Chemistry

A robotic chemist could reveal the recipe for Earth's primordial soup

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RECREATING the compounds and experimental conditions that interacted over billions of years to create life on Earth is impossible in the lab. But an autonomous robot that can shorten the time it takes to test possible mixtures could help reveal the precise combination that let proteins, DNA and enzymes emerge from the prebiotic soup on early Earth.

Lee Cronin at the University of Glasgow, UK, and his colleagues built a robotic chemist that can mix simple molecules together, watch them react, analyse the results and decide what else to add. Over several weeks, this robot can start to recreate a prebiotic soup with almost no input from human chemists, he says.

"We wanted to remove the bias from the experiments and cover as much chemical space as possible to look for the spark of life," says Cronin.

The set-up includes a tangle of tubes connecting 18 flasks of different starting materials to a central reaction vessel containing a range of clean, dry minerals such as quartz, ulexite and pyrite.

The starting materials are all small molecules with no biological or catalytic function, including simple acids, organics, reducing agents and some inorganic molecules like copper sulphate.

The robot chooses two or three of these reagents to suck into the reaction vessel, where the mixture is stirred and heated for an hour, then allowed to settle. It analyses the sample, and a portion is taken away for storage and human analysis later. A small amount is left as a seed mixture, before the robot adds a fresh batch of reagents and the process repeats. The team ran the robot for up to 150 of these cycles over many days (*Nature Communications*, doi.org/gkhvsg).

The decision on whether to let a reaction continue or whether to introduce a new molecule into the brew is based on a mass spectrometer, which reveals the size of the molecules in the mixture. If these readings suggest no change has happened, the robot will work to push the system away from a state of equilibrium by adding something new in the next cycle. "It's an anti-boredom algorithm," says Cronin.

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Number of materials a robot mixes to investigate the origins of life

The robotic chemist doesn't allow us to work out how life formed yet, but it is a useful tool to let us step towards it – and a vast improvement on the effort one person at the bench could make, says Sijbren Otto at the University of Groningen in the Netherlands.

With the right mix of starting materials, we could learn a great deal, says Otto. "The hope with these experiments is that something autocatalytic emerges from it," he says, meaning when a reaction produces its own catalyst. These reactions are considered essential for life to emerge.

Judit Šponer at the Czech Academy of Sciences says that humans tend to get in the way in origin-of-life experiments, so this robot significantly reduces such bias.

"We've seen tentative evidence of molecular replication," says Cronin. Complex molecules are forming, and despite being diluted away at the start of each new cycle, those molecules persist, he says.

He is planning a bigger version of the robot. "This is a dummy run," he says. With more complex algorithms, the researchers hope to see evidence of large, complicated molecules that can process information.

Animal behaviour

Female seahorses cheat on partners they can't smell

MONOGAMOUS female seahorses cheat on their male partners when they can't smell them any more.

"Seahorses can express incredible loyalty and affection once a pair has bonded during the reproductive season," says Dong Zhang at the Chinese Academy of Fishery Sciences in Shanghai.

The curvy-tailed couples usually stay together for months or years. They live within a few metres of each other and meet at dawn for "morning greetings" that reinforce their bond – swimming in parallel, brightening their hues and "dancing", says Zhang.

They reproduce through male pregnancy after the female deposits her eggs into the male's abdominal brood pouch. The couple takes a mating break during the 12 to 20 days the male is pregnant, but then they mate again within 48 hours after he gives birth.

Zhang and his team wondered what kept each female faithful during the waiting time and how she distinguished her mate from other males. They tested 200 pairs of virgin, lab-raised lined seahorses (*Hippocampus erectus*) in various situations. They allowed them to couple up, placing a female and her pregnant mate in a tank with a second male that had just given birth, which may have made him more attractive because he had proven to be fertile, says Zhang.

MICHAEL PATRICK O'NEILL/ALAMY

Lined seahorses are monogamous and bond with "morning greetings"

Then they placed the pregnant mate either in a mesh cage, an opaque, open-ended pipe or a transparent plastic bag. These barriers respectively blocked morning greetings, vision or odours.

After the mate gave birth, the researchers let all three seahorses swim freely. If a female hadn't been able to see or greet her mate during pregnancy, she still chose him over the other male, except for a few rare cases in which a female didn't choose either male, says Zhang.

However, 75 per cent of the females that hadn't been able to smell their enclosed mates chose the other male (*Behavioural Processes*, doi.org/ghmq). It is possible that while the mate was in the transparent bag, the female forgot his scent and got used to the other male's odours, says Zhang.

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