



## Life One-Pager

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Life in a nutshell.

Life arose around half a billion years after the earth's formation, perhaps 4 billion years ago.

In 2000, a place called Lost City was discovered. In the sea, porous stone with circulating water (alkaline hydrothermal vents), allowed life to come into existence. Holes in the stone had thin walls, water with a different acidity flew at the two sides of the walls. The inner and the outer side of the walls got a different electrical charge, this became the energy of life.

All kinds of things could be done with this free energy, and all kinds of things happened.

One of the things that happened there was the formation of organic material from CO<sub>2</sub> and H<sub>2</sub>.

The vents not only made organic material, but also concentrated it.

Nature then invented organic cell membranes, to be independent of the porous rocks, and to be able to escape from the vents.

Some of these proto-cells were closed instead of porous, but with many tiny selective pumps.

In this way the available energy to do all kinds of things, e.g. make more organic material, increased.

Evolution invented an effective kind of handling energy (ATP) and an effective way of storing information (DNA) so that after dividing information could be passed to the new cells.

Two kind of pumps in the cell wall evolved (and survived), and from here two kind of cells emerged, the archaea (Greek for old) and the bacteria (Greek for staff). The pumps, at the outer cell membrane, were used to intake material (food) from the sea, make energy out of it, and release waste.

These two kinds of cells conquered the world, and evolved since then until now. Their chemistry has changed in these 4 billion years, but they still look the same. They got stuck in their development, they were not able to grow, to evolve into multicellular organisms, or to invent more complexity.

Two billion years after archaea and bacteria came into existence, an accident happened: bacteria entered an archaeon and survived. This happened just once in 4 billion years!

These bacteria made energy for their archaea host, and are now called mitochondria.

These archaea now were not dependent on their outer membrane to make energy, which was a real bonus, lots of energy came available for these archaea. With this energy, the archaea could grow immensely, they could protect their DNA in a nucleus and they could become multi-cellular.

Some of these archaea became a second invasion from bacteria, these evolved into chloroplasts, here all plants come from. The other archaea, with just mitochondria, evolved into animals like ourselves.

Roland Sassen Thinsia Research, extract from *The Vital Question: Why Is Life The Way It Is?* Nick Lane