Scientists propose new hypothesis on the origin of life

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The new hypothesis suggests that life on Earth originated at photosynthetically-active porous structures made of zinc sulfide similar to deep-sea hydrothermal vents. Credit: The Institute for Exploration, the University of Rhode Island (URI) Graduate School of Oceanography (GSO), and the URI Institute for Archaeological Oceanography.

The Miller-Urey experiment, conducted by chemists Stanley Miller and Harold Urey in 1953, is the classic experiment on the origin of life. It established that the early Earth atmosphere, as they pictured it, was capable of producing amino acids, the building blocks of life, from inorganic substances.

Now, more than 55 years later, two scientists are proposing a hypothesis that could add a new dimension to the debate on how life on Earth developed.

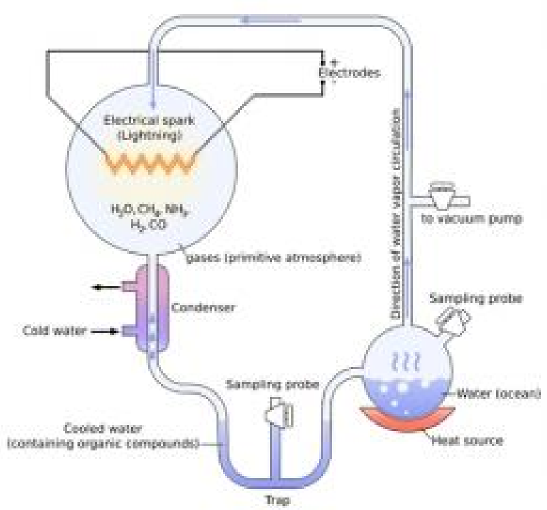
Armen Mulkidjanian of the University of Osnabrueck, Germany and Michael Galperin of the U.S. National Institutes of Health present their hypothesis and evidence in two papers published and open for review in the web site *Biology Direct*.

The scientists suggest that life on Earth originated at photosynthetically-active porous structures, similar to deep-sea hydrothermal vents, made of zinc sulfide (more commonly known as phosphor). They argue that under the high pressure of a carbon-dioxide-dominated atmosphere, zinc sulfide structures could form on the surface of the first continents, where they had access to sunlight. Unlike many existing theories that suggest UV radiation was a hindrance to the development of life, Mulkidjanian and Galperin think it actually helped.

"The problem of the origin of life is such that you have to answer a set of different questions to explain how life has originated," says lead author Mulkidjanian. "We just provide answers to the problem of energetics of the origin of life."

Altering the Early Atmosphere

According to Mulkidjanian, the debate about whether life could arise from chemical reactions began to change when scientists started to question the atmospheric conditions used by Miller and Urey. In their famous experiment, Miller and Urey replicated the early Earth atmosphere with a mixture of methane, hydrogen, ammonia and water vapor. This mixture, along with some "sparks" which simulated lightning, led to the formation of amino acids. With this setup, Miller and Urey assumed that the early Earth had a reducing atmosphere, which meant it had large amounts of hydrogen and almost no oxygen.



Miller-Urey experiment (1953). Image: YassineMrabet, via Wikipedia.

However, many scientists have now abandoned the notion of a reducing early Earth atmosphere. Instead, they believe Earth had a neutral atmosphere, composed primarily of carbon dioxide, with smaller amounts of nitrogen and hydrogen, similar to the modern atmospheres of Mars and Venus. Researchers who have repeated the Miller-Urey experiment under the new atmospheric assumptions, including Miller, have shown that this new mixture does not produce amino acids.

“After it became clear that the origin of the atmosphere was made of carbon dioxide,” says Mulkidjanian, “there was no physically or chemically plausible hypothesis of the origin of life.”

Living organisms can exist only if there is some form of energy flow—solar radiation or chemical reactions, for example.

“If you have an atmosphere of carbon dioxide, you need, in addition, a source of electrons to reduce carbon dioxide if you want to make complex compounds,” Mulkidjanian explains.

From A-biotic to Zinc

Mulkidjanian's "Zn world" hypothesis presents a different version of the prebiotic Earth atmosphere—one in which zinc sulfide plays a major role in the development of life. In nature, zinc sulfide particles precipitate only at deep-sea hydrothermal vents. Its unique ability to store the energy of light has made it popular in many modern-day devices, from various types of television displays to glow-in-the-dark items (and zinc oxide is used in sunscreen).

Its ability to store light makes zinc sulfide an important factor in the discussion on life's origin. Mulkidjanian explains that, once illuminated by UV light, zinc sulfide can efficiently reduce carbon dioxide, just as plants do.

To test the hypothesis, Mulkidjanian and Galperin analyzed the metal content of modern cells and found "surprisingly high levels of zinc," particularly in the complexes of proteins with DNA and RNA molecules.

"We have found that proteins that are considered 'evolutionarily old' and particularly those related to handling of RNA specifically contain large amounts of zinc," Mulkidjanian says.

The scientists say the result is evidence that the first life forms evolved in a zinc-rich environment. But as the authors indicate in their paper, acceptance of a new hypothesis for the origin of life will likely require more work, particularly to further describe the nature of life and the chemical reactions in these zinc-rich communities.

"We cannot explain fully the properties of modern organisms unless we understand how life has originated," says Mulkidjanian.

For astrobiologists, this new hypothesis presents a considerable shift in the debate on the origin of life.

“If this hypothesis is adopted in the origins of life community, it would represent a real conceptual shift, and so it would be significant,” says NASA astrobiologist Max Bernstein. “Whether it will be adopted or not eventually I cannot say, but I expect that many will want to see experimental evidence of the viability of reactions consistent with the hypothesized scheme under prebiotic conditions.”

Source: Astrobio.net, by Anuradha K. Herath

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