Mission 13 Logbook
The Viking Search for Life on Mars

Is There Life on Mars?

Mission to the Schoolyard – Directions

Your team will play the role of an extraterrestrial probe being sent to a specific landing site on that mysterious third planet from the Sun, Earth. At the landing site, you will randomly select a sample of Earth "soil" for analysis. You will also make a drawing of your sample area and take a photograph if a camera is available.

Procedure

1. Go to the general target site assigned to your team.

2. Choose one student to be the lander. Blindfold the lander and turn him or her around a few times. Lead your lander forward a few steps. Hand the lander a plastic ring. The lander should then gently toss the ring to the ground. (This simulates the randomness in the exact touchdown point for your probe.)

3. If your team has a camera, photograph the area inside the sampling ring. This is the only view that your lander can see!

4. Whether or not your team has a camera, everyone should sketch what they see within the sampling ring. (This simulates the pictures of the landing site taken by your probe and sent to your extraterrestrial world.) Be as precise as you can in indicating the number of objects and the size, shape, and color (if you have colored pencils) of objects.

5. After everyone has sketched the area, have one student be the soil sampler. This student should use a sampling scoop (plastic cup) to take a sample from the center of the ring and bring it back to class. If it is not possible to actually collect any soil, sample anything present inside the ring that can be scooped up by the cup (e.g., dust, gravel). (This simulates the collecting of soil for your probe's life detection experiments.)

6. Return to the classroom. Each team will present its observations to the class, including photos and sketches, and discuss them in terms of a search for life. A concrete surface, for example, is not a living thing, but is it a sign of life? Could it be a hard clay surface left by evaporating water? Could it be very smooth rock? Based upon the sampling and observation, did your team detect any life or signs of life on Earth? Or would your mission lead you to believe that Earth is a dead planet?

7. If there are no obvious signs of life, are there any tests that you could perform on your "soil" sample to detect unseen life? Recall the tests your class has done on other soil samples. What do you think the results of these tests would be when performed on your "soil" sample?

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Mission to the Schoolyard – Worksheet

Name: _____ Date: _____

1. On the back of this paper, draw your sampling site.

2. Describe your "soil" sample in detail. Include information about its color, texture, and moisture.

3. Did you detect any life or signs of life? What observations lead you to this conclusion? Can you be sure of this conclusion? Why? Why not?

4. Are there some further tests that you could do to tell if your landing site contained living organisms? Describe these tests.

5. If you were an extraterrestrial scientist and this was your only sample of the surface of Earth, what would you conclude about life on Earth?

6. Do you think that this type of random sampling is an effective way to search for life on a planet?

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The Viking Mission- Image

Figure 13.1—*Viking* Life Detection Tests.

