Why is life left-handed? The answer is in the stars

July 21 2015, by Elizabeth Tasker

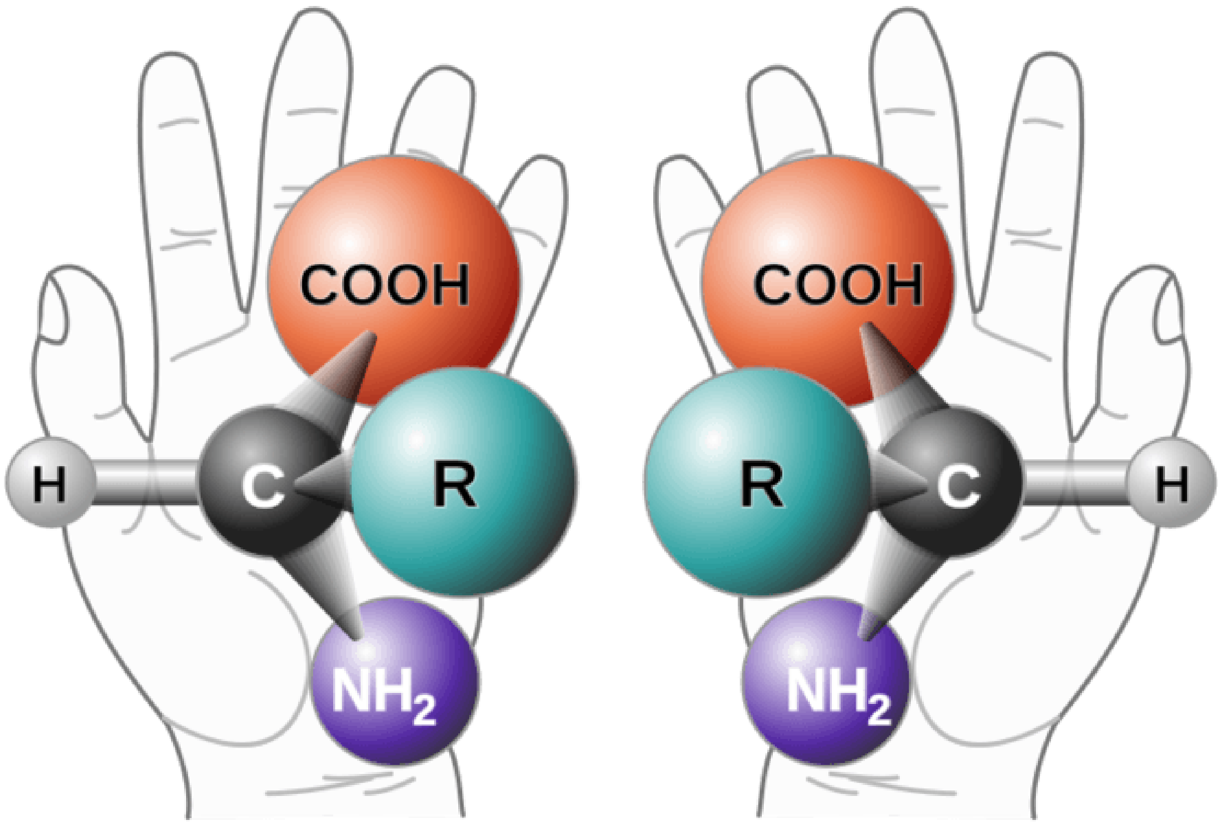
A needle in a haystack? Search for the first ever biological molecule. Credit: Hubble Heritage/Flickr, CC BY-SA

While most humans are right-handed, our proteins are made up of lefty molecules. In the same way your left and right hands mirror one another, molecules can assemble in two reflected structures. Life prefers the left-handed version, which is puzzling since both mirrored types form equally in the laboratory. But a new study suggests that this may be because the star-forming cloud that created the first-ever biological molecule, before our sun was even born, made it left-handed.

In 2004, NASA's Stardust spacecraft swept through the nebulous halo surrounding a comet. What it found was the simplest of life's building blocks: the amino acid glycine. Comets are frozen remnants from the earliest days in our solar system. Their material is therefore not made in planets, but likely originates in the natal gas cloud that formed our sun.

A research team recently recreated the freezing conditions inside such a star-forming cloud. In apparatus sealed completely from the already crisp air in the laboratory, the temperature can be brought down to -263 degrees Celsius, just ten degrees above absolute zero where even molecules stop vibrating. They believed that on the surface of dust grains suspended in this chilly gas, glycine may have undergone a change that made it left-handed.

At the core of the glycine molecule is a carbon atom with four bonds. If two of these bonds attach to hydrogen atoms, then the molecule is symmetric and neither right nor left handed. However, swap a hydrogen for a heavier atom and this symmetry is broken. The molecule can then form two mirrored versions, giving it handedness or "chirality" as it is called in chemistry.



Protein molecules: just a bunch of lefties. Credit: Perhelion/wikimedia

The experiments suggest that a glycine hydrogen atom could be displaced by an atom of deuterium, which is a heavier version of hydrogen that contains an extra neutron in its nucleus, doubling its weight. It is abundant inside star-forming clouds, which is why they create many deuterium-enriched compounds, including heavy water. Once a deuterium atom has replaced a hydrogen, it is very hard to dislodge. This means that the fraction of chiral glycine steadily increases, until the main species of glycine inside the cloud shows left or right handedness.

Chiral glycine is very similar to original glycine, but with an important extra property. Laboratory experiments have shown that chiral glycine is a catalyst for other chiral molecules. That is, it promotes the production of other species with the same handedness as itself.

The result is that if glycine became a left-handed molecule, then future biological molecules would also be predominantly left-handed. When life developed on Earth, it would therefore build from a pool of left-handed molecules, giving it the bias we observe today.

Pinning down glycine in space

This discovery potentially resolves another issue. While glycine is expected to be abundant inside star-forming clouds, it has never actually been observed. Individual molecules absorb different wavelengths of the starlight passing through them. Which wavelengths are absorbed depends on the atoms and their arrangement, providing a fingerprint for the presence of a particular molecule. Glycine's fingerprint has never been seen. However, these searches have been looking for the symmetric version of glycine, not its left-handed twin. If most of the glycine was left-handed, it would absorb different wavelengths and be missed.

It is an exciting idea, but many questions still remain. In the new experiment, the scientists could tell that deuterium had replaced hydrogen to form chiral glycine, but the quantities were too small to see which mirrored version had formed.

It could be that the dust grain structure favours left or right handedness. Alternatively, both types could form but one might be more easily destroyed. The answer to this would tell us if life beyond our own solar system is expected to share our left-handed bias.

Source: The Conversation