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Eva Lee, Eyesites, 2000

Space Case

MOLECULES FOR MAKING MEMBRANES COULD BE SYNTHESIZED IN THE COSMOS

THE VACUUM OF SPACE is a hostile, forbidding place: people must remain in high-tech cocoons if they are to travel or work above the lowest few thousand feet of the earth's atmosphere. And living beings aren't the only things at risk. The very molecules of life—amino acids and other organic substances—are subject to damage from the extreme temperatures and intense radiation in space.

Given such conditions, the idea that the building blocks of life originated in space rather than on the earth might seem preposterous. But the terrestrial environment poses some of the same problems for building such molecules: although complex organic compounds could readily have been synthesized under primordial conditions, the energy that drives those chemical reactions is also enough to break the organic molecules apart. As a result, some theorists argue that space—not the earth—might be the source of biologically important molecules, and that the entire universe could be seeded with the building blocks of life. Now, a team of investigators at the NASA Ames Research Center in Mountain View, California, and at the University of California, Santa Cruz, has demonstrated experimentally that one of the most important biological building blocks could be created in abundance in outer space.

For the earliest biological ingredients to survive the harsh terrestrial environment, they must have been sheltered in some kind of receptacle. "Molecules that make membranes are thought to be important for the origin of life," says the biochemist Jason P. Dworkin of NASA Ames. "Membrane structures are necessary to separate and protect the chemistry involved in the life process from that of the outside environment, so all known biology uses membranes to capture and generate cellular energy."

Of course, the first membranes would also have been subject to the same destructive terrestrial forces they were able to shield against. Although the interior of an asteroid in the vacuum of space presents its own challenges to combinatorial chemistry, the absence of large quantities of liquid water could enable complex molecules to form slowly without being diluted in solution. And investigators knew that at least small amounts of compounds that can give rise to membranes are created in space: carbon-rich compounds extracted from a meteorite that fell in Australia in 1969 spontaneously formed vesicles when the compounds were dissolved in water.

To see how readily molecules that are precursors to such membranes could be synthesized in space, Dworkin and his colleagues mixed together the basic materials of the solar system: water, methanol, ammonia and carbon monoxide. The team then deposited its brew on thin sheets of metal and subjected the sheets to intense ultraviolet radiation in a vacuum at temperatures approaching absolute zero (minus 273 degrees Celsius). The mixture was permitted to warm; when water was added, small, beadlike vesicles formed along the surface. The investigators have not yet identified the compounds that make up the skin of the vesicles, but they have observed that the skin resembles a cell membrane.

The finding has powerful implications for the emerging field of astrobiology. It is possible that such membranous compounds could have arrived on earth as stowaways on the meteorites or comets that pounded the planet during the early history of the solar system. And since other planets would have had access to the same reservoir of compounds, some of the molecules that could be precursors to life should be found elsewhere in the solar system, including on Mars and the moons of Jupiter. If it turns out that biologically important compounds can be formed when simple interstellar ices are irradiated, the idea that life could exist elsewhere in the universe would gain legitimacy.

But Dworkin cautions against taking