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New RNA Research Demonstrates Prebiotic Possibility

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Creationists and other religious fundamentalists commonly (and erroneously) bring up the issue of abiogenesis as an argument against evolution, claiming that life is too complex to have arisen naturally from simple (non-living) chemicals. Abiogenesis is the development of chemical life from non-living chemicals, and is an active area of research for scientists studying the "Origin Of Life" question. The issue is largely irrelevant as an argument against evolution because evolution deals with what happens *after* life is formed. It is widely accepted that modern abiogenesis research traces back to the Miller-Urey experiment, performed by Stanley Miller at the University of Chicago (with assistance from Harold Urey) and published in 1953. In this experiment, Miller mixed some simple chemicals thought to be components of the prebiotic atmosphere and exposed them to an electric discharge for a week. After that time, analysis of the contents showed the formation of several amino acids. (Recent re-analysis of sealed samples using modern techniques indicated the presence of more than 20 amino acids, some of which are non-proteinogenic, *i.e.*, not known to be used in protein synthesis). Since that time, countless additional experiments have been performed that demonstrate the generation of the building blocks of life from non-living chemical sources. (A good summary of abiogenesis can be found at the TalkOrigins website, talkorigins.org.)

Life is complex, however (irreducibly so, claim some creationists, although none of their claims have held up to scrutiny), and while all of the fundamental building blocks of life have been identified in at least some abiogenesis experiments, getting all of them at the same time has been a challenge. Recent research has focused on the components of RNA (ribonucleic acid), because one currently-favored hypothesis is that RNA developed on primordial earth before DNA (deoxyribonucleic acid) did. RNA is composed of three units: a phosphate group (one phosphorus atom connected to four oxygen atoms), ribose (a type of sugar molecule), and a cyclic nitrogen-containing fragment called a *base*. There are four different types of bases found in RNA, called adenine, cytosine, guanine, and uracil. Cytosine and uracil are in a class of molecules called *pyrimidines* that contain a six-atom ring, while adenine and guanine are in a class called *purines* that have one six-atom ring and one five-atom ring. A particular challenge in abiogenesis research has been to identify conditions that generate both the purine and pyrimidine bases simultaneously, as both types of bases are needed for RNA (and DNA) synthesis. To date, synthetic models have produced only purines or only pyrimidines, but not both under the same conditions.

Until recently, that is. In the October 4, 2019, issue of *Science* magazine, a group of researchers published a study (Becker *et al.*, *Science*, volume 336, pages 76 – 82) that demonstrates a plausible synthesis of both purines and pyrimidines from likely primordial starting materials (formaldehyde, hydrogen cyanide, urea, and other small molecules) in the presence of metal compounds containing zinc, cobalt, and iron (all known to be present on earth in a variety of rocks). In the presence of ribose and phosphate-containing minerals, the researchers were able to demonstrate the formation of the phosphate-ribose-base triads that ultimately make up RNA.

One key part of the so-called “one-pot” synthesis was the cycling of conditions from dilute aqueous solutions (“wet”) to significantly more concentrated solutions (“dry”) which would occur in, say, isolated pools or on land, where excess water would evaporate. By doing this, the researchers were able to avoid extreme conditions of temperature and pH that would degrade complex molecules—experimental temperatures ranged between 10 and 95°C (50 to 203°F) and the pH never exceeded 10 (considered slightly basic; for comparison, this is the approximate pH of milk of magnesia, a common antacid). Also by doing this, the researchers were able to avoid using external sources of energy like electric sparks (to simulate lightning) or temperatures outside the liquid-water range (to simulate atmospheric or oceanic volcanic activity) that some argue would be too infrequent to allow for formation of significant amounts of biotic material. Finally, it is worth pointing out the time scale of the experiments: Experimental durations were cited to be as short as two hours and as long as three weeks—a blink of an eye on cosmic time scales (or 6000 years, for that matter).

Does this research mean we know how life arose from prebiotic earth? No, it doesn’t. It merely establishes that there exists a plausible, simultaneous chemical synthesis of all four bases found in RNA that uses starting molecules and conditions likely to be present billions of years ago. In other words, this research demonstrates that *it’s possible*. (Or, in the words of Dr. Ian Malcolm in “Jurassic Park”: “Life finds a way.”) Even if abiogenesis were a valid argument against evolution, this research adds to the mountain of evidence suggesting that the chemicals of life may be a product of chemical inevitability and not chance (or creation). Now, if anyone were to convincingly demonstrate that it was chemically *impossible* to make the molecules of life from reasonable starting materials and conditions, then maybe creationists’ arguments might be taken more seriously. But then, creationists are more well-known for their contributions to specious rhetoric than they are for peer-reviewed scientific research, are they?

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