

Things to Think About

•What motivates our search for other life forms in the universe? Why has the question of whether or not we are alone – whether there is anybody else out there – dominated people's thoughts for so long?

•Research the conditions necessary for human and animal life to evolve and survive on Earth. Then consider what we know about the environments on other planets. What have scientists learned about the extreme conditions (on Earth and elsewhere) under which other kinds of life could exist?

•What is the significance, in terms of life, of finding evidence of water on Mars? What such evidence is there? Do you believe that life can exist anywhere there is water?

•If a scientific mission brought a rock back to Earth from Mars, what precautions would you take before studying it? Would you try to revive any possible life forms? Why or why not?

•Extraterrestrial life has long been the subject of science fiction. Explore the different ways aliens look and act in popular books, movies, and television programs. How have these images changed over the years? If you were to encounter alien life forms, what do you think they would look like? How would you attempt to communicate with them?

Internet Resources

www.astrobiology.com – The Astrobiology Web, with news on the search for life and other astronomical matters.

www.planetary.org – The site of the Planetary Society, dedicated to exploring the solar system and searching for extraterrestrial life.

www.seti-inst.edu – The SETI Institute Online, the home page of the institute dedicated to the Search for Extraterrestrial Intelligence.

Other Resources

For students:

Bortz, Fred. *Martian Fossils on Earth? The Story of Meteorite ALH84001.* Millbrook Press, 1997.

Clark, Stuart. *Life on Other Worlds and How to Find It.* Springer Verlag, 2000.

Couper, Heather and Nigel Henbest. *Is Anybody Out There?* Dorling Kindersley, 1998.

For adults:

Davies, Paul. *The Fifth Miracle: The Search for the Origin and Meaning of Life.* Simon & Schuster, 1999.

Fisher, David E. and Marshall Jon Fisher. *Strangers in the Night: A Brief History of Life on Other Worlds.* Counterpoint, 1998.

Parker, Barry R. *Alien Life: The Search for Extraterrestrials and Beyond.* Perseus Books, 1998.

Shapiro, Robert. *Planetary Dreams: The Quest to Discover Life Beyond Earth.* John Wiley & Sons, 1999.

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Human beings have long looked up at the sky and wondered: Are we alone? Are there other creatures like us? Is there intelligent life elsewhere in the universe? The answers may soon be at hand. Already, some scientists believe they have found microscopic fossils and other signs of life in a Martian meteorite, while researchers with sensitive telescopes are constantly tuned to the stars, listening for radio signals and laser light messages that might be sent by intelligent extraterrestrials. Moreover, we know now that life forms can exist in environments previously believed to be inhospitable, lending credence to the notion that life could well exist on other planets or moons despite their being considerably different from Earth. Learn how planned missions to Mars and Europa, one of Jupiter's moons, could bring back exciting answers to the question of whether there is life elsewhere in the Universe.



Vocabulary

ALH84001 — A meteorite that left Mars 17 million years ago, crashed into Antarctica more than 11,000 years ago, and was recovered by geologists in 1984. In 1996 scientists announced that it contained evidence of microscopic fossils from Mars.

Europa — A moon of Jupiter, discovered by Galileo in 1610, that has water, ice and, a thin atmosphere.

galaxy — A collection of hundreds of billions of stars as well as gas and dust, held together by gravity. Our Milky Way is an example.

Galileo — The first spacecraft to orbit Jupiter, launched by the shuttle Atlantis in October 1989. In 1995 the Galileo launched a probe into Jupiter's atmosphere.

hydrobot — A dwarf submarine. On a planned mission to Jupiter's moon Europa, a hydrobot will pierce Europa's icecap and swim down to explore the ocean there.

hydrothermal vents — Deep-sea vents on the ocean floor from which hot water rises, which are the site of exotic life forms that do not depend on sunlight to live.

meteorite — A chunk of material from space that enters Earth's atmosphere and reaches the ground. While most meteorites are believed to be from asteroids or comets, some may be from the Moon or Mars.

microbes — Microscopic organisms or forms of life.

Milky Way — The galaxy in which our own solar system is located.

permafrost — A perpetually frozen layer (as of a planet) below the surface.

planet — A large body that orbits a star. Earth is an example.

SETI Institute — An institute, located in California, that is dedicated to the Search for Extraterrestrial Intelligence—the search for radio signals from other intelligent life forms.

solar system — A star and the bodies orbiting it—planets, moons, etc. In our solar system, nine planets orbit the Sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

star — A large ball of primarily very hot hydrogen and helium gas that produces copious amounts of light. The Sun is an example.

Sun — The star at the center of our solar system. It is an average star which, at 5 billion years old, is middle-aged.

Upsilon Andromedae — A star, in the constellation Andromeda that in 1999 was found to have three planets in orbit around it. It is the first solar system discovered apart from our own in which planets orbit a normal star like the Sun.

July and September 1976 — *Viking 1* and *Viking 2* (launched in August and September 1975, respectively) land on Mars and scoop up and analyze soil samples for signs of microbial life, but do not find any; the Martian channels suggest that water once flowed.

