

BOOK REVIEW

GENESIS: THE SCIENTIFIC QUEST FOR LIFE'S ORIGINS by Robert M. Hazen. Joseph Henry Press, Washington, D.C., 2005. 339 pages, \$27.95

How life originated remains an unanswered fundamental question. The author's aim in this book is to bring research and debate about the origin of life to a popular audience. Hazen's book frequently contains personal anecdotes that will resonate with any scientist: he recounts thinking up hypotheses and experiments, stumbling into serendipitous collaborations, and getting unexpected results that initially make no sense. He also clearly believes that the interesting science is in the details rather than the overview. Consequently, in order to tell stories about particular lab experiments, he has no qualms in enthusiastically discussing how to weld a gold capsule on page 5 or the details of using an electron microprobe on page 51. These personal interludes come across as refreshingly novel. In this way, Hazen actually gets across how science is done and cleverly introduces key ideas without lecturing us.

The book's theme is "emergence," meaning self-assembly of structures and processes. The book is divided up into four parts. Part I discusses emergence in general terms and the evidence for Earth's earliest life, while parts II–IV describe current ideas on the emergence of simple organic molecules, macromolecules, and self-replication, respectively. Hazen is a mineralogist who broadened his interests to origin of life around the mid-1990s and has come to know the field and its practitioners thoroughly.

In my view, Hazen's description of past and current research into the origin of life (parts II–IV) is where the book shines best. Many students are familiar with Stanley Miller's 1950s experiment where electric sparks transform reducing gases to biomolecules. But where textbooks give us turgid accounts, Hazen provides the colourful story of a determined grad student, the details of what was actually done down to the paper chromatography, and the context of subsequent follow-up experiments. Hazen then traces the development of alternative ideas for the origin of organic molecules: the hypothesis that hydrothermal seafloor vents were the sites of the origin of life or that prebiotic molecules came from space. We're also told of continual staunch criticisms from the Miller camp, as well as fringe ideas about the origin of organic molecules, such as Tom Gold's "deep hot biosphere."

The book moves on to the next challenge of selection and assembly of simple organic molecules into useful macromolecules. It is here that university teachers can mine this book for various nuggets to spice up their lectures. For example, to introduce the topic of how the tree of life is being deduced from DNA sequences, Hazen recounts Barbrook and Howe's genetic analysis of 58 different manuscripts of Chaucer's *The Canterbury*

Tales to deduce the common ancestral manuscript from textual differences. In discussing molecular chirality, Hazen notes how limonene flavoring tastes like lemons in right-handed form, but oranges in left-handed form; or how left-handed thalidomide cures morning sickness while the right-handed variant induces birth defects. Of course, we also get serious discussion of where chirality comes from (was it from a mineral template, like quartz or clay?) as well as a primer on the origin of cell membranes.

The final part of the book is about the emergence of self-replicating systems. We revisit deep-sea vents to explore Gunter Wächtershäuser's "Iron-Sulfur World," which is a model where organic molecules emerge on iron sulfide mineral surfaces and enter into a self-sustaining system of reactions, or proto-metabolism. Finally, the book ends with "RNA World," which is probably the most significant contribution to origin of life research in recent years. The idea that RNA preceded DNA as the genetic material of primitive organisms and catalyzed its own self-replication has received many experimental boosts in recent years. Hazen provides a clear account of RNA World, but as an insider, he is able to embellish it with the unfinished story of how one of his former students, Nick Platts, has suggested that genetic polymers based on polyaromatic hydrocarbons (PAHs) preceded RNA.

The tricky part of the book is Part I, which attempts to discuss the meaning of complexity and to address the "What is Life?" question. Hazen necessarily struggles to provide answers. There are also some small omissions in the coverage of evidence of Earth's earliest life. While Hazen describes how carbon isotope data for the earliest life in Akilia, Greenland, is widely disbelieved, there is no mention of Minik Rosing's more robust work from other Greenland rocks of more than 3.7 Ga age. Also, while the doubt by Martin Brasier and colleagues about the biological nature of Bill Schopf's "world's oldest microfossils" is presented as a bombshell, in fact, criticism of these amorphous microfossil forms had been floating around at conferences for years.

Nonetheless, overall this is an excellent book. I would recommend it any to student, researcher, or member of the public who wants to get up to date on origin of life research. Because Hazen has moved into research on the origin of life relatively recently, he brings both the freshness of a newcomer and the experience of a working scientist. Consequently, Hazen's guided tour to the origin of life, from past to current ideas, is probably the best introduction to the subject that you'll currently find.

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