Is It Alive?

High School Alignment Document
National Resource Council Framework, Next Generation Science Standards, Common Core State Standards, and 21st Century Skills

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

This lesson is designed to be an introduction to the characteristics of living things. 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.

NRC FRAMEWORK / NGSS CORE QUESTION	INSTRUCTIONAL OBJECTIVES (IO)
HOW DO ORGANISMS LIVE, GROW, RESPOND TO THEIR ENVIRONMENT, AND REPRODUCE? *NGSS Core Question: LS1: From Molecules to Organisms: Structures and Processes*	*Students will be able to* **IO1: Generate a list of criteria for the characteristics of life and conduct an investigation searching for empirical evidence for living/nonliving material among three samples.**

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1.0 About This Activity

The 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. Construction of rubrics also draws upon Lanz's (2004) guidance, designed to measure science achievement.

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. This five-part sequence is the organizing tool for the Mars instructional series. The 5E stages can be cyclical and iterative.

2.0 Instructional Objectives, Learning Outcomes, & Standards

Instructional objectives and learning outcomes are aligned with

- National Research Council's, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*
- 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
- Partnership for 21st Century Skills, *A Framework for 21st Century Learning*

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 document).

Important Note: This lesson is color-coded to help teachers identify each of the three dimensions of NGSS. The following identifying colors are used: Practices are blue, Cross-Cutting Concepts are green, and Disciplinary Core Ideas are orange.

This color-coding is consistent with the NGSS Performance Expectations and Foundation Boxes.

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 DO ORGANISMS LIVE, GROW, RESPOND TO THEIR ENVIRONMENT, AND REPRODUCE?

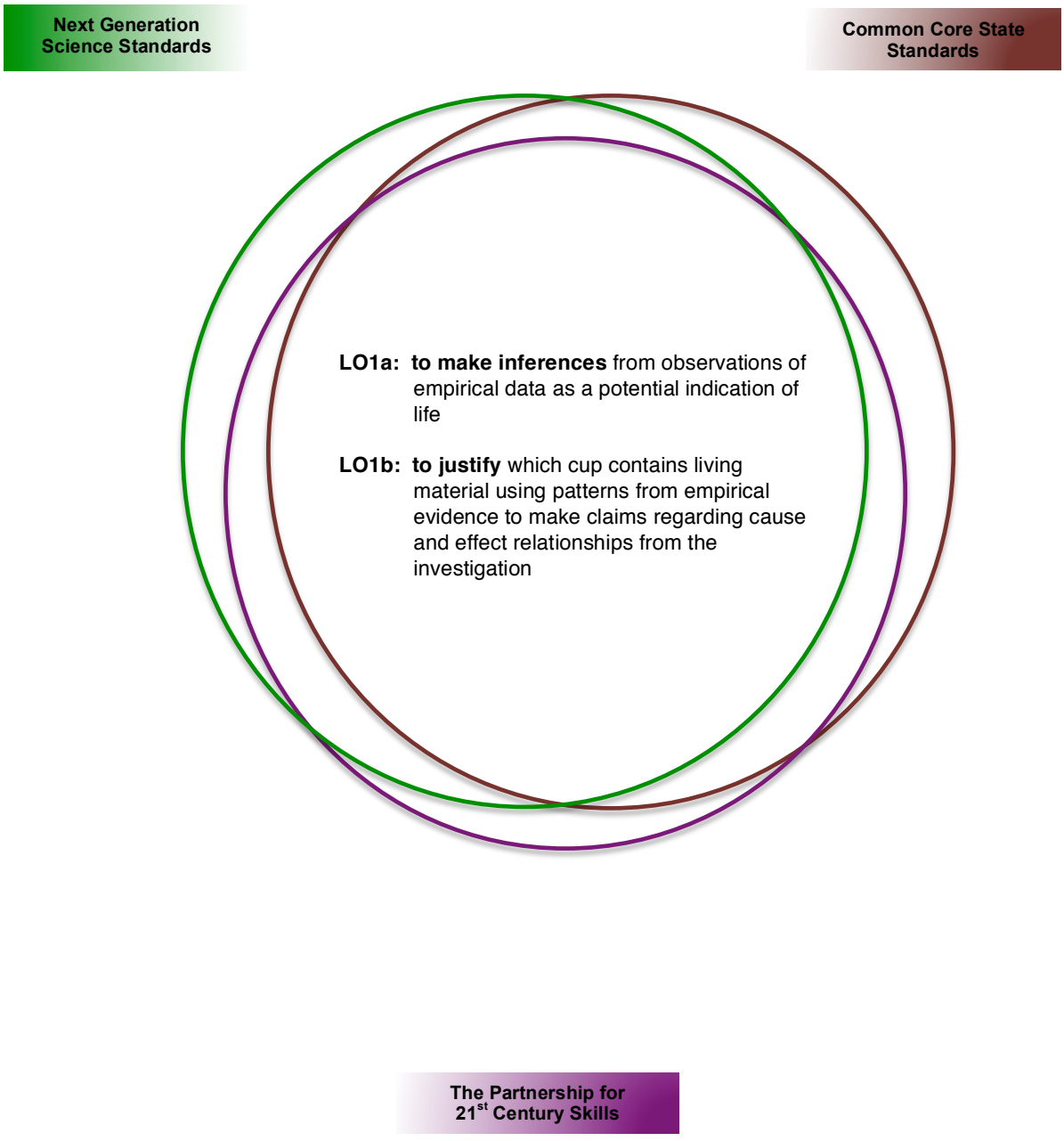
NGSS Core Question: LS1: From Molecules to Organisms: Structures and Processes

