Lesson Five — Searching for Life on Mars

This lesson contains four exercises within three activities. The activities have been grouped to encourage students to think about the characteristics of life and about the possibility of looking for life on Mars.

Activity 1 — Imaginary Martians

Students will listen to one or more excerpts from science fiction that describe a fictional living organism from Mars. They will then draw their interpretations of the creatures and compare them to what they already know about life on Mars today.

Activity 2 — Looking for Life

Part A: An Operational Definition of Life Students will research characteristics of living organisms and develop a chart that will help them define important features of a living organism.

Part B: It's Alive! They will then use their definition to determine whether there is anything alive in three different soil samples, an experiment similar to the Mars Viking Lander in 1976 that looked for signs of life. Students will record their observations and draw pictures as they collect data from the samples.

Activity 3 — Mars Critters

Students will design a plant or animal life form that might survive on Mars.

Activity 1 — Imaginary Martians

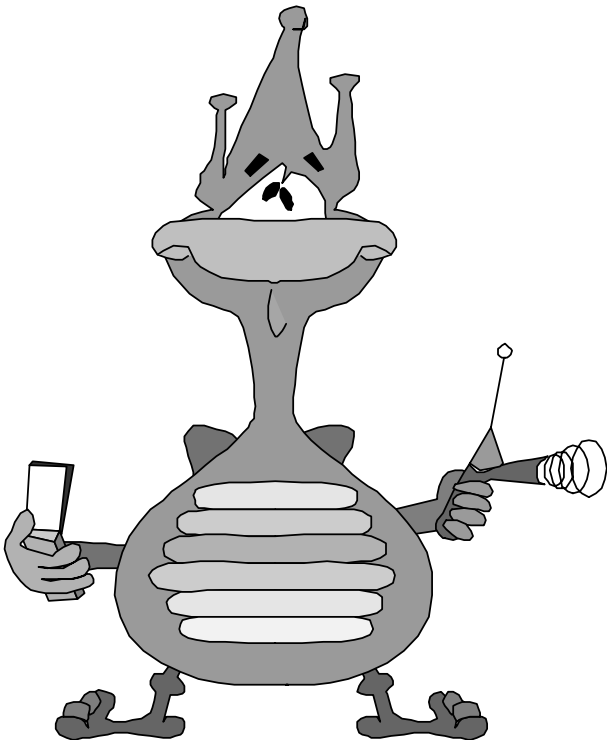
About This Activity

Students will listen to one or more excerpts from science fiction that will describe fictional living organisms from Mars. They will then draw their interpretations and compare them to what they already know about life on Mars today.

Objectives

Students will:

- draw their interpretation of a Martian after listening to a science fiction reading.
- analyze the realism of this Martian based on today's knowledge of Mars environment.
- discuss the popularity of Mars in literature.



Background

There are many science fiction stories related to Mars. Each one has its own explanation of how a Martian might look. The descriptions are based on the author's imagination and the known information about Mars from the time period. In this interdisciplinary activity, students will interpret an author's description of a Martian (language arts and art) and evaluate the possibility of such a creature living on Mars (science).

Vocabulary

interpretation, atmosphere, radiation

Materials

- ❑ drawing paper
- ❑ coloring utensils
- ❑ Student Sheet, *If You Went to Mars* (pg. 37)
- ❑ excerpts from science fiction novels Examples are Mars by Ben Bova (chapter 7), Out of the Silent Planet by C. S. Lewis (chapter 7), The Martian Chronicles by Ray Bradbury (February 1999-YUa), The Day The Martians Came by Frederick Pohl (chapter 17)

Procedure

Advanced Preparation

1. Check various novels and choose excerpt(s) to use.
2. Practice reading the excerpt(s).
3. Distribute student supplies.
4. Distribute the *If You Went to Mars* student sheet.

