What makes a world habitable?

Searching for a habitable world

Planet/Moon	LIFE IS LIKELY	LIFE IS POSSIBLE	LIFE IS UNLIKELY	Rationale
MERCURY				
VENUS				
EARTH				
Earth's MOON				
MARS				
JUPITER				
Jupiter's Moon IO				
Jupiter's Moon EUROPA				
Jupiter's Moon GANYMEDE				
Jupiter's Moon CALLISTO				
SATURN				
Saturn's Moon TITAN				
URANUS				
NEPTUNE				
PLUTO				

What makes a world habitable?

A key of habitability factors

Temperature

At about 125°C, protein and carbohydrate molecules and genetic material (e.g., DNA and RNA) start to break down. Cold temperatures cause chemicals in a living cell to react too slowly to support the reactions necessary for life. Thus, life seems to be limited to a temperature range of about minus 15°C to 115°C.

Water

Life as we know it requires liquid water. It can be available on an irregular basis with organisms going dormant until it becomes available, but, eventually, it needs to be available. On a cold planet or moon, there must be internal heat to melt ice or permafrost. On a hot planet or moon, the water will boil away or evaporate unless it is far beneath the surface.

Atmosphere

Atmospheres can insulate a planet or moon and protect life from harmful ultraviolet radiation and small- and medium-sized meteorite impacts. In addition, atmospheres can serve as an important source of biochemicals. For example, nitrogen from nitrogen gas can be used for proteins, and carbon from carbon dioxide and methane can be used for carbohydrates and fats. Atmospheres also moderate day-night and seasonal temperature swings. However, to serve as an effective shield or insulator, the atmosphere has to be fairly substantial, as it is on Earth, Venus, and Titan. A planet or moon depends on its gravity to hold an atmosphere. A small-sized body such as Pluto or Earth's moon has too little gravity to hold onto an atmosphere, making life on or near the surface difficult.

Energy

Organisms use either light or chemical energy to run their life processes. At some point, light energy from the sun becomes too dim to be a viable energy source. On Earth, many microbes obtain energy from the sulfur, iron, and manganese compounds present in the Earth's crust and surface layers. When they absorb such compounds and break them down, they obtain a small amount of energy from this chemical change. This energy is sufficient to power microbial life.

Nutrients

The solid planets and moons in our solar system have the same general chemical composition. As a result, the necessary raw materials to construct and maintain an organism's body are in place. However, a planet or moon needs to have processes such as plate tectonics or volcanic activity to make these chemicals constantly available. In addition, liquid water is a powerful solvent and is an important vehicle for transporting and delivering dissolved chemicals. Therefore, planets or moons with volcanic activity, plate tectonics, or a way to cycle liquid water have a way to supply the chemicals required by living organisms.