To illustrate how cooperative behaviour may have arisen, the authors build simple computer simulations of Pleistocene human societies. Plausibly, they propose that the crucial step towards human social systems was the evolution of a cooperative unit that was big enough to insure against the risks involved in hunting large game, comprising around 32 adults plus juveniles and the elderly. Such bands, the authors argue, would have a modest amount of genetic variation between them. So, even if violent conflict between bands was common, group selection could not favour costly altruistic acts.

Selection among groups for cooperation gains traction only where it exceeds that for selfishness within a group. Social institutions can reduce the advantages of selfish behaviour. For example, modern hunter-gatherers typically share their resources. More successful providers are 'taxed' in food to support the collective. This sharing limits variation in reproductive success within groups, imposing selection on groups for individually costly acts of cooperation.

The authors' modelling shows that other institutions — such as ostracism, coordinating punishment of defectors and restricting altruism to the local genetically related group — can have the same effects. They suggest that selection can favour emotions such as shame or guilt that internalize social norms and benefit the group but cost the individual.

Although *A Cooperative Species* is broadly representative of the gene–culture co-evolutionary approach to human cooperation, I beg to differ on some points. In my view, the critical late-Pleistocene groups in which altruism should be explained are the larger tribes composed of many bands. These have the crucial feature of substantial cooperation between genetically unrelated individuals, on which the evolution of complex societies is based. Although bands do sometimes have violent conflicts, intratribal relations are usually more peaceful than intertribal ones. In my opinion, the authors also accept too high a value for the genetic differences between neighbouring populations in their simulations. However, such a discussion illustrates the book's strength. By presenting clear models that are tied tightly to empirically derived parameters, Bowles and Gintis encourage much-needed debate on the origins of human cooperation. ■

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T. HOFFMAN

Biochemist David Deamer poured chemicals into a hot pool in 2005 to see if primitive cells would form.

ASTROBIOLOGY

Life's beginnings

Robert Shapiro on a reminder that laboratory experiments don't always translate to nature.

In June 2005, an group of international scientists clustered around a small, near-boiling pool in a volcanic region of Siberia. Biochemist David Deamer took a sample of the waters, then added to the pool a concoction of organic compounds that probably existed 4 billion years ago on the early Earth. One was a fatty acid, a component of soap, which his laboratory studies suggested had a significant role in the origin of life.

Over several days, Deamer took many more samples. He wished to see whether the chemical assembly process that he had observed in his laboratory, which eventually produced complex 'protocell' structures, could also take place in a natural setting. The answer was a resounding no. The clays and metal ions present in the Siberian pool blocked the chemical interactions.

This experiment was a reality check, explains Deamer in *First Life*. He proposes in the book that the complex molecules that led to life developed not in 'warm little ponds', but in tiny droplets bound by fatty acids. Although his account lacks the tales of personality and conflict that enliven other works in astrobiology, Deamer's demonstration that we cannot translate lab results to natural settings is valuable.

➲ NATURE.COM
For more on the RNA-world hypothesis, see:
go.nature.com/kuolyb

First Life: Discovering the Connections between Stars, Cells, and How Life Began
DAVID DEAMER
University of California Press: 2011. 288 pp. $28.95, £19.95

Because we can get reactions to work in the controlled conditions of a laboratory, he cautions, it does not follow that similar ones occurred on prebiotic Earth. We might overlook something that becomes apparent when we try to reproduce the reactions in a natural setting. This provocative insight explains why the origin-of-life field has been short on progress over the past half century, whereas molecular biology has flourished.

Today, the simplest living cells depend on molecules that are far more intricate than those that have been isolated from sources unrelated to life (abiotic), such as meteorites. The most noteworthy chemical substances in life are functioning polymers — large molecules made of smaller units called monomers, connected in a specific order. The nucleic acids RNA and DNA, carriers of genetic information and heredity, are made of connected nucleotide monomers. Similarly, proteins are vital polymer catalysts that are made by combining monomer amino acids. Such modern biological constructions were unlikely to have been present on the early Earth.

Despite this, many researchers have tried to demonstrate that RNA, or something similar, turned up spontaneously between 3 billion and 4 billion years ago. Physicist and biochemist Walter Gilbert suggested in 1986 that life began with the spontaneous generation of an RNA that could copy itself: the 'RNA world'. The advantage of this idea is that the formation of just one polymer would be all that was needed to get life started. The disadvantage is that such an event would be staggeringly improbable.

"The advantage of the 'RNA world' idea is that one polymer would be all that was needed to get life started."

