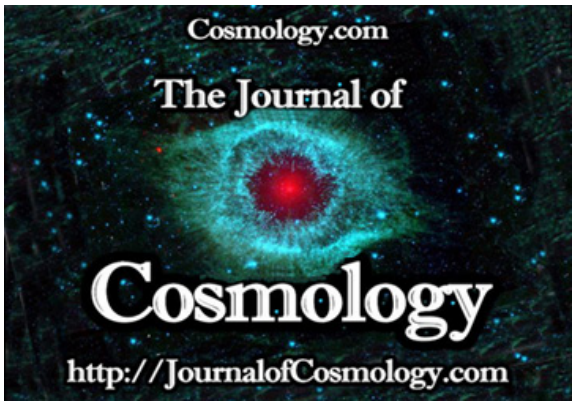

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Commentaries: Artificial Life

Abstract

On May 20, 2010, famed geneticist Craig Venter and colleagues published a landmark study in the emerging field of 'synthetic biology', the creation of an artificial bacterium genome (copied from DNA sequences of Mycoplasma mycoides) which was transferred into a closely related microbe which began to successfully reproduce, making over a billion copies of itself.

Venter's achievement has drawn mostly enthusiastic praise, with some likening it to the 'splitting the atom' and deserving of the Nobel Prize. Yet others' warn of a 'Frankenstein monster' and 'genetic pollution'; fearing that artificial genes and artificial life may take over the world, and end life as we know it.

Scientists and bioethicists from around the world have been asked to comment and to explain. What is the real significance of this achievement, and is there any reason to feel fear?

Artificial Claims About Synthetic Life: The View from Relational Biology

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The achievement of The J. Craig Venter Institute, "Creation of a Bacterial Cell..." (Gibson et al, 2010), is an exceptional feat in biotechnology. And for that, the team must be congratulated. They did not, however, *create* a bacterial cell, and they did not produce *synthetic life*. Their work is one step closer to the *telos* of an artificial lifeform, perhaps, but the final goal remains out of reach.

They have clearly transformed one cell into another. But there is nothing new about the modification of existing organisms; people have been doing that for millennia, at least since the dawn of agriculture. In the 21st century, we simply have more sophisticated tools. The Venter achievement differs in degree, but not in kind. Instead of the now-commonplace partial modification of the genome by multiple insertions, substitutions, or deletions, they have synthesized the entire genome — but still just one component of the whole cell.

What it ultimately comes down to, as it does in most contention, is definitions. In Gibson et al (2010), they admit as much:

> We refer to such a cell controlled by a genome assembled from chemically synthesized pieces of DNA as a "synthetic cell", even though the cytoplasm of the recipient cell is not synthetic.

If it were truly and completely obviously a "synthetic cell", no further justification of the selfevident usage would have been necessary. (But of course, they may simply *define* "synthetic cell" to be whatever they say it is, in which case its semantics become tautological.) Their 'explanation' that after ">30 divisions or $>10^9$ fold dilution", "progeny will not contain any protein molecules that were present in the original recipient cell" is a very poor attempt in clutching at straws. Similarly desperate and silly is the next sentence "The properties of the cells controlled by the assembled genome are expected to be the same *as if* [italics mine] the whole cell had been produced synthetically (the DNA software builds its own hardware)."

Craig Venter reportedly said in an interview after the publication of Gibson et al (2010): "This is the first synthetic cell that's been made, and we call it synthetic because the cell is totally derived from a synthetic chromosome, made with four bottles of chemicals on a chemical synthesizer, starting with information in a computer." Note the unbridgeable gap between "synthetic cell" and "synthetic chromosome". I think Craig Venter was closer to the mark in 2007, when (in a quote attributed to him) he likened the process to "changing a Macintosh computer into a PC by inserting a new piece of software". In 2007 it was prophesied that artificial life would appear within months. Now, three years later (to continue the imperfect machine metaphor), the Venter group may have replaced the operating system, but they have not built a whole new computer from scratch — nor will they be able to in any foreseeable future.

Craig Venter has synthetic genome; George Church at Harvard has synthetic ribosome. Are we once again proverbially "within months" of a truly artificial lifeform? For fundamental logical reasons, this kind of 'synthetic biology' — a mechanistic, algorithmic, and by-parts fabrication of life — will not work. Biochemistry has progressed so far and so fast in the past century that people find it hard to imagine that the process cannot continue *ad infinitum*. The main problem is that the reductionist biology-is-chemistry approach has been so successful in solving biological puzzles, that although everyone can recognize that a living system is not just a machine, there is a great reluctance to admit that the two are different in kind and not just in degree.

Relational Biology

Biology is a subject concerned with organization of relations. A living system is a material system, so its study shares the material cause with physics and chemistry. But physicochemical theories are only surrogates of biological theories, because the manners in which the shared matter is organized are fundamentally different. Hence the behaviours of the realizations of these mechanistic surrogates are different from those of organisms. This in-kind difference is the impermeable dichotomy between predicativity and impredicativity.

The study of biology from the standpoint of this 'organization of relations' is a subject called relational biology. It was founded by Nicolas Rashevsky in the 1950s, thence continued and flourished under Robert Rosen (For a comprehensive exposition on relational biology, see *More Than Life Itself* (Louie 2009)).

The principles of relational biology may be considered the operational inverse of reductionistic ideas. The essence of reductionism in biology is to keep the matter of which an organism is made, and throw away the organization, with the belief that, since physicochemical structure implies function, the organization can be effectively reconstituted from the analytic material parts. Relational biology, on the other hand, keeps the organization and throws away the matter; function dictates structure, whence material aspects are entailed. Stated otherwise, an

organism is a material system that realizes a certain kind of relational pattern, whatever the particular material basis of that realization may be.

The relational pattern that makes a natural system alive turns out to be the impredicativity that is 'closure to efficient causation'. There is an alternative to physicochemical and algorithmic means in the quest for the fabrication of life.

The important and consequential Venter achievement is an impressive one in technology, but no synthetic life, alas, has been made. An achievement is diminished if it is accompanied by overreaching claims of success, when such hyperbolic 'accomplishment' is illusory, and not entailed from what has actually been done.

References

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