Model sheds light on the chemistry that sparked the origin of life

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The question of how life began on a molecular level has been a longstanding problem in science. However, recent mathematical research sheds light on a possible mechanism by which life may have gotten a foothold in the chemical soup that existed on the early Earth.

Researchers have proposed several competing theories for how life on Earth could have gotten its start, even before the first genes or living cells came to be. Despite differences between various proposed scenarios, one theme they all have in common is a network of molecules that have the ability to work together to jumpstart and speed up their own replication—two necessary ingredients for life. However, many researchers find it hard to imagine how such a molecular network could have formed spontaneously—with no precursors —from the chemical environment of early Earth.

"Some say it's equivalent to a tornado blowing through a junkyard and assembling the random pieces of metal and plastic into a Boeing 747," said co-author Wim Hordijk, a visiting scientist at the National Evolutionary Synthesis Center in Durham, North Carolina, and a participant in an astrobiology meeting held there last year.

In a previous study published in 2004, Hordijk and colleague Mike Steel of the University of Canterbury in New Zealand used a mathematical model of simple chemical reactions to show that such networks might form more easily than many researchers thought. Indeed, biochemists have recently created such networks in the lab.

In a new study published this year, Hordijk, Steel, and colleague Stuart Kauffman of the University of Vermont analyzed the structure of the networks in their mathematical models and found a plausible mechanism by which they could have evolved to produce the building blocks of life we know today, such as cell membranes or nucleic acids.

"It turns out that if you look at the structure of the networks of molecules [in our models], very often they're composed of smaller subsets of molecules with the same self-perpetuating capabilities," Hordijk explained.

By combining, splitting, and recombining to form new types of networks from their own subunits, the models indicate that these subsets of molecules could give rise to increasingly large and complex networks of chemical reactions, and, presumably, life.

"These results could have major consequences for how we think life may have originated from pure chemistry," Hordijk writes.

The study will appear in the December 2012 print issue of the journal *Acta Biotheoretica*.

More information: Hordijk, W., M. Steel, et al. (2012). "The structure of autocatalytic sets: evolvability, enablement, and emergence." *Acta Biotheoretica* DOI: 10.1007/s10441-012-9165-1

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