Immaculate creation: birth of the first synthetic cell

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For the first time, scientists have created life from scratch – well, sort of. Craig Venter's team at the J. Craig Venter Institute in Rockville, Maryland, and San Diego, California, has made a bacterial genome from smaller DNA subunits and then transplanted the whole thing into another cell. So what exactly is the science behind the first synthetic cell, and what is its broader significance?

Life re-created: blue colonies indicate a successfully transplanted genome (Image: JCVI)

What did Venter's team do?

The cell was created by stitching together the genome of a goat pathogen called *Mycoplasma mycoides* from smaller stretches of DNA synthesised in the lab, and inserting the genome into the empty cytoplasm of a related bacterium. The transplanted genome booted up in its host cell, and then divided over and over to make billions of *M. mycoides* cells.

Venter and his team have previously accomplished both feats – creating a synthetic genome and transplanting a genome from one bacterium into another – but this time they have combined the two.

"It's the first self-replicating cell on the planet that's parent is a computer," says Venter, referring to the fact that his team converted a cell's genome that existed as data on a computer into a living organism.

How can they be sure that the new bacteria are what they intended?

Venter and his team introduced several distinctive markers into their synthesised genome. All of them were found in the synthetic cell when it was sequenced.

These markers do not make any proteins, but they contain the names of 46 scientists on the project and several quotations written out in a secret code. The markers also contain the key to the code.

Crack the code and you can read the messages, but as a hint, Venter revealed the quotations: "To live, to err, to fall, to triumph, to recreate life out of life," from James Joyce's *A Portrait of the Artist as a Young Man*; "See things not as they are but as they might be," which comes from *American Prometheus*, a biography of nuclear physicist Robert Oppenheimer; and Richard Feynman's famous words: "What I cannot build I cannot understand."

Does this mean they created life?

It depends on how you define "created" and "life". Venter's team made the new genome out of DNA sequences that had initially been made by a machine, but bacteria and yeast cells were used to stitch together and duplicate the million base pairs that it contains. The cell into which the synthetic genome was then transplanted contained its own proteins, lipids and other molecules.

Venter himself maintains that he has not created life . "We've created the first synthetic cell," he says. "We definitely have not created life from scratch because we used a recipient cell to boot up the synthetic chromosome."

Whether you agree or not is a philosophical question, not a scientific one as there is no biological difference between synthetic bacteria and the real thing, says Andy Ellington, a synthetic biologist at the University of Texas in Austin. "The bacteria didn't have a soul, and there wasn't some animistic

property of the bacteria that changed," he says.

What can you do with a synthetic cell?

Venter's work was a proof of principle, but future synthetic cells could be used to create drugs, biofuels and other useful products. He is collaborating with Exxon Mobil to produce biofuels from algae and with Novartis to create vaccines.

"As soon as next year, the flu vaccine you get could be made synthetically," Venter says.

Ellington also sees synthetic bacteria as having potential as a scientific tool. It would be interesting, he says, to create bacteria that produce a new amino acid – the chemical units that make up proteins – and see how these bacteria evolve, compared with bacteria that produce the usual suite of amino acids. "We can ask these questions about cyborg cells in ways we never could before."

What was the cost of creating life?

About $40 million. Cheap for a deity, expensive if you are a lab scientist looking to create your own synthetic bacterium. "This does not look like the sort of thing that's going to be doable by your average lab in the near future," Ellington says.

This reminds me of Frankenstein's monster! Are synthetic cells safe?

Yes. Venter's team took out the genes that allow *M. mycoides* to cause disease in goats. The bacterium has also been crippled so it is unlikely to grow outside of the lab. However, some scientists are concerned that synthetic organisms could potentially escape into the environment or be used by bioterrorists.

Ellington brushes aside those concerns, noting that the difficulty of engineering cells is beyond the scope of all would-be bioterrorists. "It's not a real threat," he says. "Unless you are Craig Venter with a crew of 20 postdocs you're not going to do this."

However, George Church, a synthetic biologist at Harvard Medical School, is calling for increased surveillance, licensing and added measures to prevent the accidental release of synthetic life. "Everybody in the synthetic biology ecosystem should be licensed like everybody in the aviation system is licensed."

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