

Evolution of life, primitive cellular structure and diversification – An introduction to prokaryotes

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Chemical evolution of life

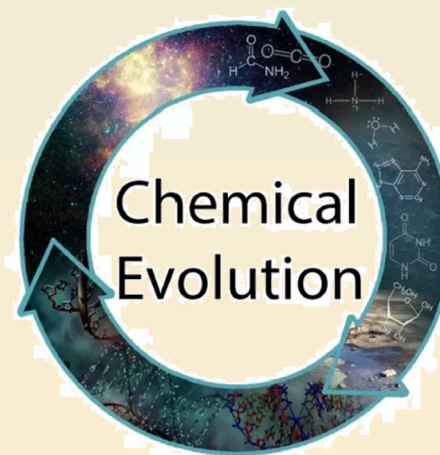
- ❑ Life ~ 4.5 billion years ago (450 crore years ago)
i.e. Chemical evolution i.e. chemogeny or abiogenesis

First acellular life ~ 3 billion years ago (300 crore years ago)

First cellular life ~ 2 billion years ago (200 crore years ago)

Speculation

- ❑ The temperature of earth at that time was high.
Ocean was also hot.
- ❑ Atmosphere was reducing.
Atmosphere contained Hydrogen (H_2), Methane (CH_4),
and Ammonia (NH_3)
- ❑ Electric discharge & UV radiation in hot reducing atmosphere resulted in the formation of RNA and protein like molecules or proteinoids.

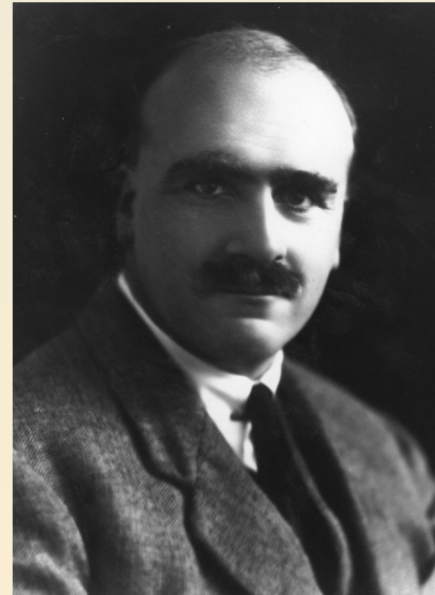


Theory propounded

- ❑ The early speculation was later put forwarded in theoretical form by **Aleksandr Ivanovich Oparin**, a Russian scientist and John Burdon Sanderson Haldane (popularly known as **J. B. S. Haldane**), a British – Indian Scientist.
- ❑ They put forwarded his notion in the book entitled “The Origin of Species” in 1936.

