WHAT STUDENTS DO: Generate Criteria for Living vs. Non-Living.

In Part A, students will use research to develop their criteria for determining if something is alive. The class will combine their ideas in a teacher-guided discussion. In Part B, they will then use their criteria to determine whether there is anything alive in three different soil samples. They will make observations and draw pictures as they collect data from the sample and investigation. The purpose of this lesson is for students to use a critical thinking and a collaborative approach to identifying and applying the criteria needed for life. Students will:

• Use scientific observations to establish criteria;
• Differentiate between living and non-living objects; and
• Attribute criteria as Earth-based definitions of life.

NGSS CORE & COMPONENT QUESTIONS

HOW AND WHY DO ORGANISMS INTERACT WITH THEIR ENVIRONMENT AND WHAT ARE THE EFFECTS OF THESE INTERACTIONS?
NGSS Core Question: LS2: Ecosystems: Interactions, Energy, and Dynamics

HOW CAN ONE EXPLAIN THE STRUCTURE, PROPERTIES, AND INTERACTIONS OF MATTER?
NGSS Core Question: PS1: Matter and It's Interactions

Students will be able
IO1: to conduct and investigation to generate a list of criteria for determining if something is alive

How do matter and energy move through an ecosystem?
NGSS LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?
NGSS PS1.B: Chemical Reactions
1.0 About This Activity

Mars lessons leverage *A Taxonomy for Learning, Teaching, and Assessing* by Anderson and Krathwohl (2001) (see Section 4 and Teacher Guide at the end of this document). This taxonomy provides a framework to help organize and align learning objectives, activities, and assessments. The taxonomy has two dimensions. The first dimension, cognitive process, provides categories for classifying lesson objectives along a continuum, at increasingly higher levels of thinking; these verbs allow educators to align their instructional objectives and assessments of learning outcomes to an appropriate level in the framework in order to build and support student cognitive processes. The second dimension, knowledge, allows educators to place objectives along a scale from concrete to abstract. By employing Anderson and Krathwohl's (2001) taxonomy, educators can better understand the construction of instructional objectives and learning outcomes in terms of the types of student knowledge and cognitive processes they intend to support. All activities provide a mapping to this taxonomy in the Teacher Guide (at the end of this lesson), which carries additional educator resources.

Combined with the aforementioned taxonomy, the lesson design also draws upon Miller, Linn, and Gronlund’s (2009) methods for (a) constructing a general, overarching, instructional objective with specific, supporting, and measurable learning outcomes that help assure the instructional objective is met, and (b) appropriately assessing student performance in the intended learning-outcome areas through rubrics and other measures.

*How Students Learn: Science in the Classroom* (Donovan & Bransford, 2005) advocates the use of a research-based instructional model for improving students’ grasp of central science concepts. Based on conceptual-change theory in science education, the 5E Instructional Model (BSCS, 2006) includes five steps for teaching and learning: Engage, Explore, Explain, Elaborate, and Evaluate. The Engage stage is used like a traditional warm-up to pique student curiosity, interest, and other motivation-related behaviors and to assess students’ prior knowledge. The Explore step allows students to deepen their understanding and challenges existing preconceptions and misconceptions, offering alternative explanations that help them form new schemata. In Explain, students communicate what they have learned, illustrating initial conceptual change. The Elaborate phase gives students the opportunity to apply their newfound knowledge to novel situations and supports the reinforcement of new schemata or its transfer. Finally, the Evaluate stage serves as a time for students’ own formative assessment, as well as for educators’ diagnosis of areas of confusion and differentiation of further instruction. The 5E stages can be cyclical and iterative.
2.0 Instructional Objectives, Learning Outcomes, & Standards

Instructional objectives and learning outcomes are aligned with

- Achieve Inc.’s, *Next Generation Science Standards (NGSS)*
- National Governors Association Center for Best Practices (NGA Center) and Council of Chief State School Officers (CCSSO)’s, *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects*

The following chart provides details on alignment among the core and component NGSS questions, instructional objectives, learning outcomes, and educational standards.

- Your **instructional objectives (IO)** for this lesson align with the NGSS Framework and NGSS.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO)**.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics** (see Teacher Guide at the end of this lesson).

