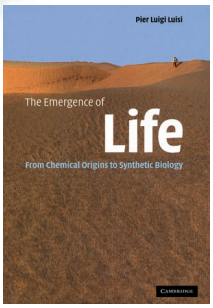
The Emergence of Life



From Chemical Origins to Synthetic Biology. By *Pier Luigi Luisi*. Cambridge University Press 2006. 315 pp., hardcover £40.00.—ISBN 0-521-82117-7

The new book entitled *The Emergence of Life—From Chemical Origins to Synthetic Biology*, by Pier Luigi Luisi, Professor of Biochemistry at the University of Rome, takes a radical new approach to this very complex problem, which has been tackled previously over a long period by many other eminent authors. He has not set out to describe in detail the numerous earlier attempts to formulate a credible prebiological scenario that would allow the synthesis of biological (living) matter from nonliving "primordial" chemicals that were abundant on the early earth immediately after its formation as a solid planet within the solar system. Instead, the author emphasizes the importance of ideas that do not strictly belong to classical chemistry, such as recently developed concepts of autocatalysis, nonlinearity, self-organization, self-reproduction, conditions far from equilibrium, autopoiesis, and other theoretical building blocks—supported by a growing amount of experimental evidence!—which make up the hypothesis presented in detail in his book. Luisi's authority to write on this subject rests on the fact that, whereas he originally trained as a macromolecular chemist, his academic interests, during an impressive scientific career, were increasingly concentrated in the area of essentially biological ideas, enriched by a sound background in modern physical concepts that deal with the "soft matter" of the subject, such as self-organization, autocatalysis, and the other key ideas mentioned above. Physicists have only recently started to become successfully engaged in studying and understanding biological processes that are essential to our life. No doubt this is a quite modern trend in science, and Luisi has been one of the pioneers in this highly interdisciplinary field, roaming around between biology, chemistry, and physics. I dare to say, this is very good, and one has to congratulate the author on his endeavor to familiarize the truly interested reader with the idea of moving outside one's sacred field of narrow specialization, whether it be macromolecular chemistry, physics of solid matter, or molecular biology, to name only a few of them. Of course, one has to pay a price for roaming in different specialized areas, and consequently some areas are treated only rather briefly, perhaps even superficially, in Luisi's monograph, in the interest of presenting a very readable book with a great number of fresh thoughts (and afterthoughts), leading to some "aha's" and "oh's" within a work of limited size (about 300 pages).

The book is structured in 11 chapters, covering topics that range from the definition of LIFE as such, through the—more—historic attempts at creating an independent research subject such as prebiotic chemistry, the concepts of self-organization, emergence, and autopoiesis mentioned above, the crucial importance of the idea of compartments, such as vesicles, micelles, and cells (in a very generalized sense at first), to the highlight, the attempt to create a "minimal cell", which could be described as being at least similar to a "limping" (the author's word!) living cell.

Clearly, Luigi is greatly impressed and strongly influenced by the tremendous creative work of the Varela and Maturana group, here called in short the "Santiago de Chile group" (with a reference to the fact that they had to leave their home, having sympathized with Allende after his brutal assassination!). These two scientists introduced the term "autopoiesis". Luisi places this concept at the center of the origins-of-life puzzle; yes, I think this really makes sense, once a cell has started to metabolize chemicals imported from outside and export its waste products beyond the cell, thus stabilizing and sustaining its own existence "forever", one is inclined to give such an entity the noble name "living cell". I can follow this argument. Such a property of the cell in question, and the search for such a minimal cell in our laboratories, promises more of a real perception about the origin of life on early earth than does the hunt for the exact formulas of the primordial chemical compounds involved, whether they were of an oligo- or macromolecular, or of a proteinic or nucleic acid type!

