Writing a new code for life?

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On "Star Trek, the aliens often look so human that crew members fall in love with them. But in real life, scientists in the field known as astrobiology can't be sure alien life would even be carbon-based like us, or use DNA to carry a genetic code.

Some insight now is coming from earthly labs, where scientists are building alternative kinds of genetic codes, and showing how they can evolve.

Whether life could be built with an alien biochemistry was among the more interesting questions that came up during a public event with famed biologist Richard Dawkins and physicist Lawrence Krauss, author of the book "The Physics of Star Trek."

Dawkins saw the question as a biological equivalent of one posed by Einstein: Did God have any choice in making the universe? Not that Einstein believed in a biblical God, as the famously atheistic Dawkins was quick to point out.

Dawkins noted that 99 percent of the living things that ever existed are now extinct. The way carbon-based life works on Earth is downright wasteful, he said. "Any decent engineer would have sent it back to the shop."

The event, which drew more than 3,000 people, was held at Arizona State University in Tempe. Dawkins didn't lecture but instead took part in an onstage discussion with Krauss, who runs a multidisciplinary

program there on the origins of humanity, life, and the cosmos.

Krauss - while not going so far as to say alien chicks would be hot - did say the laws of physics and chemistry might favor carbon-based life resembling ours.

Dawkins said he was inclined to think life could exist in more diverse forms, as long as it included some kind of code-carrying system equivalent to DNA, copying itself with high fidelity. Such genetic material is critical for Darwinian evolution, which, to Dawkins and many others, is the defining characteristic of life.

Perhaps it wasn't a complete coincidence that at the same university, biochemist John Chaput was creating an alternative version of DNA, called TNA, and had last month published the first evidence that the stuff can undergo Darwinian evolution.

Chaput, who works at ASU's Biodesign Institute, said Dawkins is correct to emphasize the need for genetic material - something that can carry a code. All known life does this with DNA and RNA.

NASA has taken a great interest in such possible alternative code-carriers. In late 2010 the space agency claimed that scientists had forced a bacteria to substitute arsenic for phosphorus in its DNA. Despite the fanfare, the team never presented adequate evidence that alternative life really existed, said chemist Steve Benner of the Florida-based Foundation for Applied Molecular Evolution.

And when biochemist Rosemary Redfield of the University of British Columbia tried to replicate this, she discovered that the bacteria failed to grow when fed arsenic and no phosphorus.

Benner said the original arsenic life paper admitted to a small amount of

phosphorus contamination. From the start, he said, he thought the contamination was fooling the team into thinking the organism was using arsenic the way we use phosphorus.

Benner said this new TNA work is just as exciting and relevant to astrobiology as the arsenic bacteria would have been if it had been proven.

This alternative genetic material is like RNA in that it's single-stranded and it carries a chemical code with four different units. But the backbone that holds it together has a different structure, incorporating a sugar called threose where RNA has a sugar called ribose.

Threose is found in meteorites, said Chaput, suggesting it can form spontaneously in the absence of life. It's also simpler than RNA, making it a reasonable candidate for a precursor to our current genetic material.

The existence of a precursor fits with the widely held view that life didn't start out as complex as even the simplest microbes today. Instead, the simplest known living things evolved from yet simpler life that no longer exists.

Chaput showed that, like RNA, TNA can undergo Darwinian evolution. In theory, then, life elsewhere could use TNA as its genetic code, and if early life on Earth used it, TNA-based life could evolve into DNA-based life.

To demonstrate TNA evolution, he used selection to prompt the molecules to do a fairly simple task - to stick to a specific protein. This is what so-called receptors do in our bodies. He continued to select those TNA molecules that best stuck to the protein until he had a decent receptor.

TNA evolution worked the same way as in DNA, with accidental mutations leading to variation, and natural selection amplifying those variants that are best at surviving and reproducing themselves.

That suggests the possibility of TNA-based life elsewhere, said Benner. It's also possible, he said, that arsenic-using DNA would be stable, say, under the frigid conditions of Saturn's moon Titan.

So now we have TNA and code-carrying molecules that use six or 12 characters rather than the usual four. With these increasing possibilities known, Benner sides more closely with Dawkins on the question of life forms with alternative chemistries.

Our life is not the best of all possible forms, Benner said, but a product of chance, our biochemistry hinging on which molecules happened to bump into each other. God did have alternatives, in other words, but chance determined which one would evolve to create works like "Star Trek."