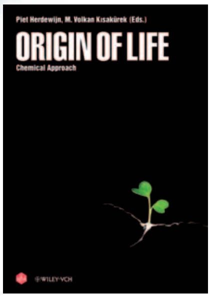
Origin of Life



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There is a story that Professor Albert Einstein was challenged by an undergraduate during an oral examination, when the student complained: "Oh, you asked me this question last year, and last year you said that my answer was correct!". Einstein answered: "Indeed, last year the question was the same, but meanwhile the answer has changed". What should we learn from that dialogue?—Science advances, but its rate of advancement is not the same everywhere and varies greatly depending on the discipline and the scientific field. So, hand on heart, which is the scientific discipline today in which Einstein's remark would most likely be true? In chemistry there are several fields, but one chemistry-related scientific domain is particularly intriguing because advances in knowledge regularly require new hypotheses that change the answers. It is the search for the chemical roots of the origin of life on Earth.

Piet Herdiwijn and Volkan Kisakürek are the editors of the multi-author book *Origin of Life—Chemical Approach*, in which a "Who's Who" of the international top researchers in this field present new answers on vital questions. I start this review by highlighting the contribution of André Brack of CBM in Orléans, who sheds light on the chemistry of how and where the molecular building blocks of life were formed. He assumes that amino acids were crucial to triggering the appearance of life on Earth, and describes in detail their endogenous prebiotic production, either by submarine hydrothermal systems or by electric discharges in a prebiotic atmosphere. The exogenous formation of amino acids that has apparently become a serious alternative theory is explained using various examples of laboratory experiments to simulate interstellar environments, a theory supported by the identification of amino acids in some meteorites. Later on, Brack describes various condensation reactions of amino acids leading to the formation of oligopeptides and proteins.

The following chapter by Sandra Pizzarello of Arizona State University is concerned with the chemical analysis of organic molecules, including amino acids, in meteorites. Data on the molecular and isotopic composition are given, and also the question of the origin of the homochirality of biomolecules is considered by presenting original data on the resolution of enantiomers for the amino acids isovaline (L: 6% *ee*), 2-amino-2-methylheptanoic acid (L: 2% *ee*), and 2-methylglutamic acid (L: 8% *ee*) in meteorites. Pizzarello points out that the promising analytical results up to now from meteorites still do not answer the fundamental question of a chemobiogenesis hypothesis, namely whether abiotic organic materials could have assisted the evolution of life on the Earth and elsewhere. Consequently, and as outlined in this book, Pizzarello recently began further research in which Soai's asymmetric autocatalytic reaction was successfully performed with meteorite powder.

Günter Wächtershäuser, who works as a European Patent and Trademark Attorney in Munich and is an honorary professor at the University of Regensburg, does not entirely agree with the above-described models of the formation of high-molecular-weight biopolymers, such as proteins, starting from homochiral and low-molecular-weight monomer units. In his inimitable approach, Wächtershäuser comments that conventional theories of the origin of life are beset by several deep-seated misconceptions, based on the fact that the bulk material of all extant organisms, and notably the genetic material, consists of polymers. It is therefore assumed that the origin of life must share with all extant life the role of macromolecular polymers and their replication as the physical basis for reproduction, heredity, and evolution. According to Wächtershäuser, these kinds of replication-first theories associate the chemical process of the origin of life with the onset of an autocatalytic polycondensation. These theories suffer from some paradoxes, for example they require liquid water, but have to avoid hydrolysis. He describes his theory of a chemo-autotrophic origin of life in a volcanic iron–sulfur world. A similar argument is used by other authors, which shows that the previously common school of thought has now split into two, so that the problem of the origin of life is approached in the framework of either the "replication first" paradigm or the "metabolism first" scenario. The first paradigm suggests that life started from the spontaneous emergence of the first, supposedly RNA-based, "replicators", whereas the alternative hypothesis of "metabolism first" views life as being derived from increasingly complex autocatalytic cycles.

The book includes chapters by Antonio Lazcano, Albert Eschenmoser, Christian de Duve, Alan Schwartz, Peter Nielsen, and many others. For students it is intellectually appealing, for lecturers it includes valuable information and numerous colored figures, and researchers will find it stimulating. In 2009, one year after the appearance of this book, our questions on the origin of life will remain the same; will the answers change?

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