TOWARDS THE CREATION OF ARTIFICIAL LIFE?

Craig Venter's team have succeeded in producing a synthetic bacterium capable of self-replication. The group synthesised from scratch a variant of the *Mycoplasma mycoides* genome, which they then transplanted into a different *Mycoplasma* species to produce a bacterium controlled by the synthetic genome. The resulting bacterium could be regarded as the first truly synthetic organism. Earlier forms of genetic engineering have involved modifying the genome of an existing organism; Venter's group have produced an organism whose genome was instead pieced together from chemical building blocks.

The prospects created by this kind of work are huge. Synthetic organisms could in theory be programmed to perform a range of useful functions: to produce drugs, biofuels or other useful chemicals, to act as 'bioremediators', breaking down environmental toxins, or perhaps to act as anti-cancer 'search and destroy' agents.

However this research also raises profound ethical concerns.

In synthesising novel organisms from scratch, synthetic biologists are 'playing God', and doing so much more effectively than earlier genetic engineers. They are not just tinkering with life, they are designing and creating it. Synthetic biology of the sort pursued by Venter's team involves the intelligent design of life. For many of us, this is not a problem. But some will hold that it involves usurping the proper role of God, or taking an arrogant and hubristic attitude to life.

Venter's work also challenges the common sense distinction between living things and machines. Venter's synthetic bacterium possesses many of the characteristics that we ordinarily take to be definitive or characteristic of life: for example, homeostatic physiological mechanisms, a nucleic acid genome and protein-based structure, and the ability to reproduce. But it also possesses some of the features characteristic of non-living machines: for example, modular construction based on rational design by humans. Again, for many, this fact will have little ethical significance. Many of us think the moral importance of living things has been over-blown. What matters morally is not whether something is alive, but whether it is conscious, sentient and so on. For others, though, life itself has great moral significance. For these people, determining whether synthetic entities are living things, machines, or something entirely different is an important and urgent matter.

A third ethical concern cannot be avoided so easily: this is the concern that synthetic entities will be misused, for example, in bioterrorism or biological warfare. With further progress in synthetic biology, it may become possible to cheaply and easily synthesise pathogens, such as the smallpox virus, for use in biological weapons. In the more distant future, further understanding of what makes a microbe virulent may enable the synthesis of pathogens *more* dangerous than any that have existed to date. These possibilities are speculative at the moment, but their potentially devastating consequences make them worthy of consideration regardless. Policymakers, scientists and society at large need to start thinking now about how to reap the benefits of synthetic biology without bearing the costs.

In 1979, *The Progressive* published the blueprint for the H bomb, so perhaps enabling India, Pakistan and South Africa to develop this weapon. Venter's *Science* paper is not such a complete blueprint. But it may be the first part of it. In the mid-twentieth century, many physicists knew that their work could be used both to do much good and to inflict

great harm. For the life sciences, though, this dilemma has never been as acute as it is now. Though other types of bio-science can be misused, the risk of misuse has never been as serious as it is with synthetic biology. There's been a tendency to assume that the life sciences are unreservedly a force for good, and that we needn't worry about their misuse in the same way that we must worry about nuclear physics. Synthetic biology means an end to the age of innocence for the life sciences.

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