Nature's Jump-Starter

By Phil Berardelli
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How in the world did life emerge on a planet composed only of simple chemical compounds? Scientists say they may have found part of the answer in a mineral that seems to act as an effective catalyst for the earliest organic processes.

Every organism on Earth, from the smallest bacterium to the blue whale, makes energy using the same biochemical pathway. Called the Krebs--or citric acid--cycle, this series of chemical steps converts carbohydrates, fats, and proteins into energy that powers cellular activities. To figure out how the Krebs cycle got started, scientists have been working backward to identify the nonorganic materials that originally helped set the cycle in motion.

Reporting in next week's *Journal of the American Chemical Society*, researchers at Harvard University say they may have found at least one of the original players. Called sphalerite, the compound is a mix of zinc and sulfur ejected from hydrothermal vents and known to have been plentiful in Earth's early seas. Geochemist and co-author Scot Martin says the team's new lab experiments show that when immersed in sterile water and exposed to sunlight, sphalerite can create three of the five basic organic chemicals necessary to start the Krebs cycle in relatively quick fashion. Further research is needed to isolate the other compound or compounds that could have produced the remaining two Krebs ingredients, he notes. If scientists can find their sources, then they will know that the five chemical foundations of the Krebs cycle were being manufactured easily and routinely in Earth's early oceans.

It's "elegant" research, says mineralogist Robert Hazen of the Carnegie Institution in Washington, D.C. The idea that sphalerite can catalyze three of the five Krebs cycle basic compounds all by itself is "an exciting result ... [that brings us] a lot closer to understanding the chemical origins of life."

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HEADLINE: Why **life on Earth was a sure thing**

BYLINE: Rowan Hooper

BODY:

WHAT if life on Earth was inevitable - and arose merely as a consequence of the laws of physics? Perhaps it would encourage alien hunters in their search for life elsewhere in the universe.

The notion that life is bound to emerge has been given renewed credence by an experiment that has run parts of the key metabolic reaction known as the Krebs cycle in reverse. In this direction it makes simple biomolecules from carbon dioxide, sunlight and two compounds thought to have been present in the primordial soup.

Almost all organisms on Earth use the Krebs cycle to produce energy by breaking down carbohydrates, liberating carbon dioxide in the process; it is one of the most ancient and fundamental of all biochemical reactions. Previous experiments have managed to get parts of the Krebs cycle to work in reverse, but only at temperatures above 100 °C. The new method, created by Xiang Zhang and Scot Martin of Harvard University, works at 15 °C, without enzymes, and is the first to use ultraviolet light as the energy source.

The Harvard researchers mixed a chemical called oxaloacetate with particles of the zinc sulphide mineral sphalerite, and irradiated them with UV light. This led to a fall in oxaloacetate levels and the production of malate, an intermediate step in the Krebs cycle. Several other steps of the cycle followed, in which some carbon dioxide was assimilated (*Journal of the American Chemical Society* , DOI: 10.1021/ja066103k).

In the 1950s the American chemist Stanley Miller famously produced amino acids, the building blocks of proteins, by zapping a mixture of simple chemicals with electricity. His work showed how biomolecules could arise spontaneously as a result of physical processes. Oxaloacetate could be one of these primordial biomolecules.

The new work can be viewed as a stepping stone between Miller's process and the basic metabolism that goes on in all living things. "It's fair to say that this can be seen as an important step between the inorganic and the living world," Martin claims.

"It's possible to reconcile these two reports by assuming that oxaloacetate or other dicarboxylic acids of prebiotic origin became the raw material for reactions such as those described by Zhang and Martin," says Antonio Lazcano of the National Autonomous University of Mexico, who is president of the International Society for the Study of the Origin of Life.

These compounds could have been made in the way Miller described or arrived on the early Earth via meteorites. But problems remain, Lazcano says, most importantly the fact that not all of the cycle has yet been made to run in reverse and the yield of some of the reactions is low.

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DISCOVERIES

Massage effective against pain and joint stiffness

The Boston Globe

December 18, 2006

ARTHRITIS

Massage helps reduce pain and joint stiffness in osteoarthritis patients, a new study finds. As many as 21 million Americans suffer from osteoarthritis, the most common form of arthritis, which affects the hands, feet, spine, hip and knee joints. For the study, 68 patients with osteoarthritis of the knee were enrolled: 34 were offered eight weeks of massage twice a week for the first four weeks and once a week for the next four weeks, and the rest were not. All participants continued with previously prescribed medications and treatments. After eight weeks, the pain, stiffness, and range of knee motion was assessed in both groups. Participants who had received massage reported less pain, joint stiffness, and improved mobility in the knees, whereas the control group reported no change in symptoms. From week nine to 16, the control group also received massage therapy and they reported a decrease in pain and stiffness as well. The first group was assessed again two months after discontinuing massage and reported still feeling its benefits, a finding that, according to senior researcher Dr. David Katz of the Yale School of Medicine, makes this study especially worthwhile because massage requires time and money and if it can be used less it becomes more affordable.

BOTTOM LINE: Massage can help arthritis patients cut back on their medications.

WHAT'S NEXT: The researchers want to study the extent to which massage can reduce medication use and to determine its cost-effectiveness as an alternative, or adjunct to, current drug treatments.

CAUTIONS: This is the first study of its kind, and larger and longer studies are required to confirm this finding and to assess how long massage benefits last.

WHERE TO FIND IT: Archives of Internal Medicine, Dec. 11.

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CHEMISTRY

A plausible means for creating life's building blocks

Researchers at Harvard have created a chemical stew that could, theoretically, have led to the first life on earth. Using only ingredients available on the primordial planet -- carbon dioxide, water, sunlight, and a zinc sulfide mineral called sphalerite -- they triggered a chemical reaction that could have generated the first organic molecules necessary for life. The new study showed that sphalerite and light promoted 3 of 11 reactions necessary to create a "reverse Krebs cycle," the process by which life is believed to have been jump-started. Sphalerite was probably common in the early ocean, so similar processes could plausibly have occurred in shallow, sunlit early seas, said study coauthor Scot Martin, an environmental chemist at Harvard. "What we've introduced is a new rule to the game which says that mineral photochemistry . . . can make these reactions occur," he said.

BOTTOM LINE: Researchers have discovered a plausible means for the chemical creation of life's molecular building blocks.

CAUTIONS: This research shows one theoretically possible means for the origins of life; it does not provide evidence that life on earth actually started this way.

WHAT'S NEXT: Researchers will try to trigger more of the 11 reactions needed to make the first molecules that led to life.

WHERE TO FIND IT: Journal of the American Chemical Society, Dec. 13.