the level of Biology I.
3. Knowledge related to the specific chemical process of the Calvin cycle.
4. Knowledge related to the specific chemical process of the citric acid cycle.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect or irrelevant structures
2. Incorrect or irrelevant functions
3. Incorrect relationships between structure and function
4. Incorrect properties or characteristics of prokaryotic or eukaryotic cells
5. Incorrect classification or grouping of cells or events from given information
6. Predictions, structures or functions not supported by given data/diagrams/or charts
7. Inferences, analyses, or conclusions not supported by given observations or data

**OAS Standard:**

Content Standard 1: The Cell—Cells are the fundamental unit of life, composed of a variety of structures that perform functions necessary to maintain life. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Standard 1: Cells are composed of a variety of structures such as the nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.

**OAS Skill:**

Content Skill 1.1a: The cell/plasma membrane functions (i.e., active transport, passive transport, diffusion, osmosis, and surface-to-volume ratio) to maintain homeostasis.

**Item Specifications:**

Emphasis:

Know how chemical, energetic, and electrical homeostasis are maintained by the membrane functions of active transport, passive transport, diffusion, osmosis, and the establishment of membrane surface-area-to-cell-volume ratio.

Stimulus Attributes:

Items may include written descriptions, graphical representations, Venn diagrams, and/or data tables.

Format:

Assessable content includes:

1. Identify the general function of the following cell structures: cell/plasma membrane, cell wall, and cytoplasm.
2. Describe the special functions of the cell/plasma membrane, including active transport, passive transport, osmosis, diffusion, and surface-area-to-volume ratio of a cell.
3. Explain each of the following processes by recognizing and interpreting process/chart/or diagrams related to how materials are exchanged across membranes (i.e., active and passive transport, osmosis, diffusion, and the ratio of surface area to volume in cells).
4. Identify and explain how cell structures help various organisms maintain homeostasis.
5. Interpret diagrams of cells which model how internal balance is maintained.
6. Interpret data and predict trends in homeostatic responses.
7. Apply the appropriate calculations and/or reasoning to explain scientific concepts related to cell membrane function. Refer to page 51.

Content Limits:

Non-assessable content includes:

1. Specific knowledge of these structures: cytoskeleton, lysosome, centrioles, endoplasmic reticulum, golgi apparatus, cytosol, vacuoles, cilia, and flagella.
2. Knowledge related to the specific chemical/molecular structure and/or chemical interaction with other organelles or structures around it that would be above the level of Biology I.
3. Knowledge related to the specific chemical process of the Calvin cycle.
4. Knowledge related to the specific chemical process of the citric acid cycle.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect or irrelevant structures
2. Incorrect or irrelevant functions
3. Incorrect relationships between structure and function
4. Incorrect properties or characteristics of prokaryotic or eukaryotic cells
5. Incorrect classification or grouping of cells or events from given information
6. Predictions, structures, or functions not supported by given data/diagrams/or charts
7. Inferences, analyses, or conclusions not supported by given observations or data

**OAS Standard:**

Content Standard 1: The Cell—Cells are the fundamental unit of life, composed of a variety of structures that perform functions necessary to maintain life. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 1: Cells are composed of a variety of structures such as the nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.

**OAS Skill:**

Content Skill 1.1b: Differentiate between hypotonic, hypertonic, and isotonic conditions.

**Item Specifications:**

Emphasis:

Know the difference between hypotonic, hypertonic, and isotonic conditions and the impact each condition has on cells.

Stimulus Attributes:

Items may include written descriptions, graphical representations, Venn diagrams, and/or data tables.

Format:

Assessable content includes:

1. Identify and classify major cell structures in relation to their function, such as: cell/plasma membrane, cell wall, and cytoplasm.
2. Identify the general function of the following cell structures: cell/plasma membrane, cell wall, and cytoplasm.
3. Differentiate between hypotonic, hypertonic, and isotonic conditions between a cell and its environment.
4. Explain each of the following processes by recognizing and interpreting process/chart/or diagrams related to how materials are exchanged across membranes (i.e., active and passive transport, osmosis, diffusion, and the ratio of surface area to volume in cells).
5. Identify and explain how cell structures help various organisms maintain homeostasis.
6. Interpret diagrams of cells which model how internal balance is maintained.
7. Interpret data and predict trends in homeostatic responses.

   Apply the appropriate calculations and/or reasoning to explain scientific concepts related to the internal and external environments of the cell. Refer to page 48.

Content Limits:

Non-assessable content includes:

1. Specific knowledge of these structures: cytoskeleton, lysosome, centrioles, endoplasmic reticulum, golgi apparatus, cytosol, vacuoles, cilia, and flagella.
2. Knowledge related to the specific chemical/molecular structure and/or chemical interaction with other organelles or structures around it that would be above the level of Biology I.
3. Knowledge related to the specific chemical process of the Calvin cycle.
4. Knowledge related to the specific chemical process of the citric acid cycle.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect or irrelevant structures
2. Incorrect or irrelevant functions
3. Incorrect relationships between structure and function
4. Incorrect properties or characteristics of prokaryotic or eukaryotic cells
5. Incorrect classification or grouping of cells or events from given information
6. Predictions, structures, or functions not supported by given data/diagrams/or charts
7. Inferences, analyses, or conclusions not supported by given observations or data

**OAS Standard:**

Content Standard 1: The Cell—Cells are the fundamental unit of life, composed of a variety of structures that perform functions necessary to maintain life. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Standard 1: Cells are composed of a variety of structures such as the nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.

**OAS Skill:**

Content Skill 1.1c: Compare and contrast prokaryotic and eukaryotic cells.

**Item Specifications:**

Emphasis:

Compare and contrast the cellular organization and functions of prokaryotic and eukaryotic cells using structural characteristics.

Stimulus Attributes:

Items may include written descriptions, graphical representations, Venn diagrams, and/or data tables.

Format:

Assessable content includes:

1. Compare and contrast prokaryotic and eukaryotic cells using structural characteristics to differentiate between bacteria, plant, fungal, and animal cells (i.e., nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts).
2. Classify cells as plant, animal, fungal, or bacterial based on assessable structures (i.e., nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts).
3. Identify and classify major cell structures in relation to their function, such as: nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.
4. Identify the general function of the following cell structures: nucleus, cell/plasma membrane, cell wall, cytoplasm, ribosomes, mitochondria, and chloroplasts.

Content Limits:

Non-assessable content includes:

1. Specific knowledge of these structures: cytoskeleton, lysosome, centrioles, endoplasmic reticulum, golgi apparatus, cytosol, vacuoles, cilia, and flagella.
2. Knowledge related to the specific chemical/ molecular structure and/or chemical interaction with other organelles or structures around it that would be above the level of Biology I.

3. Knowledge related to the specific chemical process of the Calvin cycle.
4. Knowledge related to the specific chemical process of the citric acid cycle.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect or irrelevant structures
2. Incorrect or irrelevant functions
3. Incorrect relationships between structure and function
4. Incorrect properties or characteristics of prokaryotic or eukaryotic cells
5. Incorrect classification or grouping of cells or events from given information
6. Predictions, structures, or functions not supported by given data/diagrams/or charts
7. Inferences, analyses, or conclusions not supported by given observations or data

Sample Test Item:
Process Objective: 1.2
**Content Objective: 1.1**
Depth-of-Knowledge: 1
Correct Response: A

**Which method would allow a biologist to view the site of food production in a plant cell?**

**A** use a microscope to view the chloroplasts

**B** use a microscope to view the mitochondria

**C** use a magnifying glass to view the chloroplasts

**D** use a magnifying glass to view the mitochondria

Sample Test Item:
Process Objective: 2.1
**Content Objective: 1.1**
Depth-of-Knowledge: 2
Correct Response: C

**Cell Structures in an Organism**

| Structure | Present or Absent? |
|---|---|
| Cell wall | Absent |
| Chloroplasts | Absent |
| DNA | Present |
| Mitochondria | Present |
| Nucleus | Present |

**According to the table, how should this organism be classified?**

**A** bacteria

**B** plant

**C** animal

**D** virus

Sample Test Item:
Process Objective: 2.1
**Content Objective: 1.1**
Depth-of-Knowledge: 3
Correct Response: D

**Classification System**

| Group | Color of Organism | Cells Have a Nucleus? | Cells Contain Chloroplasts? | Cells Contain Mitochondria? |
|---|---|---|---|---|
| 1 | Brown | Yes | No | Yes |
| 2 | Yellow | Yes | No | Yes |
| 3 | Green | Yes | Yes | Yes |
| 4 | Green | No | No | No |

**According to the classification system, which statement is true?**

**A** Organisms classified in Group 1 and Group 2 are plants.

**B** Organisms classified in Group 3 and Group 4 are animals.

**C** Organisms classified in Group 1 are animals, and in Group 2 are bacteria.

**D** Organisms classified in Group 3 are plants, and in Group 4 are bacteria.

**OAS Standard:**

Content Standard 1: The Cell—Cells are the fundamental unit of life, comprised of a variety of structures that perform functions necessary to maintain life. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 2: In multicellular organisms, cells have levels of organization (i.e., cells, tissues, organs, organ systems, and organisms).

**Item Specifications:**

Emphasis:

Multiple levels of organization exist in organisms. Complexity of structure and function increases at each successive level. All levels work together for the survival of the organism.

Stimulus Attributes:

Items may include descriptions, illustrations (e.g. life cycles), data tables, and/or graphs.

Format:

Assessable content includes:

1. Students will apply knowledge of the general concepts of levels of organization in organisms (i.e., cells, tissues, organs, organ systems, and organisms).
2. Use the concepts of the cell theory to evaluate an experimental design.
3. Correlate appropriate SI units of measure and tools with organizational levels of structure.
4. Compare and contrast the unicellular and multicellular organization (e.g., division of labor, cooperation among cells and colonies, single cell organisms).
5. Classify simple properties of tissues or cells based on the functions of cell organelles (e.g., muscle tissue composed of cells with a high number of mitochondria due to high demand for energy).
6. Describe in general terms how organisms are organized and classified at the cellular, tissue, organ, and organ-system levels.
7. Analyze the basis of a cause-effect relationship and/or predictability of an outcome.