Instructional Objective (IO) *Students will be able to:*	**Learning Outcomes (LO)** *Students will demonstrate the measurable abilities*	**Standards** *Students will address*
IO1: **Generate a list of criteria for the characteristics of life and conduct an investigation searching for empirical evidence for living/nonliving material among three samples.**	**LO1a:** to make inferences from observations of empirical data as a potential indication of life **LO1b:** to justify which sample contains living material using patterns from empirical evidence to make claims regarding cause and effect relationships from the investigation	**DISCIPLINARY CORE IDEAS:** LS1: From Molecules to Organisms: Structures and Processes **PRACTICES:** 1. Asking Questions and Defining Problems 2. Planning and Carrying out Investigations 3. Analyzing and Interpreting Data 4. Constructing Explanations and Designing Solutions 5. Engaging in Argument from Evidence **CROSSCUTTING CONCEPTS:** 1. Patterns 2. Cause and Effect: Mechanism and Prediction 3. Stability and Change **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

Last edited: February 26, 2016

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.



4.0 Evaluation/Assessment

Use the *(L) Is It Alive? Rubric* as a formative and summative assessment, allowing students to improve their work and learn from mistakes during class. The rubric evaluates the activities using the Next Generation Science Standards, Common Core State Standards, and 21st Century Skills.

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.

Anderson, L.W., & Krathwohl (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Bybee, R., Taylor, J., Gardner, A., Van Scotter, P., Carson Powell, J., Westbrook, A., Landes, N. (2006) *The BSCS 5E instructional model: origins, effectiveness, and applications.* Colorado Springs: BSCS.

Donovan, S. & Bransford, J. D. (2005). *How Students Learn: History, Mathematics, and Science in the Classroom.* Washington, DC: The National Academies Press.

Miller, Linn, & Gronlund. (2009). *Measurement and assessment in teaching*. Upper Saddle River, NJ: Pearson.

National Academies Press. (1996, January 1). *National science education standards*. Retrieved February 7, 2011 from http://www.nap.edu/catalog.php?record_id=4962

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: Authors.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

The Partnership for 21st Century Skills (2011). *A framework for 21st century learning.* Retrieved March 15, 2012 from http://www.p21.org

(I) Teacher Resource. Is it Alive? NGSS Alignment (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.

