SCIENCE > SPACE • 6 MIN READ

Scientists found tryptophan, the 'sleepy' amino acid, in an asteroid. Here's what it means

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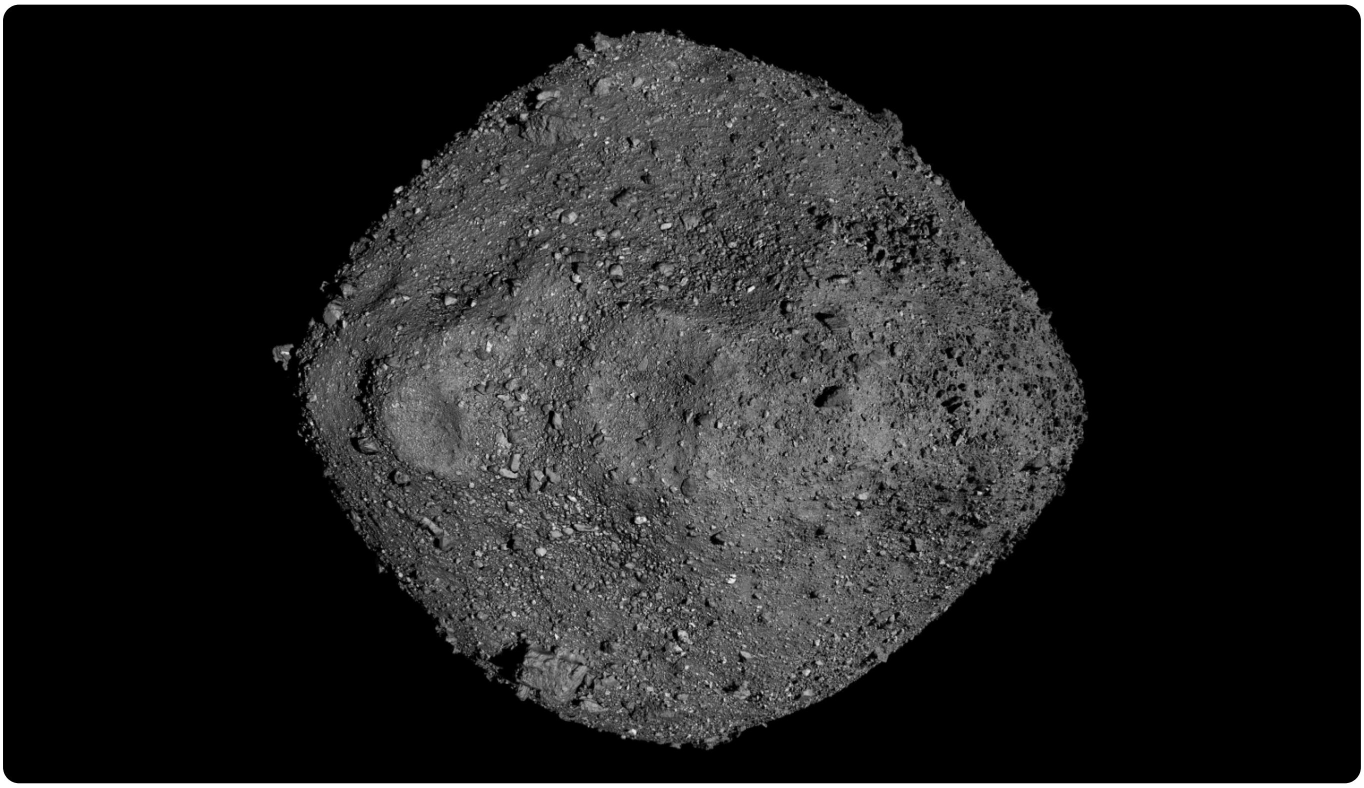
By Jacopo Prisco



A mosaic of Bennu created from observations made by NASA's OSIRIS-REx spacecraft, which was in close proximity to the asteroid for over two years. *(NASA/Goddard/University of Arizona)*

Tryptophan, the essential amino acid behind the **Thanksgiving myth** that eating turkey can make you sleepy, has been found to exist on Bennu, a small asteroid that swings by our planet about every six years.

The discovery stems from an unprecedented sample collected by NASA's OSIRIS-REx mission, which landed a spacecraft on the asteroid in 2020, captured 4.3 ounces (121.6 grams) of rocks and dust, and safely **returned** the cache to Earth in 2023. NASA has since distributed a small portion of that sample to researchers around the world to be analyzed.

Studying Bennu is important because its composition reflects that of the early solar system, giving scientists a glimpse into the beginnings of life. Previous research on Bennu samples had already found 14 of the 20 amino acids all living organisms on Earth stem from, as well as all five biological nucleobases — the components that make up the genetic code in DNA and RNA.