Content Limits:

Non-assessable content includes:

1. The specifics of cell development through the process of cleavage, cell determination and differentiation or stem cell formation.
2. Items will not require knowledge related to the specific chemical/molecular structure and/or chemical interaction within or between levels of organization that would be above the level of Biology I.
3. Distinguishing between open and closed systems.

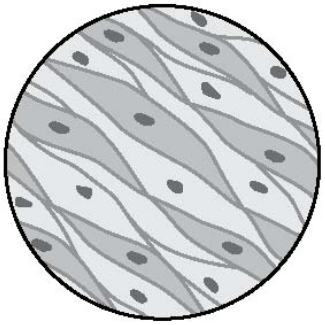
Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Wrong level of organization
2. Inappropriate SI units of measure or tools
3. Wrong application of cell theory to experimental design
4. Common misconceptions

Sample Test Item:
Process Objective: 1.1
**Content Objective: 1.2**
Depth-of-Knowledge: 1
Correct Response: C



**Which statement best describes the diagram?**

**A** a tissue made of the same type of organs

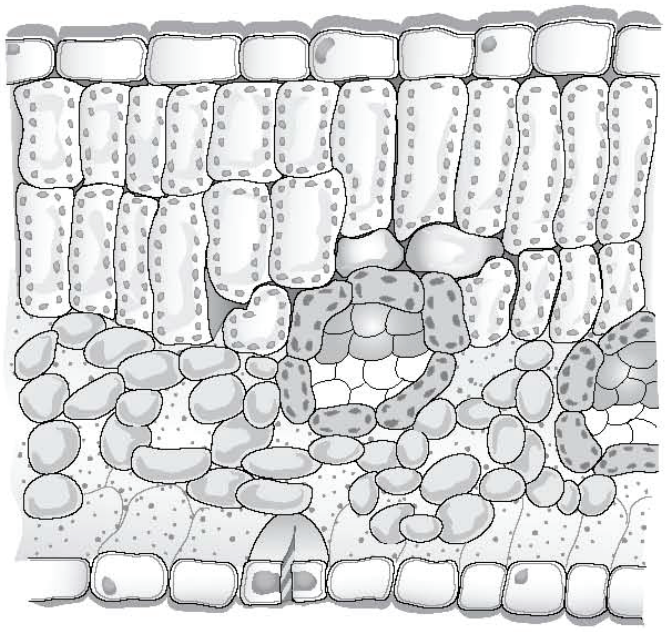
**B** an organ made entirely of the same type of cells

**C** a tissue made entirely of the same type of cells

**D** an organ made of different types of tissues

Sample Test Item:
Process Objective: 2.1
**Content Objective: 1.2**
Depth-of-Knowledge: 2
Correct Response: D

**The picture shows a cross-section of a living structure.**



**There are many different types of plant cells in the structure.**

**What is the correct classification for the living structure?**

**A** organism, because different cells are involved in gas exchange

**B** tissue, because a single cell is involved in photosynthesis and the movement of water

**C** organ system, because a single tissue is involved in support and the movement of water

**D** organ, because different tissues are involved in gas exchange, support, and photosynthesis

Sample Test Item:
Process Objective: 1.1
**Content Objective: 1.2**
Depth-of-Knowledge: 2
Correct Response: A

**In an ecosystem, energy from the sun is converted and transferred to all members of the biotic community.**

**At which level of organization is solar energy converted by photosynthesis?**

**A** cells

**B** organs

**C** organisms

**D** populations

**OAS Standard:**

Content Standard 1: The Cell—Cells are the fundamental unit of life, composed of a variety of structures that perform functions necessary to maintain life. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 3: Specialized cells enable organisms to monitor what is going on in the world around them (e.g., detect light, sound, specific chemicals, gravity, plant tropism, sense organs, homeostasis).

**Item Specifications:**

Emphasis:

Organisms respond physiologically to changes in the environment in order to survive.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, Venn diagrams, and/or graphs.

Format:

Assessable content includes:

1. Students will apply knowledge of how organisms respond to their environment physiologically.
2. Analyze data and predict immediate physiological response to environmental changes (stimulus and response).
3. Understand the relationship between stimulus and response.
4. Identify a cell's ability to respond to internal changes and external stimuli.
5. Identify and analyze an organism's response to light, sound, chemicals, and gravity.
6. Predict how changes in the immediate environment result in stimulus responses necessary for survival.
7. Interpret models of homeostasis, geotropism, chemotropism, phototropism, feedback loops, and the role of sensory cells.

Content Limits:

Non-assessable content includes:

1. Knowledge related to the specific chemical/molecular structure and/or chemical interaction that would be above the level of Biology I.
2. Complex feedback loops
3. Specialized systems that are beyond the scope of Biology I.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Data misinterpretations
2. Common misconceptions

Sample Test Item:
Process Objective: 4.4
**Content Objective: 1.3**
Depth-of-Knowledge: 2
Correct Response: B

**Specialized cells in certain male insects produce a scent. Bart hypothesizes that if a male insect does not have scent, then he will not attract females. Bart extracts the scent molecules from some male insects and then coats a model of the male insect with the scent. Bart exposes fifty females to the treated model and fifty females to a model of the male insect that was not coated with the chemical.**

**Which result will provide support for this hypothesis?**

**A** Fewer females are attracted to the treated model than the untreated model.

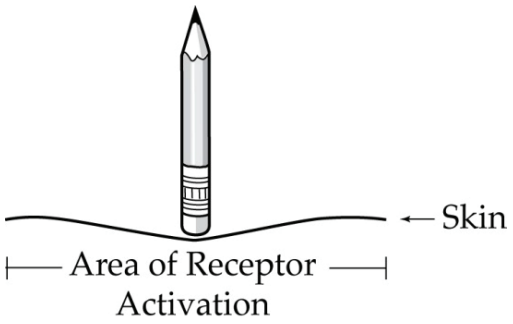
**B** More females are attracted to the treated model than the untreated model.

**C** Females are not attracted to either the treated model or the untreated model.

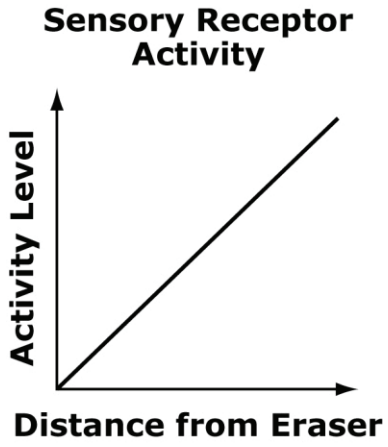
**D** Females are equally attracted to both the treated and the untreated models.

Sample Test Item:
Process Objective: 4.8
**Content Objective: 1.3**
Depth-of-Knowledge: 3
Correct Response: B

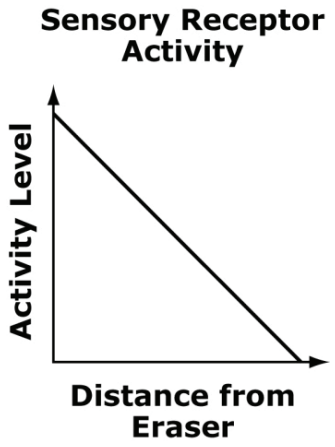
**When a pencil eraser is pressed against the skin, there is an increase in the activity level of the sensory receptors closest to that area of skin.**



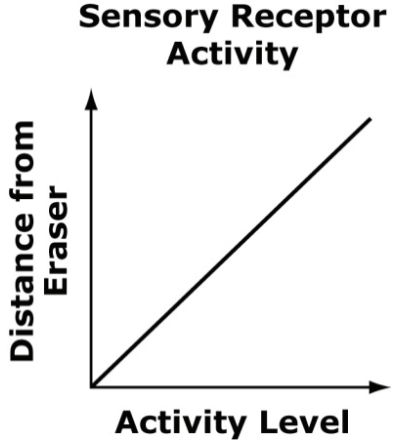

**Which graph <u>best</u> illustrates the activity level of sensory receptors in and around an area of skin that is pressed by an eraser?**



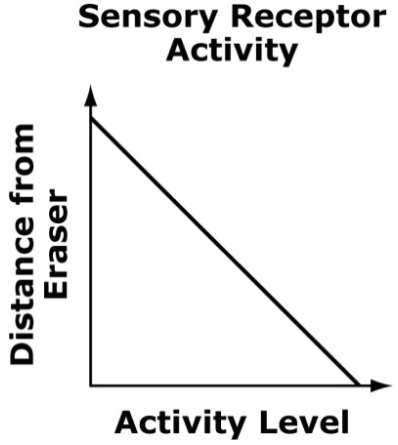

**A**




**B**




**C**




**D**

**OAS Standard:**

Content Standard 2: The Molecular Basis of Heredity—DNA determines the characteristics of organisms. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 1: Cells function according to the information contained in the master code of DNA (i.e., cell cycle, DNA to DNA, and DNA to RNA). Transfer RNA and protein synthesis will be taught in life science courses with rigor greater than Biology I.

**Item Specifications:**

Emphasis:

DNA regulates all cellular functions, processes, and heredity.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, Venn diagrams, and/or graphs.

Format:

Assessable content includes:

1. Students will apply knowledge of DNA and the cell cycle in different contexts, including relating it to various cellular functions, processes, and heredity.
2. Compare and contrast the genetic material (i.e., DNA, RNA) and the nucleotides of each (i.e., adenine, thymine, cytosine, guanine, and uracil).
3. Sequence the events of DNA replication.
4. Interpret basic models of the processes of replication (DNA to DNA) and transcription (DNA to RNA).
5. Interpret a model of DNA in the process of formation of mutations.
6. Identify the parts of the cell cycle (i.e., interphase [G1, S, and G2], mitosis, and cytokinesis).
7. Calculate the number of cells produced over a period of time based upon a set time for the cell cycle.
8. Compare/contrast the basic processes and results of meiosis and mitosis (e.g., number of daughter cells produced, number of cell divisions, number of chromosomes, cell type).
9. Apply the concept that proteins are involved in expressing traits coded in DNA (i.e., DNA $\rightarrow$ RNA $\rightarrow$ proteins).