Classroom Procedure

1. Explain to the students that people in the past have had very different ideas of what life is like on Mars and that you would like to share some of these interpretations with them.
2. Ask the class to close their eyes and listen to the reading(s).
3. Read the excerpt(s) with animation and sound effects.
4. Tell the students to open their eyes, take the drawing materials of their choice, and draw what they think the author(s) described.
5. Ask the students why they think the author wrote the descriptions in this way. Discuss answers in terms of the literature and the time when the story was written.
6. Ask the students why they think there is so much literature about the planet Mars?
7. Ask each student to explain why the alien drawn could or could not really be found on Mars.
8. Discuss what it would be like to live on Mars. Use the *If You Went to Mars* student sheet.

Alternatives

1. Instead of a standard sheet of paper, have the students work in groups using a large sheet of butcher paper. Then you can also discuss how differently we each interpret what we hear. Display art.
2. Divide the class into teams and read several different excerpts, each team drawing an interpretation of a separate excerpt, then comparing the team drawings. Display art.

If You Went to Mars

from "Guide to the Solar System,"
by The University of Texas, McDonald Observatory

Mars is more like Earth than any other planet in our solar system but is still very different. You would have to wear a space suit to provide air and to protect you from the Sun's rays because the planet's thin atmosphere does not block harmful solar radiation. Your space suit would also protect you from the bitter cold; temperatures on Mars rarely climb above freezing, and they can plummet to -129ºC (200 degrees below zero Fahrenheit). You would need to bring water with you; although if you brought the proper equipment, you could probably get some Martian water from the air or the ground.

The Martian surface is dusty and red, and huge duststorms occasionally sweep over the plains, darkening the entire planet for days. Instead of a blue sky, a dusty pink sky would hang over you.

Student Sheet

Fundamental Criteria for Life Chart

Fill in Criteria after the class has made observations and the teacher has grouped the observations.

Living Organism	Criteria	Criteria	Criteria	Criteria	Criteria

Activity 2—

Looking for Life

About This Activity
In Part A students will use research to develop their criteria for life. The class will combine their ideas in a teacher-guided discussion. In Part B they will then use their definition of life 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 samples and experiment.

Objectives
Students will:

- form an operational definition of life.
- conduct a simulated experiment with soil samples similar to the experiments on the Mars Viking Lander.
- state relationships between the soil samples using their operational definition of life.
- make an inference about the possibility of life on Mars based on data obtained.

Background
We usually recognize something as being alive or not alive. But when scientists study very small samples or very old fossilized materials, the signs of life or previous life are not easy to determine. Scientists must establish criteria to work with in their research. The tests for life used by the Viking Mars missions were based on the idea that life would cause changes in the air or soil in the same way that Earth life does. The Viking tests did not detect the presence of life on Mars. The Viking tests would not have detected fossil evidence of past Mars life or a life form that is very different from Earth life.

Vocabulary
criteria, characteristics, organism, replication, metabolic

Part A:
An Operational Definition of Life

About This Part
Students will conduct research to identify characteristics of living and non-living organisms. They will record their observations on a chart that will help the class to come to a consensus about how to identify living things.

Materials

- ❑ Student Sheet *Fundamental Criteria for Life Chart* (pg. 38)
- ❑ dictionaries and encyclopedias
- ❑ examples of living and non-living things (should include plants, animals, and microorganisms—pictures can be substituted for the real thing)

Procedure

Advanced Preparation

1. Gather materials.
2. Review Background and Procedure.

Classroom Procedure

1. Explain to students that their job is to come up with a definition of how living things can be detected.
2. Ask students to state (or write) what characteristics make an individual item alive or not alive. Encourage them to find pictures and definitions of living and non-living things. Allow the students use of dictionaries and encyclopedias. Use the examples on the following page to encourage the students but not to limit them.

Example: 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 do need 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 can not reproduce— it is made by humans—and we know that the tree makes seeds that may produce more trees. The tree also takes in nutrients and gives off gasses and grows. The light uses electricity and gives off light, but it is strictly an energy exchange and there is no growth and there are no metabolic processes.