**Quick View of Standards Alignment:**

The Teacher Guide at the end of this lesson provides full details of standards alignment, rubrics, and the way in which instructional objectives, learning outcomes, 5E activity procedures, and assessments were derived through, and align with, Anderson and Krathwohl’s (2001) taxonomy of knowledge and cognitive process types. For convenience, a quick view follows:
HOW AND WHY DO ORGANISMS INTERACT WITH THEIR ENVIRONMENT AND WHAT ARE THE EFFECTS OF THESE INTERACTIONS?
NGSS Core Question: LS2: Ecosystems: Interactions, Energy, and Dynamics

HOW CAN ONE EXPLAIN THE STRUCTURE, PROPERTIES, AND INTERACTIONS OF MATTER?
NGSS Core Question: PS1: Matter and It’s Interactions

How do matter and energy move through an ecosystem?
NGSS LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?
NGSS PS1.B: Chemical Reactions

<table>
<thead>
<tr>
<th>Instructional Objective</th>
<th>Learning Outcomes</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able</td>
<td>Students will demonstrate the measurable abilities</td>
<td>Students will address</td>
</tr>
<tr>
<td>IO1:</td>
<td></td>
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<tr>
<td>to conduct an investigation to generate a list of criteria for determining if something is alive</td>
<td>LO1a. to use scientific observations of phenomena to guide the criteria development</td>
<td>NSES (A): Science as Inquiry: Abilities Necessary to Do Scientific Inquiry Grades 5-8: A1c, A1d, A1e</td>
</tr>
<tr>
<td></td>
<td>LO1b. to differentiate and justify between living and non-living objects</td>
<td>NSES (C): Life Science Characteristics of Organisms Grades 5-8: C1c</td>
</tr>
<tr>
<td></td>
<td>LO1c. to attribute the established criteria to life as we know it on Earth</td>
<td>NGSS Disciplinary Core Idea: LS2.B: Cycles of Matter and Energy Transfer in Ecosystems PS1.B: Chemical Reactions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NGSS Practices: Planning and Carrying out Investigations Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Engaging in Argument from Evidence Scientific Knowledge is Open to Revision in Light of the New Evidence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NGSS Cross-Cutting Concept: Cause and Effect Scale, Proportion and Quantity Systems and System Models Energy and Matter Stability and Change Science Addresses Questions About the Natural and Material World</td>
</tr>
</tbody>
</table>
3.0 Learning Outcomes, NGSS, Common Core, & 21st Century Skills Connections

The connections diagram is used to organize the learning outcomes addressed in the lesson to establish where each will meet the Next Generation Science Standards, ELA Common Core Standards, and the 21st Century Skills and visually determine where there are overlaps in these documents.

LO1b: to differentiate and justify between living and non-living objects

LO1a: to use scientific observations of phenomena to guide the criteria development

LO1c: to attribute the established criteria to life as we know it on Earth

Next Generation Science Standards

Common Core

The Partnership for 21st Century Skills
4.0 Evaluation/Assessment

Rubric: A rubric has been provided to assess student understanding of the simulation and to assess metacognition. A copy has been provided in the Student Guide for students to reference prior to the simulation. This rubric will allow them to understand the expectations set before them.

5.0 References

Achieve, Inc. (2013). Next generation science standards. Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS.


IS IT ALIVE?

(L) Teacher Resource. Is It Alive? Rubric (1 of 3)

You will know the level to which your students have achieved the Learning Outcomes, and thus the Instructional Objective(s), by using the suggested Rubrics below.

Instructional Objective 1: To conduct an investigation to generate a list of criteria for determining if something is alive

Related Standard(s)

National Science Education Standards (NSES)
(A) Science as Inquiry: Abilities Necessary to Do Scientific Inquiry
Use data to construct a reasonable explanation (Grades 5-8: A1d).
Communicate investigations and explanations (Grades 5-8: A1e).

Develop description, explanations, predictions, and models using evidence (Grades 5-8: A1d). Think critically and logically to make the relationships between evidence and explanations (Grades 5-8: A1e).

National Science Education Standards (NSES)
(C) Life Science: Characteristics of Organisms
All organisms are composed of cells—the fundamental unit of life. Most organisms are single cells; other organisms, including humans, are multicellular (Grades 5-8: C1b). Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs (Grades 5-8: C1c).

This lesson supports the preparation of students toward achieving Performance Expectations using the Practices, Cross-Cutting Concepts and Disciplinary Core Ideas defined below: (5-LS2-1); (5-PS1-4)

Next Generation Science Standards (NGSS)
Practices: Planning and Carrying out Investigations- Grades 3-5
(Learning Outcomes Addressed: LO1a)

• Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Next Generation Science Standards (NGSS)
Practices: Analyzing and Interpreting Data – Grades 3-5
(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

• Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
Next Generation Science Standards (NGSS) Practices: Constructing Explanations and Designing Solutions – Grades 3-5 (Learning Outcomes Addressed: LO1b, LO1c)

• Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
• Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
• Identify the evidence that supports particular points in an explanation.