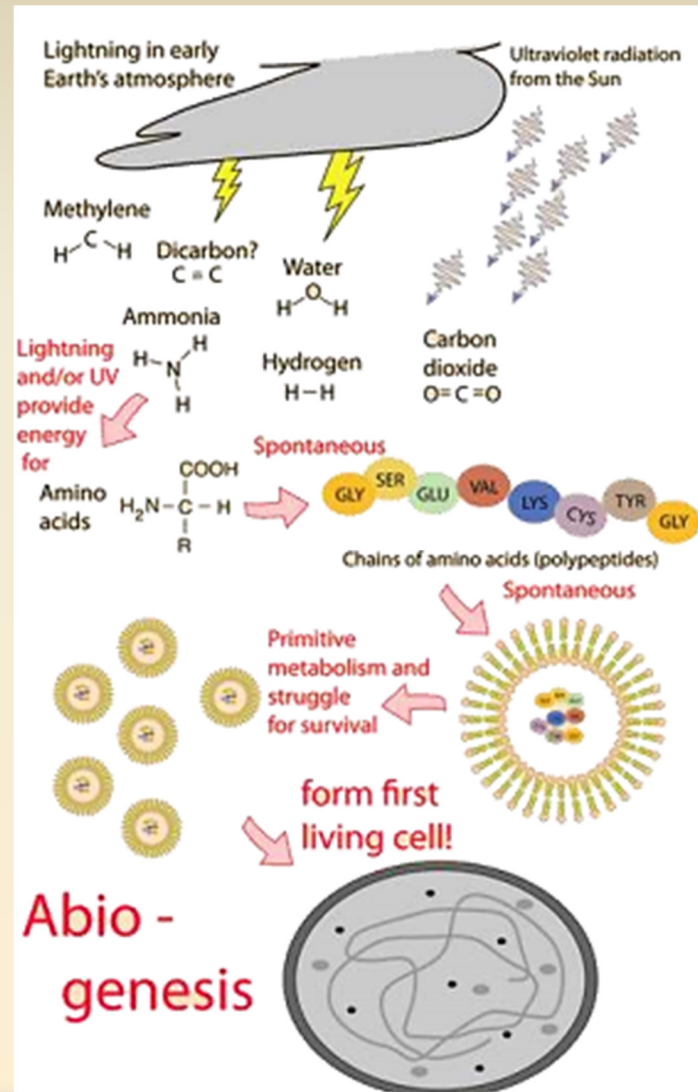


Aleksandr Oparin



J. B. S. Haldane

Oparin – Haldane theory



..... Theory propounded

Oparin – Haldane hypothesis

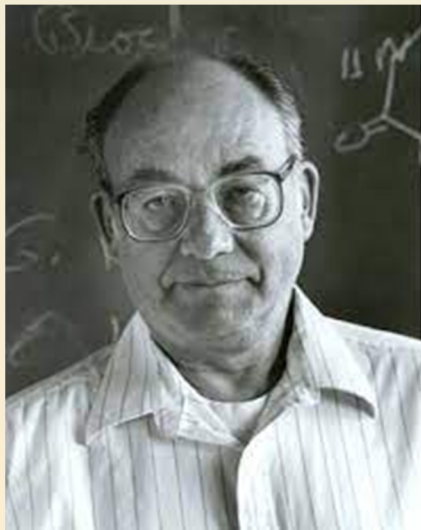
- The temp of earth was about 60°C.
- The atmosphere was reducing not oxidizing as it is now.
- The chemicals in earth were NH₃ (ammonia), CH₄ (methane), CO₂ (Carbon Dioxide) and H₂O vapors (water vapors).
- Ultraviolet radiation from the Sun provided the energy for the transformation of these substance into organic molecules.

In today's environment, where 21 percent gas is O₂, such spontaneous synthesis process can not be happened. This process can only be happened in primitive environment.



Scientific evidence: Miller – Urey Experiment

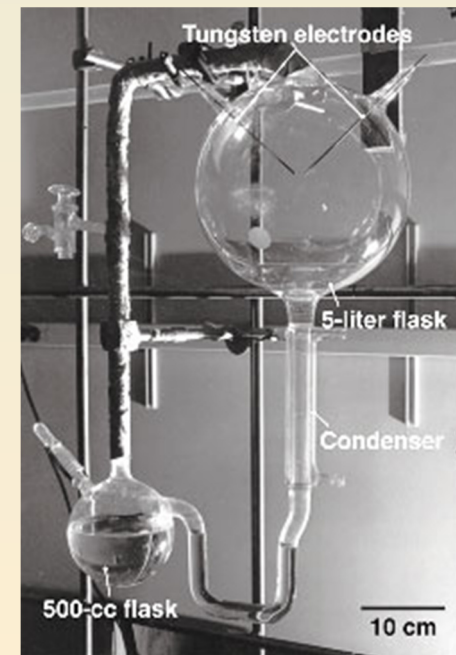
- ❑ First laboratory evidence came from the experiment of **Stanley Miller**, an American Chemist and **Harold Urey**, an American Physical – Chemist in 1957.
- ❑ They recreated the artificial environment in the specialized apparatus designed by them.
- ❑ After the experiment, they found amino acids & protein simple pike molecules.