However, students might not list the fundamental criteria for life. They might go for the more obvious signs like methods of locomotion. The more subtle but fundamental signs of life are:

- metabolic processes that show chemical exchanges which may be detected in some sort of respiration or exchange of gases or solid materials.
- some type of reproduction, replication or cell division.
- growth.
- reaction to stimuli.

3. As a class, discuss the indications of life, asking for examples from a diverse sampling of living things. The teacher will paraphrase and group criteria on the blank chart, then guide the students to summarize the groupings to reflect the fundamental criteria for life.

4. Students will use these criteria for the following activities.

Part B: It's Alive!

About This Part

Students will take three different soil samples and look for signs of life based on the criteria from Part A.

Materials

- ❑ sand or sandy soil sample
- ❑ three glass vials, baby food jars, or beakers for soil per group
- ❑ sugar- 5 ml (sugar will be added to all soil samples)
- ❑ instant active dry yeast- 5 ml added to 50 ml of soil
- ❑ Alka-Seltzer tablets crushed- 1 tablet added to 50 ml of soil
- ❑ hot water - enough to cover the top of the soil in all jars (not hot enough to kill the yeast!)
- ❑ cups for distributing the water
- ❑ magnifying lens- 1 per group or individual
- ❑ Student Sheets *Data Chart I* and *Data Chart II* (pgs. 43-44)

Procedure

Advanced Preparation

1. Fill all jars 1/4th full of soil. (You will need 3 jars per team.)
2. Add just sugar to 1/3rd of the jars. Label these jars "A."
3. Add instant active dry yeast and sugar to 1/3rd of the jars. Label these jars "B."
4. Add the powdered Alka-seltzer and sugar to the remaining jars. Label these jars "C."
5. Give each group a set of three jars, magnifying lens, and the chart from previous activity.

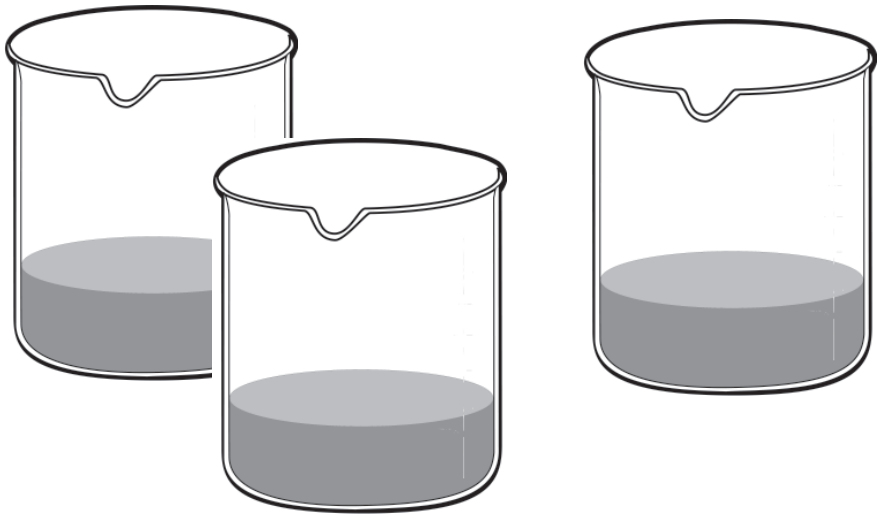
Classroom Procedure

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

1. Explain to the students that each team has been given a set of 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.
2. 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. Students should then record their data.
3. Give each group a cup of water. (Use hot tap water (~50°C) for the best results, do not kill the yeast.) Ask students to pour the water so that each sample is covered with the water.
4. Repeat step 2 and record data on a second sheet or in a separate area of the first sheet. Students should look for and record differences caused by adding water. After recording the first observations have students go back and observe again. (After about ten minutes Sample B will show even more activity.)
5. Discuss which samples showed indication of activity (B and C). Does that activity mean there is life in both B and C and no life in Sample A? Are there other explanations for the activity in either B or C?