Next Generation Science Standards (NGSS) Practices: Engaging in Argument from Evidence – Grades 3-5 (Learning Outcomes Addressed: LO1b, LO1c)

• Compare and refine arguments based on an evaluation of the evidence presented.
• Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.
• Construct and/or support an argument with evidence, data, and/or a model.
• Use data to evaluate claims about cause and effect.

Next Generation Science Standards (NGSS) Practices: Scientific Knowledge is Open to Revision in Light of New Evidence – Grades 3-5 (Learning Outcomes Addressed: LO1b, LO1c)

• Science findings are based on recognizing patterns.
• Scientists use tools and technologies to make accurate measurements and observations.

Next Generation Science Standards (NGSS) Cross-Cutting Concepts: Cause and Effect – Grades 3-5 (Learning Outcomes Addressed: LO1a, LO1b)

• Students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship.
Next Generation Science Standards (NGSS)  
Cross-Cutting Concepts: Scale, Proportion and Quantity – Grades 3-5  
(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

• Students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume.

Next Generation Science Standards (NGSS)  
Cross-Cutting Concepts: Systems and System Models – Grades 3-5  
(Learning Outcomes Addressed: LO1b, LO1c)

• Students understand that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. They can also describe a system in terms of its components and their interactions.

Next Generation Science Standards (NGSS)  
(Learning Outcomes Addressed: LO1a)

• Students learn matter is made of particles and energy can be transferred in various ways and between objects. Students observe the conservation of matter by tracking matter flows and cycles before and after processes and recognizing the total weight of substances does not change.

Next Generation Science Standards (NGSS)  
Cross-Cutting Concepts: Stability and Change – Grades 3-5  
(Learning Outcomes Addressed: LO1a, LO1b)

• Students measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change.

Next Generation Science Standards (NGSS)  
Cross-Cutting Concepts: Science Addresses Questions about the Natural an Material World – Grades 3-5  
(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

• Science findings are limited to what can be answered with empirical evidence.

Next Generation Science Standards (NGSS)  
Disciplinary Core Idea: LS2.B: Cycles of Matter and Energy Transfer in Ecosystems  
(Learning Outcomes Addressed: LO1b, LO1c)

• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment,
and release waste matter (gas, liquid, or solid) back into the environment.

**Next Generation Science Standards (NGSS)**
**Disciplinary Core Idea: PS1.B: Chemical Reactions**
(Learning Outcomes Addressed: LO1a, LO1b)

- When two or more different substances are mixed, a new substance with different properties may be formed.

**Common Core State Standards**
**Writing Standards Grade 5: Text Types and Purposes**
(Learning Outcomes Addressed: LO1b)

- Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
  a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.
  b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.
  c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially).
  d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
  e. Provide a concluding statement or section related to the information or explanation presented.

**Common Core State Standards**
**Speaking and Listening Standards Grade 5: Comprehension and Listening**
(Learning Outcomes Addressed: LO1a)

- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others’ ideas and expressing their own clearly.
  o Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
  o Follow agreed-upon rules for discussions and carry out assigned roles.
  o Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
  o Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

**21st Century Skills**
**Critical Thinking and Problem Solving**
(Learning Outcomes Addressed: LO1a, LO1c)
• Students plan and conduct scientific investigations and write detailed explanations based on their evidence. Students compare their explanations to those made by scientists and relate them to their own understandings of the natural and designed worlds. (Grade 8 Benchmark)

21st Century Skills Collaboration
(Learning Outcomes Addressed: LO1a)

• Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning. (Grade 8 Benchmark)
# IS IT ALIVE?