Content Limits:

Non-assessable content includes:

1. The specific processes and terminology of translation (protein synthesis).
2. Questions which require the student to distinguish between the events of a normal cell cycle and events related to a specific disease.
3. Knowledge regarding specific enzymes related to regulation of the cell cycle.
4. Identify the details of how mutations affect protein formation.
5. Use of specific chemical names and/or chemical processes.
6. The events and specific details of each stage of mitosis and meiosis and the correct sequence of each.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect response
2. Common misconceptions

Sample Test Item:
Process Objective: 2.2
**Content Objective: 2.1**
Depth-of-Knowledge: 1
Correct Response: A

**Genetic material is classified according to the function it performs. Which term describes a segment of DNA that codes for an inherited trait?**

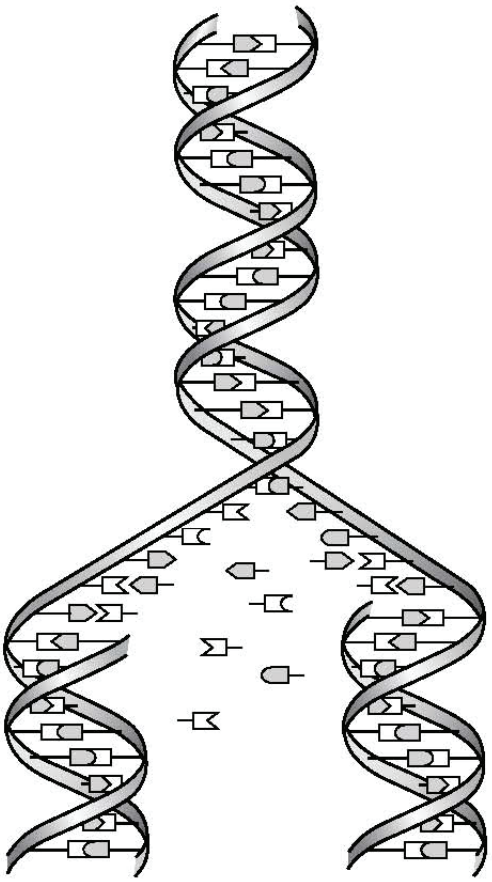
**A** gene

**B** genome

**C** nucleotide

**D** chromosome

Sample Test Item:
Process Objective: 5.2
**Content Objective: 2.1**
Depth-of-Knowledge: 2
Correct Response: D



**Based on the model, which feature is characteristic of DNA replication?**

**A** The molecule makes chromatin fibers

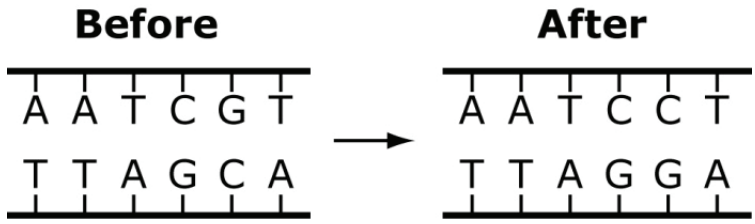
**B** The molecule is in the form of a triple helix

**C** Sequence mutations occur in all DNA strands

**D** Complementary bases pair together to form new DNA

Sample Test Item:
Process Objective: 1.1
**Content Objective: 2.1**
Depth-of-Knowledge: 2
Correct Response: C

**The diagram below shows a segment of a gene before and after a process.**




**Which is a result of the process shown in the diagram?**

**A** an identical DNA sequence that will code for an identical protein

**B** a shorter RNA sequence that will code for a shorter protein

**C** a substituted base in the DNA molecule that could change the structure of a protein

**D** an added base in the RNA molecule that could change the structure of a protein

**OAS Standard:**

Content Standard 2: The Molecular Basis of Heredity—DNA determines the characteristics of organisms. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 2: A sorting and recombination of genes in reproduction results in a great variety of possible gene combinations from the offspring of any two parents (i.e., Punnett squares and pedigrees). Students will understand concepts in a single trait cross (e.g, alleles, dominant trait, recessive trait, phenotype, genotype, homozygous, and heterozygous, incomplete dominance, and sex-linked traits).

**Item Specifications:**

Emphasis:

A great variety of gene combinations result from sexual reproduction.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, Punnett squares, pedigrees (legends provided), and graphs.

Format:

Assessable content includes:

1. Interpret, analyze, evaluate data, and make predictions from a given monohybrid cross.
2. Use mathematical models to determine the end products of meiosis.
3. Interpret and/or predict possible genetic combinations using Punnett squares and/or pedigrees (e.g., single-trait crosses, sex-linked traits, co-dominance, and incomplete dominance).
4. Identify possible parent (P) genotype given the appropriate offspring (F1 and F2) genotypic ratios.
5. Distinguish the corresponding phenotypes for a given genotype.
6. Predict percentage and/or probability of offspring utilizing a Punnett square.
7. Apply Mendel's principles to solve basic genetics problems involving monohybrid crosses.
8. Identify the appropriate pedigree chart that traces basic patterns of human inheritance.
9. Identify results or products of crossing-over and nondisjunction.

Content Limits:

Non-assessable content includes:

1. The events and specific details of each stage of mitosis and meiosis and the correct sequence of each.
2. The specific process of crossing-over or synapsis, and tetrads, non-disjunction, multiple alleles and polygenic traits.
3. Categorizing different types of mutations that can occur in DNA.
4. Knowledge related to the specific chemical/molecular structure and/or chemical interaction that would be above the level of Biology I.

Process Objectives May Include:

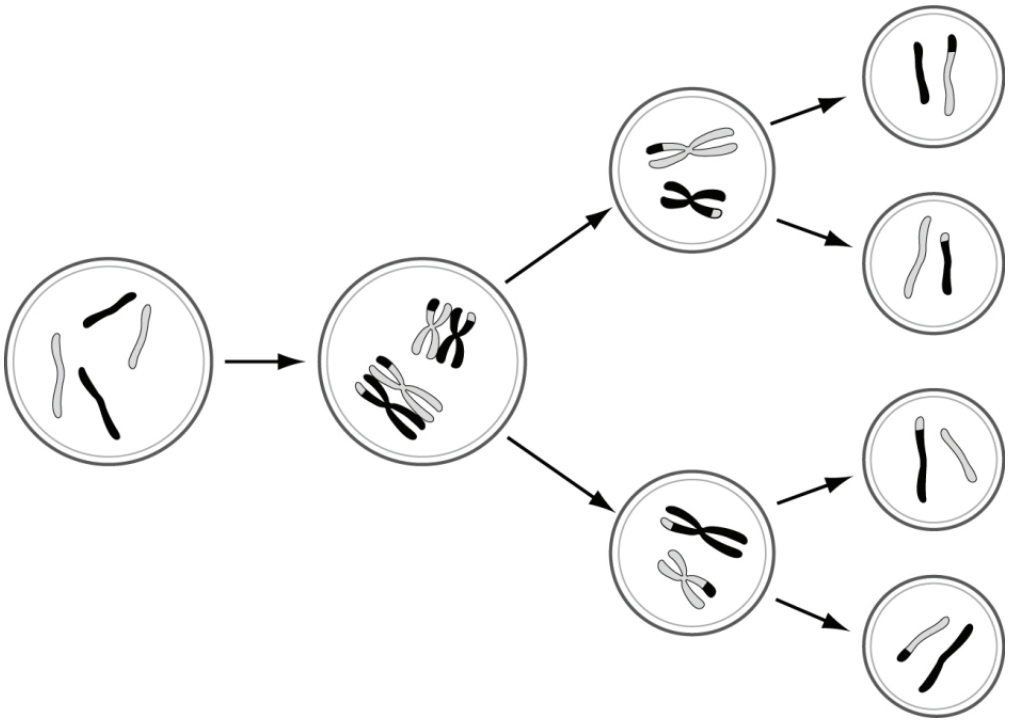
Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect percentages or ratios
2. Misinterpretation of data
3. Common misconceptions
4. Inappropriate predictions

Sample Test Item:
Process Objective: 5.1
**Content Objective: 2.2**
Depth-of-Knowledge: 2
Correct Response: D

**Meiosis**



**Which statement <u>best</u> describes the outcome of the process in the diagram?**

**A** four identical daughter cells

**B** four sex cells, two male and two female

**C** four daughter cells, each with a different number of chromosomes

**D** four sex cells, each with a different combination of genetic material

Sample Test Item:
Process Objective: 4.5
**Content Objective: 2.2**
Depth-of-Knowledge: 2
Correct Response: D

**Robert is conducting breeding experiments with mice. He crossed two brown mice and found that 25% of their offspring were white.**

**Which conclusion from this experiment is most logical?**

**A** White color is dominant over brown color.

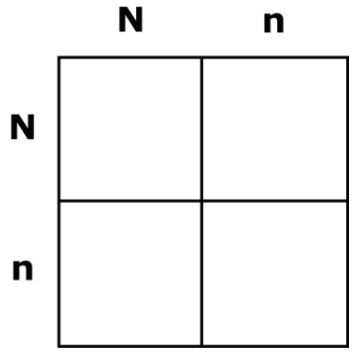
**B** One of the parent mice is homozygous for the dominant allele.

**C** All of the offspring carry two copies of the recessive allele.

**D** The white offspring are homozygous for the recessive allele.

Sample Test Item:
Process Objective: 3.3
**Content Objective: 2.2**
Depth-of-Knowledge: 2
Correct Response: B

**A certain disease in humans is a recessive trait (n) while the normal condition is dominant (N). The Punnett square below shows the genotypes for a couple that wants to have a child.**




**What is the probability that the couple's child will inherit the disease?**

**A** 0%

**B** 25%

**C** 50%

**D** 100%

**The information below is used to answer the next two items.**

**Green light is reflected from green leaves. Other light is absorbed. Most of blue light is absorbed and about half of red light is absorbed. Maria grew five pea plants in five different colors of light. She measured the mass of each pea plant before and after two weeks in the light. The table shown lists the wavelengths of different colors of light.**

| Color of Light | Wavelength (nanometers) |
|---|---|
| Red | 700 – 650 |
| Orange | 640 – 600 |
| Yellow | 590 – 550 |
| Green | 540 – 500 |
| Blue | 490 – 450 |

Sample Test Item:
Process Objective: 4.3
**Content Objective: 2.2**
Correct Response: A

**In which wavelengths of light would photosynthesis be fastest in the pea plant?**

**A** 490–450 nanometers

**B** 590–550 nanometers

**C** 540–500 nanometers

**D** 640–600 nanometers

Sample Test Item:
Process Objective: 3.2
**Content Objective: 2.2**
Depth-of-Knowledge: 3
Correct Response: C

**Which factor is indirectly measured by the dependent variable?**

**A** leaf color

**B** rate of mutation

**C** rate of photosynthesis

**D** optimum temperature

**OAS Standard:**

Content Standard 3: Biological Diversity—Diversity of species is developed through gradual processes over many generations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 1: Different species might look dissimilar, but the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry (e.g., homologous and analogous structures, embryology, fossil record, genetic data).

