



Exobiology

How to detect life

<http://library.thinkquest.org/C003763/index.php?page=exobio03>

Civilizations are easier to find

Note that we don't use the word 'civilization' - generally, civilizations are visible from a great distance away. If aliens were to enter our solar system and look at Earth, they'd not only be swamped by a torrent of radio signals but they'd be able to detect dozens of artificial chemicals in our atmosphere, over a hundred satellites in orbit and city lights emanating from the surface.

Even if these hypothetical aliens came hundreds of years ago, when we were not a technological civilization, a quick infrared spectrometry survey of our atmosphere would show that we have high levels of methane and ozone gases, gases that naturally break down very quickly unless they're sustained by life.

In both these cases, it's very easy to detect life. The problem scientists have is when they're looking for very small signs of life; for example, evidence that bacteria live on a certain planet. If you're looking for bacteria, you're not likely to detect them by their radio wave transmissions or any city lights.

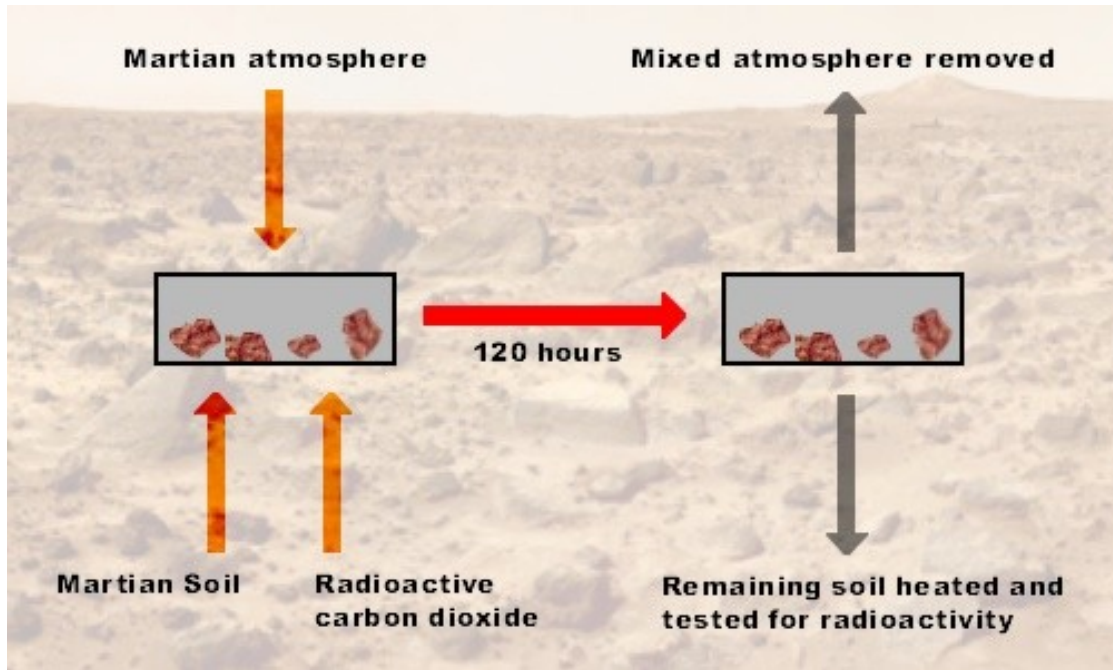
Assuming that you're actively looking for life on another planet (in other words, not using SETI), there are a number of well-established ways of detecting life.

Possibly the first serious attempt to detect life on another planet was by the Viking probes sent to Mars in 1976, whose primary aim was in fact to find life. Scientists on the Viking mission were felt fairly certain that there were no large Martian life forms alive (large being anything bigger than the size of an ant) - with a average surface temperature of minus 26C, you can understand why they came to this conclusion.

So they knew that if life existed on Mars, it would be in the form of microbes, or micro-organisms. The Viking landers (both identical) carried three different tests to look for life, and a gas-chromatograph mass spectrometer (GCMS - to analyze the composition of chemicals found on mars). The first was called the pyrolytic release experiment.

The pyrolytic release experiment involves taking a sample of Martian soil and also adding Martian atmosphere and radioactive carbon dioxide. The atmosphere of Mars is made up primarily of carbon dioxide, and the scientists believed that any organisms would have found a way to use it. So once everything is placed in a container, it would be left for 120 hours. After this time, the mixed atmosphere would be flushed out and the soil heated to a high temperature. If the soil contained any radioactive carbon, that would mean that some process had pulled the radioactive carbon dioxide out of the atmosphere and combined it with the soil - and that process would probably be life (after all, that's what plants do on Earth).

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The Pyrolytic Release Experiment

The other two experiments depended on exposing Martian soil to nutrients in solutions of water, and monitoring them to see if there were any changes indicating life.

When the Viking landers touched down, the latter two experiments showed astonishing signs of life; so astonishing, in fact, that the scientists couldn't quite believe it. They had monitored large changes in the soil/nutrient mixtures - too large for the small amounts of life they were expecting.

The first experiment, the pyrolytic release, took a little longer and returned evidence that something was going on, but the data was ambiguous. In other words, there was no strong evidence for the existence of life. Finally, the GCMS returned its results - there was no sign of any organic materials - no microbes, no waste products of microbes and no dead remains of microbes.

Scientists came to the conclusion that there was no life, and that the strange results had been caused by an oxidising chemical called hydrogen peroxide in the soil. Hydrogen peroxide (H_2O_2) does not exist on Earth in large quantities because it reacts with water violently, breaking down in. But since there's no water on Mars, when the hydrogen peroxide in the soil had the water nutrients added to it, it reacted violently to produce oxygen - which people first mistook as being a sign of life.

So in the end, the Viking experiments didn't really prove anything, although they helped scientists understand more about Mars and how to design better experiments.



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The Martian Way

The British Beagle 2 lander is set to touch down on Mars in 2003, and its primary aim, like the Viking landers, is to look for life. This time, the Beagle 2 has been armed with an entirely new set of tests for life.

One relatively easy way to tell whether life has existed on Mars in the past is looking for the remains of micro-organisms. These remains will be composed of organic material that is composed of carbon compounds. However, carbon compounds can be produced by other methods than biochemical reactions (which is one of the reasons why scientists dispute the fact that ALH 84001 showed there was life on Mars). Fortunately, by looking at the different isotopes of carbon that make up the carbon compounds, you can tell whether they were produced by life, since organisms use the 'lighter' carbon-12 preferentially over the 'heavy' carbon-13.

By burning carbon compounds that are taken from rocks on the surface and examining the carbon dioxide that is produced, scientists will be able to determine the isotopic composition of the carbon, and so discover whether life existed (this will be carried out by an incinerator and a mass spectrometer).



A photograph of the fully deployed Beagle 2. © Beagle 2.

The one experiment that will attract the greatest attention from the public is the search for methane in the Martian atmosphere. Methane is solely produced by biological processes, and is quickly destroyed by light. Therefore, if any methane at all is found in the atmosphere, we can be almost certain that life exists on Mars right now. The equipment used to perform this experiment has already proven its worth in helping us understand the process of global warming, and perhaps it will make similarly ground-breaking discoveries on Mars.