NOVA

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PBS

Is There Life on Mars?

PROGRAM OVERVIEW

NOVA follows scientists as they seek signs of life on Mars.

The program:

- reviews early missions to Mars.
- follows the trials and triumphs of the Mars Exploration Rovers, *Spirit* and *Opportunity*, as they land on and navigate the Red Planet.
- shows how scientists used tools on each rover to explore and determine the chemical makeup of the planet's surface.
- notes that while some scientists think that water once flowed on Mars and may have sustained life, other scientists maintain that the planet's environmental conditions would not have supported life.
- features scientists who investigate whether microbes can survive in salty Arctic springs on Earth.
- reports on the *Phoenix* Mars Lander's efforts to find signs of liquid water in the northern polar region of Mars.
- shows how the team troubleshoots the lander's equipment difficulties.
- reveals how the lander found evidence of water on the Red Planet.
- notes that one test showed signs of the chemical percholate in the Martian soil and reports that researchers have identified organisms on Earth that thrive on percholate.
- describes plans for the next mission in 2010—the Mars Science Laboratory—that will search for organics on Mars.

LINKS AND BOOKS

Links

Are We Alone
Explains the search for extraterrestrial intelligence.

Mars Dead or Alive: A Hostile Environment
Describes the Mars Exploration Rover mission and why scientists are so interested in exploring the Red Planet.

***Phoenix* Mars Mission**
Provides detailed information about the *Phoenix* mission.

Books

A Traveler's Guide to Mars
by William K. Hartmann.
Workman Publishing Company, 2003.
Presents a tour guide–style overview of Mars based on decades worth of photographs and research data.

Postcards from Mars: The First Photographer on the Red Planet
by Jim Bell.
Dutton Adult, 2006.
Presents more than 150 photographs of the Martian landscape taken by the Mars Exploratory Rover cameras.

Planet Mars: Story of Another World
by François Forget, François Costard, and Philippe Lognonné.
Springer Praxis, 2007.
Recounts the complex history and evolution of Mars from its formation through recent exploration.

The Rock from Mars: A True Detective Story on Two Planets
by Kathy Sawyer.
Random House, 2006.
Presents the story of the controversial meteorite ALH84001, which may or may not have contained evidence of bacterial life on Mars.

BEFORE WATCHING

1. **Consider the requirements for life.** People have long been fascinated with the idea that life exists elsewhere in the universe. For more than 200 years, people have looked to Earth's closest planetary neighbor, Mars, as the most likely place to find signs of life. Speculation of intelligent life on the Red Planet picked up in the 1870s when Giovanni Schiaparelli's observations of linear crisscrossing, features he called *canali* (meaning "natural water channels"), were mistranslated into English as *canals* (man-made waterways). Although scientists have now abandoned the idea of little green men, the hope of finding evidence of past and present life on Mars still persists. But will we recognize life if we find it? Will life beyond Earth resemble life as we know it? These may seem like simple questions, but they are actually quite profound. Although Earth itself is teeming with life—even in some of the most unexpected locations—defining life can be quite a difficult task.

   NASA designed its *Phoenix* mission to determine if life or the conditions for life ever have or might eventually exist on Mars. Before watching the program and learning about the *Phoenix* mission's search for water and evidence of life on Mars, have the class play the following game.

   Ask student pairs or groups to discuss and write down their ideas about what it means for something to be alive. Have them consider the following questions:
   - How do you know something is alive?
   - What do all living things seem to have in common?
   - What are the basic requirements for life?
   - How would you define life? Write a working definition.

   Next, write the following examples on the board. Each has some but not all of the characteristics of life: fire *(consumes oxygen and fuel, grows, reproduces, and gives off energy and waste products)*, a mule *(which is sterile and cannot reproduce)*, a cloud, a light, a stream, an icicle, crystals, a television, a virus, and a car.

   Ask groups to consider each example and see if their definition can distinguish whether the item is alive. Have groups revise their definitions to accommodate this set of ambiguous examples.

   Have a follow-up discussion and ask groups which examples posed the greatest challenge when trying to develop an accurate definition for a living thing. As a class, develop a working definition of life. *(Although the specifics may vary, scientists agree that all life forms are made of cells. Living things respond to their environment. They need sources of energy, nutrients, and water—these conditions should appear somewhere in the students' final definition. Reproduction is important for life forms to persist, especially reproduction that allows for change and adaptability within a population.)*

2. **Test a soil sample for habitability.** In 1996, the meteorite ALH84001, which was discovered in Antarctica in 1984 and thought to be from Mars, stirred up a great deal of excitement and controversy when scientists announced that it contained structures that appeared to be fossilized bacteria. Although tests for organic material in the meteorite have revealed the presence of amino acids (the building blocks of proteins) and polycyclic aromatic hydrocarbons (PAHs, chemical

compounds considered by some to be a likely candidate as a basis for early forms of life), there is much debate over whether the organic molecules are actually indicators of past Martian life, were instead created by nonbiological processes, or due to contamination from the Antarctic ice. Scientists hope that the chemical properties of Martian soil, as discovered by *Phoenix*, will provide evidence that **habitability** (the ability to support life) may exist in the historic record of Martian soil.