Stanley Miller



Harold Urey



Apparatus made by Miller & Urey



Scientific evidence: Miller – Urey Experiment

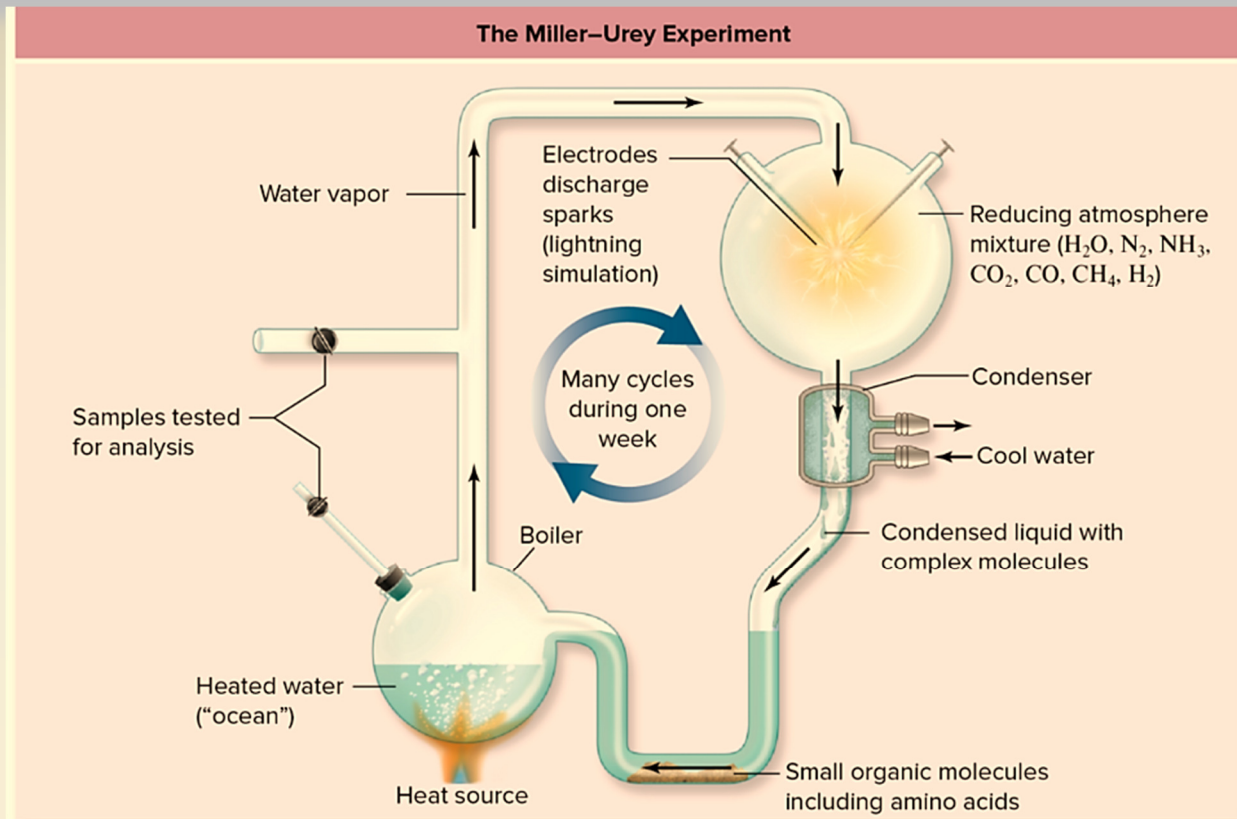


Figure : The Miller–Urey experiment. The apparatus consisted of a closed tube connecting two chambers. The upper chamber contained a mixture of gases thought to resemble the primitive Earth's atmosphere. Electrodes discharged sparks through this mixture, simulating lightning. Condensers then cooled the gases, causing water droplets to form, which passed into the second heated chamber, the "ocean." Any complex molecules formed in the atmosphere chamber would be dissolved in these droplets and carried to the ocean chamber, from which samples were withdrawn for analysis.

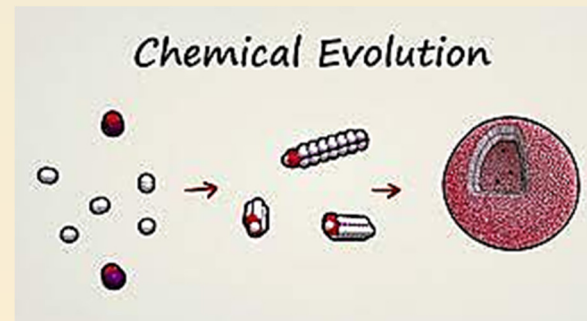
Notion of the Miller – Urey experiment

- ❑ The speculation about the formation of primitive environment is correct and the primordial seas gave rise to the chemical building blocks of organisms.
- ❑ They successfully produced probionts from those simple organic molecules; however they are not able to reproduce and pass genetic information.
- ❑ The **probionts** mixed with cool water assembled into droplets or **microsphere** that further developed membranes on their surfaces which are semipermeable and excitatory.
- ❑ In the final steps of chemical evolution, probionts developed the ability to reproduce and pass genetic information from one generation to the next, similar to those found in cells.