   - Both B and C are chemical reactions
   - Sample C reaction stops
   - Sample B sustains long term activity
   - Sample A is a simple physical change where sugar dissolves

   Students should realize that there could be other tests that would detect life in Sample B. There might be microbes in the soil that would grow on a culture medium.
6. Determine which sample(s) contain life by applying the fundamental criteria for indicating life developed in Activity 2.
7. Tell students that Sample B contained yeast and Sample C contained Alka Seltzer. Discuss how scientists could tell the difference between a non-living chemical change (Alka Seltzer) and a life process (yeast) which is also a chemical change.
8. Discuss which of their criteria would identify yeast as living and Alka Seltzer as non-living.



It's Alive! Data Chart I

Initial Descriptions (no water added):

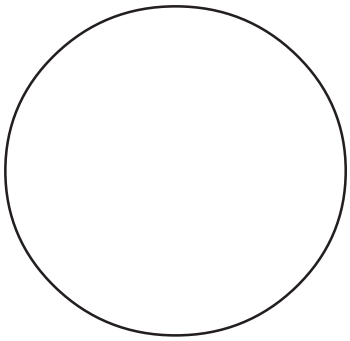
Sample A:

Sample B:

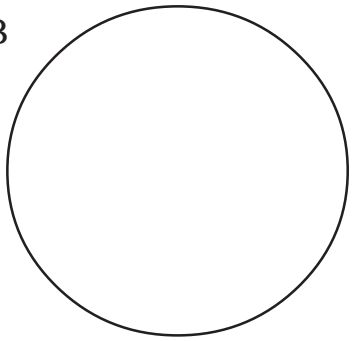
Sample C:

Initial Drawings (no water added):

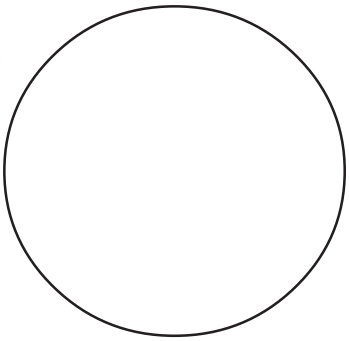
Sample A



Sample B



Sample C



It's Alive! Data Chart II

Initial Descriptions (after water is added):

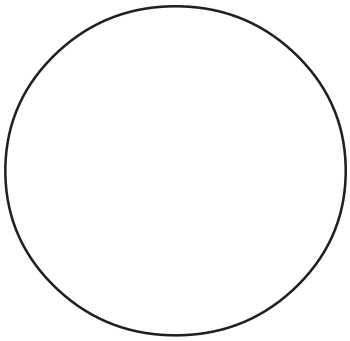
Sample A:

Sample B:

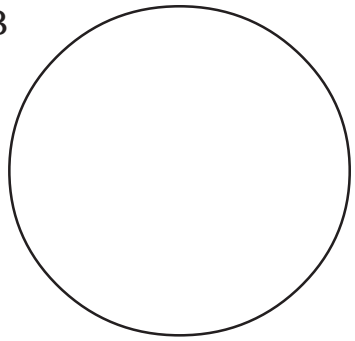
Sample C:

Initial Drawings (after water is added):

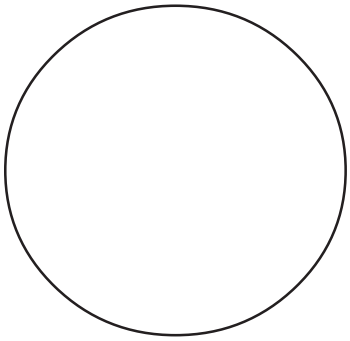
Sample A



Sample B



Sample C



Activity 3—

Mars Critters

About This Activity

In groups or as individuals, students will use their knowledge of Mars and living organisms to construct a model of a plant or animal that has the critical features for survival on Mars. This is a "what if" type of activity that encourages the students to apply knowledge. They will attempt to answer the question: What would an organism need to be like in order to live in the harsh Mars environment?

