Section 4: Constructional Morphology and Evolution
The Early Evolution of the Planet Earth and the Origin of Life

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Abstract

The early evolution of the planet earth and the origin of life is reviewed under structural, functional, biomechanical, chemical and physical aspects. On a global scale, the biosphere is organised as a self-regulating, thermodynamically open system, which however consists of individual organisms. They are operating as biomechanical closed structures, which have the ability to transport energy and matter actively from the surrounding environment to their interior.

Organic molecules may have formed on earth or derived from outside space. Accretion to prebiotic stages with first metabolic reactions probably evolved attached to mineral surfaces, followed by membranes enclosing fluid filled vesicles or protocells. Evolutionary transformations enabled protocells to reach a level supporting a more complex turnover of matter and energy, development of a hydraulic system, mobility and multiplication. Already very early in earth history a variety of different metabolic pathways evolved and permitted the various ways of life within the early ecosystem. Three evolutionary lineages are of particular interest for the further evolution of the planet earth: (1) Archaea are the most primitive organisms today, and therefore are generally accepted as close relatives of the first organisms. (2) Eubacteria efficiently drive energy and matter cycles in anoxic and oxic environments. Therefore they were the main driving force of environmental changes from anoxic to oxic and stimulated further evolutionary innovations. (3) Eucaryotic cell were the most important innovation, from which finally the multicellular organisms evolved.

Eucarya represent organisms of progressively increased complexity. But they depend on the metabolic activity of endosymbiotic bacteria, which act as membrane-enclosed organelles within eucaryotic cell.

Key words: origin and prebiotic history of earth, metabolic pathways, membranes, mechanically and operationally closed structures, hydraulic principle, Archaea, Eubacteria, Eucarya

The solar system and the planet earth formed about 4.6 billion years ago and life originated some hundred million years later. Several theories have been developed to explain the origin of life on earth. But so far only the origin of the organic substances on earth via simple chemical reactions and lightning has been proven by experiments (e.g. MILLER 1953). However, organic molecules not necessarily originated on earth. They have been found in interstellar clouds and they probably have formed in the outer, cold parts of the accretionary disc of our planetary system and still exist in present day comets. Thus, organic molecules might have been brought to earth by fragments of meteorites and comets (Hiroi et al. 2001). Recent discoveries of meteorites with 70 different amino acids make this idea at least a possible scenario.

However, the understanding of the origin and formation of organic molecules does not explain the origin of life. This question is still not answered. Here we try to draw a possible and plausible picture of the physico-chemical conditions of the early earth, and we try to understand the innovative steps necessary for the origin of life, and to determine the possible meta-