Further advancement

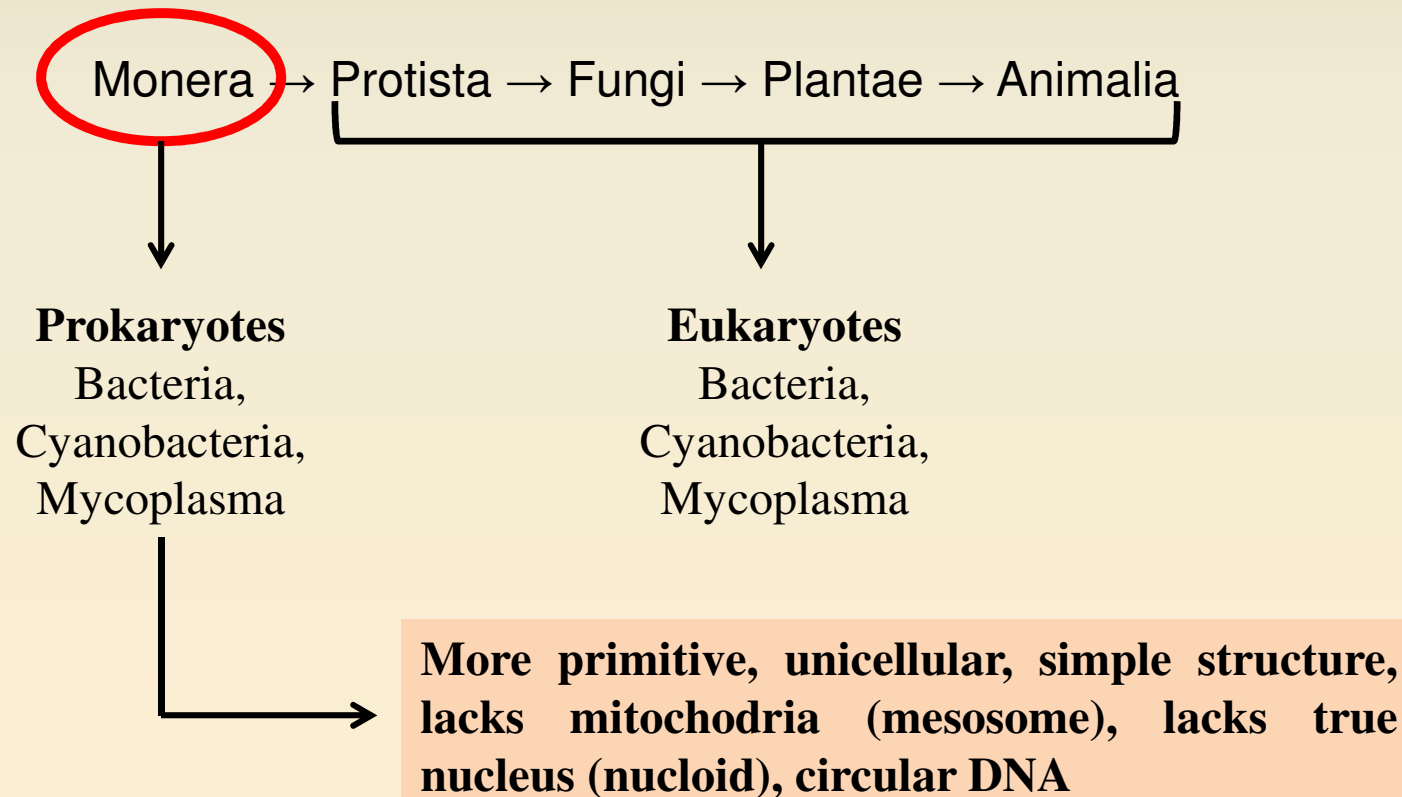
- ❑ Scientist theorize RNA to be the original hereditary molecules. Some polymers of RNA have been synthesized abiotically in the laboratory.
- ❑ Thomas Cech and his associates at the University of Colorado discovered in 1980s that RNA molecules can function as enzymes in cells implying that RNA molecules could have replicated in prebiotic cells without the use of protein enzymes.
- ❑ Later on, variation of RNA molecules could have produced by mutations and by error during replication leading to subsequent evolutionary development.
- ❑ As the prokaryote grew and split, their RNA was passed on to offspring. In time, a diversity of prokaryotic cells came into existence. Under the influence of natural selection, the prokaryotes could have given rise to the vast variety of life on earth.