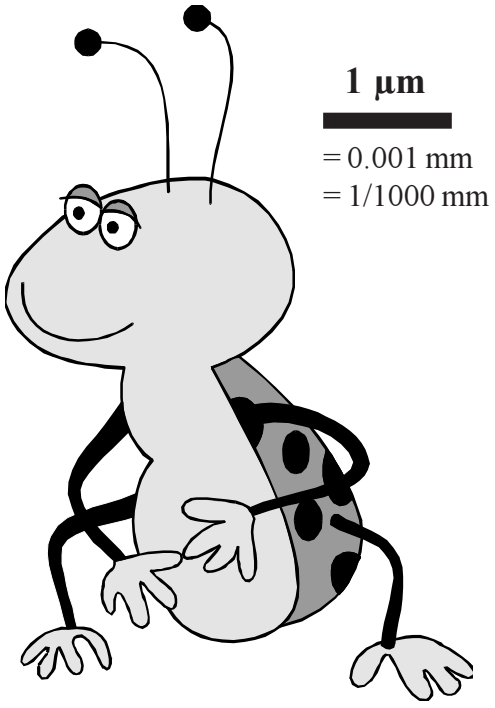
Objectives

Students will:

- draw logical conclusions about conditions on Mars.
- predict the type of organism that might survive on Mars.
- construct a model of a possible martian life form.
- write a description of the life form and its living conditions.

Background

To construct a critter model, students must know about the environment of Mars. The creature must fit into the ecology of a barren dry wasteland with extremes in temperature. The atmosphere is much thinner than the Earth's; therefore, special adaptations would be necessary to handle the constant radiation on the surface of Mars. Also the dominant gas in the Mars atmosphere is carbon dioxide with very little oxygen. The gravitational pull is just over 1/3rd (0.38) of Earth's. In addition, Mars has very strong winds causing tremendous dust storms. Another requirement for life is food—there are no plants or animals on the surface of Mars to serve as food!



Scientists are finding organisms on Earth that live in extreme conditions previously thought not able to support life. Some of these extreme environments include: the harsh, dry, cold valleys of Antarctica, the ocean depths with high pressures and no sunlight, and deep rock formations where organisms have no contact with organic material or sunlight from the surface.

Vocabulary

ecology, adaptations, gravity, geology, atmosphere, radiation exposure, weather, environment

Materials

- ❑ paper (construction, tag board, bulletin board, etc.)
- ❑ colored pencils
- ❑ glue
- ❑ items to decorate critter (rice, macaroni, glitter, cereal, candy, yarn, string, beads, etc.)
- ❑ pictures of living organisms from Earth
- ❑ Student Sheet, *Mars Critters* (pg. 47)
- ❑ Student Sheet - Activity 1, *If You Went to Mars* (pg. 37)
- ❑ Mars Fact Sheet (pg. 56)

Procedure

Advanced Preparation

1. Gather materials.
2. Set up various art supplies at each table for either individual work or small group work. This activity may be used as a homework project.
3. Review the "If You Went to Mars" sheet, Mars Fact Sheet, and the background provided above. Other research and reading may be assigned as desired.

Classroom Procedure

1. Ask students to work in groups to construct a model of an animal or plant that has features that might allow it to live on or near the surface of Mars. Have them consider all the special adaptations they see in animals and plants here on Earth. They must use their knowledge of conditions on Mars, consulting the Mars Fact Sheet, *If You Went to Mars*, and other resources such as web pages if necessary. Some key words for a web search might be "life in space" or "extremophile" (organisms living in extreme environments). They must identify a specific set of conditions under which this organism might live. Encourage the students to use creativity and imagination in their descriptions and models.
2. If this is assigned as homework, provide each student with a set of rules and a grading sheet, or read the rules and grading criteria aloud and post a copy.
3. Review the information already learned about Mars in previous lessons.
4. Allow at least 2 class periods for this project: one for construction, one for presentation.
5. Remind the students that there are no wrong critters as long as the grading criteria are followed.
6. Include a scale with each living organism.