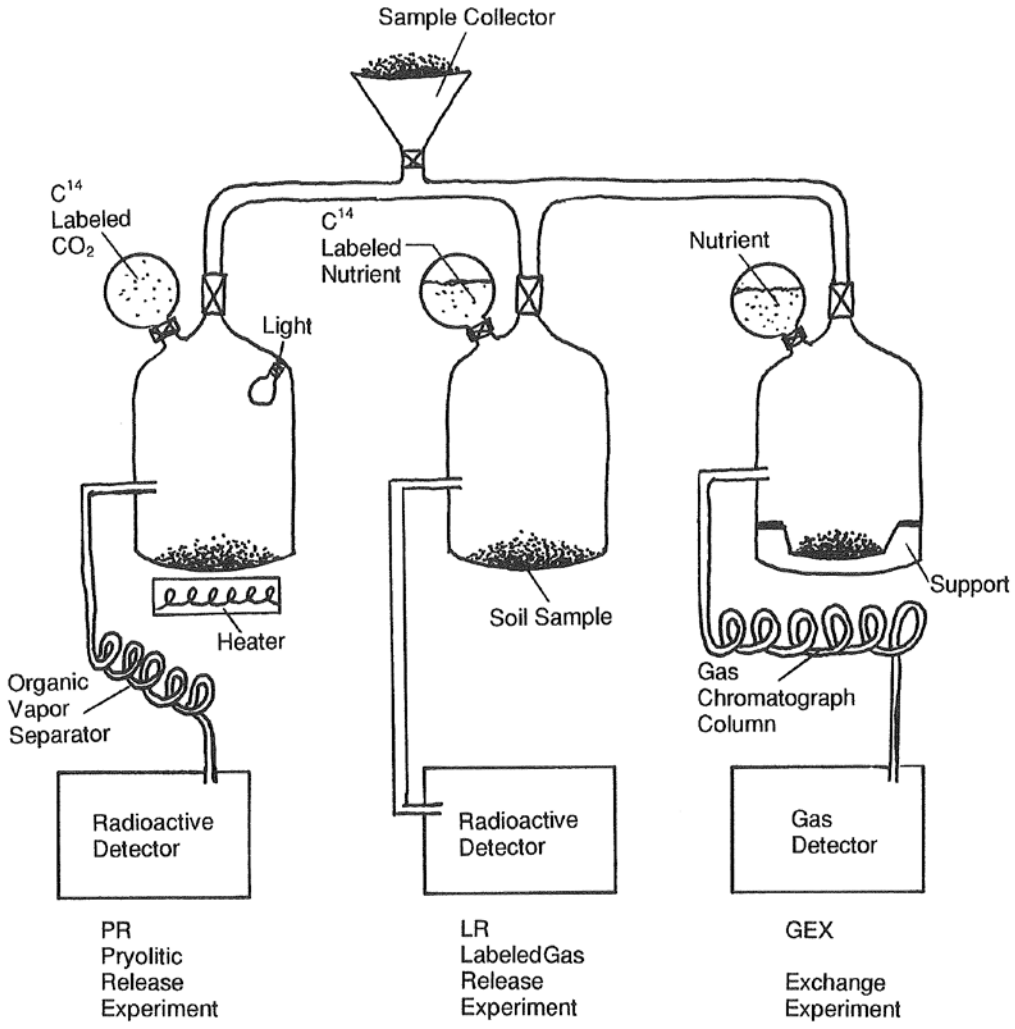

Table 13.1—Life Detection Tests Used by *Viking* Landers

Name of Test	**How It Works**
The Gas Exchange (GEX) Experiment	Measures changes in the gas composition above a soil sample after a warm, liquid nutrient, or plain water is added.
The Labeled Release (LR) Experiment	Relies on the detection of labeled (radioactive) carbon compounds released into the gas above a soil sample after adding a labeled (radioactive) liquid nutrient.
The Pyrolitic (PR) Experiment	The detection of labeled carbon compunds in "roasted" soil sample after exposure to those radioactive compounds in the air above the sample.

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Viking's Life Detection Tests- Image

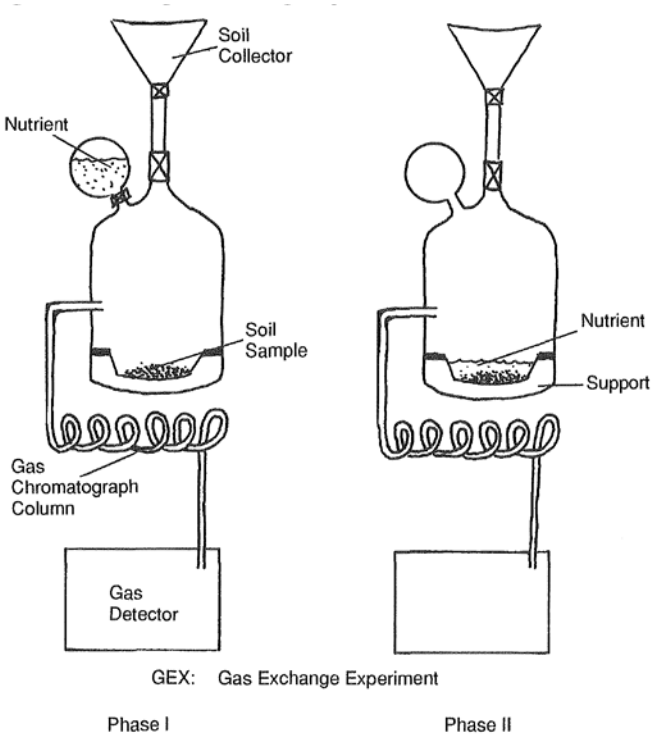
The Gas Exchange (GEX) Experiment
(or the "Chicken Soup" Experiment)

Phase One

1. The Lander scoops soil into a container. (See figure 13.2, left side.)

2. The soil is exposed to water vapor rising from the nutrient solution. (See figure 13.2, right side.) Note that there are no nutrients in this vapor, just water. If the soil contains bacteria that need only water to grow, they may use up gas by absorbing it into their bodies or produce gas.

Figure *13.2-Viking Gas* Exchange Experiment.



3. The gas chromatograph indicates if gas has been used or produced.

Phase Two

1. Ten days after phase one, the soil is covered with nutrient solution. The newspapers called this nutrient solution “chicken soup.” If the soil contains bacteria that can use these nutrients to grow, they may use up or produce gas.