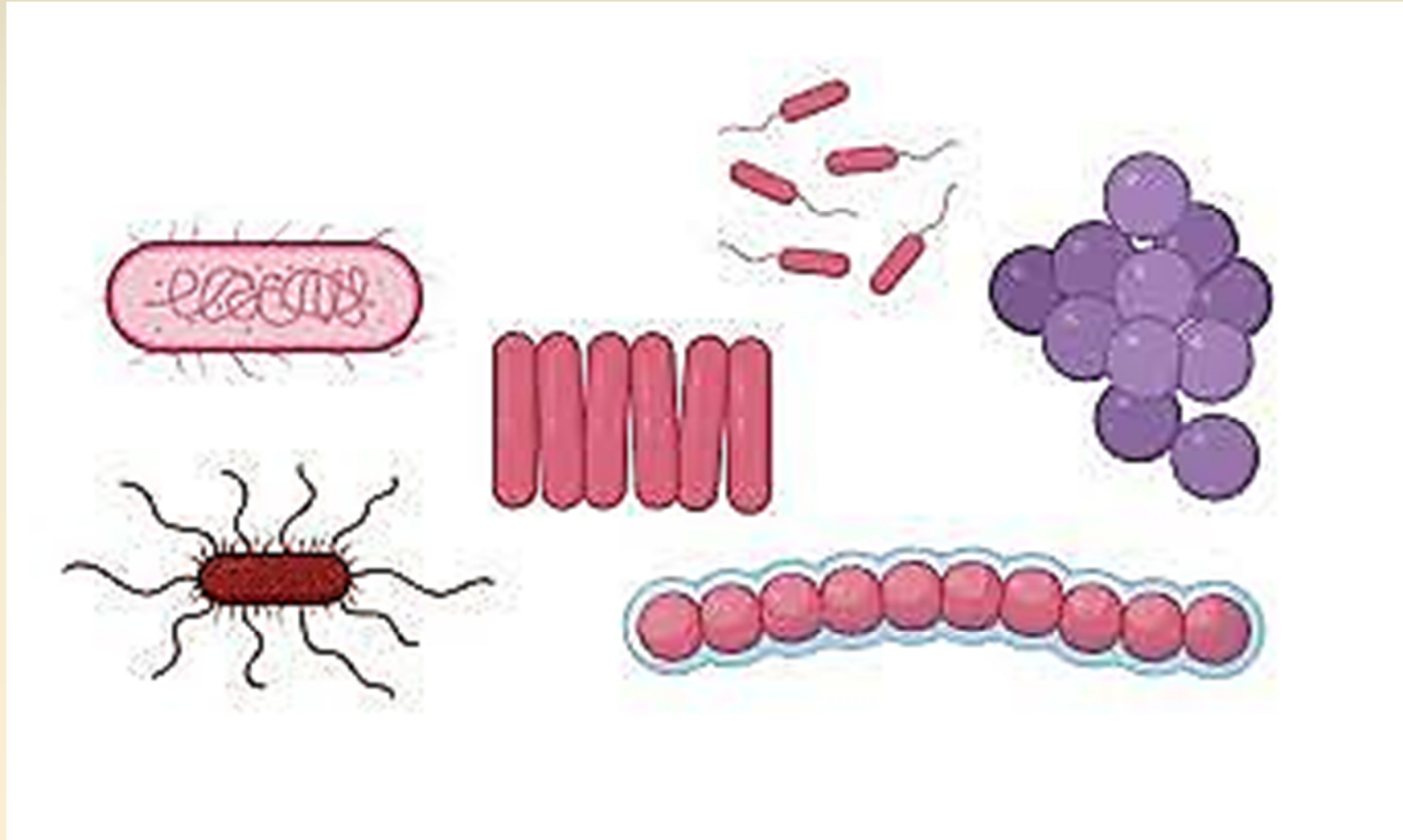
Thus, a single and simple cell developed from such a complex mechanism, and from that single cell only, we have been evolved.

