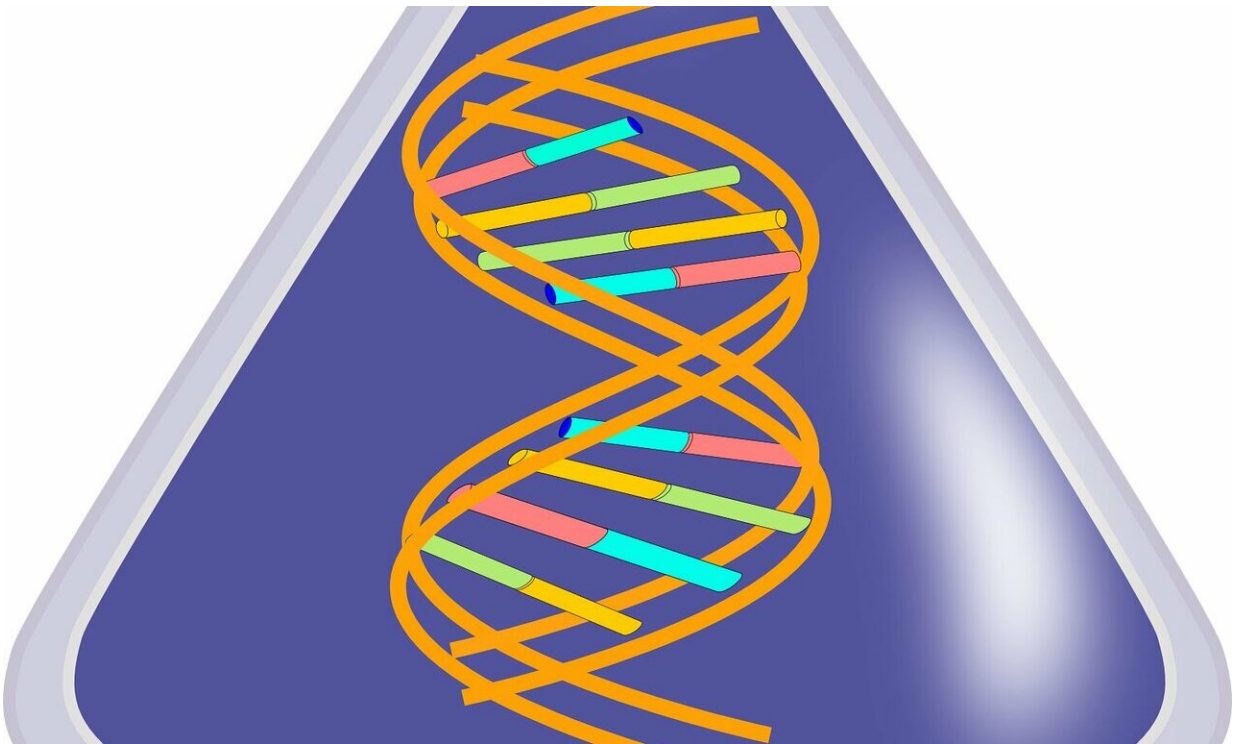


Did life emerge in the 'primordial soup' via DNA or RNA? Maybe both

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Scientists have long debated which genetic information carrier—DNA or RNA—started life on Earth, but a new study suggests life could have begun with a bit of both. The research, led by scientists from the Medical Research Council (MRC) Laboratory of Molecular Biology (LMB), in Cambridge, shows for the first time how some of the building

blocks of both DNA and RNA could have spontaneously formed and co-existed in the 'primordial soup' on Earth.

The work challenges one of the leading hypotheses for the advent of life—the 'RNA world' theory, which arose in the 60s and has gained wide acceptance.

Today, all known living organisms use the same genetic molecules—called nucleic acids—to store information. There are two sorts of nucleic acids: DNA and RNA. DNA encodes instructions in genes. Genes are turned into messages using RNA, which carries instructions to make proteins. Proteins can make structures and act as molecular machines.

In the 'RNA world' theory, life started with RNA molecules, which can both store instructions and can act as a modest machine, potentially enabling them to self-replicate. It proposes that through evolution, life in the RNA world gave way to the era of DNA and proteins, because DNA is more stable and durable than RNA.

In the current study, published in *Nature*, the researchers simulated the conditions on a primordial rocky Earth with shallow ponds in the lab. They dissolved chemicals that form RNA in water, then dried them out and heated them, then they simulated the early sun's rays by exposing them to UV radiation.

In this recreation of early Earth geochemistry, intermediates in the synthesis of two of the [building blocks](#) of RNA were simultaneously also converted into two of the building blocks of DNA.

It is the first demonstration that reasonable amounts of a genetic alphabet made up of four building blocks, two for RNA and two for DNA—potentially sufficient to have encoded early life, which was far

less complex than life today—may have been available on the primordial Earth.

Professor John Sutherland from the MRC Laboratory of Molecular Biology, who led the work, says: "The RNA world hypothesis suggests that life began with RNA, before a genetic takeover occurred involving primitive biosynthetic machinery and [natural selection](#) to result in DNA."

"Our work suggests that in conditions consistent with shallow primordial ponds and rivulets there was a mixed genetic system with RNA and DNA building blocks co-existing at the dawn of life. This fulfill what many people think is a key precondition for the spontaneous emergence of life on Earth."

The team's experiments to simulate early Earth geochemistry showed that four of the building blocks for DNA and RNA can arise from the same reagents and conditions. They produced cytidine and uridine, two of the building blocks of RNA, and deoxyadenosine, which is one of those of DNA. Deoxyadenosine was partly converted to deoxyinosine, which can take the role of another DNA building block.

They believe that these four [building](#) blocks may have coexisted before life evolved and were the beginnings of a primitive genetic alphabet.

Professor Sutherland adds: "The nucleic acids, RNA and DNA, are clearly related and this work suggests that they both derive from a hybrid ancestor, rather than one preceding the other."

"Since genetic information always flows from nucleic acids to proteins, and never in reverse—a principle called the 'central dogma' of molecular biology by Francis Crick—we now need to uncover how the information which can be stored and purveyed by these [nucleic acids](#) could have been

first used to make to proteins."

Understanding the chemical origins of life is a fundamental aspect of natural science, and can inform the design of future synthetic biology.

Dr. Megan Dowie, head of molecular and cellular medicine at the MRC commented: "This study shows that blue skies research can reveal fascinating insights into how the very beginnings of life may have emerged, and demonstrates the importance of supporting fundamental research. These underpinning discoveries in the life sciences could enable exciting future strategies for artificial biology."

More information: Selective prebiotic formation of RNA pyrimidine and DNA purine nucleosides, *Nature* (2020). [DOI: 10.1038/s41586-020-2330-9](https://doi.org/10.1038/s41586-020-2330-9), www.nature.com/articles/s41586-020-2330-9

Provided by MRC Laboratory of Molecular Biology

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