AUTUMN BOOKS

GENETICS

The genetic watchmaker

Nathaniel Comfort assesses Craig Venter's vision of nature-as-machine.

For centuries, the metaphor of nature-as-machine served as evidence of design in the Universe — and the existence of a Divine Machinist. William Paley's famous 1802 image of the watch and watchmaker prodded Charles Darwin towards his naturalistic theory of evolution. Machine metaphors remain ubiquitous in modern biology, but today, mechanisms such as 'clocks', 'signalling', 'transport', 'molecular hinges' and enzymatic 'locks and keys' are invoked reflexively — almost automatically — and each gives tacit testimony against vitalism, the belief in an ineffable life force.

In his characteristically brash, lively book, biologist Craig Venter gives us nature-as-computer, rigidly deterministic and controlled by the central program of DNA. Splicing an account of his own genomics research onto a historical trajectory, *Life at the Speed of Light* is a story about science accelerating towards total mastery of the living world. "This new understanding of life, and the recent advance in our ability to manipulate it," he writes, is leading us into "an era of biological design. Human-kind is about to enter a new phase of evolution." For Venter, life is an information

Life at the Speed of Light: From the Double Helix to the Dawn of Digital Life
J. CRAIG VENTER
Viking Adult: 2013.

system, intrinsically digital and hence as manipulable as software. His vision is to code, debug and compile synthetic organisms that will make us and our environment healthier, more harmonious, better.

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Venter first traces the slow, steady march of the engineering ideal in biology. He examines thinkers such as the philosopher Francis Bacon, whose *New Atlantis* (1623) portrayed a scientific Utopia in which man established “dominion over Nature”, and the physiologist Jacques Loeb, who said in 1905 that “control and nothing else is the aim of biology”. So eager is Venter to exterminate vitalism from science that he treats the concept of emergent properties — the notion that the whole can be more than the sum of its parts — as vitalistic. But emergence need not require some spooky mystical glue; it can be accommodated by ordinary physics and chemistry. I can see, though, why it makes Venter uncomfortable: it introduces indeterminacy.

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For a review of
Craig Venter's
autobiography, see:
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Venter then gives the standard account of the mid-twentieth-century rise of the molecular view of

life, up through the double helix, the genetic code and the tools for sequencing and synthesizing DNA. He lingers affectionately on the contributions of his friend and collaborator Hamilton Smith to early recombinant-DNA research, which ties the history to the memoir.

By the 1980s, two information sciences were firmly established: molecular genetics, with its jargon rich in metaphors of text and information; and computer science. Venter's innovations have involved merging them. He has a talent for thinking algorithmically about DNA, for bold approaches that use huge computing power to gain dominion over the genetic material, and he has a keen business sense. His method of expressed sequence tagging, for example, identified thousands of genes and triggered a controversy when his employer (the US National Institutes of Health) attempted to patent them. Venter raised venture capital and went private, going head-to-head with his former employer in the race to sequence the human genome, and vastly accelerating the Human Genome

Project with his new method of ‘shotgun’ sequencing. To pull off this feat, Venter's company Celera assembled the largest and most powerful computer in the civilian world, which could handle 80 terabytes of data using 64 gigabytes of RAM — more than 1,000 times that of a high-end personal machine at the time.

Venter continued to ask engineering questions, such as, “what is the minimal genome that can support life?”. Turning to nature for a model, he selected one of the smallest known genomes, that of the virus Φ X174, which was sequenced by Fred Sanger in 1977. Venter and his team then synthesized that sequence, chunk by oligomeric chunk, and stitched the pieces back together to make a complete genome. In 2008, they repeated this feat with *Mycoplasma genitalium*, a bacterium that has the smallest genome of any organism that can be cultured. With a flourish, they branded the first “synthetic genome” by including a sequence that spelt out the names of the collaborators — ‘Venter Institute’ and ‘Synthetic Genomics’ — like a “watermark” on a document, as Venter says.

Their next step was to take the natural genome of *Mycoplasma mycoides* and insert it into the de-genomed husk of the related species *M. capricolum*. Venter calls this “converting one species into another”. Finally, the Venter team repeated the trick with an *M. mycoides* genome that came out of a DNA sequencer. This time, along with the brand names, they stuffed a DNA-coded message into their cellular bottle that said, in effect, ‘If found, please contact ...’, providing the organism with its own e-mail address. Venter called this a “synthetic cell”

and dubbed it a new species: “*M. mycoides* JCVI-syn 1.0”.

So much for the book's coding region. After sketching some of his ongoing projects, Venter speculates on the future. He gives us his own New Atlantis, a secular genotopia in which novel DNA sequence will be synthesized to specification, “teleported” at light speed and printed out on biological three-dimensional printers. Fans of *Star Trek*, however, know that teleporters do not leave the original behind. More aptly, DNA would move into the Cloud,

infinitely copyable from anywhere. Novel synthetic life forms, Venter writes, could help to solve some of society's most pressing problems. Climate change? There would be bio-apps for that, such as engineered algal biofuels. Famine? Drought? Ditto. It is biology for the Google set: unsentimental, joyfully technophilic and boundlessly optimistic.

There is geeky cool in this view of life, but little grandeur. Venter won't brook the complexities of Darwin's tangled banks: to make his claims, as he admits, he must clean up messy terms such as ‘life’, ‘organism’, ‘species’ and ‘teleportation’ for the laboratory. In effect, biology becomes what the J. Craig Venter Institute produces. The machine in the metaphor now is the JCVI itself. And the watchmaker, of course, is Venter. ■

Nathaniel Comfort is professor of the history of medicine at Johns Hopkins University in Baltimore, Maryland. His most recent book is *The Science of Human Perfection: How Genes Became the Heart of American Medicine*.
e-mail: nccomfort@gmail.com

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