Lesson 6: Is It Living?

Time: approximately 35-50 minutes, depending on length of discussion
Materials: Small containers, such as film containers (4 per group)
- Objects for containers, (see following – 4 per group)
- Hand lenses (at least 1 per group)
- Text: Final Planet Details (from web site – 1 per group)

Overview
This is probably the most difficult lesson of the unit. Students examine “artifacts” from their planets to attempt to determine if the artifact is living, evidence of life, or non-living. Students then use their observations to generate a list of characteristics of living things.

Purpose
Defining life has been one of the most difficult tasks of science. This difficulty increases when considering the possibility of extra-terrestrial life, which may be radically different from anything seen of Earth. This lesson is intended to start students thinking about what life is and how it can be detected.

Standards
A complete list of the standards covered by this lesson is included in the Appendix at the end of the lesson.

Procedure
Before class: Assemble “artifacts.” You will need 4 artifacts for each group; each group should have the same artifacts. Containers should be numbered 1 through 4. Place one artifact in each container #1, a different artifact in each container #2, etc. It is good if the containers are opaque so that students can not see the artifacts beforehand, but this is not critical.

You should have one artifact that is living, one that is evidence of life and one that is non-living. The fourth can be from any category. Artifacts should be chosen to blur the distinction between these categories as much as possible. Examples of possible artifacts are given below:

Living: Acorn, millet seed, ant larvae, dried yeast.

Evidence of life: Fossil, trace fossil, shell or shell fragment, bone, anything manufactured, wood or leaf fragment. (Small fossils are available free for classrooms. Contact Glenn Simonelli via the web site for a classroom set.)

Non-living: Any crystal or rock, especially a rock shaped like any of the objects used for either of the other categories, thin sliver of mica. (Do not anything manufactured because it would be considered evidence of life.)

During the lesson: Begin the lesson with a brief whole class discussion of the question, “How can we tell if something is alive?” Keep a list of student ideas. After completing the list, ask students to think about which, if any, of their ideas would necessarily be true of life on another planet.
Part 2: Build Your Own Planet

Have students read Lesson 6: Is It Living?

You and your crewmates have finally landed on your chosen planet. It is now time to begin exploring it. Remember that you are seeking out signs of life. In order to cover the most territory, your group decides to split up and explore different areas, with each of you agreeing to bring back samples of anything that looks like it might contain life or evidence of life.

After putting on protective space suits, you go out and explore. The first thing you notice is that the planet is very different from Earth. Nothing looks familiar, and you realize that any life forms on this planet are likely to be very different from anything you’ve seen before. How can you tell if something is living or not? After exploring for awhile, you see some objects that look very interesting, so you collect a few samples and head back to the ship.

When you get back you learn that several of your crewmates have also brought back samples, so you and your crewmates examine them. Now comes the hard part. You must decide if the samples are living things, or evidence of living things, or non-living. How will you decide this? What will you look for? What experiments might you conduct on these samples to decide?

Have the groups read the instructions. Distribute the artifacts to the groups. They should look at one artifact at a time, discuss it thoroughly, and record their comments on the worksheet (see Appendix B) before moving on to the next. After examining all four artifacts, the groups should discuss the question on the last page and record their ideas in the space below it.

Students have a tendency to try to identify the object first and then determine how to classify it. This is fine, but encourage them to focus on how they know whether it is living or not, rather than how they know what it is. Ask for specific, concrete observations. Go around to the groups and ask questions like, “Suppose I disagreed with you. How could you prove this was non-living? What tests could you do?” If possible, teachers can encourage students to carry out these tests and record their results.

Assignment: You and your crewmates have 4 samples to examine. Working with one sample at a time, examine and discuss it as a group, and try to decide if it is living, evidence of life, or non-living. Fill out the form for each sample. Check “Not sure” if your group isn’t sure or can’t agree. After you’ve made a decision, discuss why you decided how you did. List some observations about the object that makes you think it is living, evidence of life, or non-living. If your group is not sure, list what you would want to know about a sample in order to make a decision. Then discuss how you might test the sample to learn more about it. Come up with some ideas for experiments that you might conduct on the sample to prove that it is living, evidence of life, or non-living.