**Note: You may see Practices, DCI's, or Crosscutting Concepts from earlier grades. This has been done strategically to spiral learning to support student cognitive development of learning progressions, preparing them for more difficult tasks. This will be indicated in the rubric below with italics.

Next Generation Science Standards Alignment (NGSS)			
Instructional Objective *Students will be able to*	**Science and Engineering Practices**	**Disciplinary Core Idea**	**Crosscutting Concepts**
IO1: **Generate a list of criteria for the characteristics of life and conduct an investigation searching for empirical evidence for living/nonliving material among three samples.**	**Asking Questions and Defining Problems:** Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. **Planning and Carrying out Investigations:** Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. **Analyzing and Interpreting Data:** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Constructing Explanations and Designing**	**LS1: From Molecules to Organisms: Structures and Processes:** How do organisms live, grow, respond to their environment, and reproduce? All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organ- isms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms. Organisms respond to stimuli from their	**Patterns:** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. *(Reconnection to K-2 Crosscutting Statement)* Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. Empirical evidence is needed to identify patterns. **Cause and Effect: Mechanism and Prediction** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Stability and Change:** Much of science deals with constructing

	Solutions: Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **Engaging in Argument from Evidence:** Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.	explanations of how things change and how they remain stable. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.

(I) Teacher Resource. Is it Alive? NGSS Alignment (2 of 3)

Next Generation Science Standards Alignment (NGSS)

Learning Outcomes *Students will be able to*	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
LO1a: to make inferences from observations of empirical data as a potential indication of life	**Asking Questions and Defining Problems:** Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. **Analyzing and Interpreting Data:** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Constructing Explanations and Designing Solutions:** Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **Engaging in Argument from Evidence:** Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	**LS1: From Molecules to Organisms: Structures and Processes:** How do organisms live, grow, respond to their environment, and reproduce? All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organ- isms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms. Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of these processes and	**Patterns:** Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. Empirical evidence is needed to identify patterns. **Cause and Effect: Mechanism and Prediction** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Stability and Change:** Much of science deals with constructing explanations of how things change and how they remain stable. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.

		functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.	
LO1b: to justify which sample contains living material using patterns from empirical evidence to make claims regarding cause and effect relationships from the investigation	**Analyzing and Interpreting Data:** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Constructing Explanations and Designing Solutions:** Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **Engaging in Argument from Evidence:** Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	**LS1: From Molecules to Organisms: Structures and Processes:** How do organisms live, grow, respond to their environment, and reproduce? All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organ- isms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms. Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.	**Patterns:** Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. Empirical evidence is needed to identify patterns. **Cause and Effect: Mechanism and Prediction** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Stability and Change:** Much of science deals with constructing explanations of how things change and how they remain stable. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.

(I) Teacher Resource. Is it Alive? NGSS Activity Alignment (3 of 3)

Next Generation Science Standards Activity Alignments (NGSS)

Activity	Phases of 5E Instructional Model	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Identifying Prior Knowledge	**Engage**	**Asking Questions and Defining Problems:** Ask questions to clarify and refine a model, an explanation, or an engineering problem.	**LS1: From Molecules to Organisms: Structures and Processes:** How do organisms live, grow, respond to their environment, and reproduce? All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organ- isms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms. Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of	**Patterns:** Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments.

			these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.	
(A) Students Sheet #1	**Explore**	**Asking Questions and Defining Problems:** Ask questions to clarify and refine a model, an explanation, or an engineering problem. **Constructing Explanations and Designing Solutions:** Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **Engaging in Argument from Evidence:** Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	**LS1: From Molecules to Organisms: Structures and Processes:** How do organisms live, grow, respond to their environment, and reproduce? All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organ- isms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms. Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.	**Patterns:** Empirical evidence is needed to identify patterns.