**Item Specifications:**

Emphasis:

The study of the relatedness among species.

Stimulus Attributes:

Items may include descriptions, illustrations, data tables, models, phylogenetic trees, cladograms, classification keys, and/or graphs.

Format:

Assessable content includes:

1. Differentiate between appropriate (e.g., fossils, anatomical, embryological development, biochemical, geographical, ecological evidence, vestigial structures) and inappropriate information for determining species relatedness.
2. Compare/contrast divisions of a biological classification system.
3. Identify various relationships among species and how those species have diversified or become more similar over time (e.g., convergent and divergent adaptations).
4. Use phylogenetic trees, cladograms, and/or dichotomous keys to discern the relatedness among species.
5. Compare/contrast anatomical features of various organisms.
6. Interbreeding between subspecies (e.g., a male donkey and a female horse to produce a mule).

Content Limits:

Non-assessable content includes:

1. The specifics of cell development through the process of cleavage, cell determination, and differentiation or stem cell formation.
2. Classification of viruses
3. Interbreeding between related species, or organisms under unnatural conditions, such as in captivity will not be addressed (e.g. coydogs – combination of a dog- coyote hybrids, artificial insemination).

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

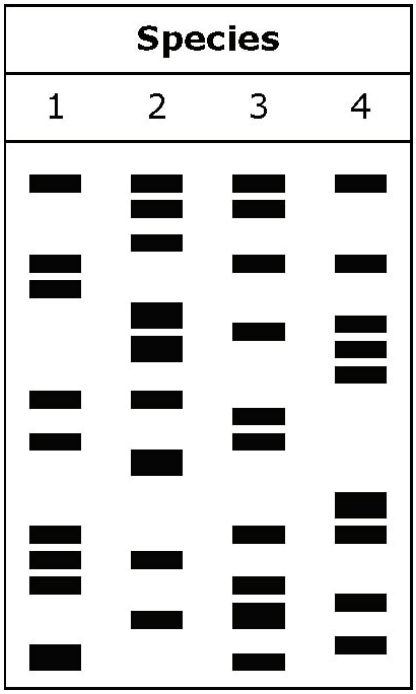
Distractor Domain:

1. Incorrect interpretations
2. Incorrect conclusions
3. Common misconceptions

Sample Test Item:
Process Objective: 2.2
**Content Objective: 3.1**
Depth-of-Knowledge: 2
Correct Response: A

**A scientist is studying the results of a DNA gel electrophoresis from four different species.**

**Electrophoresis Gel**




**What kind of information can the scientist determine from this test?**

**A** how closely related the species are

**B** which species are carnivores

**C** how the different species live

**D** what is the common ancestor for the species

Sample Test Item:
Process Objective: 2.1
**Content Objective: 3.1**
Depth-of-Knowledge: 2
Correct Response: C

## Characteristics of Four Organisms

| Type of Organism | Native to Africa? | Main Food Source | Number of Toes | Number of Chambers in Stomach | Number of Horns | Number of Days of Gestation |
|---|---|---|---|---|---|---|
| Goat | No | Grasses and leaves | 2 | 4 | 2 | 150 |
| Horse | No | Grasses | 1 | 1 | 0 | 270 |
| Giraffe | Yes | Leaves and twigs | 2 | 4 | 2 | 420 |
| Elephant | Yes | Many types of vegetation | 3 to 5 | 1 | 0 | More than 600 |

**According to the information in the table, which two types of organisms are <u>most closely</u> related?**

**A** horses and goats

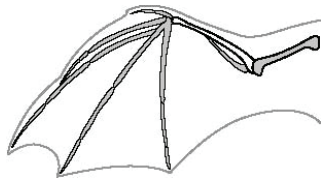
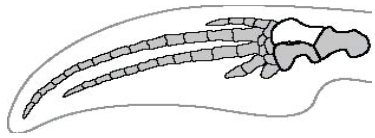
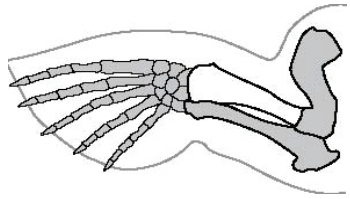
**B** giraffes and elephants

**C** giraffes and goats

**D** horses and elephants

Sample Test Item:
Process Objective: 2.1
**Content Objective: 3.1**
Depth-of-Knowledge: 2
Correct Response: B

## Characteristics of Three Organisms

| Organism | Forelimb Structure | Habitat | Diet |
|---|---|---|---|
| 1 |  | Trees | Fruit |
| 2 |  | Ocean | Fish |
| 3 |  | Ocean | Fish |

**Which statement is <u>most</u> accurate about the organisms in the table?**

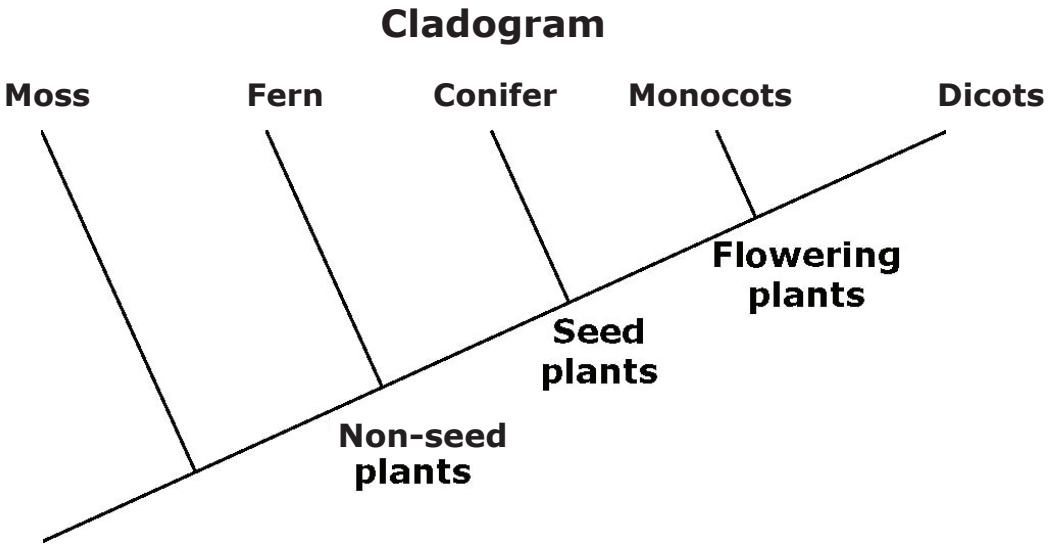
**A** The three organisms are related because they share analogous structures.

**B** The three organisms are related because they share homologous structures.

**C** Organisms 2 and 3 are the most closely related because they share the same habitat.

**D** Organisms 2 and 3 are the most closely related because they eat the same type of food.

Sample Test Item:
Process Objective: 2.2
**Content Objective: 3.1**
Depth-of-Knowledge: 3
Correct Response: D




**Which statement describes how the cladogram is organized?**

**A** The age of the species in each group increases from left to right.

**B** The size of the species in each group decreases from left to right.

**C** The number of species in each group decreases from left to right.

**D** The complexity of the species in each group increases from left to right.

**OAS Standard:**

Content Standard 3: Biological Diversity—Diversity of species is developed through gradual processes over many generations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 2: Characteristics of populations change through the mechanism of natural selection. These biological adaptations, including changes in structures, behaviors, and/or physiology, may enhance or limit survival and reproductive success within a particular environment.

**Item Specifications:**

Emphasis:

Populations of organisms adapt over time through natural selection. Biological adaptations are genetically determined.

Stimulus Attributes:

Items may include descriptions, illustrations, data tables, models, phylogenetic trees, cladograms, Venn diagrams, and graphs.

Format:

Assessable content includes:

1. Apply knowledge of natural selection in different contexts.
2. Compare/contrast variations within and between populations (including niches and biomass) using the process of natural selection.
3. Interpret, analyze, and/or evaluate information to determine how biological adaptations (e.g., changes in anatomical structures, behaviors, and physiology) enhance or deter survival and reproductive success in a particular environment.
4. Compare/contrast characteristics acquired during an organism's lifetime with the organism's characteristics as determined by natural selection.
5. Distinguish between short-term adjustment to environment and a biological adaptation.
6. Apply the concept that populations of organisms adapt over time.
7. Apply the concept that biological adaptations are determined genetically.
8. Identify ways in which organisms have responded physiologically to changes in the environment in order to survive.
9. Compare/contrast the mechanisms of natural selection (i.e., mass extinction, mutation, changes in gene frequency, variation within a species).
10. Distinguish between evolutionary patterns (i.e., showing convergent/divergent evolution) using phylogenic trees and cladograms, and interpret each type of model.

11. Apply the general idea that mutations occur randomly and are selected because they help some organisms survive and produce more offspring.
12. Identify structures, behaviors, or physiology between or among species, within the context of a biome, that would enhance or limit the survival and reproductive success in a specific environment (e.g., in the desert for water conservation, or in the Arctic tundra for resource acquisition, comparing an organism's adaptations to what is required to live in a biome).

Content Limits:

Non-assessable content includes:

1. Knowledge related to the specific chemical/molecular structure and/or chemical interaction that would be above the level of Biology I.
2. Describing man-made strategies used in conservation biology.
3. Relating success in protecting an endangered species to the methods used to protect it.
4. Specific details of biomes not related to the interactions between species or structures, behaviors or physiology (e.g., microclimates).

