Searching for Signs of Life

Background

One question we all ponder is whether or not we are alone in the Universe. Mars is one of many places where we might find an answer. Being the most similar to Earth, Mars has water vapor and permafrost on the surface. At one time, Mars had an abundance of flowing water. It is these places where there is or was water that the possibility of life exists.

When scientists go in search of life it is not necessarily a quest for large human-like beings or even life that can be seen with the naked eye. Most scientists expect that we are much more likely to find microscopic evidence, such as bacteria, or fossilized bacteria. The most recent prospect for life on Mars is centered around the Martian meteorite, ALH84001. The meteorite, found in Antarctica, dates back to an early period on Mars when the conditions were much wetter and more suitable for life. Formations in the rock suggest that it may contain a fossilized form of bacteria.

Scientists would like to study rock samples from areas that appear to be dried riverbeds. Collecting rock samples is one goal of future Mars missions. In the past, however, we have looked for life in the soil on Mars. When Viking 1 and 2 landed on Mars in 1976, the landers analyzed the Martian soil in search of carbon based life. Analysis of some soil samples seemed to indicate lifelike characteristics. However, scientists did not find evidence of organic matter. They found unusual geochemistry which had some lifelike characteristics, but they did not find life.

Topic

Soil Analysis

Objectives

Students will:

- Conduct a simulated experiment with soil samples similar to the experiments on the Mars Viking Lander.
- Identify relationships between the soil samples using an operational definition of life.
- Make an inference about the possibility of life on Mars based on data obtained.

Overview

Students will analyze soil samples. They will use the given definition of life to determine whether there are any signs of life in three different soil samples. Teams will make observations, draw pictures as they collect data from the samples, and draw conclusions.

Key Question

What characteristics must be present to determine if life exists?

Key Concepts

- The fundamental criteria for indicating life is: metabolic processes, exchange of gases, reproduction, and continued reaction to stimuli.

Materials & Preparation

- Dictionaries and encyclopedias
- Sand or sandy soil
- Three baby food jars or beakers per group
- 5 ml of sugar (sugar water will be added to all soil samples)
- Instant active dry yeast
- Alka-seltzer® tablets, crushed
- Hot water–enough to cover the top of the soil in all jars
- Goggles–1 per student
- Cups for distributing the water–1 per group
- Magnifying lens–1 per group or individual
- Student sheets–1 per student

Advanced Preparation

1. Label all jars: label 1/3 "A," label 1/3 "B," label 1/3 "C."
2. Fill all jars 1/4 full of soil (3 jars per team).
3 Mix one half pack of instant active dry yeast into the soil in jars labeled "B."
4 Mix one powdered Alka-seltzer® into jars labeled "C."
5. Give each group a set of three jars, magnifying lens, and the chart from previous activity.

Part 1

1. Divide students into cooperative groups before beginning the lesson.
2. Explain to students that their job is to come up with fundamental criteria for indicating life.
3. Have students conduct research on the characteristics of living and non-living organisms. Allow the students use of dictionaries, books, encyclopedias, and the Internet. Use the examples below to encourage the students, but not to limit them.

   Examples: Consider a bear and a chair—they both have legs, but one can move on its own and the other would need a motor made by humans; therefore, independent movement might be one characteristic that indicates life. Not every living organism needs legs or roots, but they have a mode of locomotion or a way to get nutrients. Also, the bear breathes and the chair does not, another indication of life. Or consider a tree and a light pole. We know that a light pole cannot reproduce it is made by humans, and we know that the tree makes seeds that may produce more trees. The tree also absorb nutrients, gives off gasses, and grows. The light uses electricity and gives off light through a strict energy exchange; there is no growth and there are no metabolic processes.
4. Have students share their research in their cooperative groups, then have the class come to a consensus about how to identify living things.
5. Discuss the indications of life, ask students for examples from a diverse sampling of living things. Then paraphrase and write each groups' criteria on the board, overhead, or chart. This can be used to guide the students to summarize the groupings and to reflect the fundamental criteria for life.
6. If students have difficulty developing criteria, the following will be used for this activity:
   - Metabolic processes that show chemical exchanges that may be detected in some sort of respiration
   - Exchange of gases or solid materials
   - Reproduction, replication, or cell division
   - Continued reaction to stimuli

Part 2

(Information for teacher only–do not share all the information with students!)

1. Students will take three different soil samples and look for signs of life based on the criteria from Part 1.
2. Explain to the students that each team has a set of simulated Martian soil samples. No one knows if there is anything alive in them. The assignment is to make careful observations and check for indications of living material in them—based on their criteria.
3. Ask students to observe all three samples. They can smell and touch the samples but not taste them. Encourage students to put a few grains on a flat white surface and observe them with a hand lens.
4. Students should then record their data in the Data Log.
5. Give each group a cup of hot sugar water, which can be used by living organisms as nutrient solution. (Use warm tap water, approximately ~50 C so as not to kill the yeast.)
6. Have students "feed" (add stimulus to) each soil sample by pouring the sugar water so that each soil sample is covered.
7. Students should look for and record in the Data Log differences caused by adding sugar water.
8. After recording the first observations have students go back after 10 minutes and observe again. (After about ten minutes Sample B will show even more activity.)
9. Now have students "feed" (add stimulus to) each soil sample again after 10 minutes by adding 5 ml of sugar water to each soil sample.

10. Have students observe and record the reaction to the second feeding.
11. Discuss with students which samples showed activity after the first "feeding" (adding of stimulus)B and C.
12. Discuss with students which samples showed activity after the second "feeding" (adding of stimulus) C.
13. Does that activity mean there is life in both B and C and no life in A?
14. Did the reaction start again after the second feeding?
15. Are there other explanations for the activity in either B or C?
    - Sample A shows no reaction.
    - Both B and C are chemical reactions.
    - Sample C chemical reaction stops and does not react to the second "feeding" because the first "feeding" used up all reactants in the sample.
    - Sample B sustains long term activity and reacted again to the second "feeding" indicating life is present i.e. when life is present, more food means more biological activity.
16. Students should realize that there could be other tests that would detect life in Sample B.
17. Have students determine which sample(s) should be studied further by applying the fundamental criteria for indicating life developed in Part 1.
18. Tell students that Sample B contained yeast and Sample C contained Alka-seltzer®. Discuss how you might tell the difference between a non-living chemical change (Alka Seltzer®) and a life process (yeast).

Management

Students will observe all safety procedures and policies including, but not limited to, personal safety protection and safe materials handling. This activity should take two to three class periods to complete.

Reflection & Discussion

1. When adding water, what differences did you see in the grains?
2. How can geologists use this procedure to identify possible life on Mars?
3. What other tests could be run on the soil samples?

Transfer/Extension

1. Research the Mars meteorite. Have students form teams and debate the presence of fossilized life.
2. Find out about the search for life under the ice in Antarctica that NASA is conducting. Write a news article about your findings.
3. Does life require sunlight and oxygen? Research the life in underground caves and on the bottom of the ocean at hydrothermal vents and design a bulletin board or poster.

STUDENT WORKSHEET

Searching for Signs of Life

Student Data Log		
	Record Observation No water added	**Draw Observation No water added**
Sample A		
Sample B		
Sample C		
	Record Observation Water added	**Draw Observation Water added**
Sample A		
Sample B		
Sample C		