(B) Student Sheet #2	**Explain**	**Analyzing and Interpreting Data:** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Asking Questions:** Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information **Constructing Explanations and Designing Solutions:** Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS1: From Molecules to Organisms: Structures and Processes:** How do organisms live, grow, respond to their environment, and reproduce? All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organ- isms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms. Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.	**Patterns:** Empirical evidence is needed to identify patterns. **Cause and Effect: Mechanism and Prediction** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
(C & D) Data Chart #1 and Data Chart #2	**Explore**	**Planning and Carrying Out Investigations:** Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects	**LS1: From Molecules to Organisms: Structures and Processes:** How do organisms live, grow, respond to their environment, and reproduce? All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all	**Stability and Change:** Much of science deals with constructing explanations of how things change and how they remain stable.

		and evaluate the investigation's design to ensure variables are controlled. **Asking Questions:** Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information	organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organ- isms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms. Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.	

(J) Teacher Resource. Is it Alive? CCSS Alignment (1 of 2)

Common Core State Standards			
Instructional Objective *Students will be able to*	**Reading Standards for Literacy in Science and Technical Subjects (9-12)**	**Writing Standards for Literacy in Science and Technical Subjects (9-12)**	**Speaking and Listening Standards (9-12)**
IO1: **Generate a list of criteria for the characteristics of life and conduct an investigation searching for empirical evidence for living/nonliving material among three samples.**		**Text Types and Purposes:** **Grades 9 – 10:** Write arguments focused on discipline-specific content. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented. **Grades 11 – 12:** Write arguments focused on discipline-specific	**Comprehension and Collaboration:** **Grades 9 - 10:** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. b. Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed. c. Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions. d. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.

		content. a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented. **Research to Build and Present Knowledge:** **Grades 9 – 10:** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **Grades 11 – 12:** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	**Grades 11 - 12:** Initiate and participate effectively in a range of collaborative discussions (one on- one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed. c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives. d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

(J) Teacher Resource. Is it Alive? CCSS Alignment (2 of 2)

Common Core State Standards			
Learning Outcome *Students will be able*	**Reading Standards for Literacy in Science and Technical Subjects (9-12)**	**Writing Standards for Literacy in Science and Technical Subjects (9-12)**	**Speaking and Listening Standards (9-12)**
LO1a: to make inferences from observations of empirical data as a potential indication of life			**Comprehension and Collaboration:** **Grades 9 - 10:** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. b. Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed. c. Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions. d. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and

			reasoning presented. **Grades 11 - 12:** Initiate and participate effectively in a range of collaborative discussions (one on- one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed. c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives. d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
LO1b: **to justify which sample contains living material using patterns from empirical evidence to make claims regarding cause and effect relationships from the investigation**		**Text Types and Purposes:** **Grades 9 – 10:** Write arguments focused on discipline-specific content. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while	**Comprehension and Collaboration:** **Grades 9 - 10:** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other

		pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented. **Grades 11 – 12:** Write arguments focused on discipline-specific content. a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.	research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. b. Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed. c. Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions. d. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented. **Grades 11 - 12:** Initiate and participate effectively in a range of collaborative discussions (one on- one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed. c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and

		e. Provide a concluding statement or section that follows from or supports the argument presented. **Research to Build and Present Knowledge:** **Grades 9 – 10:** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **Grades 11 – 12:** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	creative perspectives. d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

(J) Teacher Resource. Is it Alive? 21st Century Skills Alignment

21st Century Skills		
Learning Outcomes *Students will demonstrate the measurable abilities*	**21st Century Skill**	**Grade 12 Benchmark**
LO1a: to make inferences from observations of empirical data as a potential indication of life	**Collaboration**	Students collaborate with peers and experts during scientific discourse and appropriately defend arguments using scientific reasoning, logic, and modeling.
	Flexibility and Adaptability	Students are able to revise their own scientific ideas and hypotheses based on new evidence or information.
LO1b: to justify which sample contains living material using patterns from empirical evidence to make claims regarding cause and effect relationships from the investigation	**Collaboration**	Students collaborate with peers and experts during scientific discourse and appropriately defend arguments using scientific reasoning, logic, and modeling.
	Flexibility and Adaptability	Students are able to revise their own scientific ideas and hypotheses based on new evidence or information.