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Organisms deciding, attempting, or trying to adapt
2. Incorrect conclusions or predictions
3. Misconceptions relating to short term and long term adaptations (e.g., failure to make a conceptual connection between the occurrence of new variations in a population and the potential effect of those variations on long-term survival of the species)

Sample Test Item:
Process Objective: 4.1
**Content Objective: 3.2**
Depth-of-Knowledge: 2
Correct Response: D

**What would most likely happen to a population of rabbits if their environment experiences long-term climate change that results in much colder temperatures?**

**A** The rabbits would become extinct.

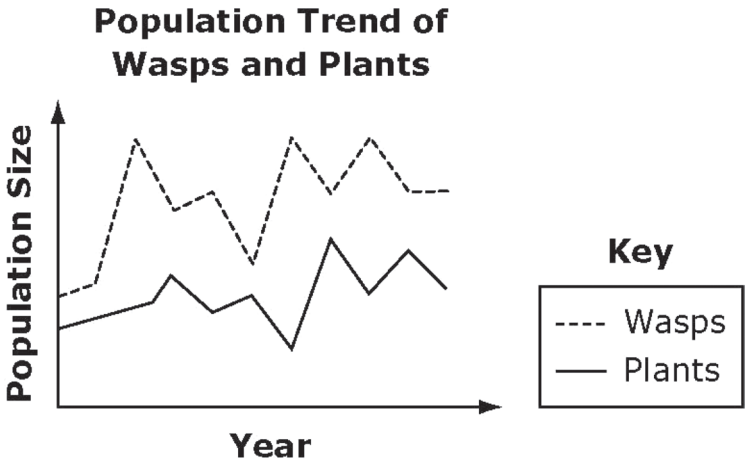
**B** The rabbits would start growing thicker coats.

**C** The rabbits would give birth to offspring with thicker coats.

**D** The rabbits with thicker coats would have greater reproductive success.

Sample Test Item:
Process Objective: 4.1
**Content Objective: 3.2**
Depth-of-Knowledge: 2
Correct Response: B

**A certain species of wasp is the only pollinator for a certain species of plant. The plant is the only source of food and shelter for the wasp. The graph shows the plant and wasp population trends.**




**Which will <u>most likely</u> happen to the plant population if an introduced disease kills all the wasps in a short period of time?**

**A** It will grow more slowly.

**B** It will become extinct.

**C** It will be pollinated by other species of wasps.

**D** It will change into a different species of plant.

Sample Test Item:
Process Objective: 4.1
**Content Objective: 3.2**
Depth-of-Knowledge: 3
Correct Response: D

**A scientist is studying three bird species that live on three different islands. Island 1 is much larger than Island 2 or Island 3. For each island, he records which species are present and the range of beak sizes for each species. Birds with larger beaks are able to eat larger seeds. His data are shown in the tables below.**

### Bird Species on Three Islands

| Island | Bird Species Present |
|---|---|
| 1 | Species X, Y, and Z |
| 2 | Species X |
| 3 | Species Y |

### Beak Sizes of Three Bird Species

| | Range in Size of Beaks (millimeters) | | |
|---|---|---|---|
| **Island** | **Species X** | **Species Y** | **Species Z** |
| 1 | 3–8 | 10–15 | 18–22 |
| 2 | 7–12 | | |
| 3 | | 7–12 | |

**Which statement is supported by the data in the tables?**

**A** The three species on Island 1 all originated from Species Z.

**B** Competition will soon cause Species Z to become extinct on Island 1.

**C** Predators of the bird species on Island 1 led to the different beak sizes.

**D** Competition between the bird species on Island 1 led to different feeding specializations.

**OAS Standard:**

Content Standard 3: Biological Diversity—Diversity of species is developed through gradual processes over many generations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 3: Broad patterns of behavior exhibited by animals have changed over time to ensure reproductive success. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses can be either innate or learned.

**Item Specifications:**

Emphasis:

Species display complex behaviors that ensure reproductive success.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, and/or graphs.

Format:

Assessable content includes:

1. Apply the concepts of innate and learned behaviors to survival and/or reproductive success.
2. Classify complex behavioral adaptations displayed by species as innate or learned to ensure reproductive success.
3. Describe how the following behaviors influence reproductive success (e.g., migration, hibernation, schooling, flocking, territoriality, mating rituals, and feeding behavior).
4. Predict an organism's behavioral responses to long-term environmental changes (e.g., plant tropisms, and migratory patterns).
5. Identify an organism's behavioral responses caused by interactions with the organism's own species and with other species (e.g., social behaviors, communication).

Content Limits:

Non-assessable content includes:

1. Knowledge related to the specific chemical/molecular structure and/or chemical interactions that would be above the level of Biology I.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Misinterpreting effect of behavior or reproductive success
2. Common misconceptions

Sample Test Item:
Process Objective: 2.2
**Content Objective: 3.3**
Depth-of-Knowledge: 2
Correct Response: D

**Joshua is studying the mating behavior of hanging flies. Female hanging flies typically require their male mates to bring them a gift, such as a moth to eat. Joshua raised a group of female and male hanging fly larvae in isolation from adult hanging flies. When these larvae became adults, the females also required a gift from their mates.**

**Which explanation is the best for this behavior?**

**A** The behavior is acquired randomly.

**B** The behavior is learned through imprinting.

**C** The behavior is learned through experience.

**D** The behavior is inherited through genes.

Sample Test Item:
Process Objective: 4.5
**Content Objective: 3.3**
Depth-of-Knowledge: 2
Correct Response: A

**A group of students studied the effect of an acidic environment on the survival of a certain organism.**

**Effect of pH Level on Survival of an Organism**

| pH | Environmental Conditions | Number of Surviving Individuals | | |
|---|---|---|---|---|
| | | **Day 1** | **Day 2** | **Day 3** |
| Acidic ↓ Neutral | W | 30 | 15 | 6 |
| | X | 30 | 15 | 13 |
| | Y | 30 | 25 | 20 |
| | Z | 30 | 27 | 26 |

**Why did the population of organisms decrease after Day 2 in environmental condition W?**

**A** This type of organism responded adversely to the acidic conditions.

**B** This type of organism responded positively to acidic conditions.

**C** This type of organism responded adversely to neutral conditions.

**D** This type of organism responded positively to neutral conditions.

Sample Test Item:
Process Objective: 4.4
**Content Objective: 3.3**
Depth-of-Knowledge: 2
Correct Response: B

**Helper birds are young birds that delay reproduction and instead help their parents raise more offspring. A researcher hypothesized that if a bird is a helper, then it will have higher reproductive rate than non-helper birds. The researcher observed many birds over the course of their lives. She found that helpers produced less offspring than non-helpers, but that those offspring were healthier and survived longer than offspring of non-helpers.**

**Based on these results, should the researcher accept or reject the hypothesis?**

**A** Accept, because helper birds had less offspring

**B** Reject, because non-helper birds had more offspring

**C** Accept, because helper birds had less healthy, shorter-lived offspring

**D** Reject, because non-helper birds had less healthy, shorter-lived offspring

Sample Test Item:
Process Objective: 4.5
**Content Objective: 3.3**
Depth-of-Knowledge: 2
Correct Response: D

**A biology class exposed three groups of 100 brine shrimp eggs to different levels of light and counted the number that hatched over the next three days.**

**Effect of Light on Hatching of Brine Shrimp Eggs**

| Group (100 eggs per group) | Light Exposure per Day (in hours) | Number of Hatched Brine Shrimp | | |
|---|---|---|---|---|
| | | Day 1 | Day 2 | Day 3 |
| A | 0 | 0 | 1 | 8 |
| B | 12 | 0 | 20 | 45 |
| C | 24 | 0 | 32 | 74 |

**Which statement correctly describes the effect of light on the hatching of brine shrimp eggs?**

**A** The minimal temperature for brine shrimp hatching was reached after 24 hours.

**B** No light exposure prevents brine shrimp eggs from hatching.

**C** After 72 hours the optimal temperature for hatching was reached.

**D** Longer light exposure causes fewer brine shrimp eggs to hatch.

**OAS Standard:**

Content Standard 4: The Interdependence of Organisms—Interdependence of organisms in an environment includes the interrelationships and interactions between and among organisms. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 1: Organisms both cooperate and compete in ecosystems (e.g., symbiotic relationships).

**Item Specifications:**

Emphasis:

Identify, analyze, or evaluate interactions within a species and between species.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, and/or graphs.

Format:

Assessable content includes:

1. Students will apply knowledge of the basic types of interactions between organisms.
2. Compare/Contrast the variations within and between populations (population, niche, habitat, community, and ecosystem) and the process of natural selection.
3. Classify relationships between organisms in an ecosystem (e.g., mutualism, parasitism, symbiosis, competition, predator-prey, and commensalism).
4. Analyze a biological model of given ecosystem.
5. Relate and identify interactions between species within the context of a biome (e.g., in the desert for water conservation or in Arctic tundra for resource acquisition).

Content Limits:

Non-assessable content includes:

1. Items will not require knowledge related to the specific chemical/molecular structure and/or chemical interaction that would be above the level of Biology I.
2. Specific details of biomes not related to interactions between species (e.g., microclimates).