Researchers also previously detected amino acids in samples from another asteroid, **Ryugu**, which the Japan Aerospace Exploration Agency collected in 2019, as well as in various meteorites that have fallen to Earth. This growing body of evidence suggests that asteroids might have delivered essential life ingredients to our planet early on, according to experts.

Now, a new analysis of Bennu samples has confidently, although not yet conclusively, identified tryptophan, increasing the tally of protein-building amino acids in the asteroid to 15 out of 20.

A vial that contains part of the sample from asteroid Bennu is held up by Jason Dworkin, the NASA's OSIRIS-REx mission's project scientist, in 2023. *(James Tralie/NASA)*

"Finding tryptophan in the Bennu asteroid is a big deal, because tryptophan is one of the more complex amino acids, and until now it had never been seen in any meteorite or space sample," said José Aponte, an astrochemist in the Astrobiology Analytical Laboratory at NASA's Goddard Space Flight Center. He coauthored a **study** on the findings that published Monday in the journal PNAS.

The presence of tryptophan in an asteroid supports the idea that the recipe for life might not have begun only on Earth, Aponte added in an email: "Seeing it form naturally in space tells us that these ingredients were already being made out in the early Solar System. That would have made it easier for life to get started."

Jigsaw pieces

Bennu, with a name that name refers to an ancient Egyptian deity associated with the sun, creation and rebirth, stretches about one-third of a mile wide. The space rock likely represents a chunk that broke off of a much larger asteroid sometime between 2 billion and 700 million years ago. It probably formed in the main asteroid belt between Mars and Jupiter, and its chemical composition reflects the beginnings of the solar system, dating back about 4.5 billion years, **according to NASA**.

The asteroid has been **orbiting close to Earth** for about 1.75 million years. Data has shown it could hit our planet in the year 2182, potentially leading to a "global winter." Scientists currently estimate the **odds of impact** to be 1 in 2,700, or 0.037% chance.

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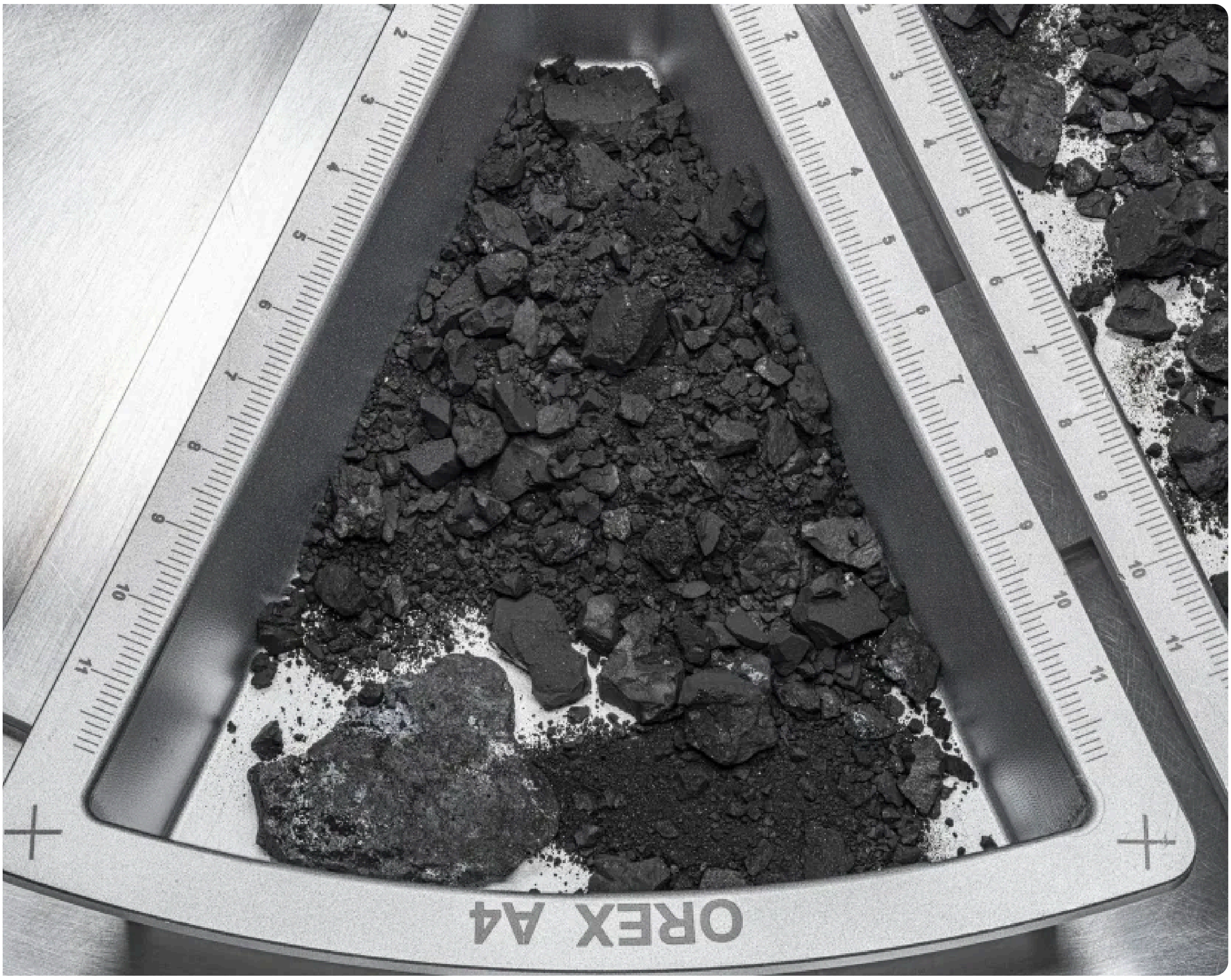
Originally, the material that Bennu is made up of came from supernovas, explosions of old stars that occurred well before the formation of the solar system. The extreme heat of the explosions acted as a forge, cooking up the elements found in the asteroid, which then endured more heat from the impact that formed Bennu, as well as radiation from the sun, further altering the elements within. Bennu has also been found to contain ammonia, a chemical that can help form molecules like amino acids, as well as different types of minerals, presenting many of the necessary ingredients for creating the building blocks of life — but not life itself.