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

Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):

Next Generation Science Standards Alignment (NGSS)

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a: to make inferences from observations of empirical data as a potential indication of life	Uses observations of empirical data to make inferences about criteria of life. Clearly shows that multiple criteria are necessary to differentiate between living and non-living.	Uses observations of empirical data to make inferences about criteria of life. Recognizes that several criteria are necessary to differentiate between living and non-living.	Describes observations of data. Uses some of these observations to accurately make inferences about criteria of life.	Generates a list of observations from data.
LO1b: to justify which sample contains living material using patterns from empirical evidence to make claims regarding cause and effect relationships from the investigation	Classifies samples as containing living/nonliving material based on patterns of evidence using consistent criteria. Justifies the different outcomes of the investigation as related to the presence or absence of life and articulates a cause/effect relationship between results of investigation and the criteria of life.	Classifies samples as containing living/nonliving material based on patterns of evidence using consistent criteria and justifies the different outcomes of the investigation as related to the presence or absence of life.	Classifies samples as containing living/nonliving material based on patterns of evidence using somewhat consistent criteria and/or justifies the different outcomes of the investigation as related to the presence or absence of life.	Classifies samples as living/nonliving based on prior knowledge or misconceptions.

(L) Teacher Resource. Is it Alive? CCSS Rubric (2 of 3)

Common Core – ELA

	Expert	Proficient	Intermediate	Beginner
Text Type and Purposes	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.	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.	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; May or may not provide a concluding statement.	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.
Research to Build and Present Knowledge	Recalls relevant information from experience; summarizes information in finished work; draws evidence from informational texts to support analysis, reflection, and research.	Recalls relevant information from experience; draws evidence from informational texts to support analysis, reflection, and research.	Recalls information from experience; draws evidence from informational texts to support analysis, reflection, and research.	Recalls information from experience.
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.

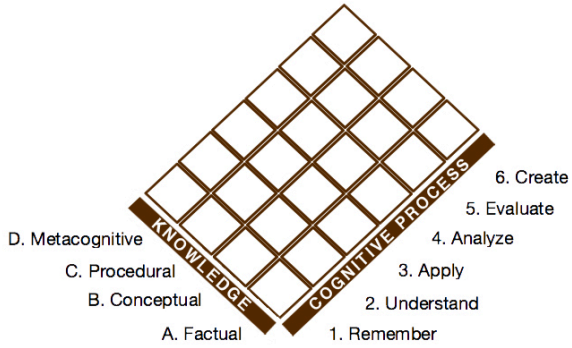
(L) Teacher Resource. Is it Alive? 21st Century Skills Rubric (3 of 3)

Partnership for 21st Century Skills

	Expert	Proficient	Intermediate	Beginner
Effectiveness of collaboration and flexibility with team members and class.	Extremely interested in collaborating in the group. Actively provides solutions to problems, listens to suggestions from others, attempts to refine them, revises own scientific ideas and hypotheses based on new evidence, monitors group progress, and attempts to ensure everyone has a contribution.	Extremely Interested in collaborating in the group. Actively provides suggestions and occasionally listens to suggestions, scientific ideas or hypotheses from others. Refines suggestions from others.	Interested in collaborating in the group. Listens to suggestions from peers and attempts to use them. Occasionally provides suggestions in group discussion.	Interested in collaborating in the group.

(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (1 of 3)

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.

