

Evolution Quick Reference

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Firmitas.org

Proteinoid= abiotically produced polypeptide.

Protobiont= (Oparin's term) aggregation of simple organic molecules into a unit that does osmosis, has a selectively permeable membrane, and can do basic self-replication.

Whittaker's

Five-Kingdom

Taxonomy:

Monera, Protista, Plantae, Fungi, Animalia.

Domains of life:

Bacteria, Archaea, Eukaria

Natural

Selection:

differential success in reproduction due to environmental factors.

Artificial

Selection:

differential success in reproduction due to decisions by intelligent mammals.

Origins of Life

Earth is 4.5 billion years old, crust stable @ 3.9. Early Earth: *no oxygen* (O₂), much UV because no ozone layer (O₃) for protection, hot, windy, much lightning, plus gases from volcanoes. Basically, simple molecules + UV + lightning combined to create simple organic compounds. Atmosphere = methane, ammonia, water, CO₂.

Aleksandr I. Oparin (Russian) & Haldane (English) in 1920's proposed that life could arise from prebiotic soup i.e. oceans. Oparin argued that new life doesn't arise today because O₂ attacks chemical bonds & the ozone layer prevents sufficient heat, lightning, & UV.

Four stages of chemical evolution (proven in the lab), called the Oparin-Haldane model:

1. Abiotic (nonliving) molecules e.g. ammonia, methane, H₂, water → monomers i.e. amino acids, sugars, lipids, purine and pyrimidine bases, even ATP (the energy of life).
2. Monomers → polymers, specifically proteins and RNA, establishing the "RNA world."
3. Eventually DNA evolves, providing more stable inheritance, less mutation.
4. Phospholipid bilayers formed creating protobionts i.e. pre-cells with enzymes inside that did osmosis and had selective permeability and did basic self-replication.

Stanley Miller, grad student of Harold Urey at U. Chicago in the 1950's put this model to the test for the first time in the lab, simulating early Earth in a special-built apparatus. The two proved that abiotic synthesis occurs to create monomers. Since then, experiments using their apparatus have produced all 20 amino acids, all bases, lipids, and some sugars.

Oparin shook a container of these molecules, and he got protobionts.

Sidney W. Fox in the 1960's

Discovered proteinoids, which are abiotically synthesized polypeptides that are catalytic, 3D. These automatically form from amino acids when placed on hot rocks or hot clay.

Thomas Cech in 1986 discovered that some RNA are self-splicing: they catalyze their own replication because they can act as an enzyme. An RNA that is enzymatic is called a *ribozyme*.

Prokaryotes (single cell, no nucleus) evolved 3.5 billion years ago, i.e. Bacteria and Archea. **Eukaryotes** evolved from bacteria 1.7 billion years ago, leading to plants & animals.

Endosymbiotic theory says eukaryotes arose when bacteria engulfed other bacteria which became its mitochondria and chloroplasts; note, both of these have DNA and divide by fission. And, mtDNA is just like bacterial DNA.

Lamarck had claimed that traits respond to greater use, e.g. giraffes' stretching of neck → longer neck in offspring.

Charles Darwin publishes *Origin of Species* Nov 24, 1859.

1. He presents evidence for many species of heredity from ancient times.
2. He proposes *Natural Selection* as the mechanism of this evolution.

He had traveled around the world on the HMS Beagle as an unpaid naturalist, collecting data. He especially looked at Galapagos *finches*. Finch beaks differed by food type e.g. cactus.

Alfred Wallace had same theory at same time but less data and he published later.

Carolus Linnaeus, inventor of taxonomy, rejected Natural Selection. He had religion.

Evidence for evolution:

- **Georges Cuvier** proved that species went extinct; started vertebrate paleontology.
- Comparative anatomy shows that related species have homologous structures.
- Vestigial traits were important for ancestors: coccyx was tail, goosebumps were erect hair.
- Comparative embryology shows embryos are strikingly similar but get expressed differently.
- Comparative molecular biology looks at proteins etc., differences in hemoglobin protein Cytochrome C of Electron Transport Chain.
- Universal Codon of Life.

Life started with RNA (Gilbert's "RNA World")

- It self-replicates from bases.
- Acts as an enzyme i.e. is catalytic.
- Translatable into proteins.

However RNA mutates a lot, and stability was achieved when DNA evolved.