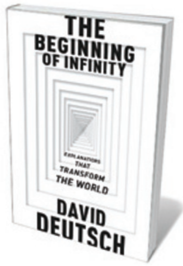
Nucleotides, for example, are not encountered in nature beyond organisms or laboratory synthesis. To construct RNA, high concentrations of four select nucleotides would be needed in the same location, with others being excluded. If this is the prerequisite for life, then it is an unusual phenomenon, rare in the Universe. As an alternative, other scientists (myself included) have suggested that life started without the presence of polymers; that instead, heredity and catalysis began with monomers.

Deamer's thesis diverges from the standard RNA-world concept. He focuses not on the generation of a naked RNA-like polymer, but on the formation of a simple cell-like compartment, or vesicle. Modern cells are enclosed by a complex fatty membrane, which prevents leakage. Vesicles with similar properties have been formed in the lab from certain fatty acids. Deamer holds that the spontaneous formation of vesicles, into which RNA could be incorporated, was a crucial step in life's origin. Unfortunately, his theory retains the improbable generation of self-replicating polymers such as RNA.

Nevertheless, Deamer's insight deflates the synthetic proofs put forward in numerous papers supporting the RNA world. He ends *First Life* by calling for the construction of a new set of biochemical simulators that match more closely the conditions on the early Earth. Unfortunately, the chemicals that he suggests for inclusion are drawn from modern biology, not from ancient geochemistry. We should let nature inform us, rather than pasting our ideas onto her. ■

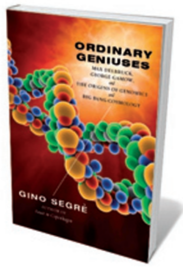
Robert Shapiro *was professor emeritus of chemistry at New York University. Sadly he passed away on 15 June 2011, shortly after completing this review.*

Books in brief



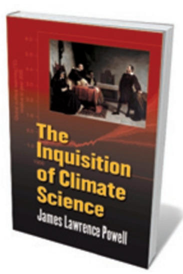
The Beginning of Infinity: Explanations That Transform the World
David Deutsch Allen Lane *496 pp. £25 (2011)*
Scientific explanations have an infinite scope and are ever-adaptable, argues quantum computation expert David Deutsch in his latest book, which is sure to provoke many philosophers of science. Since the Enlightenment of the eighteenth century, the scientific method has allowed us to continually describe, assess and reconfigure ideas about the Universe, in a virtuous cycle that Deutsch sees as boundless. Everything is within the reach of reason, he claims, from free will to creativity and the laws of nature. It is our duty to seek the best explanations, he says.

The Sorcerers and Their Apprentices: How the Digital Magicians of the MIT Media Lab Are Creating the Innovative Technologies That Will Transform Our Lives
Frank Moss Crown *272 pp. $27.50 (2011)*
Frank Moss, a former director of the Media Lab at the Massachusetts Institute of Technology (MIT) in Cambridge, reflects on five years at the helm of this innovative institution. Through tales of the people who worked on such imaginative projects as the development of child-safe air bags and Lego robots, he highlights the Media Lab's ethos of creative freedom, serendipitous discovery and porous disciplinary boundaries.



Ordinary Geniuses: Max Delbrück, George Gamow, and the Origins of Genomics and Big Bang Cosmology
Gino Segrè Viking *352 pp. $27.95 (2011)*
Genetics and cosmology owe their origins to two physicists, Max Delbrück and George Gamow, respectively. In this insightful double biography, theoretical physicist Gino Segrè portrays them as exemplary yet ordinary scientists who overcame personal struggles to work on big questions. He describes how Delbrück's flight from Nazi Germany turned him towards biology; and how Gamow's escape from Stalinist Russia to the United States led to him working on the hydrogen bomb and the formation of elements in the Big Bang.

Future Science: Essays from the Cutting Edge
Edited by Max Brockman Vintage *272 pp. $15.95 (2011)*
In a sequel to *What's Next?* (Vintage, 2009), editor Max Brockman's latest collection of essays showcases the cutting-edge research of 19 leading young scientists — only a few of whom have written for a general audience before. Contributions include discussions of the biology of antiviral immunity by virologist William McEwan; the physical impact of social rejection by neuroscientist Naomi Eisenberger; the physics of infinity, discussed by physicist Anthony Aguirre; and the role of huge data sets in society by computer scientist Jon Kleinberg.



The Inquisition of Climate Science
James Lawrence Powell Columbia University Press *272 pp. $27.95 (2011)*
Geologist James Powell exposes the tactics of climate-change deniers in his latest book. Arguing that the current attempt to undermine trust in climate research is the most egregious attack on science in history, he examines the movement and its protagonists. He points out the rhetorical tricks, lack of credentials and industry backing of many deniers, their unwillingness to present alternative theories, and historical precedents of resistance to scientific evidence.