Scientists Discovered a Creature That Breaks a Fundamental Rule of Biology

A new study finds that at least one Archaea has surprisingly flexibility when interpreting genetic code, which goes against a long-held rule of biology.

-While codons (combinations of three nucleotides) may vary in which do what functions, a long-standing rule was that each codon serves one specific purpose.
-New evidence, however suggests that one microbe sometimes uses the codon UGA as a stop codon and sometimes use it to code for the amino acid pyrrolysine.
-The discovery of this "loosey-goosey" translation could help scientists better understand archaea in our bodies and improve treatments of diseases.

The building blocks of life are formed from a **simple process**: **DNA** is transcribed into **RNA**, which then becomes **proteins**. And all life follows the same instructions for how those proteins form—instructions based on 61 codons made of three nucleotides, all of which are combinations of the four nucleic acids named adenine (A), cytosine (C), guanine (G), and uracil (U).

These codons are typically assigned either to one of the 20 canonical amino acids or to what's known as a stop codon (usually UAA, UAG, or UGA), the latter of which sends a signal to terminate protein-building and release the polypeptide chain. For decades, scientists have assumed that this process needs to be exact to avoid an imprecise genetic code. However, a new study—published **in the journal *Proceedings of the National Academy of Sciences (PNAS)*** and led by scientists at the University of California (UC) Berkeley—discovered that at least one archaea, a methane-producing **microbe** named *Methanosarcina acetivorans*, survives by utilizing a more "loosey-goosey" translation method.

"Objectively, ambiguity in the genetic code should be deleterious; you end up generating a random pool of proteins," Dipti Nayak, senior author of the paper from UC Berkeley. But biological systems are more ambiguous than we give them credit to be and that ambiguity is actually a feature—it's not a bug."

The scientists theorize that this "ambiquity" allowed the microbe to introduce the uncommon amino acid, pyrrolysine, to create enzymes that break down certain foods. Although life varies when it comes to the number of **amino acids** and what codons code which ones (with some even being redundant), one thing is *usually* certain: A codon has only one meaning. That is, until now.

Pyrrolysine is widespread in methanogenic archaea, and lead study author Katie Shalvarjian (a postdoctoral researcher at the Lawrence Livermore National Laboratory) noticed while studying these methanogenic organisms that, strangely enough, the UAG codon in *M. acetivorans* wasn't always being interpreted as pyrrolysine.

“The UAG codon is like a fork in the road, where it can be interpreted either as a stop codon or as a pyrrolysine residue,” Shalvarjian said.

“They’re flip-flopping back and forth between whether they should call this a stop or whether they should keep going by adding this new amino acid,” Nayak added. “They cannot decide. They just do both and they seem to be fine by making this random choice.”

Preliminary findings suggest that the archaea’s choice isn’t completely random. When the amino acid is flooding the cell, the microbe tends to interpret UAG as integrated pyrrolysine and turn it into the appropriate protein. However, when less of it was around, UAG often acted as a stop codon, which yields a different protein entirely.

This research connects to the future of human health in surprising ways. For example, the human body relies on archaea to remove methylamines and keep the liver healthy, so it’s important to understand this ambiguity in its molecular machinery. Additionally, scientists could experiment with introducing a similar level of imprecision into gene therapies, which could address maladies caused by premature “stop codons” (such as cystic fibrosis).

“This really opens the door to finding interesting ways to control how cells interpret stop codons,” Nayak said.

Questions:

1. Where was the research (study) done for this article? _____
2. Who was the doctor quoted in the article? _____
3. What institution did she work for? _____
4. What is a malady? _____
5. What malady is mentioned specifically in this article? _____
6. What publication was the study published in? _____
7. What substance does *Methanosarcina acetivorans* produce?_____
8. According to the article, are the substances really “deciding” what to do? (explain) _____

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