anti-hypertension drug labeled for use exclusively on African-American patients.

Essential reading for anyone interested in genetics, disease, and the meaning of race, *The Troubled Dream of Genetic Medicine* is a notable contribution to the study of the intersection of science and society. Wailoo and Pemberton provide important historical context to the disparate courses of the three genetic diseases, emphasizing that the experience of disease is embedded in a social landscape that builds on prevailing values, attitudes, and beliefs. The powerful refraction of the prism of race in the detailed accounts of Tay-Sachs, cystic fibrosis, and sickle cell provides further evidence that science alone cannot render race obsolete. As long as race continues to be a salient dimension along which our society assigns meaningful social and biological differences, it will have an indelible influence on how we interpret health and disease.

References

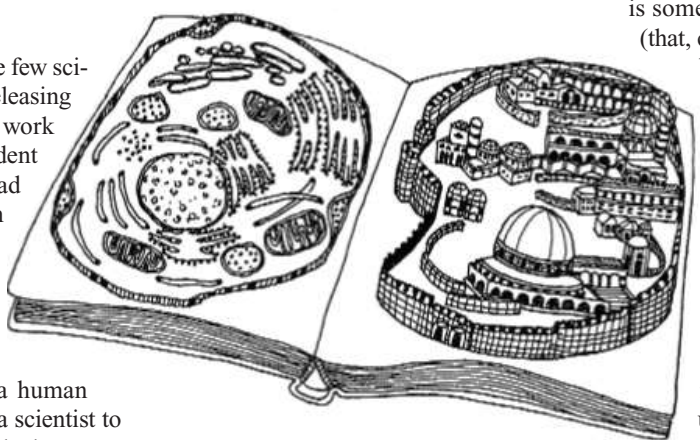
1. H. J. Gans, in *On the Making of Americans: Essays in Honor of David Riesman*, H. Gans, N. Glazer, J. Gusfield, C. Jencks, Eds. (Univ. Pennsylvania Press, Philadelphia, 1979), pp. 193–220.
2. K. Wailoo, *Dying in the City of the Blues: Sickle Cell Anemia and the Politics of Race and Health* (Univ. North Carolina Press, Chapel Hill, NC, 2001).
3. S. Reverby, *Tuskegee's Truths: Rethinking the Tuskegee Syphilis Study* (Univ. North Carolina Press, Chapel Hill, NC, 2000).

10.1126/science.1132060

SCIENCE AND RELIGION

DNA, Evolution, and the Moral Law

Robert Pollack



CREDIT: AMY POLLACK/FROM R. POLLACK, *THE BIOLOGY OF FAITH AND THE FAITH OF BIOLOGY* (COLUMBIA UNIV. PRESS, NEW YORK, 2000)

The Language of God
A Scientist Presents Evidence for Belief

by Francis S. Collins

Free Press (Simon and Schuster), New York, 2006. 303 pp. $26, C$32.95. ISBN 0-7432-8639-1.

Francis Collins is among the few scientists who can write of releasing the publication of his work while standing next to the president of the United States. As the head of the NIH's National Human Genome Research Institute, he stood in early 2000 with President Bill Clinton and Celera's Craig Venter to announce the completion of a draft sequence of the 3 billion base pairs of a human genome. It is almost as rare for a scientist to claim his work to be written in "the language of God," as he claims for this DNA sequence in his book by that title. He has written well for a general audience. To the best of my ability to judge, the facts of nature are laid out clearly. His religious life is as well, and that makes the book rare if not unique. But still, what can he mean by "the language of God"?

Midway through the book, Collins delivers a clear and cogent answer: He is an evangelical Christian. He sees no difficulty in accepting the continuity of life from its origins on Earth some 4 billion years ago. He makes plain that the continuity of life since then has depended upon the physical continuity of DNA backbones whose sequences undergo random mutation. He accepts wholeheartedly the complete capacity of natural selection to explain the emergence of new forms of life with new complexities, and of higher taxa emerging from long-lost species, over time. He sees humanity as but one example of that fecundity. And lastly, he sees all of this as being the intention of a Creator God, whose continued interest in Creation is exemplified not by any particular miracle but rather by these scientific facts.