After all the groups have had a chance to complete the worksheet bring the whole class back together to discuss their ideas. If time permits, discuss each artifact in turn and
record a list of all the observations that students made that helped them identify it as living, etc. Then go on to the two questions on the last page: “What are some ways to tell living things from non-living things?” and “What are some things that all living things have in common?” If time is an issue, skip the first part of the discussion and go right to these two questions.

It is important when having this discussion that students understand that scientists have yet to agree on a complete definition of life, or even on what things should be considered living. Viruses, for example, are an area of occasional disagreement. Still, it is possible to list some of the characteristics that most living things have. These include the following:

- Living things respond to their environment;
- They get energy from their environment;
- They adapt to changes in their environment;
- They have internal structure and differentiation;
- They regulate their internal environment;
- They self-replicate—that is, they have the ability to make copies or newer versions of themselves;
- They contain DNA;
- They grow and/or change over time;
- They use complex chemistry;
- They share a common ancestor.

Students should be aware of these traits, although the wording can be very different. Many non-living things display some of these traits, but most living things display all of them.

Conclude the discussion by asking the class to come up with their own definition of “life,” that they can use when exploring their planet or have students write one on their own for homework and discuss them the next day.
Appendix A

Standards Addressed

Benchmarks (Grades 3 through 5)

1A – The Scientific World View
Results of similar scientific investigations seldom turn out exactly the same. Sometimes this is because of unexpected differences in the things being investigated, sometimes because of unrealized differences in the methods used or in the circumstances in which the investigation is carried out, and sometimes just because of uncertainties in observations. It is not always easy to tell which.

1B Scientific Inquiry
Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Investigations can focus on physical, biological, and social questions.

5A – Diversity of Life
A great variety of kinds of living things can be sorted into groups in many ways using various features to decide which things belong to which group.

Features used for grouping depend on the purpose of the grouping.

5E – Flow of Matter and Energy
Some source of "energy" is needed for all organisms to stay alive and grow.

12A – Values and Attitudes
Offer reasons for their findings and consider reasons suggested by others.

12E – Critical-Response Skills
Seek better reasons for believing something than "Everybody knows that . . ." or "I just know" and discount such reasons when given by others.

Benchmarks (Grades 6 through 8)

5A – Diversity of Life
One of the most general distinctions among organisms is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. Some kinds of organisms, many of them microscopic, cannot be neatly classified as either plants or animals.

Animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce.

5E – Flow of Matter and Energy
Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.
12A – Values and Attitudes
*Know that often different explanations can be given for the same evidence, and it is not always possible to tell which one is correct.*

12E – Critical-Response Skills
*Be aware that there may be more than one good way to interpret a given set of findings.*

**Benchmarks (Grades 9 through 12)**

5E – Flow of Matter and Energy
*The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials. Human activities and technology can change the flow and reduce the fertility of the land.*

12D – Communication Skills
*Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.*

12E – Critical-Response Skills
*Insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position being taken—whether one's own or that of others—can be judged.*

**National Standards (Grades 5-8)**

Understandings about Scientific Inquiry
*Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.*

Structure and Function in Living Systems
*Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems.*

Reproduction and Heredity
*Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually.*

*Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.*

Regulation and Behavior
*All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.*
Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.

An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

Diversity and Adaptations of Organisms
Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry.

National Standards (Grades 9-12)
Biological Evolution
The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.

Matter, Energy and Organization in Living Systems
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.

The Behavior of Organisms
Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.

Nature of Scientific Knowledge
Scientific explanations must meet certain criteria. First and foremost, they must be consistent with experimental and observational evidence about nature, and must make accurate predictions, when appropriate, about systems being studied. They should also be logical, respect the rules of evidence, be open to criticism, report methods and procedures, and make knowledge public. Explanations on how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not scientific.

Indiana Standards
Grade 5
English/Language Arts – Writing: Process
5.4.5 – Use note-taking skills
Mathematics – Problem Solving
5.7.1 – Analyze problems by identifying relationships, telling relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

Science – The Scientific View of the World
5.1.1 – Recognize and describe that results of similar scientific investigations may turn out differently because of inconsistencies in methods, materials, and observations.