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect relationships
2. Common misconceptions

Sample Test Item:
Process Objective: 4.5
**Content Objective: 4.1**
Depth-of-Knowledge: 2
Correct Response: D

**Two species, Species X and Species Y, are found living in a symbiotic relationship. In an experiment, 20 individuals of each species are grown together and 20 individuals of each species are grown apart.**

**Populations of Species X and Species Y After Experiment**

| Conditions | Number of Species X | Number of Species Y |
|---|---|---|
| Grown together | 20 | 20 |
| Grown apart | 20 | 10 |

**Which conclusion about the relationship between the two species is best supported by the data?**

**A** One species preys on the other species.

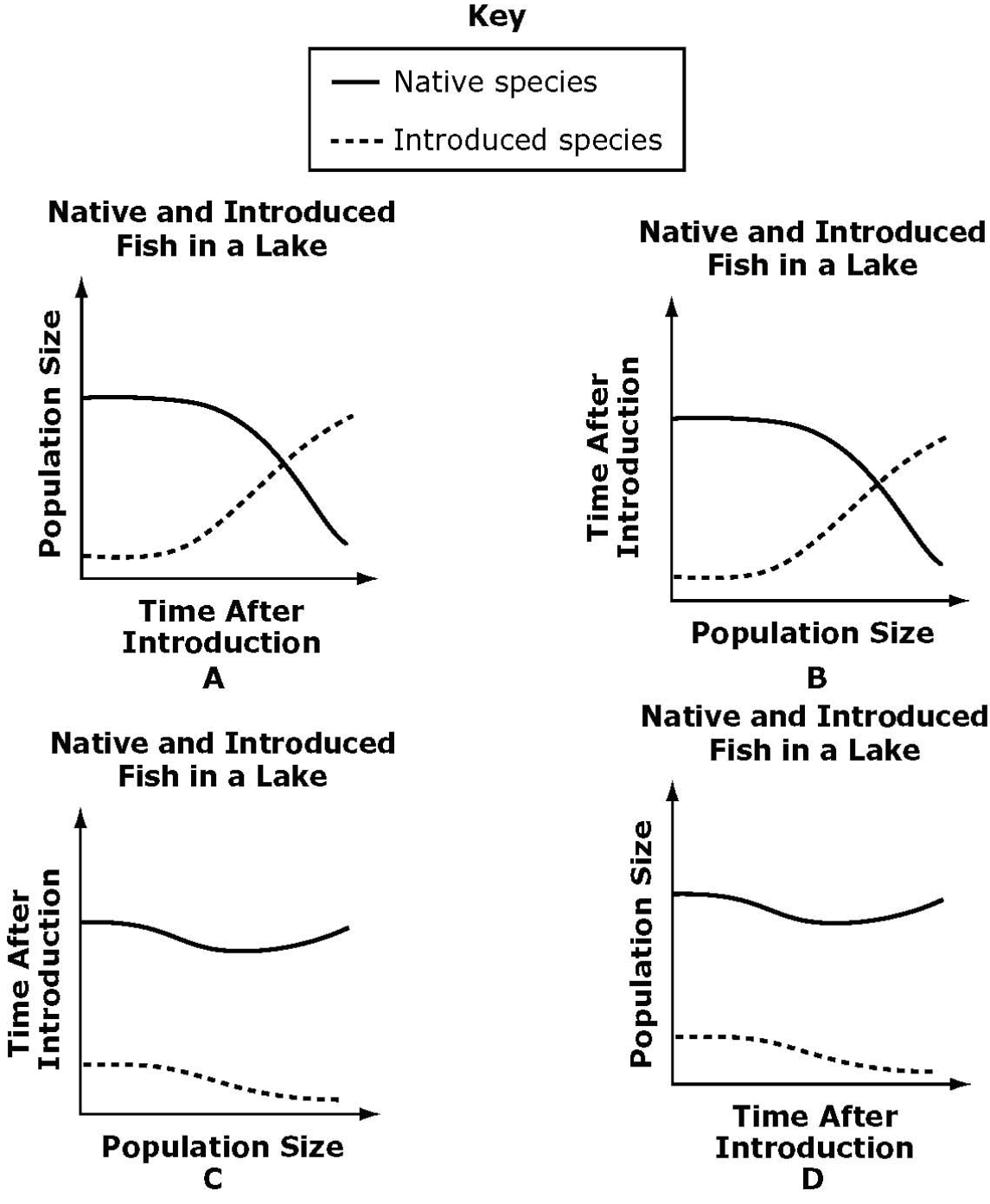
**B** Both species benefit from the relationship.

**C** One species benefits from the relationship while the other is harmed.

**D** One species benefits from the relationship while the other is not affected.

Sample Test Item:
Process Objective: 4.8
**Content Objective: 4.1**
Depth-of-Knowledge: 3
Correct Response: D

**Fishermen introduced a species of fish into a lake that already contained a native fish species. The two species competed for the same resources, but the native species was more successful. Which graph best shows what probably happened to the two species of fish?**



Sample Test Item:
Process Objective: 4.5
**Content Objective: 4.1**
Depth-of-Knowledge: 2
Correct Response: B

**Gulls will steal food directly from other birds, including oystercatchers. A researcher observed oystercatchers hunting for prey with and without gulls present.**

**Effect of Gulls on Oystercatcher Feeding**

| Gulls Present? | Prey Captured | Prey Eaten |
|---|---|---|
| Yes | 9 | 5 |
| No | 8 | 8 |

**Which conclusion about the gull-oystercatcher relationship is supported by the data?**

**A** Gulls and oystercatchers are harmed.

**B** Gulls benefit while oystercatchers are harmed.

**C** Gulls benefit and the oystercatchers are unaffected.

**D** Gulls and oystercatchers both benefit by cooperation.

**OAS Standard:**

Content Standard 4: The Interdependence of Organisms—Interdependence of organisms in an environment includes the interrelationships and interactions between and among organisms. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 2: Living organisms have the capacity to produce populations of infinite size, but environments and resources limit population size (e.g., carrying capacity, limiting factors, ecological succession).

**Item Specifications:**

Emphasis:

Identify, analyze, and evaluate factors affecting population size. Predict possible changes in populations. Calculate average population growth rate. Calculate population density at different carrying capacities.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, and/or graphs (including those making use of a broken axis).

Format:

Assessable content includes:

1. Interpret the population dynamics resulting in J-shaped and S-shaped growth curves.
2. Predict possible changes to population based on environmental factors, immigration, emigration, and colonization.
3. Describe how populations are limited (e.g., predation, food supply, and change in habitat).
4. Identify factors that limit an environment's biotic potential.
5. Identify the impact of the following terms on population size: carrying capacity, natality (birth rate), mortality (death rate), immigration, emigration, and population density.
6. Explain the predator-prey relationship in terms of limiting factors for populations.
7. Predict possible changes in populations (e.g., percentage growth rate).
8. Identify and analyze factors related to ecological succession that would have an effect upon population size, and/or an ecosystem's carrying capacity.
9. Apply the appropriate mathematical calculations and/or reasoning related to changes in population size. Refer to page 48.

Content Limits:

Non-assessable content includes:

1. Compare the age structure of rapidly growing, slow-growing and no-growth countries.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect relationships
2. Common misconceptions
3. Misinterpretations of graphics
4. Miscalculations

Sample Test Item:
Process Objective: 4.5
**Content Objective: 4.2**
Depth-of-Knowledge: 1
Correct Response: C

**A scientist is growing cells in a solution containing water, amino acids, sugar, and salts. Just before the cells stop growing, the sugar in the solution runs out. If more sugar is added, the cells will continue to grow.**

**Which role does the sugar have in this system?**

**A** control

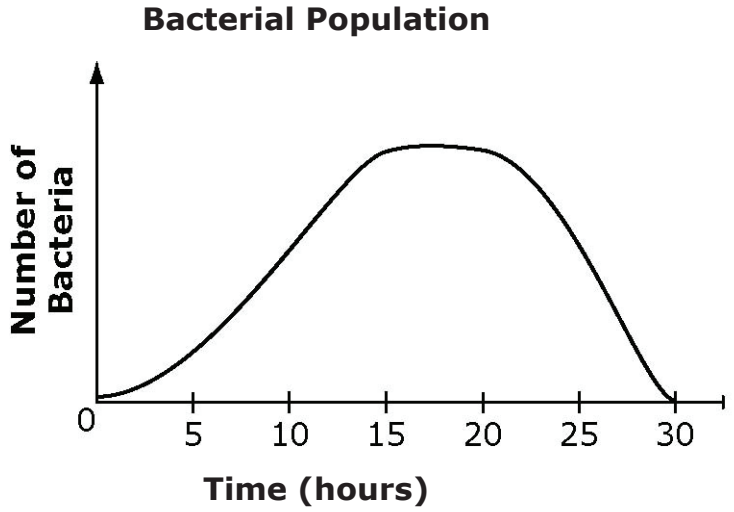
**B** producer

**C** limiting factor

**D** dependent variable

Sample Test Item:
Process Objective: 4.3
**Content Objective: 4.2**
Depth-of-Knowledge: 2
Correct Response: B

**Julia is monitoring the growth of a bacterial population in a 50-mL flask.**




**According to the graph, the population reached the carrying capacity of its environment in about**

**A** 10 hours.

**B** 15 hours.

**C** 20 hours.

**D** 30 hours.

Sample Test Item:
Process Objective: 3.2
**Content Objective: 4.2**
Depth-of-Knowledge: 2
Correct Response: B

**A rabbit population in a grassland ecosystem is kept well below carrying capacity by its primary predator, the coyote. A disease causes a decrease in the coyote population. A biologist will study how the disease affects the coyotes and rabbits. He hypothesizes that if the coyote population continues to decrease, then the rabbit population will exceed carrying capacity.**

**Which of these is a dependent variable in this study?**

**A** the carrying capacity

**B** the rabbit population

**C** the introduction of the disease

**D** the introduction of a new predator

**OAS Standard:**

Content Standard 5: Matter, Energy, and Organization in Living Systems—Living systems require a continuous input of energy to maintain their chemical and physical organizations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 1: The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism (i.e., photosynthesis and cellular respiration).

**Item Specifications:**

Emphasis:

The basic processes of photosynthesis and respiration and the relationship between the two processes. All organisms use cellular respiration to obtain energy from food.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, and/or graphs.

Format:

Assessable content includes:

1. Students will apply knowledge of photosynthesis and respiration in different contexts.
2. Items will focus on photosynthesis and cellular respiration—the need to make food and release energy from food and the basic steps in these processes.
3. Identify why organisms need energy and how they obtain it.
4. Evaluate the importance of energy to living things.
5. Compare and contrast the basic processes and equations of photosynthesis and cellular respiration. Photosynthesis requires light, carbon dioxide ($CO_2$), chlorophyll, and water ($H_2O$), which produces oxygen ($O_2$) and glucose ($C_6H_{12}O_6$). Respiration requires glucose ($C_6H_{12}O_6$) and oxygen ($O_2$) which produces carbon dioxide ($CO_2$), water ($H_2O$), and releases energy (ATP).
6. Analyze factors that affect photosynthesis (e.g., temperature, wave length, and concentration of gases).
7. Apply knowledge of the role of cellular respiration and photosynthesis in conservation and cycling of matter and energy.
8. Apply the concept that all energy available to living things ultimately relies on the sun.
9. Differentiate between the reactants and products of photosynthesis and cellular respiration.

