science news
OF THE WEEK

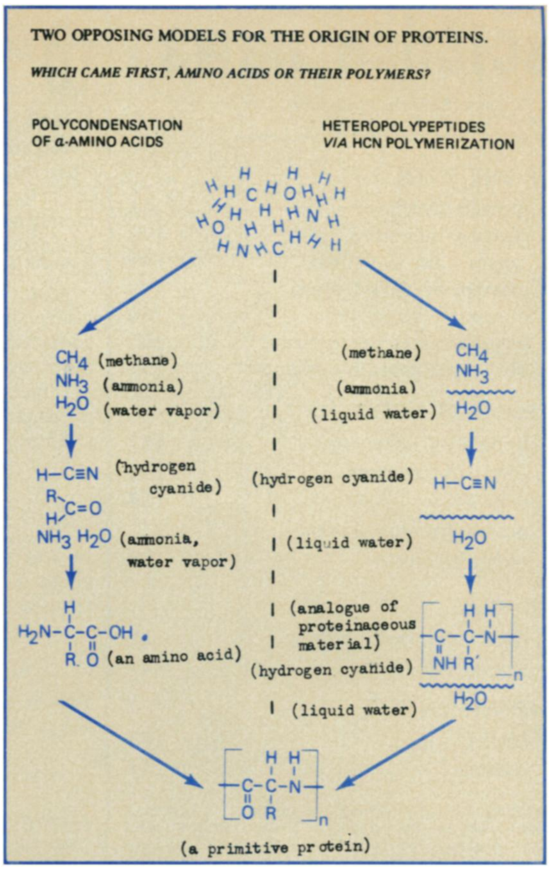
Protein evolution: Up the down staircase

Experiments indicate that proteins might have evolved on the early earth without the intervention of amino acids

An era in the chemical exploration of biological evolution opened in 1953. Stanley L. Miller and Harold C. Urey of the University of Chicago made four amino acids from a simulated early earth environment that consisted of methane, ammonia, water vapor and electrical discharges. Since then, virtually all of the amino acids that make up present-day proteins have been made under similar conditions. And when Sidney W. Fox of the University of Miami heated these primitive amino acids in the absence of water, they linked together into primitive proteins.

Evidence is substantial, then, that amino acids were first created on the primitive earth, and that these amino acids then evolved into primitive proteins. Such a theory is pleasing to chemists, since it is in keeping with how modern proteins are made.

In recent years, however, Clifford N. Matthews of the University of Illinois has become increasingly convinced that proteins formed on the primitive earth without the intervention of amino acids. He and co-worker Robert Minard presented the latest evidence for his theory at a meeting of the American Chemical Society last week in Chicago. The key ingredient in his experiments is hydrogen cyanide.

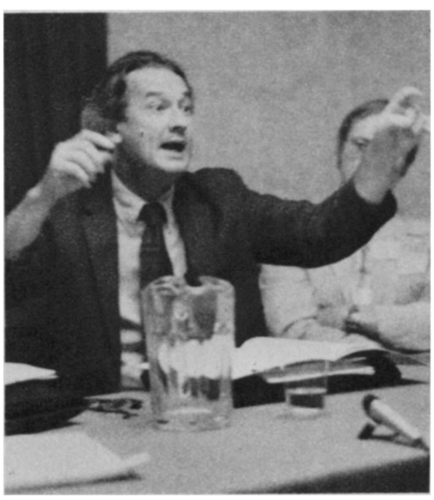


Traditional model of protein evolution (left side of chart) says amino acids were necessary for protein formation. Matthews' model (right side) says amino acid intervention was not necessary.

Matthews/Univ. of Illinois

It is well known that methane and ammonia, when subjected to ultraviolet light or any high-energy source, give a high yield of hydrogen cyanide. In his earlier experiments, Matthews assumed that the primitive atmosphere was methane and ammonia with water present as liquid rather than as vapor. He put these components together with ultraviolet light and got, as expected, hydrogen cyanide. But he also got a messy brown compound with protein-like properties that further broke down into amino acids. So he thought it possible that hydrogen cyanide on the primitive earth gave rise to proteins in a similar manner. So he, with the help of Minard, set out to chemically document the possibility.

They made a compound analogous to the brown material and treated it with hydrogen cyanide and liquid water. The result was a primitive protein with side chains that are present on modern proteins. So Matthews is further convinced that hydrogen cyanide might have allowed proteins to be made on the early earth without the intervention of amino acids.



Joan Arehart-Treichel

Matthews: Hydrogen cyanide the key.

If his model of protein evolution eventually proves right, it has two virtues. It bypasses an energetically unfavorable step—the linkage of amino acids into proteins (which in modern protein production is carried out by enzymes, which are themselves proteins). It also shows how the early earth could have been covered with protein-like material that would have catalytically assisted in the formation of nucleic acids, the genetic material of life, in the way that today enzymes assist in modern production of nucleic acids. □

Reverse transcription: Still cancer-implicated

A few years ago, Howard Temin of the University of Wisconsin came up with some valuable scientific evidence. It was that certain RNA tumor viruses could make copies of DNA from the RNA molecules comprising their genetic cores. This feat ran exactly counter to what usually happens in cells, in which DNA, a cell's genetic information, is transcribed into molecules of RNA.

Then in 1970, Temin and David Baltimore of the Massachusetts Institute of Technology made a simultaneous but independent discovery. RNA tumor viruses were able to make DNA from their RNA cores because they possessed a special enzyme. The enzyme was called "RNA-dependent DNA polymerase," or "reverse transcriptase."

The discovery of RNA-directed DNA synthesis and of reverse transcriptase—subsequently confirmed by other researchers—rocked the scientific world. Many investigators hoped that the mechanism and the enzyme would provide a key to the cancer process. Might RNA tumor viruses, with the help of the reverse transcriptase enzyme, convert