**Teacher Resource. Is it Alive? Rubric (1 of 3)**

## Learning Outcomes Assessment:

<table>
<thead>
<tr>
<th>LO1a: to use scientific observations of phenomena to guide the criteria development</th>
<th>Expert</th>
<th>Proficient</th>
<th>Intermediate</th>
<th>Beginner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria list correlates to specific scientific observations and inferences made during exploration.</td>
<td>Criteria list correlates to scientific observations made during exploration.</td>
<td>Criteria list correlates to scientific observations and misinterpretations</td>
<td>Criteria list correlates to student preconceptions and misinterpretations</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO1b: to differentiate and justify between living and non-living objects</th>
<th>Expert</th>
<th>Proficient</th>
<th>Intermediate</th>
<th>Beginner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria list is used to correctly identify living organisms vs. non-living objects and further discriminates objects that are “close” to living, but not meeting all of the criteria, as non-living</td>
<td>Criteria list is used to correctly identify living organisms vs. non-living objects.</td>
<td>Criteria list is loosely used to identify living organisms vs. non-living objects.</td>
<td>Identification of living vs. non-living is based on preconceptions such as movement, having eyes, talking and eating.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO1c: to attribute the established criteria to life as we know it on Earth</th>
<th>Expert</th>
<th>Proficient</th>
<th>Intermediate</th>
<th>Beginner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoughtful examples are given of objects on Earth that do not meet the criteria of living based on Earth’s standards. Recognizes that new “objects” may redefine the criteria used to identify “living”</td>
<td>Examples of objects on Earth that do not meet the criteria of living based on Earth’s standards are recorded. Recognizes that new “objects” may redefine the criteria used to identify “living”</td>
<td>Examples of objects on Earth that do not meet the criteria of living based on Earth’s standards are recorded.</td>
<td>Identification examples of living vs. non-living is based on preconceptions such as movement, having eyes, talking and eating.</td>
<td></td>
</tr>
</tbody>
</table>
### Partnership for 21st Century Skills

<table>
<thead>
<tr>
<th>Expert</th>
<th>Proficient</th>
<th>Intermediate</th>
<th>Beginner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness of collaboration with team members and class.</td>
<td>Extremely interested in collaborating in the simulation. Actively provides solutions to problems, listens to suggestions from others, attempts to refine them, monitors group progress, and attempts to ensure everyone has a contribution.</td>
<td>Extremely interested in collaborating in the simulation. Actively provides suggestions and occasionally listens to suggestions from others. Refines suggestions from others.</td>
<td>Interested in collaborating in the simulation.</td>
</tr>
<tr>
<td>Effectiveness of critical thinking</td>
<td>Develops detailed explanations based on credible evidence. Compares explanations to those made by scientists and relates them to their own understandings of the geology.</td>
<td>Develops detailed explanations based on credible evidence. Relates them to their own understandings of the geology.</td>
<td>Attempts to explain the geology based on own understanding of geology.</td>
</tr>
</tbody>
</table>
### Common Core – ELA

<table>
<thead>
<tr>
<th>Text Types and Purpose</th>
<th>Expert</th>
<th>Proficient</th>
<th>Intermediate</th>
<th>Beginner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduces topic clearly, provides a general observation and focus, and groups related information logically; Develops the topic with facts, definitions, concrete details, or other examples related to the topic; Links ideas using words, phrases, and clauses; Use domain-specific vocabulary to explain the topic; Provides a concluding statement related to the explanation.</td>
<td>Introduces topic clearly, provides a general observation, or groups related information logically; Develops the topic with concrete details, or other examples related to the topic; Links ideas using words or phrases; Uses domain-specific vocabulary to explain the topic; Provides a concluding statement related to the explanation.</td>
<td>Introduces topic, provides a general observation; Develops the topic with details, or other examples related to the topic; Links ideas using words or phrases; Uses domain-specific vocabulary to explain the topic; Provides a concluding statement related to the explanation.</td>
<td>Introduces topic; Develops the topic with details, or other examples, potentially unrelated; Uses specific vocabulary to explain the topic; May or may not provide a concluding statement.</td>
<td></td>
</tr>
</tbody>
</table>

| Effective Demonstration of Comprehension and Collaboration | | |
|---|---|---|---|
| Clearly articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Extremely prepared drawing from experiences. Asks clarifying questions to ensure full understanding of content. Articulates own ideas related to the discussion and connects others ideas to own. | Articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Prepared for discussion by drawing from experiences. Asks questions. Articulates own ideas related to the discussion. | Interested in collaborative discussion. Asks questions. Articulates own ideas related to the discussion. | Interested in collaboration with peers. |
This lesson adapts Anderson and Krathwohl’s (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s). Activity procedures and assessments are designed to support the target knowledge/cognitive process.