Content Limits:
Non-assessable context includes:

1. ATP - Chemical composition of, formation and breaking down ATP.
2. Formation of ADP.
3. Specifics of the citric acid cycle.
4. Organic compounds and chemical reactions outside of the basic equations for photosynthesis and cellular respiration.
5. Specifics of the Calvin cycle and how $CO_2$ is used to make glucose.
6. Comparing and contrasting aerobic and anaerobic respiration.
7. Types of chemical bonds between the atoms of carbon-containing molecules.
8. Balancing of chemical equations.

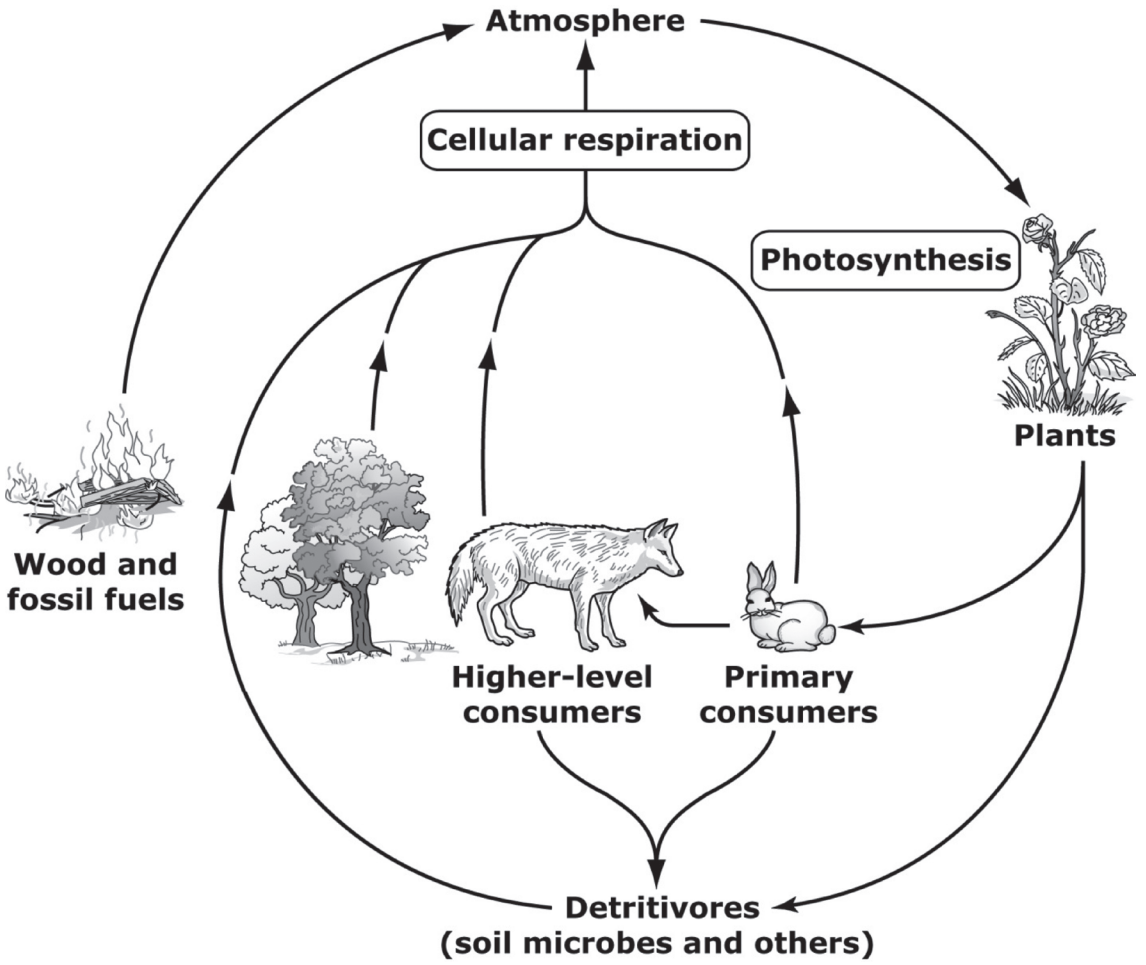
Process Objectives May Include:
Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Common misconceptions (e.g., plant cells do not respire, living systems do not require a continuous input of energy to maintain their chemical and physical organizations)
2. Incorrect relationships between cellular respiration and photosynthesis.

Sample Test Item:
Process Objective: 5.1
**Content Objective: 5.1**
Depth-of-Knowledge: 2
Correct Response: A

**The model below shows how carbon is recycled in ecosystems.**




**Which best explains how plants contribute to this cycle?**

**A** Plants combine carbon dioxide and water to make food.

**B** Plants obtain their food energy directly from the soil.

**C** Plants convert carbon dioxide into chlorophyll.

**D** Plants combine carbon dioxide and oxygen to make food.

Sample Test Item:
Process Objective: 3.2
**Content Objective: 5.1**
Depth-of-Knowledge: 3
Correct Response: A

**Molly grew four bean plants in pots with the same soil and provided each with an equal amount of light. She gave each plant different amounts of the reactants involved in photosynthesis. She then measured the amount of gas produced by each plant and their increase in height over a few weeks.**

**An independent variable in Molly's experiment is the amount of**

**A** water given to each plant.

**B** height gained by each plant.

**C** oxygen produced by each plant.

**D** carbon dioxide produced by each plant.

**OAS Standard:**

Content Standard 5: Matter, Energy, and Organization in Living Systems—Living systems require a continuous input of energy to maintain their chemical and physical organizations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 2: As matter and energy flow through different levels of organization of living systems and between living systems and the physical environment, chemical elements are recombined in different ways by different structures. Matter and energy are conserved in each change (i.e., water cycle, carbon cycle, nitrogen cycle, food webs, and energy pyramids).

**Item Specifications:**

Emphasis:

Energy and matter are conserved in various levels of organization as they are transferred from one component of the biosphere to another.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, Venn diagrams, and/or graphs.

Format:

Assessable content includes:

1. Students will apply knowledge of how matter and energy are transferred in different scenarios.
2. Compare/contrast between autotrophs and heterotrophs.
3. Compare/contrast among producer and consumer (i.e., herbivores, carnivores, omnivores, and decomposers).
4. Apply the concepts of matter and energy flow through ecosystems as chemical elements are recombined and matter and energy are conserved (i.e., water cycles, carbon cycles, nitrogen cycle, food webs, food chains, and energy pyramids).
5. Calculate and analyze the amount of energy available in any given component of the biosphere (e.g., trophic levels [primary/1st level, secondary/2nd level, tertiary/3rd level, and quaternary/4th level], 10% rule, energy pyramid, biomass, and food chain).
6. Interpret a model illustrating the direction of energy flow through the biogeochemical cycles (i.e., carbon, water, and nitrogen cycles).
7. Explain the effect of changes of the components of biogeochemical processes (i.e., water, carbon, and nitrogen cycles; process of eutrophication) on or between living systems and the physical environment.
8. Apply the concepts of Conservation of Matter and Energy to the processes of photosynthesis and cellular respiration.

9. Recognize and associate the symbols and formulas with the appropriate biochemical process. Refer to page 48.

Content Limits:

Non-assessable content includes:

1. Stating the laws of thermodynamics.
2. Knowledge related to the specific chemical/molecular structure and/or chemical interaction that would be above the level of Biology I.
3. Balancing of chemical equations.

Process Objectives May Include:

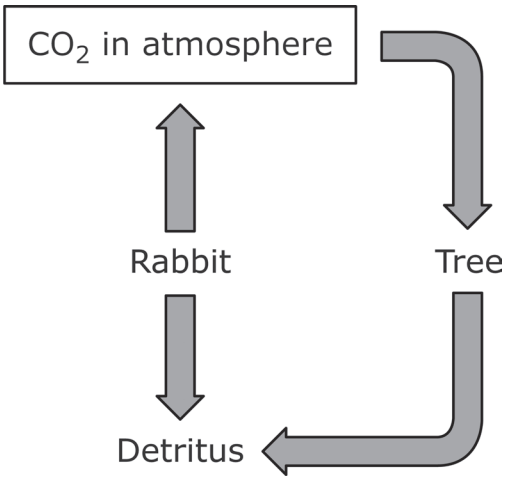
Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect interpretations
2. Common misconceptions

Sample Test Item:
Process Objective: 5.1
**Content Objective: 5.2**
Depth-of-Knowledge: 2
Correct Response: A

**Water Cycle**




**How is carbon from the rabbit cycled to the tree?**

**A** cellular respiration, then photosynthesis

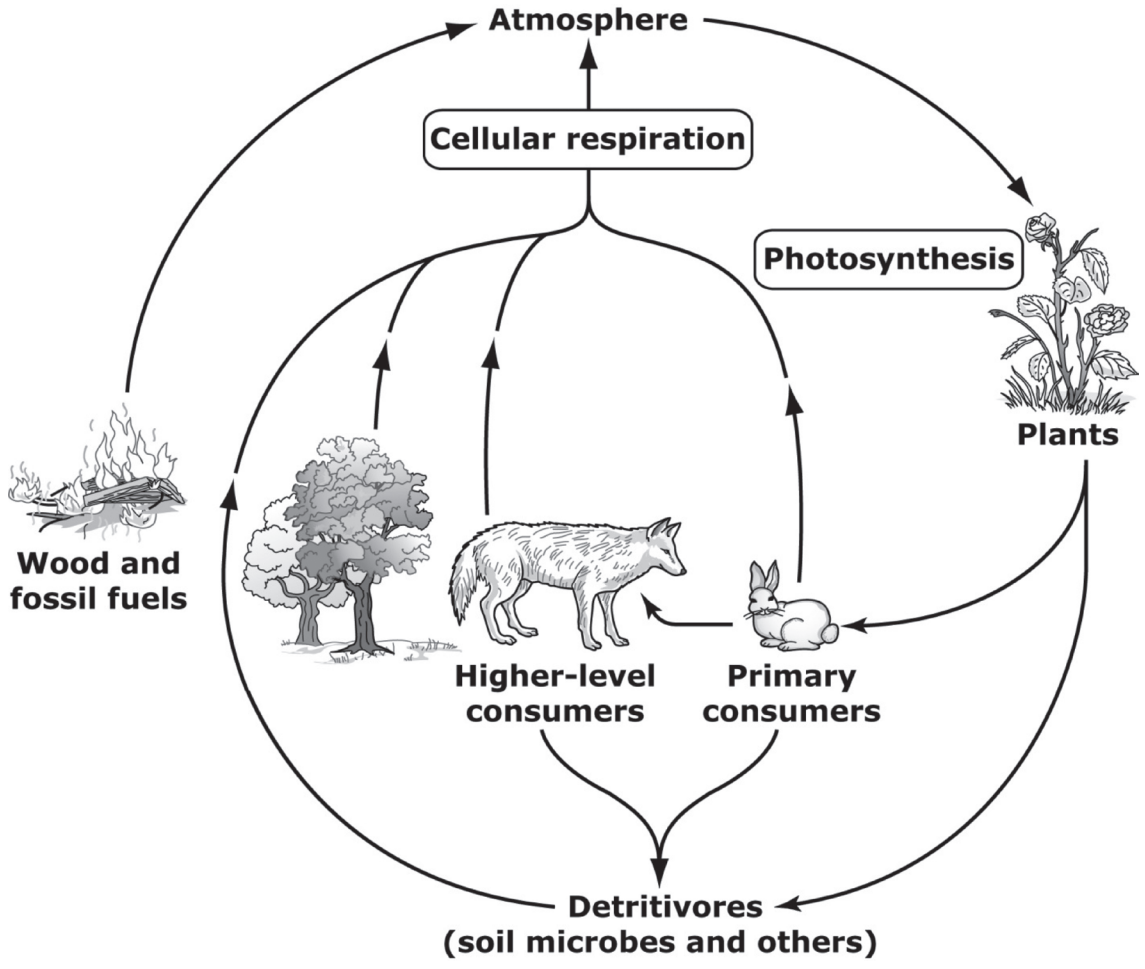
**B** cellular respiration, then decomposition