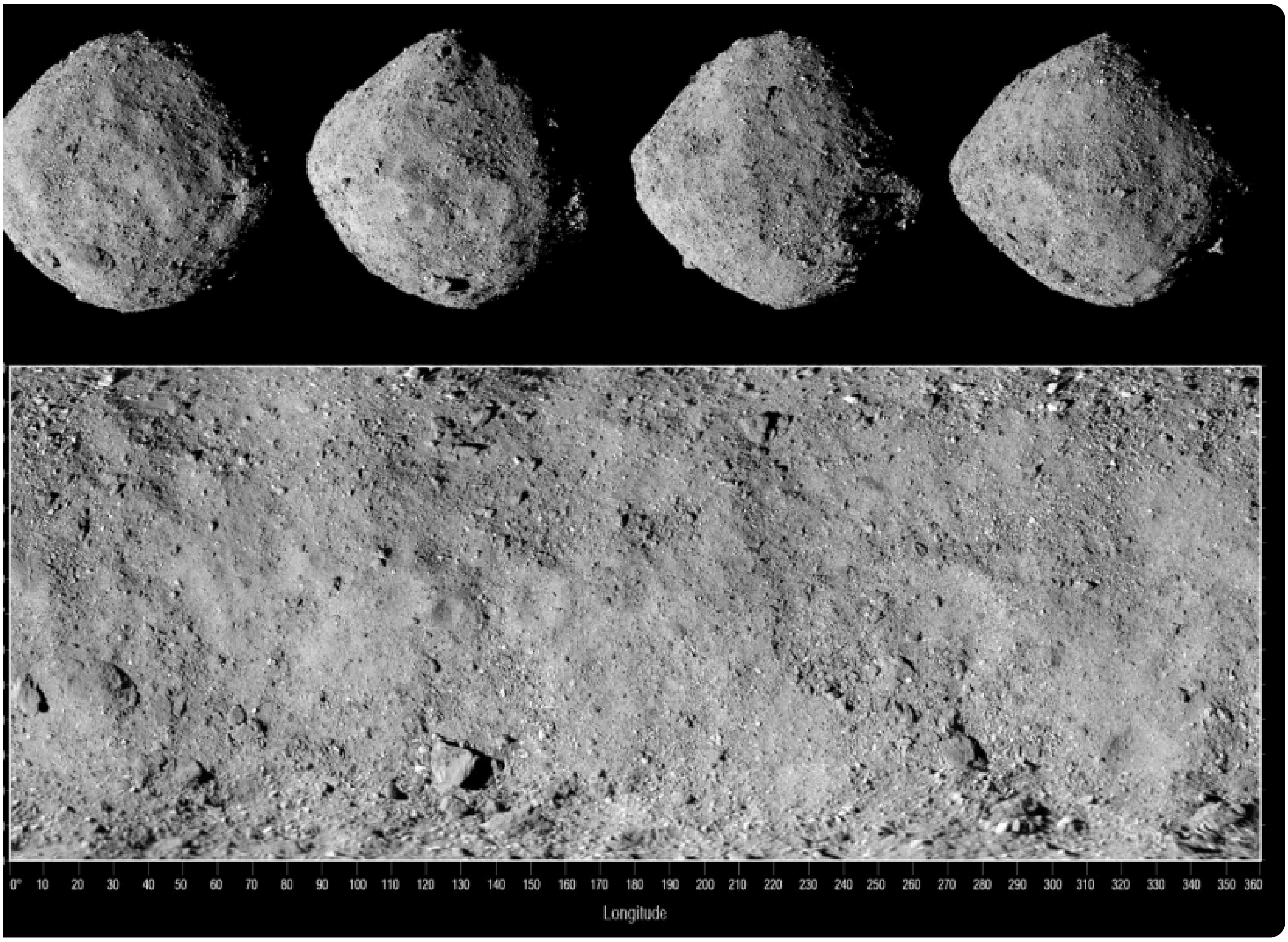
A container holding rocks and dust from asteroid Bennu. *(Erika Blumenfeld and Joseph Aebersold/NASA)*

