

## A larger role for RNA in life's emergence?

Primitive Earth more than 3.5 billion years ago offered little in the way of comfort, from a biological viewpoint.

Lightning bolts tore through an atmosphere of carbon dioxide and nitrogen, blasting exposed rocks and perhaps mounds of ice — not a friendly place to start of family of evolving organisms.

Chemical evolutionists propose that modern organisms, based on proteins and DNA, may have arisen from a primordial RNA world. In that world, strands of so-called catalytic RNA participated in self-replicating chemical systems that made a variety of molecules, including amino acids and more RNA.

Michael P. Robertson and Stanley L. Miller, both chemists at the University of California, San Diego, contend that RNA may have played an “even larger role than has previously been assumed” in the evolution of biological molecules. They propose in the May 5 *SCIENCE* that ancient RNA differed slightly in its molecular makeup from modern RNA, allowing it to “catalyze a much wider range of chemical reactions.”

Four molecular building blocks constitute RNA. One of these, uracil, tends to react with formaldehyde, a molecule that scientists think existed abundantly on prebiological Earth. The reaction forms 5-hydroxymethyluracil (HMU).

Robertson and Miller mixed HMU with several other chemicals postulated to be components of the prebiotic soup. The compounds, they observed, “reacted extremely well with HMU,” forming new molecules with many of the characteristics of modern-day amino acids.

The two contend that primordial RNA would have contained HMU at many sites where modern RNA has uracil. Noting the diversity of potential chemical paths available to HMU, they argue that ancient catalytic RNA would have had much greater “efficiency and versatility” than researchers have realized.

“The work described here demonstrates that the catalytic shortcomings of RNA can be overcome with simple modifications that would have been unavoidable under primitive Earth conditions,” the two chemists state.

Moreover, their findings may offer a plausible explanation for the prevalence of the 20 amino acids that constitute modern proteins. HMU’s reactivity, the researchers maintain, led to amino acid precursors armed with a specific set of “functional groups.” Modern proteins taking over RNA’s catalytic role would inevitably have had to retain the same functional groups.

Those critical functional groups are characteristic of the amino acids that make up today’s proteins. Without them, enzymes could not carry out the catalytic duties crucial to life, Robertson and Miller point out.

Today, those same functional groups show up in proteins prevalent in the animal kingdom, as well as in the transfer RNA of cells.

“It’s possible that the HMU present in modern organisms is a molecular remnant of the RNA world,” Miller says. Indeed, HMU “may have acted as a bridge between the RNA world and the DNA-protein world of today.”

— R. Lipkin