**C** transpiration, then cellular respiration

**D** transpiration, then photosynthesis

Sample Test Item:
Process Objective: 5.2
**Content Objective: 5.2**
Depth-of-Knowledge: 2
Correct Response: C

**Below is a diagram of the carbon cycle.**




**If a change in climate caused a large number of trees and plants to die, how would soil microbes initially be affected?**

**A** Soil microbes would convert more carbon dioxide into food.

**B** Soil microbes would convert less carbon dioxide into food.

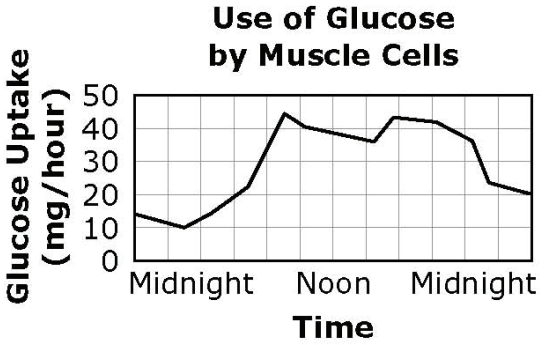
**C** Soil microbes would release more carbon dioxide into the atmosphere.

**D** Soil microbes would release less carbon dioxide into the atmosphere.

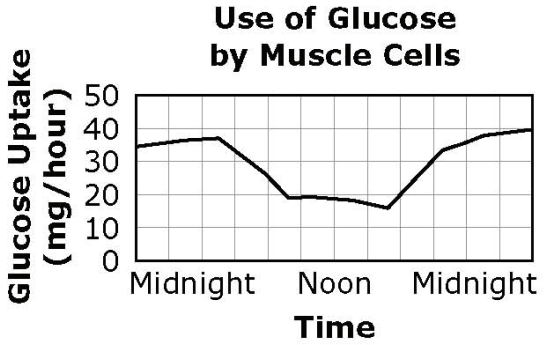
Sample Test Item:
Process Objective: 4.8
**Content Objective: 5.2**
Depth-of-Knowledge: 2
Correct Response: B

**As nocturnal animals, opossums are most active at night.**

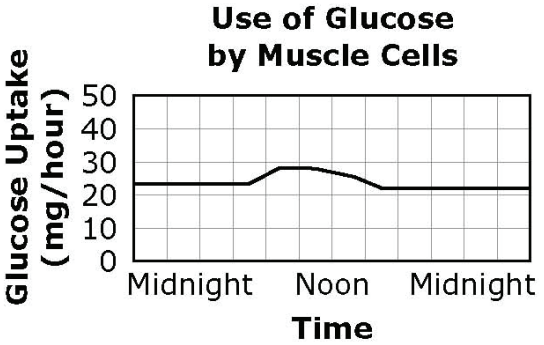
**Which graph accurately shows the use of glucose, a food molecule used in respiration, by an opossum's muscle cells over a twenty-four hour period?**



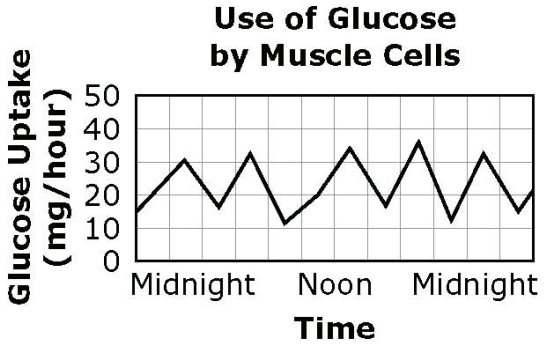

**A**




**B**




**C**




**D**

**OAS Standard:**

Content Standard 5: Matter, Energy, and Organization in Living Systems—Living systems require a continuous input of energy to maintain their chemical and physical organizations. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:

**OAS Objective:**

Content Objective 3: Matter on earth cycles among the living (biotic) and nonliving (abiotic) components of the biosphere.

**Item Specifications:**

Emphasis:

All matter is conserved and cycles repeatedly between the biotic and abiotic systems within the biosphere.

Stimulus Attributes:

Items may include descriptions, illustrations, models, data tables, Venn diagrams, and/or graphs.

Format:

Assessable content includes:

1. Describe biogeochemical processes, function of decomposers, and cycling of nutrients.
2. Apply the concept that all matter is conserved and it is cycled repeatedly between the biotic and abiotic systems within a biosphere.
3. Analyze a diagram to identify or classify the living and nonliving components of the biosphere.
4. Explain the effect of cyclic changes in the biosphere.
5. Understand and identify the processes involved in the movement of matter between living and nonliving components of the biosphere.
6. Predict a probable outcome of changing the conditions within a cycle.
7. Identify the processes of photosynthesis and cellular respiration as either a part of the biotic and abiotic cycles.

Content Limits:

Non-assessable content includes:

1. Items will not require knowledge related to the specific chemical/molecular structure and/or chemical interaction that would be above the level of Biology I.

Process Objectives May Include:

Items may be written to assess any of the process objectives, except for P3.5.

Distractor Domain:

1. Incorrect relationships between the biotic and abiotic components of the biosphere
2. Energy flow through an ecosystem in the wrong direction
3. Common misconceptions

Sample Test Item:
Process Objective: 2.2
**Content Objective: 5.3**
Depth-of-Knowledge: 1
Correct Response: C

**All elements in an ecosystem can be classified as biotic or abiotic. Which statement uses the term "biotic" or "abiotic" correctly?**

**A** Biotic factors in a river include flow rate and water depth.

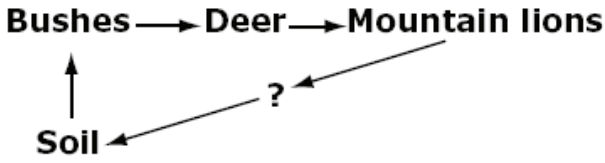
**B** Abiotic factors in a grassland include cattle grazing and predation.

**C** Abiotic factors in a corn field include rainfall and soil temperature.

**D** Biotic factors in a lake include water temperature and oxygen content.

Sample Test Item:
Process Objective: 5.1
**Content Objective: 5.3**
Depth-of-Knowledge: 1
Correct Response: D

**The diagram below shows the movement of matter from the soil to mountain lions in an ecosystem.**




**What type of organism is primarily responsible for recycling matter from mountain lions' bodies back to the soil?**

**A** herbivores

**B** omnivores

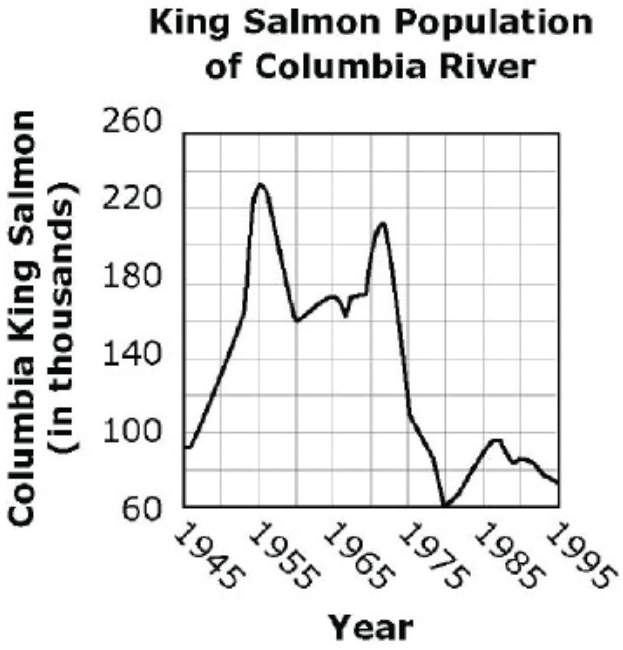
**C** producers

**D** decomposers

Sample Test Item:
Process Objective: 1.1
**Content Objective: 5.3**
Depth-of-Knowledge: 3
Correct Response: B

**A team of biologists studied how changes in climate affected the Columbia River king salmon population over a fifty-year period.**

**Climate Conditions in Columbia River Region, 1945-1995**




| Time Period | Temperature | Rainfall |
|---|---|---|
| 1945–1955 | Cool | High |
| 1956–1965 | Average | Average |
| 1966–1975 | Cool | High |
| 1976–1985 | Warm | Low |
| 1986–1995 | Average | Low |

**What were the climate conditions when the salmon population was lowest?**

**A** cool temperatures and high rainfall
**B** warm temperatures and low rainfall
**C** average temperatures and low rainfall
**D** average temperatures and average rainfall