

# Why extremophiles bode well for life beyond Earth

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We've all seen movies about terrible insects from outer space or stories of abduction by little green men, but the study of life in the universe, including the possibility of extraterrestrial life, is also a serious, scientific pursuit. Astrobiology draws on diverse fields, such as physics, biology, astronomy, and geology, to study how life was formed on Earth, how it could form elsewhere, and how we might detect it.

Many ancient religions described other worlds inhabited by known human beings, but these are more like mythical realms or parallel universes than other planets existing in the same physical world. It is only within the last century that scientists have been able to seriously undertake the search for extraterrestrial life.

We know that at the most basic level organisms on Earth need three things: liquid water, a source of energy, and organic, carbon-based material. We also know that the Earth is just the right distance from the Sun, so as not to be either frozen or molten. So, planets within such a habitable range from their own stars may be able to support life. But while we used to think that life could only exist in such Earth-like environments, one of the most amazing discoveries of astrobiology has been just how versatile life is. We now know that life can thrive in some of the most extreme environments that'd be fatal for most known organisms. Life is found everywhere, from black smoke of hydrothermal vents in the dark depths of Earth's oceans, to bubbling, hot, acidic springs on the flanks of volcanoes, to high up in the atmosphere. Organisms that live in these challenging environments are called extremophiles, and they can survive at extremes of temperature, pressure, and radiation, as well as salinity, acidity, and limited availability of sunlight, water, or oxygen. What is most remarkable about these extremophiles is that they are found thriving in environments that mimic those on alien worlds.

One of the most important of these worlds is our red and dusty neighbor, Mars. Today, astrobiologists are exploring places where life might once have existed on Mars using NASA's Curiosity rover. One of these is Gale Crater, an impact crater created when a meteor hit the surface of Mars nearly 3.8 billions years ago. Evidence from orbit suggest past traces of water, which means the crater might once have supported life. Planets are not the only places astrobiologists are looking at. For example, Europa, one of the moons of Jupiter, and Enceladus and Titan, two of Saturn's moons, are all exciting possibilities. Although these moons are extremely cold and two are covered in thick ice, there is evidence of liquid oceans beneath the shell. Could life be floating around in these oceans, or could it be living around black smoker vents at the bottom? Titan is particularly promising as it has an atmosphere and Earth-like lakes, seas, and rivers flowing across the surface. It is very cold, however, too cold for liquid water, so these rivers may instead be flowing with liquid hydrocarbons such as methane and ethane. These are composed of hydrogen, and more importantly, carbon, which is the basic building block of all life as we know it. So, could life be found in these lakes?

Although instruments are being designed to study these distant worlds, it takes many years to build them and even longer to get them where they need to be. In the meantime, astrobiologists work in our own natural laboratory, the Earth, to learn about all the weird and wonderful forms of life that can exist and to help us one day answer one of humanity's oldest questions: Are we alone?