Scientific Inquiry
5.1.2 – Begin to evaluate the validity of claims based on the amount and quality of the evidence cited.

Diversity of Life
5.4.1 – Explain that for offspring to resemble their parents there must be a reliable way to transfer information from one generation to the next.

Interdependence of Life and Evolution
5.4.7 – Explain that living things, such as plants and animals, differ in their characteristics, and that sometimes these differences can give members of these groups (plants and animals) an advantage in surviving and reproducing.

Grade 6
English/Language Arts – Writing: Process
6.4.5 – Use note-taking skills

Mathematics – Problem Solving
6.7.1 – Analyze problems by identifying relationships, telling relevant from irrelevant information, identifying missing information, sequencing and prioritizing information, and observing patterns.

Science – Communication Skills
6.2.8 – Analyze and interpret a given set of findings, demonstrating that there may be more than one good way to do so.

Diversity of Life
6.4.2 – Give examples of organisms that cannot be neatly classified as either plants or animals, such as fungi and bacteria.

Interdependence of Life and Evolution
6.4.8 – Explain that in all environments, such as freshwater, marine, forest, desert, grassland, mountain, and others, organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter. Note that in any environment, the growth and survival of organisms depend on the physical conditions.

Grade 7
Mathematics – Problem Solving
7.7.1 Analyze problems by identifying relationships, telling relevant from irrelevant information, identifying missing information, sequencing and prioritizing information, and observing patterns.

Science – Scientific Inquiry
7.1.4 Describe that different explanations can be given for the same evidence, and it is not always possible to tell which one is correct without further inquiry.

Diversity of Life
7.4.5 Explain that the basic functions of organisms, such as extracting energy from food and getting rid of wastes, are carried out within the cell and understand that the way in which cells function is similar in all organisms.

Interdependence of Life and Evolution
7.4.6 Explain how food provides the fuel and the building material for all organisms.

Grade 8
Mathematics – Problem Solving
7.7.1 Analyze problems by identifying relationships, telling relevant from irrelevant information, identifying missing information, sequencing and prioritizing information, and observing patterns.

Science – Communication
8.2.7 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.

Critical Response Skills
8.2.10 Identify and criticize the reasoning in arguments in which fact and opinion are intermingled or the conclusions do not follow logically from the evidence given, an analogy is not apt, no mention is made of whether the control group is very much like the experimental group, or all members of a group are implied to have nearly identical characteristics that differ from those of other groups.

Interdependence of Life and Evolution
8.4.5 Explain that energy can be transferred from one form to another in living things.

Reasoning and Uncertainty
8.5.7 Recognize and describe the danger of making over-generalizations when inventing a general rule based on a few observations.

Biology I
Developmental and Organismal Biology
B.1.17 Understand that and describe how the maintenance of a relatively stable internal environment is required for the continuation of life and explain how stability is challenged by
changing physical, chemical, and environmental conditions, as well as the presence of disease agents.

B.1.18 – Explain that the regulatory and behavioral responses of an organism to external stimuli occur in order to maintain both short- and long-term equilibrium.

Genetics
B.1.21 – Understand and explain that the information passed from parents to offspring is transmitted by means of genes which are coded in DNA molecules.
Appendix B
Copy of Sample Analysis Form (included with lesson)

Sample #1.  _____Living
_____Evidence of life
_____Non-living
_____Not sure
Observations: how you know or what you would like to know:

How would you test it?

Sample #2.  _____Living
_____Evidence of life
_____Non-living
_____Not sure
Observations: how you know or what you would like to know:

How would you test it?

Sample #3.  _____Living
_____Evidence of life
_____Non-living
_____Not sure
Observations: how you know or what you would like to know:

How would you test it?

Sample #4.  _____Living
_____Evidence of life
_____Non-living
_____Not sure
Observations: how you know or what you would like to know:
How would you test it?

Discuss the following questions with your group. Record your ideas below.

**Questions:**
What are some ways to tell living things from non-living things?
What are some things that all living things have in common?

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