Life elsewhere in Solar System could be different from life as we know it

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The search for life elsewhere in the solar system and beyond should include efforts to detect what scientists sometimes refer to as "weird" life -- that is, life with an alternative biochemistry to that of life on Earth -- says a new report from the National Research Council.

The committee that wrote the report found that the fundamental requirements for life as we generally know it -- a liquid water biosolvent, carbon-based metabolism, molecular system capable of evolution, and the ability to exchange energy with the environment -- are not the only ways to support phenomena recognized as life. "Our investigation made clear that life is possible in forms different than those on Earth," said committee chair John Baross, professor of oceanography at the University of Washington, Seattle.

The report emphasizes that "no discovery that we can make in our exploration of the solar system would have greater impact on our view of our position in the cosmos, or be more inspiring, than the discovery of an alien life form, even a primitive one. At the same time, it is clear that nothing would be more tragic in the American exploration of space than to encounter alien life without recognizing it."

The tacit assumption that alien life would utilize the same biochemical architecture as life on Earth does means that scientists have artificially limited the scope of their thinking as to where extraterrestrial life might be found, the report says. The assumption that life requires water, for example, has limited thinking about likely habitats on Mars to those

places where liquid water is thought to be present or have once flowed, such as the deep subsurface. However, according to the committee, liquids such as ammonia or formamide could also work as biosolvents -- liquids that dissolve substances within an organism -- albeit through a different biochemistry. The recent evidence that liquid water-ammonia mixtures may exist in the interior of Saturn's moon Titan suggests that increased priority be given to a follow-on mission to probe Titan, a locale the committee considers the solar system's most likely home for weird life.

"It is critical to know what to look for in the search for life in the solar system," said Baross. "The search so far has focused on Earth-like life because that's all we know, but life that may have originated elsewhere could be unrecognizable compared with life here. Advances throughout the last decade in biology and biochemistry show that the basic requirements for life might not be as concrete as we thought."

Besides the possibility of alternative biosolvents, studies show that variations on some of the other basic tenets for life also might be able to support weird life. DNA on Earth works through the pairing of four chemical compounds called nucleotides, but experiments in synthetic biology have created structures with six or more nucleotides that can also encode genetic information and, potentially, support Darwinian evolution. Additionally, studies in chemistry show that an organism could utilize energy from alternative sources, such as through a reaction of sodium hydroxide and hydrochloric acid, meaning that such an organism could have an entirely non-carbon-based metabolism.

Researchers need to further explore variations of the requirements for life with particular emphasis on origin-of-life studies, which will help determine if life can exist without water or in environments where water is only present under extreme conditions, the report says. Most planets and moons in this solar system fall into one of these categories. Research

should also focus on how organisms break down key elements, as even non-carbon-based life would need elements for energy, structure, and chemical reactions.

The report also stresses that the future search for alien life should not exclude additional research into terrestrial life. Through examination of extreme environments, such as deserts and deep under the oceans, studies have determined that life exists essentially anywhere water and a source of energy are found together on Earth. Field researchers should therefore seek out organisms with novel biochemistries and those that exist in areas where vital resources are scarce to better understand how life on Earth truly operates, the committee said. This improved understanding will contribute greatly toward seeking Earth-like life where the conditions necessary for its existence might be met, as in the case of subsurface Mars.

Space missions will need adjustment to increase the breadth of their search for life. Planned Mars missions, for example, should include instruments that detect components of light elements -- especially carbon, hydrogen, oxygen, phosphorous, and sulfur -- as well as simple organic functional groups and organic carbon. Recent evidence indicates that another moon of Saturn, Enceladus, has active water geysers, raising the prospect that habitable environments may exist there and greatly increasing the priority of additional studies of this body.

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Source: The National Academies