Fair enough, but still, why does his particular expression of faith feature the human genome, or any DNA, in particular? The book's subtitle, *A Scientist Presents Evidence for Belief*, embodies his answer, a heartfelt if not entirely consistent one. The evidence for belief that he presents in the book comes down to the presence in himself and others of what he calls, after C. S. Lewis (*1*), the Moral Law. This is the apparently universal human propensity to ask of oneself "What ought I do?" and to decide that what one ought to do to others is what one would wish others to do to oneself, no more and no less. I happen to agree with this myself, and I too consider myself a religious person as well as a scientist.

But surely I would not want to make of this subjective emotional experience, however ubiquitous, evidence of the sort that a scientist marshals to confirm a hypothesis. Nor would I want to make the case, as Collins seems at first to be doing, that the Moral Law is somehow encoded in the human genome (that, certainly, is the simple meaning of his book's title and subtitle).

Despite the title he has chosen, the author knows and clearly states that the biology is otherwise: The human genome encodes the instructions for the assembly of what is after all a learning organism, not for what it then learns. Mental states are the product of social interaction from birth; in principle, any brain can have any thought. The Moral Law may well be God's presence among us—I do not know how to disprove this nor why one would try—but if so, it cannot be reduced to a DNA sequence, not even to the whole human genome.

But if the Moral Law were not written in DNA, then why would DNA be the "language of God" at all? In his credo "Science and Faith in Harmony," Collins explains. To see our species as embedded in a web of life and descended through natural selection from common ancestors with whom all life is shared is to see not human DNA but DNA per se as the prerequisite for the emergence of a life form capable of asking the question "What ought I do?" This least biological of questions is to him not then an example of an encoded voice. Rather, it is evidence of a heavenly plan launched by a caring God from a timeless place, a plan that has played itself out not only through all of life's DNA-encoded common ancestry but in the emergence of a universe capable of DNA-encoded life in the first place.

Taking biology as derived from the Greek words for life (*bios*) and word or knowledge (*logos*), he calls this personal religious vision of nature "BioLogos." Because the resonance of the slight change in spelling is with the Gospel of John—"In the beginning was the Word [Logos]"—he introduces a

The reviewer is at the Center for the Study of Science and Religion and in the Department of Biological Sciences, Columbia University, New York, NY 10027, USA. E-mail: pollack@columbia.edu

Christian particularity here that is not otherwise explicitly part of his religious vision.

Collins has done a brave thing in laying out his own religious convictions in a way that permits him to appeal to his fellow evangelical Christians to cease their war with nature and to accept the facts of life as discovered through science. By itself, this makes his account worth reading. But for one whose faith lies in meeting the Moral Law's demand, Collins reveals a couple of instances of diminished conviction that I find somewhat troubling. First, given that Collins makes so clear a case for the necessity of knowing the entire human genome (even though only one part in 70 encodes a protein), it is surprising to find that he has a much less stringent expectation for the texts that write of God directly: "Much of what I found in the CliffNotes versions of different religions (I found reading the actual sacred texts much too difficult) left me thoroughly mystified."

More substantial, as a person subject by his own conviction and faith to the Moral Law, surely Collins ought to have told us more about why James Watson vacated the position of director of the Human Genome Institute and why he then took it. He mentions that Watson left out of a conviction that the genome sequences should be a public good and not a gold mine of patents. But then the author fails to fill in the obvious gap: How did he keep within the Moral Law as he understands it when he stood with the head of Celera, the company that also announced its completion of a sequencing of the human genome, one that it hoped to profit from by patenting the interesting bits?

