Life at the Speed of Light

The biologist J. Craig Venter is most praised for his success in mapping and sequencing genomes, including his own. But he is quite different from most contemporary scientists, who are usually chained to the "impact" of their own work and the "ranking" of journals in which they publish, often in a mass-production manner. Venter does not stop at merely sequencing his own genome and publishing it, he has also broadcast it into space in the form of electromagnetic waves. As he is not sure whether there is "… any creature out there capable of making sense of the instructions in my genome",[1] he provides us ordinary mortals on Earth with his new book *Life at the Speed of Light: From the Double Helix to the Dawn of Digital Life.*

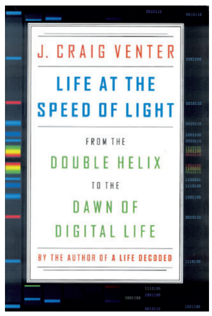
This book is certainly worth reading, with a focus on the major advances that have occurred since the time of Bacon, Wöhler, Darwin, and Monod—and on attempts to predict what is likely to come next. We have a unique opportunity to share his enthusiasm, and even his obsession with the belief that DNA can be sequenced, digitized, transmitted, and then re-synthesized in the laboratory. We are also driven to the edge of science fiction by the (still?) highly speculative assumption that life-forms on Mars should be similar to those on Earth (i.e., in using DNA to store and transmit genetic information), as Earth and Mars have continually exchanged material in the recent geological past. Here, Venter also offers mankind his skills as a scientist and services as a practical entrepreneur: "We can rebuild the Martians in a P4 spacesuit lab—that is, a maximum-containment lab—instead of risking them crash-landing in the Amazon".[1]

It is no surprise that such a self-conscious man already, in the first chapter, begins his book with an attempt to establish an interesting historical link. This chapter starts at Trinity College, Dublin, with Schrödinger's series of lectures in February 1943 (which were later summarized in a very influential book under the title "What is Life?"), and ends with Venter's Trinity College lecture on July 12, 2012 (which is the basis for *Life at the Speed of Light*). He spans the arch between Schrödinger's "aperiodic crystal" and the currently (at least among synthetic biologists) widespread idea of "digital biology". According to this, a convergence between the sequence code of DNA and digital computer code is expected to enable computer-aided design of the genome, with the possibility of transmitting it over long distances by electromagnetic waves and reconstituting it in a rapid synthesizer.

Also in this book, Venter does not forget to mention how he, as a young corporal in Vietnam, learned "… that the differences between the animate and inanimate can be subtle", which again emphasizes his obsession for disproving the theory of vitalism or any similar way of thinking. It seems that, in spite of great progress in biology since Darwin, and in spite of the contributions of whole armies of superb scientists, humanity in general has not succeeded in shedding the necessity to give life a transcendental meaning. Therefore, in the second and third chapters of the book, the interesting and important historical contributions and milestones that preceded the development of molecular and synthetic biology are provided. In fact, this is short history of our understanding of the nature of life. The author sees biology as a science of synthesis, with his own synthetic bacterium providing an even stronger demonstration and more conclusive evidence against vitalism than Wöhler's chemical synthesis of urea in the 19th century. In addition, he provides us with an impression of just how far biology has progressed since the early 1900s. Thus, it has taken only 100 years for biology as a descriptive/analytical science to become a science of synthesis (i.e., synthetic biology), with the driving idea based on the concept of modularity borrowed from software or electrical engineering.

In Chapters 3, 4, and 5, Venter further spans the arch from panspermia to biological teleportation, with his firm belief that in coming decades the major contribution that science can give to humanity is to "marry" biology with digital technologies. We will enter a post-industrial age of Western civilization, with the appearance and strong growth of biology-based design: with huge computer databases and immense amounts of DNA, the digitized information should enable us to recreate materials, living cells, and organisms. Worldwide, many research groups work at high pressure on technologies to create synthetic organisms, which make it possible to produce virtually any imaginable substance of medical or industrial interest. Living cells (especially microbes) are controlled by a widely known genetic program, a sort of "software of life". Since we are able to read and interpret it, we should also be able to completely understand how life functions, and subsequently to change it and improve it by writing new versions of the "software of life".

From the perspective of synthetic biology, living cells function as small programmable production units. DNA, as software, defines the manufacture of proteins and other macromolecules that can be viewed as its hardware, whereas cells are viewed as robots and chemical machines (Venter elaborates on Turing machines and von Neumann self-replicating automatons). Clearly, in this way, the crea-



Life at the Speed of Light
From the Double Helix to the Dawn of Digital Life. By J. Craig Venter. Viking, New York, 2013. 240 pp., hardcover, € 19.60.—ISBN 978-0670025404

tion of synthetic cells becomes an important technology in itself. In this context, Chapters 6–10 also provide a detailed description of ten years of experiments by Venter's team that enabled them to create an artificial cell by chemically synthesizing a bacterial genome and using it to "boot up" new cells. Certainly, if a synthetic genome were a faithful copy of an organism's DNA, it would perform exactly as would the natural genome upon transfer into the "empty" recipient cell. But this is an important step in a long history of attempts to modify natural organisms. The technical possibilities are largely increased, especially since the introduction of direct genetic manipulations in the 1970s. In this way, the distance between modified and natural organisms is gradually increasing. This path will ultimately lead to artificial life, which should be so genetically and metabolically distant from natural life that its survival outside the laboratory on Earth is not possible; these life forms would even result in genetic isolation, with a sort of genetic firewall. This promise is now an integral part of synthetic biology, a relatively new field of biological research and engineering.

The last two chapters of the book (11 and 12) are full of speculation about the implications of the convergence between the sequence code of DNA and digital computer code, with a (reductionist) perception of DNA as "software" or "digital life". In addition, the author repeats the mantra of "creating life at the speed of light", as a part of a coming industrial revolution where manufacturing will shift from factories as we know them to a domestic manufacturing process, thanks to the rise of 3D printer technology. But why do we need to transmit the genomic information at the speed of light? For finding life beyond Earth! It is difficult to see any other practical justification beyond that.

Life at the Speed of Light is a nice essay on science and scientists' inner workings, providing behind-the-scenes details of the experimental advances in biological sciences. Venter is certainly very skillful in using analogies to explain technical details comprehensibly to all readers who are outside this field and unfamiliar with the particular scientific terminology and laboratory jargon. This well-written book with cool science is excellent food for thought to everyone concerned with the past, present, and future of the biological sciences and bioengineering.

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DOI: 10.1002/anie.201405385

[1] Interview with J. C. Venter on 07. November 2013, published online: http://www.wired.co.uk/magazine/archive/2013/11/features/j-craig-venter-interview.