MARS CRITTERS

In order to better understand what types of life scientists will look for when they go to Mars, you will construct a model or draw a picture of an organism that has features that might allow it to live on or near the surface of Mars.

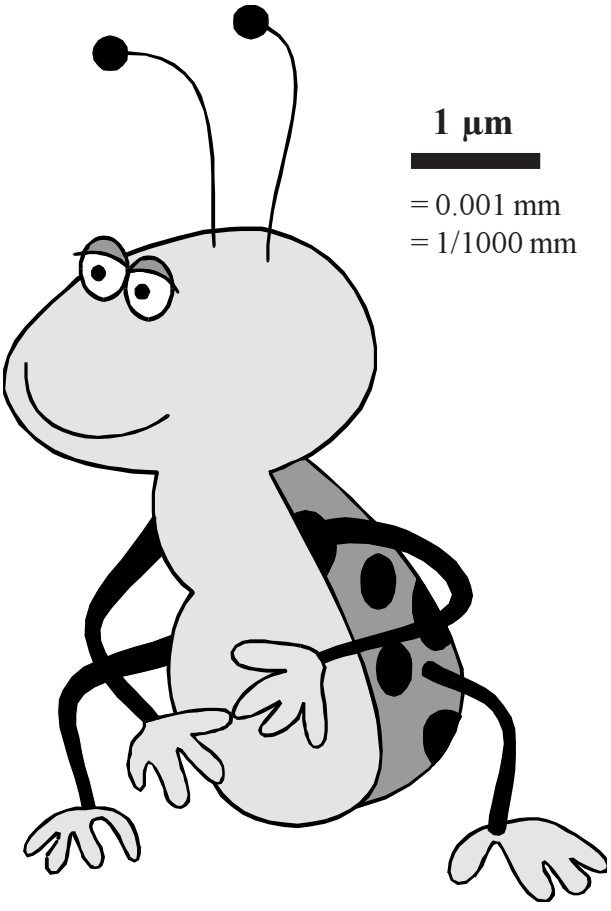
Conduct research about the environment on Mars. Consider the geology, gravity, atmosphere, radiation exposure, and weather. Choose a habitat somewhere in the Mars environment for the organism to live. Then construct a model of the plant or animal and include the special features it would need to live in that harsh environment. You may want to research the special adaptations animals and plants have to survive in difficult places here on Earth. Be creative and use your imagination.

Make a scale model or picture of your critter. Answer all the questions on the next page and attach them to the picture or model of your critter.

GRADING

1. Your entry will be graded on scientific accuracy (40%) and creativity (40%). Remember that everything on Mars must obey the laws of nature and your creature must have good martian survival traits. Provide a scale to indicate the true size of your critter.

2. Clear writing and correct grammar count for the remaining 20% of your total score.



Description and Questions

Use another page if more space is needed.

1. The critter's name:

2. Describe the habitat and climate in which your critter lives:

3. How does it move? Include both the form and method of locomotion. (For example: The miniature Mars Gopher leaps on powerful hind legs).

4. What does it eat or use as nutrients? Is it herbivorous, carnivorous, omnivorous, or other? What is its main food and how does it acquire this food?

5. What other creatures does it prey on, if any? How does it defend itself against predators?

6. How does your creature cope with Mars' extreme cold, unfiltered solar radiation, and other environmental factors?

7. Is it solitary or does it live in large groups? Describe its social behaviors.

8. What else would you like others to know about your critter?