Collins refers to the parable of the Good Samaritan as an example of the Moral Law in action. Forty years ago, Martin Luther King, speaking at Riverside Church one year to the day before he was assassinated, extended the meaning of this foundational Christian text from the personal to the social:

> On the one hand, we are called to play the Good Samaritan on life's roadside, but that will be only an initial act. One day we must come to see that the whole Jericho Road must be transformed so that men and women will not be constantly beaten and robbed as they make their journey on life's highway. True compassion is more than flinging a coin to a beggar. It comes to see that an edifice which produces beggars needs restructuring.

The place of Moral Law in science thus becomes obvious: it is to oblige us all to ask, how can my science contribute to this restructuring?

Reference

1. C. S. Lewis, *Mere Christianity* (Richard Bles, London, 1952).

10.1126/science.1133985

MOLECULAR BIOLOGY

From Magnetic Mines to DNA and Consciousness

Leslie Orgel

Francis Crick
Discoverer of the Genetic Code
by Matt Ridley
Atlas Books (HarperCollins), New York, 2006. 223 pp. $19.95, C$25.95. ISBN 0-06-082333-X. Eminent Lives.

Francis Crick, who died on 28 July 2004 at the age of 88, will be remembered by the general public for discovering, in collaboration with James Watson, the structure of DNA. Those with an interest in the history of science will also remember him for his role in the elucidation of the mechanism of protein synthesis and for his collaboration with Christof Koch that removed the taboo on the discussion of consciousness in the technical neuroscience literature. His friends from the Cambridge of the 1950s and 1960s, whether scientists or not, will remember vividly the Bohemian parties that he and his wife Odile hosted in their home at 19 Portugal Place. Science writer Matt Ridley has had to cover all of this and more, without the help of diagrams or photographs, within the constraints imposed by the format of the Eminent Lives series of short, nonspecialized biographies.

Crick had shown no signs of unusual intellectual excellence as a student before the outbreak of the Second World War. Ridley's account of his work on the design of magnetic mines seems to me to be particularly revealing. The idea of designing a mine that would sink minesweepers but not merchant ships was unconventional thinking at the time, although the story current in Cambridge that senior navy officers regarded it as unsporting must be apocryphal. Francis and his colleagues went on to calculate the sensitivity and other parameters that would be needed by analyzing photographic records of a German minesweeper exploding a mine in waters of known depth. He left it to others to engineer the mines.

There is little to add to what has already been written by Jim Watson and others on the events leading up to the discovery of the structure of DNA. Ridley provides a concise account of the factors that made the discovery possible. So many things could have changed the outcome. Without financial help from well-off Uncle Arthur, Francis might have had to give up science. If Rudolf Signer had not given a very pure DNA sample to Maurice Wilkins, Rosalind Franklin could not have obtained the critical x-ray photographs. If the atmosphere at Kings College had been more collegial, the structure might have been solved there, or Linus Pauling might have finished first if he had not been denied a visa to visit England. Without the help of Jerry Donohue, Watson might have gone on using the wrong tautomeric structures for the bases and failed to find the base pairs. Nonetheless, Ridley's account shows that Watson and Crick were much more than lucky. Unlike their competitors, they realized that the DNA structure was likely to be a key to understanding the nature of life and they wanted passionately to be the first to find it.

Ridley rightly emphasizes the key role that Crick played in working out the genetic code. Francis's own experiments established that a sequence of three nucleotides coded for a single amino acid. The adaptor hypothesis and wobble pairing were also important, but his relentless analysis of the accumulating experimental data, some of it misleading, was Francis's main contribution. He was certainly the conductor of the orchestra, but I think he would have given a great deal of credit to Marshall Nirenberg, Gobind Khorana, and the other soloists.

CREDIT: © 1976 BRADLEY SMITH/WELLCOME LIBRARY, LONDON

The reviewer is at the Salk Institute for Biological Studies, Post Office Box 85800, San Diego, CA 92186–5800, USA. E-mail: orgel@salk.edu