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Cognitive Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Factual</strong></td>
<td>1. Remember</td>
</tr>
<tr>
<td>Aa: Knowledge of Terminology</td>
<td>1.1 Recognizing (Identifying)</td>
</tr>
<tr>
<td>Ab: Knowledge of Specific Details &amp; Elements</td>
<td>1.2 Recalling (Retrieving)</td>
</tr>
<tr>
<td><strong>B. Conceptual</strong></td>
<td>2. Understand</td>
</tr>
<tr>
<td>Ba: Knowledge of classifications and categories</td>
<td>2.1 Interpreting (Clarifying, Paraphrasing, Representing, Translating)</td>
</tr>
<tr>
<td>Bb: Knowledge of principles and generalizations</td>
<td>2.2 Exemplifying (Illustrating, Instantiating)</td>
</tr>
<tr>
<td>Bc: Knowledge of theories, models, and structures</td>
<td>2.3 Classifying (Categorizing, Subsuming)</td>
</tr>
<tr>
<td><strong>C. Procedural</strong></td>
<td>2.4 Summarizing (Abstracting, Generalizing)</td>
</tr>
<tr>
<td>Ca: Knowledge of subject-specific skills and algorithms</td>
<td>2.5 Inferring (Concluding, Extrapolating, Interpolating, Predicting)</td>
</tr>
<tr>
<td>Cb: Knowledge of subject-specific techniques and methods</td>
<td>2.6 Comparing (Contrasting, Mapping, Matching)</td>
</tr>
<tr>
<td>Cc: Knowledge of criteria for determining when to use appropriate procedures</td>
<td>2.7 Explaining (Constructing models)</td>
</tr>
<tr>
<td><strong>D. Metacognitive</strong></td>
<td>3. Apply</td>
</tr>
<tr>
<td>Da: Strategic Knowledge</td>
<td>3.1 Executing (Carrying out)</td>
</tr>
<tr>
<td>Db: Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge</td>
<td>3.2 Implementing (Using)</td>
</tr>
<tr>
<td>Dc: Self-knowledge</td>
<td>4. Analyze</td>
</tr>
<tr>
<td>****</td>
<td>4.1 Differentiating (Discriminating, distinguishing, focusing, selecting)</td>
</tr>
<tr>
<td>****</td>
<td>4.2 Organizing (Finding coherence, integrating, outlining, parsing, structuring)</td>
</tr>
<tr>
<td>****</td>
<td>4.3 Attributing (Deconstructing)</td>
</tr>
<tr>
<td><strong>5. Evaluate</strong></td>
<td>5.1 Checking (Coordinating, Detecting, Monitoring, Testing)</td>
</tr>
<tr>
<td>****</td>
<td>5.2 Critiquing (Judging)</td>
</tr>
<tr>
<td><strong>6. Create</strong></td>
<td>6.1 Generating (Hypothesizing)</td>
</tr>
<tr>
<td>****</td>
<td>6.2 Planning (Designing)</td>
</tr>
<tr>
<td>****</td>
<td>6.3 Producing (Constructing)</td>
</tr>
</tbody>
</table>
IS IT ALIVE?

Teacher Guide

(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (2 of 3)

IO1: to generate a list of criteria for determining if something is alive (6.1; Bc)

LO1a. to use scientific observations of phenomena to guide the scientific question (3.2; Bc)
LO1b. to differentiate and justify between living and non-living objects (4.1; Cc)
LO1c. to attribute the established criteria to life as we know it on Earth (4.3; Db)
The design of this activity leverages Anderson & Krathwohl’s (2001) taxonomy as a framework. Below are the knowledge and cognitive process types students are intended to acquire per the instructional objective(s) and learning outcomes written for this lesson. The specific, scaffolded 5E steps in this lesson (see 5.0 Procedures) and the formative assessments (worksheets in the Student Guide and rubrics in the Teacher Guide) are written to support those objective(s) and learning outcomes. Refer to (M, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (M, 2 of 3) provides a visual description of the placement of learning outcomes that enable the overall instructional objective(s) to be met.

At the end of the lesson, students will be able

**IO1:** to generate a list of criteria for determining if something is alive

**6.1:** to generate

**Bc:** knowledge of theories, models, and structures

To meet that instructional objective, students will demonstrate the abilities:

**LO1a:** to use scientific observations of phenomena to guide the scientific question

**3.2:** to use

**Bc:** knowledge of theories, models, and structures

**LO1b:** to differentiate between living and non-living objects

**4.1:** to differentiate

**Cc:** knowledge of criteria for determining when to use appropriate procedures

**LO1c:** to attribute the established criteria to life as we know it on Earth

**4.3:** to attribute

**Db:** Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge