

Life other than that on Earth would be called extraterrestrial life. But, what exactly qualifies as “life?” All living things have several characteristics in common: made up of one or more cells, take in energy and use it to grow and develop, reproduce.

Exactly how life arose from the basic chemicals and sludge that existed on early Earth is a mystery. All we know is that lots of molecules came together under the right conditions to produce life.

### *The Goldilocks Conditions*

No one knows whether life exists anywhere other than Earth. Scientists often talk about the conditions needed for “life as we know it,” or life on Earth. Earth has liquid water and a suitable temperature range and atmosphere for living things to survive. Scientists sometimes call these conditions “Goldilocks” conditions: the temperature is not too hot and not too cold, we have liquid water, and we have oxygen.

Are these conditions necessary for all life, everywhere? Or are they just the conditions necessary for living things on Earth to survive? Scientists have only one example to study: life on Earth. Unless scientists find life elsewhere in the Universe, we can never know the answer to that question for sure.

There are some general characteristics we look for when looking for planets that might harbor life:

1. The planet must be the right distance from its star ...if it is too close, the surface gets too hot for life, or if too far, then it is too cold
2. The planet's rotation-period must not be too slow or fast
3. The planet's orbit must be almost circular...not too eccentric, which puts the planet either too close (making it too hot) or too far from its star for much of its orbit
4. The planet's mass (and gravity) must not be too large or too small so that it is massive enough to hold onto an atmosphere and not so massive it ends up with too much pressure
5. The planet's axis-tilt must be within tolerances
6. The planet must be basically solid and rocky...not gaseous

Surprisingly, in our Universe, only about 1 in 100 million planets satisfy these conditions, and there are other indicators that, in fact, fewer planets have the realistic possibility of sustaining life.

### *Extreme Conditions*

Recently, scientists have discovered living things in places where it was once believed that life could not exist. Giant tubeworms have been found under the extremely high pressures at the bottom of the ocean.

Single-celled organisms have been found in the near-boiling temperatures of hot springs. Tiny life-forms have been discovered deep inside solid rock. And, scientists have even found animals that get their energy from chemicals instead of the sun! Could there be life-forms in the solar system that do not need the Goldilocks conditions?

### *Attempting to Find Life*

In 1959, NASA started the project SETI (the Search for ExtraTerrestrial Intelligence). The purpose of SETI is to scan the sky for signals from other planets. Most scientists use radio telescopes to scan the sky for radio signals from other planets.

In 1974 scientists sent the Arecibo message from a radio telescope in Puerto Rico. We sent it in the direction of globular cluster M13 about 25,000 light-years away. The signal was 1,679 radio pulses kind of like morse code. See, 1,679 is on divisible by the prime numbers 23 and 73, but we assumed that an intelligent being would realize this. If an intelligent life were to receive the signal and realize this, then they could arrange the pulses into a rectangle 23 columns wide and 73 rows deep, which creates a pictogram that explains life on Earth.

In 1977, the Voyager 1 and Voyager 2 spacecrafts left Earth carrying a gold-plated record encoded with sounds and images of Earth.

<http://goldenrecord.org/>

In 1977 a radio telescope at Ohio State University detected a radio signal that was far outside the spectrum of signals created by natural objects that we know of. It also came from a single point in the sky. So, the 1977 Ohio signal is thought by some to be from extraterrestrial life and by others to just be a fluke, but either way, it's the closest we've come to contact with extraterrestrial life.

Finally, there is the Kepler Space Telescope, which is currently 9 million miles from Earth and is looking for terrestrial planets, roughly Earth-sized, that are close enough to their stars to have liquid water, where life as we know it may possibly exist. The Kepler mission is surveying our neighborhood of the Milky Way Galaxy, farther than we have ever directly searched for life before.

### *Life Elsewhere in Our Solar System?*

Mars: Spacecraft have found regions on the surface of Mars that look like streambeds with crisscrossing water; shapes that were almost certainly formed from flowing water. Since life as we know it requires water, scientists hypothesize that Mars may have once had the conditions needed for life to exist. The easiest way to answer these questions is to send more probes to Mars. Future missions to Mars should be able to bring back samples of rocks and soil for analysis on Earth. This may be the evidence scientists need to prove the existence of life on Mars.

Europa: Many scientists think that Europa, one of Jupiter's moons may have the conditions necessary for life to develop. Europa has a smooth, icy crust with giant cracks. Close up views from the Galileo probe show that Europa's ice has broken up and reformed, resulting in large twisted blocks of ice. Similar patterns occur over Earth's arctic ocean. Scientists hypothesize that there is a liquid ocean under Europa's ice. If there is liquid water on Europa, there might also be life.

Titan: Titan is the only moon in the solar system with a significantly dense atmosphere. Composed primarily of nitrogen, with low percentages of argon and methane, its atmosphere also contains trace amounts of organic compounds known as liquid hydrocarbons. These hydrocarbons form as methane, dominating Titan's upper atmosphere. The liquid hydrocarbons are thought to rain down on Titan's surface, potentially forming large lakes and creating conditions similar to those of the primordial Earth when terrestrial life originated.

Recent infrared photographs taken by the Hubble Space Telescope show large bright and dark regions on Titan's surface that may indicate the presence of continental landmasses.

Images used in this lesson:



Deep Sea Tube Worms

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Arecibo Observatory in Puerto Rico

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Arecibo Message

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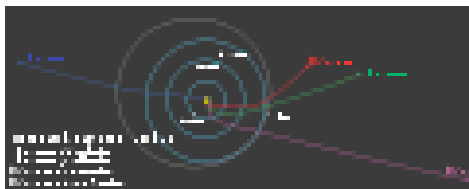
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Voyager Space Probe

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Outer Solar System Probe Trajectories

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Golden Record

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Golden Record Cover

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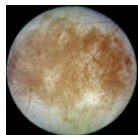
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Streambeds on Mars

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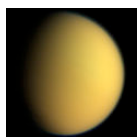
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Europa

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Titan

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