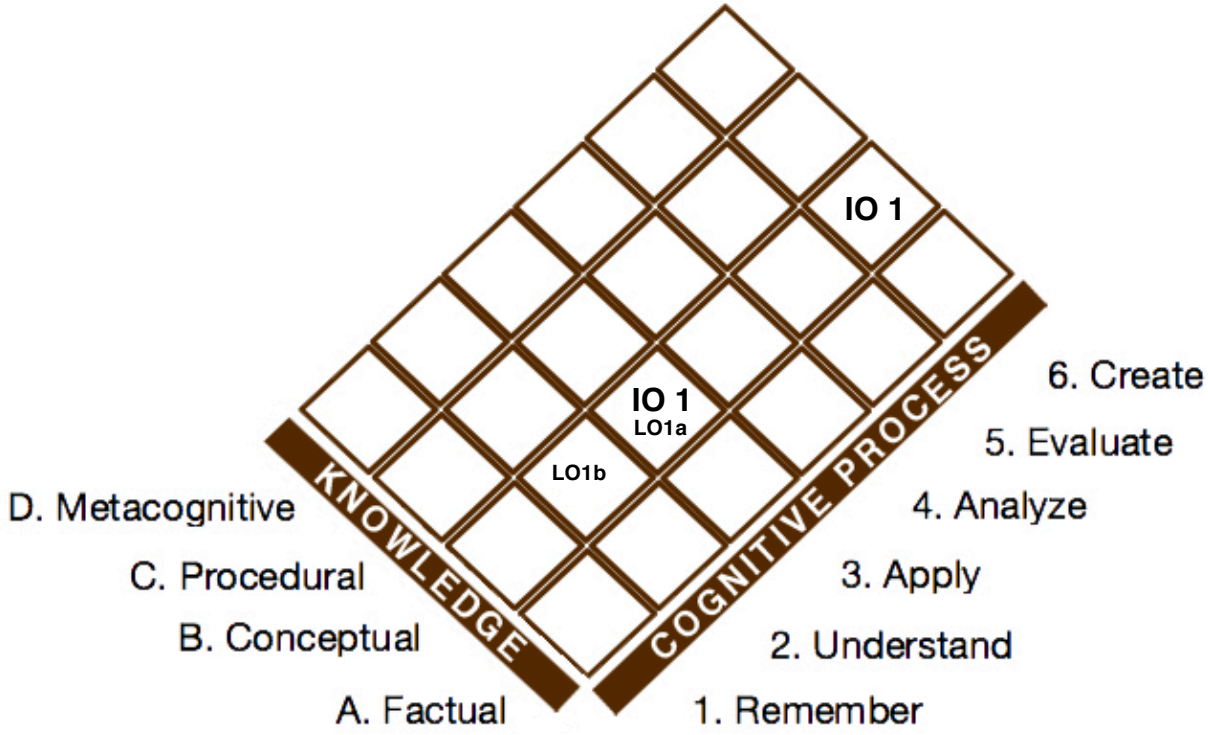


Knowledge	Cognitive Process
A. Factual **Aa:** Knowledge of Terminology **Ab:** Knowledge of Specific Details & Elements **B. Conceptual** **Ba:** Knowledge of classifications and categories **Bb:** Knowledge of principles and generalizations **Bc:** Knowledge of theories, models, and structures **C.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

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

IO1: Generate a list of criteria for the characteristics of life and **conduct an investigation** searching for empirical evidence for living/nonliving material among three samples. (6.1, 3.1; Ba)

LO1a. to make inferences from observations of empirical data as a potential indication of life (2.5; Ba)
LO1b. to justify which cup contains living material using patterns from empirical evidence to make claims regarding cause and effect relationships from the investigation (2.7; Ba)



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

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: **Generate** a list of criteria for the characteristics of life and **conduct an investigation** searching for empirical evidence for living/nonliving material among three samples.
- 6.1: to generate
- 3.1: to carry out
- Ba: Knowledge of classifications and categories

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

LO1a: **to make inferences** from observations of empirical data as a potential indication of life
- 3.2: to infer
- Ba: Knowledge of classifications and categories

LO1b: **to justify** which cup contains living material using patterns from empirical evidence to make claims regarding cause and effect relationships from the investigation
- 2.7: to explain
- Ba: Knowledge of classifications and categories