2. The gas chromatograph indicates if gas has been used or produced.

Results

The results of phase one of the GEX experiment were positive. Oxygen (0^2) and carbon dioxide (Cog) came out of the soil as soon as the sample came in contact with the water vapor.

At first, some scientists concluded that this indicated life on Mars. However, as they thought about it more, they decided that this did not prove that there was life on Mars. What could have changed their minds?

Discussion

The GEX is similar to the test you conducted in mission 12, “Can You 'Gas What's Happening?” Viking scientists expected that water or a nutrient solution would allow any microbes in the Martian soil to grow. As they grew, they would use up or produce gas. The gas chromatograph would show if the gas mixture in the container had changed.

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Viking's Life Detection Tests

The Labeled Release (LR) Experiment

Description

The LR experiment, like the GEX experiment, tried to feed any possible Martian life with a liquid nutrient that was dripped over the soil sample. However, the usual carbon-12 atoms in the nutrient were replaced with radioactive carbon-14 atoms. Chemically, carbon- 14 atoms behave the same as carbon-12 atoms. If there were living microbes in the soil, they would take in the labeled compounds, use them, and release them (as carbon dioxide, for example) into the air above the sample. The telltale carbon-14 atoms could be detected by Viking instruments sensitive to radiation.

Results

The original test results for the LR experiment were positive. Gas (carbon dioxide) containing the radioactive carbon-14 atoms appeared above the sample. Again, scientists at first concluded that this indicated life on Mars. Scientists were even more convinced after sterilization of a second soil sample by a heater prevented the reaction. But once more, after thinking about it, scientists were not so sure. What caused them to doubt their initial conclusion?

The Pyrolitic Release (PR) Experiment

Description

Essentially, this was a test for photosynthetic organisms. Once again, radioactive carbon-14 atoms were used as "tracers," but this time the labeled compounds were put into the air above the soil sample and a lamp was turned on to simulate solar illumination. Any potential Martian microbes were given the chance to use the air and incorporate the labeled compounds into their bodies. Finally, the soil sample was heated enough to pyrolize (or "roast") any potential microbes. ("Pyrolize" comes from the Greek word for fire, and means to decompose with heat.) This would release the labeled compounds, producing a radioactive signal. Ten tests were made. In two of the tests, the samples were heated to Temperatures that should have destroyed any organisms in the soil before they were exposed to the compounds in the air. The results of the tests made on these two samples were virtually the same as the results of the tests made on the unsterilized samples.

Results

For the third time, most of the original test results were positive. Compounds containing the carbon-14 atoms were detected, and scientists now had another reason to believe they had found life on Mars! And, for the third time, they soon began to doubt this conclusion.

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Mysteries of Mars – Worksheet

Name: _____ Date: _____

Mystery of Mars # 1

Why did *Viking* scientists conclude that their tests did not prove the existence of life on Mars even though all three tests initially gave positive results?

There are four clue cards available. Try to solve this Mystery with as few clues as possible. Can you solve it with no clues? If you are stuck, ask for one clue, and then try again. Good sleuthing!

1. Why might the GEX experiment give a “false positive” result?

2. Why might the LR experiment give a “false positive” result?

3. Why might the PR experiment give a “false positive” result?

4. Why might all three experiments give “false positive" results?

Mystery of Mars # 2

1. Could it be that life *is* present on Mars and *Viking* failed to detect it?

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Mystery of Mars # 1 – Clue Cards

Clue—The soil on Mars is composed of chemical. Can some nonliving chemical reactions mimic the metabolic reactions of living things?

Clue—Mars today is a dry planet. Liquid water has not existed on Mars for many, many years. The "chicken soup" nutrients used in the test were dissolved in water. Is water involved in any chemical reactions here on Earth?

Clue—The *Viking* lander came from Earth. Could *Viking* have brought something with it that might have caused chemical reactions that mimic the metabolic reactions of living things? Could it have brought chemicals from Earth? Leaky fuels? Some other form of contamination?

Clue—Other tests done by *Viking* were negative. Tests of the soil showed no organic compounds. Tests of the air showed no compounds that would indicate the presence of life (such as oxygen or methane). The cameras saw no signs of life and detected no movement of living things/ Is it likely that life exists on Mars, given these negative results?

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A New Mission to Mars–Worksheet

Name: _____ Date: _____

1. Now that you are aware of the problems exobiologists experienced because of the way they designed the *Viking* lander, you should be able to design a better mission to Mars! What basic mistakes did the *Viking* scientists make?

2. If you were designing a spacecraft and lander to search for life, how would it be different than the *Viking* spacecraft and landers? Why would you make these changes?

3. How many samples would you take?

4. Do you think that the United States should send another spacecraft and lander to Mars to search for life? Why do you think so?