Life

LIFE IS A WONDER of its own. It conceivably struck this planet at least some 3.8 billion years ago,[1] arguably the consequence of a phospholipidic layer-bound *quantum leap* in a soup of organic precursors.[2] From that singular moment on, little has been spared in guise of amazement.

[1] Mojzsis et al., 1996

[2] Miller and Urey, 1959

The first factual evidence of life on Earth appears inscribed in the fossil record some 3.5 billion years ago. It consists mainly of microfossils and ancient rock structures in Greenland and Australia called stromatolites,[3] the product of the metabolism of photosynthesizing cyanobacteria.

[3] Ohtomo et al., 2014; and Noffke et al., 2013

While the fine details of the abiogenic model[4] for the origin of life[5] remain to be chalked, a wider consensus exists to depict its primed instances as self-replicating units able to regulate their own chemical processes within the confinement of a cellular membrane. Such primeval unicellular organisms were most likely composed of some form of nucleic acid secluded from its external environment by a bilayer of phospholipids.

[4] From the Greek "spontaneous generation", this model posits that autocatalytic polymers able to function as simple molecular replicators are at the origin of life. Alternative models exist, most notably panspermia—the extraterrestrial origin of life.

[5] Much debate has been stirred around the definition of life itself, see for instance Benner, 2010.

Nucleic acids, RNA and DNA, are the sole organic molecules fit to direct their own replication and to act as genetic material. RNA was proposed as the original genetic system since it was shown to be able to catalize a variety of chemical reactions, notably the polymerization of nucleotides.[6] However, as the genetic load stored within cells increased, the lesser stability and reliability of RNA molecules rendered them unsuitable for the furtherance of genetic systems, and DNA eventually took over as universal hereditary material.

[6] Bass and Cech, 1984

These very simple and self-organized systems emerged in seas densely enriched in organic molecules and therefore didn't require sophisticated toolkits for intake of food or generation of energy. Only when systematic interactions between RNA and specific amino acids became enshrined in the genetic code[7] did evolution start to shape concerted molecular reactions between proteins that animated cells with metabolic activity. Among the first tinkered metabolic pathways are likely to have been some simpler form of modern-day glycolysis, the anaerobic breakdown of glucose to lactic acid, which provided cells with their universal source of energy, ATP.

[7] The central dogma of molecular biology, postulated by Francis Crick in 1958 and reasserted in 1970 (Crick, 1958, 1970), pertains to the rules that govern the sequential flow of genetic information between DNA, RNA and proteins. It can be summarized as "DNA makes RNA makes protein", which provides the template for the enactment of hereditary information for all living organisms and frames the scope of evolutionary forces on genetic systems.

and later when DNA took over the role of hereditary material

later replaced by DNA as the holder of hereditary information. These very simple systems emerged in a rich. Ordered interactions between RNA and amino acids then evolved into the present-day genetic code, and DNA eventually replaced RNA as the genetic material. The central dogma of biology.

[8]

[8] RNA, later eventually replaced by DNA.

evolved from the first instances of unicellular organisms. These primeval self-replicating units able to regulate their own chemical processes within the confinement of a cellular membrane might well have of modern-day prokaryotes.

Such primeval cells might well resemble modern day prokaryotes, defined by their lack of membrane-bound organelles, most particularly a nuclear envelop secluding their genetic material. Whether representants of the Eubacteria phyla (defined by) or the Archea phyla (defined by), these first cells (metabolism). Change of atmospheric conditions. Evolution of Eukaryotic cells, definition, timing. Specific acquired features, metabolism, endosymbiotic model. Multicellular life, dramatic consequences for the establishment of genetic programs controlling differentiation and proliferation. Concept of embryogenesis. Cellular interdependence. Concept of totipotency. Concept of natural evolution as an over-reching common thread to interpret and understand the evolution of life. Darwin's quotation. Colonial organisms. Modularity in biology.

endosymbiosis

multicellularity

Research on how life might have emerged from non-living chemicals focuses on three possible starting points: self-replication, an organism's ability to produce offspring that are very similar to itself; metabolism, its ability to feed and repair itself; and external cell membranes, which allow food to enter and waste products to leave, but exclude unwanted substances.

Life can be considered to have emerged when RNA chains began to express the basic conditions necessary for natural selection to operate as conceived by Darwin: heritability, variation of type, and differential transmission of genetic traits constrained by competition for limited resources.

> There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.

How ironic that one of the best models to understand this order of things is actually one of its most harrowing violations: cancer.

Cancer

Cancer is a dysfunction of

Microarrays

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