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Origins of life

DNA bases found in space rocks

We have now discovered all four building blocks of DNA in meteorite samples

Carissa Wong

ALL four of the key DNA building blocks have now been found in meteorites, suggesting that space rocks may have delivered the compounds to Earth, contributing to the origin of life.

DNA has a spiral-staircase structure, in which each step consists of pairs of molecules called nucleobases. Two of these four nucleobases – adenine and guanine, which belong to a group of chemical compounds called purines – were first detected in meteorites in the 1960s.

Now, Yasuhiro Oba at Hokkaido University in Japan and his colleagues have discovered the remaining two DNA nucleobases, cytosine and thymine, known as pyrimidines, in several meteorites.

The team found the nucleobases in about 2 grams of rock from three meteorites: the Murchison, Murray and Tagish Lake meteorites. The Murchison and Murray meteorites, which hit Earth in the mid-20th century, are thought to date to at least 5 billion years ago. Like Earth, the Tagish Lake meteorite probably formed 4.5 billion years ago, and it hit our planet about two decades ago.

Oba's team ground each rock sample into a powder that was added to water, before using ultrasound waves to separate the particles into layers. The group then used mass spectrometry to identify compounds according to their molecular weight.

The Murchison meteorite, which fell in Victoria, Australia, in 1969

THE NATURAL HISTORY MUSEUM/ALAMY

"There was a reason why cytosine and thymine in meteorites were never reported until now… these compounds are in very trace amounts, which required a method with the capability to measure such small amounts," says Michael Callahan at Boise State University in Idaho.

Could the compounds have come from contamination? In soil around the Murchison meteorite landing site in Australia, the relative amounts of nucleobases differ substantially from those in the meteorite, suggesting that the rock's nucleobases came from space (*Nature Communications*, DOI: 10.1038/s41467-022-29612-x).

"I am convinced that the data is not reflective of terrestrial contamination," says Bradley De Gregorio at the Naval Research Laboratory in Washington DC.

Rocks containing nucleobases may have hit Earth between 4 and 3.8 billion years ago, in the Late Heavy Bombardment. This precedes the earliest known undisputed microbe fossils, which are about 3.4 billion years old.

Oba's team also detected a higher concentration of nucleobases in the soil the Murchison meteorite fell onto than in the meteorite.

"If these results are representative of typical pyrimidine concentrations in meteorites," says Callahan, "then [nucleobases present on] Earth would likely have been responsible for the emergence of genetic material rather than inputs from extraterrestrial delivery." ▮

Animals

Bloodworm's copper fangs could inspire new materials

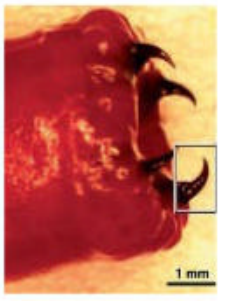
THE venom-injecting jaws of sea creatures called bloodworms contain an unusually high level of copper – and now we know that a simple protein is responsible for these impressive fangs, which could inspire new ways of creating materials.

Herbert Waite at the University of California, Santa Barbara, and his colleagues have been studying the 2-millimetre-long jaws of the *Glycera dibranchiata* bloodworm, which are made up of 10 per cent copper and last for the worm's entire five-year lifespan.

"You've got a little worm that's making a jaw that's as hard and stiff as bronze, and some ceramics as well – and they're doing this autonomically," he says.

The researchers used advanced molecular and mechanical analysis techniques and modelling to investigate the composition and detailed functions of the worms' jaws. They discovered that the composition is governed by a protein that controls a multistep process, which starts by binding copper from the environment, then mixing it in an aqueous solution before separating it to produce a dense liquid that catalyses the conversion of an available amino acid into melanin (*Matter*, doi.org/hrh5).

While melanin often serves as a pigment for colour traits in other animals, here it seems to make the bloodworm's jaws more resistant to wear, says Waite.



HERBERT WAITE

Bloodworm jaws are 10 per cent copper

The protein has a relatively simple structure, which is surprising because, in biochemistry, catalysts are usually based on much more complex proteins, and this protein does more than just catalyse. "It really does boggle the mind how a low-complexity system like that can do that many different basically unrelated tasks to come up with a composite material," says Waite.

The findings could trigger engineers to improve the design and manufacture of composite materials, like concrete and rubber-filled tyres, he says. ▮

Christa Lesté-Lasserre