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From Old Vials, New Hints on Origin of Life

By [KENNETH CHANG](#)

A classic experiment exploring the origin of life has, more than a half-century later, yielded new results.

In 1953, Stanley L. Miller, then a graduate student of Harold C. Urey at the [University of Chicago](#), put ammonia, methane and hydrogen — the gases believed to be in early [Earth](#)'s atmosphere — along with water in a sealed flask and applied electrical sparks to simulate the effects of lightning. A week later, amino acids, the building blocks of proteins, were generated out of the simple molecules.

Enshrined in high school textbooks, the Miller-Urey experiment raised expectations that scientists could unravel the origins of life with simple chemistry experiments.

The excitement has long since subsided. The amino acids never grew into the more complex proteins. Scientists now think the composition of air on early Earth was much different from what Dr. Miller used, leading some to question whether the Miller-Urey experiment had any relevance to the still unsolved problem of the origin of life.

After [Dr. Miller's death in May last year](#), Dr. Jeffrey L. Bada of the Scripps Institution of Oceanography in San Diego, who had been one of Dr. Miller's graduate students, discovered cardboard boxes containing hundreds of vials of dried residues collected from the experiments conducted in 1953 and 1954.

Consulting Dr. Miller's notebooks, Dr. Bada discovered that Dr. Miller had constructed two variations of the original apparatus. One simply used a different spark generator. The second injected steam onto the sparks.

That caught Dr. Bada's attention, because the addition of steam seemed to replicate what might have existed in lagoons and tidal pools around volcanoes.

This spring, Adam P. Johnson, a graduate student at [Indiana University](#) who was visiting Dr. Bada's laboratory on an internship, jumped on the opportunity to work on the vials produced by an experiment he had read about in high school textbooks, although the historic material did not look remarkable. "There were just a brown residue at the bottom of a old vial," Mr. Johnson said.

In his 1953 paper, Dr. Miller reported that he had detected five amino acids produced by the original apparatus. Mr. Johnson's work, using modern techniques, revealed small amounts of nine additional amino acids in those samples. In the residues from the apparatus with the steam injector, the scientists detected 22 amino acids including 10 had never been identified before from the Miller-Urey experiment.

"It just opens our eyes," Dr. Bada said. "It's still revealing new things. What else is there that we haven't found out from this experiment?"

The findings by Mr. Johnson, Dr. Bada and other collaborators appears in Friday's issue of the journal *Science*.

Although scientists no longer think that the early atmosphere resembled the gases Dr. Miller used, the gases released by volcanic eruptions do have similar properties. The scientists hypothesize that the sparks split

apart water molecules in the steam, enabling a wider range of chemical reactions to take place.

In recent years, as the Miller-Urey experiment subsided in importance, scientists suggested places like the ocean bottom as more likely locations for the origin of life. The discovery of amino acids in meteorites suggested that the building blocks of life came from space, eliminating the need for finding chemical processes that could produce them on Earth.

But, Dr. Bada said, the amount of amino acids that could have rained from the skies is still unclear, and the tidal pools would have been a place where the amino acids could have accumulated in concentrations, enabling more complex reactions to occur.

“My take on this is you want to consider everything,” Dr. Bada said. “If you can have a homegrown synthesis, perhaps by this mechanism we’ve described here, complemented by stuff falling from space, well, you’ve got a really rich inventory of compounds to work with and set the stage for the origin of life.”

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