Life is in the bag, or is it?

The Spark of Life: Darwin and the Primeval Soup
by Christopher Wills and Jeffrey Bada
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We are all stirred in one way or another by the 'spark of life', an emotive topic that has occupied man throughout the ages. How can we contemplate a world of some 4 billion years ago at the very creation of the earth and the stage upon which life began? This is perhaps guarded by our own experiences. My concepts of life's origins were shaped in the 1980s as a student with a particular leaning towards developmental biology and a curiosity about life. I therefore approached this book wanting to know whether the ideas that were prevalent at that time still hold sway, and how they have evolved over the past twenty years. Wills and Bada provide the overview that I had hoped for in an entertaining and captivating text that held my attention.

At the core of the book lie the ideas, espoused by Oparin in the 1920s, that the organic compounds necessary for life could have been formed through natural chemical processes upon the early earth. These ideas received support from the classical experiment of Miller who, under the tutelage of Urey, synthesized organic molecules including many amino acids by sending an electric spark though a mixture of reducing gases meant to simulate the atmosphere of the early earth. Although others provided variations upon this experimental theme, Miller's findings remain perhaps the most significant step towards the creation of life in the test tube. From this core, the book follows two paths. First, from the bottom up, exploring how simple substances can end up as entities with some properties of life. Second, from the top down, demonstrating how the genetic information carried by modern life can be dissected into its essential components.

The bottom-up journey begins with the creation of the earth itself, and provides a vivid description of the Hadean environment that had to spawn the first organic molecules. Wills and Bada's writing conjures an image of an earth with a moon much closer than today, producing dramatic tides of the oceans, and a chilly sun seen through mists of corrosive gases. These environmental themes lead to a darwinian-like explanation of how early conditions could have served as a means of separating and selecting organic molecules into groups with similar properties. The sands of the early beaches are imagined as giant chromatographic systems, yielding layers of 'slimy molecules' with differing affinities for other components of the prebiotic soup. In effect, each layer could serve as a huge 'pre-cell', within which particular chemical reactions would be favoured. Add to the slime layers the provision of catalytic properties by mineral deposits to which these early molecules could tenaciously cling, and soon we have an imagined environment in which all kinds of experimental chemistry are in force in this ancient laboratory on the beach.

How many life-like chemical processes could these pre-cell layers accomplish? Did life arise first as mixtures of molecules able to carry out simple metabolism, or was the first critical step the creation of a self-replicating molecule? The authors consider RNA as a present-day molecule that can have both replicative and enzymatic properties. But could this sensitive molecule survive in the prebiotic world? Recently, peptide nucleic acids in which the phospho-sugar chain is replaced by peptide linkages have been proposed as stable prebiotic alternatives to RNA. Whether or not these molecules existed in those times is still unclear. Once, however, molecules like these were formed, then perhaps the 'slime layer' provided them with a host environment in which darwinian selection could start to take place.

Such uncertainties bring us to the top-down path. It approaches evolution through the exchange of chunks of genetic information between bacteria and archaea, and through the importance of establishing symbiotic relationships between organisms. The latter is evidenced by our own acquisition of bacterial cells in the form of mitochondria. The power of this section lies in the descriptions of the genealogies of genes themselves by searching for fundamental commonalties between today's life forms and by using the existing fossil record to establish the time scales of evolutionary processes. We are left with a retrospective of evolution that fades disquietingly into the unknown past without making a final link to life's molecular origins. The authors use this to convey a sense of excitement about the future of this field and of the challenges of making these connections. So it seems that our understandings of life's origins are rather like the molecules of the primitive cell — they are not yet 'in the bag'. However, one day they should evolve.

Throughout the book Wills and Bada capture the reader by presenting a balanced view of past and ongoing debates. They entertain by not only giving a lively description of the 'spark of life', but also by conveying the sparkle of its investigators and the nature of the scientific process. These two professors have written a book that reads like a novel, and one would be happy to have them educate one's children. The topics of the chapters were carefully chosen, with perhaps the one exception of the first chapter, a broad description of pre-twentieth century views of life's origins. Readers are recommended to persist through these first 30 pages, as having done so they will be rewarded. The authors cite Haldane — "The problem of describing the origin of life is curiously like its actual origin. In each case it seems likely that a number of attempts were made and almost all of them did not work. Natural selection eliminated them". This book should survive such selection. □

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