“They’re like jigsaw pieces that are not yet assembled,” said Angel Mojarro, a postdoctoral researcher and organic geochemist in the Astrobiology Analytical Laboratory at NASA’s Goddard Space Flight Center and first author of the new study. “What this is telling us is that many, many of the building blocks of life can be produced naturally within asteroids or comets, and finding tryptophan expands the alphabet of amino acids that are produced in space and could have been delivered to the Earth.”

A total of **33 amino acids** had previously been found on Bennu, but only 14 of them are used by living organisms on Earth to build proteins. Tryptophan would join the latter group; it also belongs to a category of amino acids scientists call essential, because the human body can’t produce them and they must be acquired through diet.

Mojarro added that more tests are required to corroborate the presence of tryptophan in the Bennu sample analyzed for the study, which weighed just 50 milligrams. However, given the pristine condition of the Bennu samples, it's likely that the finding isn't a result of terrestrial contamination, according to George Cody, a staff scientist at the Carnegie Institution for Science in Washington, DC. Cody was not involved in the study but has **worked** on Bennu samples.

"I believe these molecules are legitimately derived from the Bennu asteroid," Cody wrote in an email.



These images, taken by the OSIRIS-REx spacecraft’s PolyCam camera in 2018, show four views of asteroid Bennu along with a global mosaic. *(NASA/Goddard/University of Arizona)*

By collecting the sample from the asteroid itself, researchers didn’t have to

asteroids that land on Earth, making Bennu a much more reliable “time capsule” of the early solar system’s composition.

“Because OSIRIS-REx returned these samples pristine, we’re finally seeing the fragile salts, minerals, and organics that meteorites lose on entry,” said Dante Lauretta, a professor of planetary science and cosmochemistry at the University of Arizona, Tucson, who is also a coauthor of the new study.

Bennu's parent body was a rich geologic world with multiple liquid systems operating in different places and at different times, each driving its own chemistry," Lauretta added. "Bennu preserves a collection of distinct chemical systems and together they show that small bodies were dynamic, organic-rich systems long before life emerged on Earth."

Molecular 'fossils'

This paper adds to scientists' understanding of which molecules necessary to life can be found in extraterrestrial materials, Cody said. If the natural chemistry that occurred at the dawn of our solar system produces the same molecules that life currently uses, he added, then there must be a connection between them.

The United Launch Alliance Atlas V rocket that took the OSIRIS-REx spacecraft into space, at Cape Canaveral Air Force Station in Florida on September 8, 2016. *(Kim Shiflett/NASA)*

The late Harold Morowitz, a pioneer of studies about the origins of life, believed that the molecules that constitute the core of living organisms might be molecular "fossils" from the solar system's beginnings, and identifying tryptophan and other protein-building amino acids in Bennu samples adds weight to that idea, Cody explained.

Finding tryptophan in Bennu further expands the remarkable diversity of compounds we now know can come from space, said Kate Freeman, Evan Pugh University Professor at Penn State University, in an email. "Asteroids were the early Earth's grocery delivery service, having provided a wealth of molecules to our prebiotic world," added Freeman, who was not involved with the study.

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The new research also highlights how important sample return missions are, according to Sara Russell, a professor of planetary sciences and leader of the Planetary Materials Group at the Natural History Museum in London, who did not participate in the work. Although scientists have thousands of rocks from space available in labs in the form of meteorites, they also need uncontaminated, pristine material brought to Earth by space missions in order to get the full picture, she said.

"The discovery of tryptophan in particular is surprising," Russell added, "as we don't see this in meteorites, perhaps because it does not survive the fall through the Earth's atmosphere and impact on Earth."

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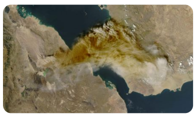

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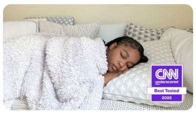

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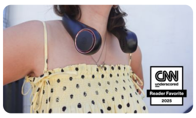

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