August 1993 — NASA loses contact with the *Mars Observer*, launched in September 1992 to study the planet's geoscience and climate.

October 1995 — Swiss scientists Michael Mayor and Didier Queloz find the first indirect evidence of a planet orbiting another ordinary star, 51 Pegasi.

December 1995 — *Galileo* (launched by the shuttle Atlantis in October 1989) encounters Jupiter and releases a probe to the surface; it then encounters several moons including Europa, which is covered with ice and may have microscopic life.

August 1996 — NASA officials and a team from Stanford University hold a news conference to announce that ALH84001, a 17-million-year-old meteorite from Mars, appears to contain microscopic fossils and other signs of life.

July 1997 — The *Mars Pathfinder* (launched by NASA in December 1996) lands on an apparent ancient Martian flood plain and deploys the tiny, roving *Sojourner*, which returns many images and analyzes the chemistry of the soil and rocks.

1998 — NASA announces ambitious plans for launching numerous orbiting and landing missions to Mars in the next decade, following a policy of "faster, cheaper, better."

March 1998 — NASA announces that data from the *Lunar Prospector* (which was launched and began orbiting the Moon in January 1998) show evidence of hydrogen, a component of water, on the Moon, in the form of ice mixed with soil around the poles.

March 1999 — A team led by Geoffrey Marcy discovers the first multiplanetary system, besides ours, around a star like our Sun — three large planets orbiting Upsilon Andromedae.

August 1999 — Scientists report finding the first liquid water in an object from space, a 4-million-year-old meteorite that landed in Monahans, TX, in March 1998.

— Astronomers announce the discovery of six new large planets orbiting stars other than the Sun, bringing the total to about 30.

September 1999 — The *Mars Climate Orbiter* (launched by NASA in December 1998 to provide information on the planet's surface and climate) reaches Mars but apparently crashes as a result of an error in calculation.

October 1999 — Scientists say they did not detect any water vapor in the debris caused when the *Lunar Prospector* was intentionally crashed into the Moon in July 1999.

November 1999 — Telescopes for the first time record direct observations of a planet blocking the light from its star, confirming the existence of planets around stars outside the solar system.

December 1999 — The *Mars Polar Lander* (launched by NASA in January 1999) disappears as it was supposed to land near Mars's south pole icecap to prospect for traces of water and evidence of past or present life.

— Scientists announce that data from the *Mars Global Surveyor* (which was launched by NASA in November 1996 and began circling the planet on a mapping mission in September 1997) show that the northern lowlands of Mars once had a wide ocean and long beaches; other scientists still contend the Mars did not have oceans.

March 2000 — As a result of recent problems and mission failures, NASA announces it will be delaying, reviewing, and/or canceling scheduled Mars projects.

— Scientists, Geoffrey Marcy and Paul Butler announce the discovery, for the first time, of two planets of similar mass to Saturn, orbiting separate stars.

The Search for Life on Mars

Since the 19th century, people on Earth have wondered whether there is life on Mars. In the late 1870s, Italian astronomer Giovanni Schiaparelli observed Mars and saw channels, long lines crossing the planet. American astronomer Percival Lowell then proposed that the channels were actually irrigation canals built by intelligent life forms. Others proposed that apparently changing patches on Mars were vegetation. But years later, when *Mariner 4* flew by Mars in 1965, it found no evidence of construction or vegetation. Moreover, when *Viking 1* and *Viking 2* landed on Mars in 1976, they found no signs of life at all, but just a cold, rocky surface; and soil samples recovered showed no signs of microbial life.

But the *Viking* crafts' photographs of the channels suggested that water once flowed on the planet. Water is essential for life. If there was once water on Mars, perhaps in the distant past life could have existed there too. There is strong evidence that Mars had flowing water in the past, perhaps even a vast, deep ocean.

In 1996, NASA and Stanford University scientists announced that ALH84001—a meteorite that left Mars 17 million years ago, crashed into Antarctica 11,000 years ago, and was recovered by geologists in 1984—contained microscopic fossils and other signs of Martian life. Some scientists contend that the microfossils are actually natural crystals, but they do bear a striking resemblance to fossils of bacteria found on Earth.

The search for life on Mars goes on. In 1997, the *Mars Pathfinder* landed on what is believed to be an ancient flood plain and deployed the roving *Sojourner*, which collected numerous soil samples. Scientists want to bring back more soil samples to test them for the presence of water and ice. They also want to understand the planet's climatic history, which could shed light on the past or present existence of life there. NASA has experienced setbacks in its search for life on Mars. In late 1999, two missions—the *Mars Climate Orbiter* and the *Mars Polar Lander*—failed. An independent report released in March 2000 cited underfunding and management problems as factors in the loss of the two craft; and in a complete review of its Mars program NASA canceled or postponed all of its planned missions to Mars except one slated for launch in 2001. However, the Mars program itself and the search for life will continue.