To help students understand how *Phoenix* will approach its analysis of Martian soil, have them test a local soil sample for signs of habitability. Collect enough soil so that each small group of students has enough soil to fill a plastic foam cup approximately halfway. Each group will also need a pH test kit (similar to those used with swimming pools and hot tubs). Have students follow these procedures to test their sample:

a. Examine the soil for immediate signs of life (e.g., roots and bugs). (Note: It may be helpful to spread the soil out on a piece of paper for contrast.)
b. Examine the soil for moisture/water. Spread the soil on a piece of paper towel and check for water droplets or moisture.
c. Examine the soil for rocks and larger grains. Rockier soil tends to be less suitable for life.
d. Test the soil for carbonates by adding a few drops of vinegar to a spoonful of soil. Carbonates, which contain one atom of carbon and three atoms of oxygen, form naturally in the presence of carbon dioxide and liquid water, and therefore may indicate habitability. If there are carbonates in your soil sample, the vinegar will cause the soil to bubble or fizz, as carbon dioxide is released.
e. Test the pH of the soil. Pour about 30 milliliters of distilled water into an 8-ounce Styrofoam cup and measure its pH using a pH test strip (it should be close to 7, which is neutral on the pH scale). Mix about 30 grams of soil into the water and retest the pH with a new test strip to determine how acidic or basic the soil is. Although some life thrives in even the most extreme conditions, most life finds it difficult to survive in soil that strays too far from neutral.

Discuss what each group found in their soil. Would they consider it to be habitable? Given the cold, bleak landscape of Mars, do they think *Phoenix* is more likely to find results that closely resemble their soil samples (evidence of plant and animal life) or something different (perhaps evidence of bacteria)?

3. **Simulate different methods of observing a planet.** Although sending people to Mars is a real possibility for the future, we currently rely on telescopes, satellites, and robots to explore the planet for us. Each method of observation provides us with a different view of the Red Planet. Have students explore the increasing level of detail afforded by different methods of planetary exploration—specifically, flybys, orbiters, and landers. Spread out a variety of objects on a table or desk in the front of the room. Try to put enough objects on the table so that they are not overlapping, but are numerous enough that it is difficult to take them all in with one glance. Have students first simulate a flyby, by walking slowly past the table at a distance of 3 meters. When they return to their seats, cover the table or try to block it from view. Have students make a list of all the objects they saw and provide a description of

BEFORE WATCHING *continued*

each object as best they can. Next, designate one or two students to be "orbiters" and have them circle the table three or four times at a distance of 1 meter, naming and describing the objects they see. Students in their seats should make a second list, recording the names and descriptions of the objects as reported by the "orbiters." Finally, have the class choose a small area of interest to which they would like to send a lander. Choose one or two students to examine that specific area (the size of an index card or sheet of paper depending on the size of the table and objects on it). Landers are typically designed to perform particular tasks such as taking pictures or analyzing soil composition. Give the "landers" one minute to examine the area of interest. They should describe the objects in as much detail as possible including appearance, feel, and what they think the object is made of. Students should record this information in a third list.

Have students compare their lists. Did they all observe the same objects in their flybys? Did the orbiter and lander missions observe the same objects as any of the flybys? How did the level of detail of each method compare with that of the other two methods? How might a manned mission increase the level of detail further? As a class, discuss the types of features and discoveries that have been made on Mars with these three methods of exploration. Visit NASA's **Mission to Mars** site for answers to these questions and information about each of NASA's missions to the Red Planet.

AFTER WATCHING

1. **Weigh the pros and cons of sending people to Mars.** If we sent humans to Mars, they could perform experiments, explore regions of the planet previously unexplored by satellites and rovers, and experience what it's really like to live on another planet. But given that three previous unmanned missions have crashed, the long journey to Mars and back, the harsh environment on the Martian surface, and other unknown dangers, would it be worth the risk? Have students use the NASA page, **A Crewed Mission to Mars**, as a starting point for investigating some of the motivations and risks associated with sending humans to Mars. Break the class into small groups and assign each group one or more of the following topics:
   - Why Go to Mars?
   - Mission Objectives and Profiles
   - Launching the Mission
   - Landing on the Martian Surface
   - Surface Systems
   - Return to Earth

   Have each group share a summary of their findings with the rest of the class and debate the issue of whether we should consider sending a crewed mission to Mars.

2. **Examine other potentially habitable worlds.** Mars is not the only place in our solar system scientists are looking for life. Many consider Saturn's moon Titan and Jupiter's moon Europa potential candidates for habitability. Have students conduct research using the Internet, newspaper articles, and other available resources to find out more about these two moons and what characteristics they each possess that have led scientists to believe life might be present on these seemingly hostile worlds. *(Titan's thick atmosphere is believed to resemble that of early Earth several billion years ago, before life began adding oxygen to the atmosphere. Like Earth, Titan's atmosphere is composed mainly of nitrogen. A more thorough understanding of Titan's surface, atmosphere and chemical composition could show us what Earth might have been like billions of years ago. Europa, though covered by solid ice, is believed to have a salty liquid ocean beneath the ice. Many scientists think this ocean is an environment in which unicellular organisms might be able to live.)*

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