

from a hot dilute soup to Homo sapiens, one selection pressure at a time

Four Old Theories of Origin *

Special creation

oldest, religious belief, no scientific proof: a supernatural power created all life

Cosmozoic / Panspermia

life descended to Earth as spores (cosmozoa); doesn't explain life's origin elsewhere

Spontaneous generation (Abiogenesis)

life arose directly from non-living matter; disproved by Louis Pasteur's swan-neck flask experiment

Biogenesis

life only comes from pre-existing life, by reproduction; explains continuity, not the FIRST origin

Chemical Evolution (Self-Assembly Theory)

- life arose on Earth through chemicals reacting over a very long time
- first formulated by Haeckel, developed by Oparin (1924, Russia) and Haldane (1929, Britain)
- the Universe formed about 20 billion years ago (Big Bang, Georges Lemaitre, 1931)
- Earth formed about 4.6 billion years ago, from a rotating cloud of gas and dust
- heavier elements sank to form the core
- Earth's primitive atmosphere was **reducing**: rich in hydrogen, carbon, nitrogen, sulphur, no free oxygen

Chemical Evolution, Step by Step

- hydrogen reacted with other elements to form CH_4 , NH_3 , H_2O and H_2S as the atmosphere cooled
- steam condensed into heavy rainfall, forming rivers, lakes and oceans
- with no ozone layer, UV radiation reached the surface directly
- energy from UV, lightning and volcanic activity drove condensation, polymerisation, oxidation, reduction
- this formed simple organic molecules: monosaccharides, amino acids, purines, pyrimidines, fatty acids, glycerol
- these collected as Haldane's "hot dilute soup" or "primitive broth"
- stable because there was no free oxygen or enzymes to break it down
- polymerisation built complex molecules: polysaccharides, fats, proteins (via protoproteins), nucleosides, nucleotides
- protein formation is considered a landmark step
- nucleotides joined into nucleic acids (RNA, DNA)
- these acquired **self-replicating ability**, the fundamental property of life
- nucleic acids plus organic/inorganic molecules formed **protobionts**: prebiotic aggregates with some living-system properties