A few positive and negative comments have to be added here. The latter ones could be worked into a second edition, if planned by the publisher. In his "Outlook", the author impresses me on the one hand by his modesty in stating, at the very end of his work: "Even if we are not able to explain how life originated on earth, we may(!) be able to give a good answer to such questions. This is satisfactory enough and a great motivation for the next generation of life scientists". This is in stark contrast to the views of other authors in this truly intriguing field, such as one occasionally meets in the literature or in oral presentations. For example, the bold statement that "… we are very close now (!) to finding the ultimate puzzle piece in creating life or a living cell in the test-tube …". The earliest of these claims to be taken seriously were published at least some 40 or so years ago!

Having praised Luisi's modesty here, on the other hand it is a bit disturbing that, in the list of references, he piles up about 80 citations (out of a total of about 220) in which he is the main or co-author, and his name makes up about 37 % of the names of individual scientists who are cited! A monograph that claims to give an objective survey of work on the mysterious origin of life, or even on the bold theme of "synthetic biology", should be more balanced, and should pay due respect to the rest of the scientific world! Among the scientists whose work is

not sufficiently represented in the list of references are Hans Kuhn, Erwin Schrödinger (the link between entropy and life is mentioned in the text, but without giving a few essential details of Schrödinger's work), U. Meierhenrich (who has worked in this reviewer's laboratory on recent advances in the search for the origin of homochirality on the earth and beyond), and S. W. Fox (who has published a great deal of work on the topic of peptide sequence preferences). The idea of using the Leuchs anhydride method to investigate the possibility of enantiomeric enrichment of amino acid monomers within a growing oligopeptide (p. 43) was first introduced by W. Darge and W. Thiemann in 1974. In the context of symmetry-breaking potential in rather simple chemical reactions, the work of the Tübingen group of F. F. Seelig and co-workers should also be mentioned alongside that of M. Lahav's group in Israel.

It is annoying that errors often occur in the spelling of authors' names, both in the text and in the list of references—that should be corrected in a second edition! A few examples may serve as an illustration, such as the inconsistent use of the German umlaut (the two dots above the vowel), in Wächtershäuser (two umlauts in one name, which must be attached to the right vowel!), Schröder, Jäger, etc. If the authentic German spelling is used, it should be done consistently. One also finds "Luisa" instead of Luisi, "de Duve" instead of De Duve, "Bada" instead of Beda, "Eschenmoser" instead of Eschemoser, and other errors such as "Zhabotinsky" and "Paecht-Horowitz"! Luisi occasionally includes some biographical notes, such as the mention on page 103 of Turing's suicide. However, he should have added that Turing became famous for having constructed a very ingenious and powerful computing machine for the British intelligence, which led to the deciphering of the secret wartime code of the Nazi military, thus making an essential contribution to its ultimate defeat in the war. In a further edition of the book, a glossary explaining the many acronyms would certainly be beneficial to the general reader.

In spite of these small flaws, I would like to strongly recommend Luisi's monograph as a sort of "advanced introduction" to the intriguing topic of the emergence (mostly addressed as "origin" by previous authors) of life on earth. The work is of a truly and, in the best sense, interdisciplinary nature, and will fascinate scientists as well as philosophers of all areas, in particular, of course, biologists, chemists, physicists, astronomers, astrophysicists, and others (even including theologians, because the author devotes a lot of thought to the subject of creationism and its latest variant, the "intelligent design" hypothesis!). Both the structure and the index are very well organized. This new book, which deals with the earliest embryonic signs of life, as well as with the more recent branches of biological evolution on earth, deserves to claim a solid and eminent position on the bookshelf of the researcher into the subject of life's beginnings. Despite the extremely complex and challenging nature of the subject, this is a very readable book, not least because of the many humorous remarks interspersed in the text, such as this (p. 21): "… they may be eaten up in the meantime. Victims of a wrong definition of life!", where the author imagines some poor NASA astronaut encountering a strange life-form and failing to recognize it as such, because of an over-simplistic official NASA definition of life. Again, on page 173: "… For a fish, a rose is not a rose …"; how true, where the author is describing the interaction of our conscious mind with the object, and the difficulty of recognizing familiar objects around us as such! Chapeau!

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