Life on earth

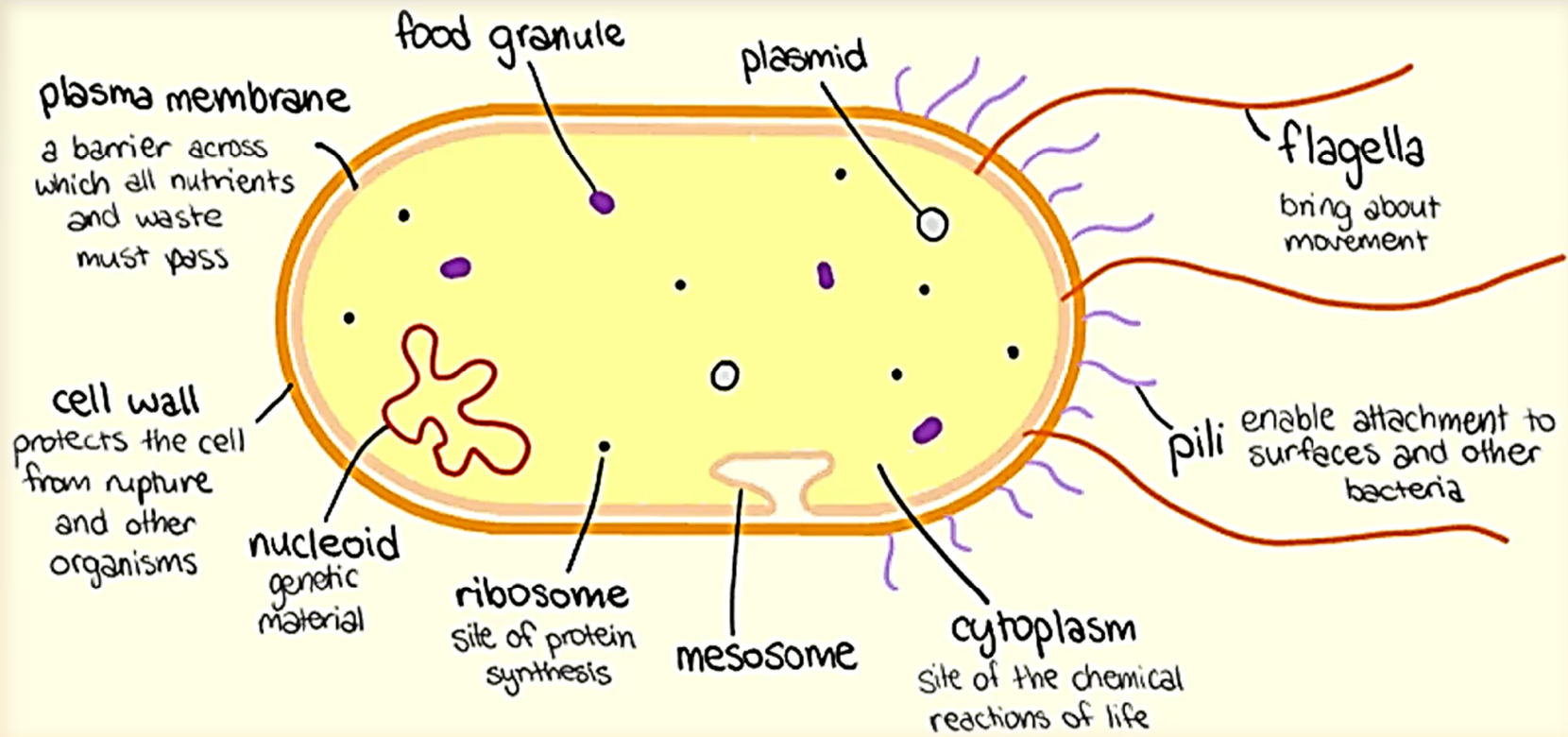
Increasing order of complexity in the organism:



Various types of prokaryotic cells

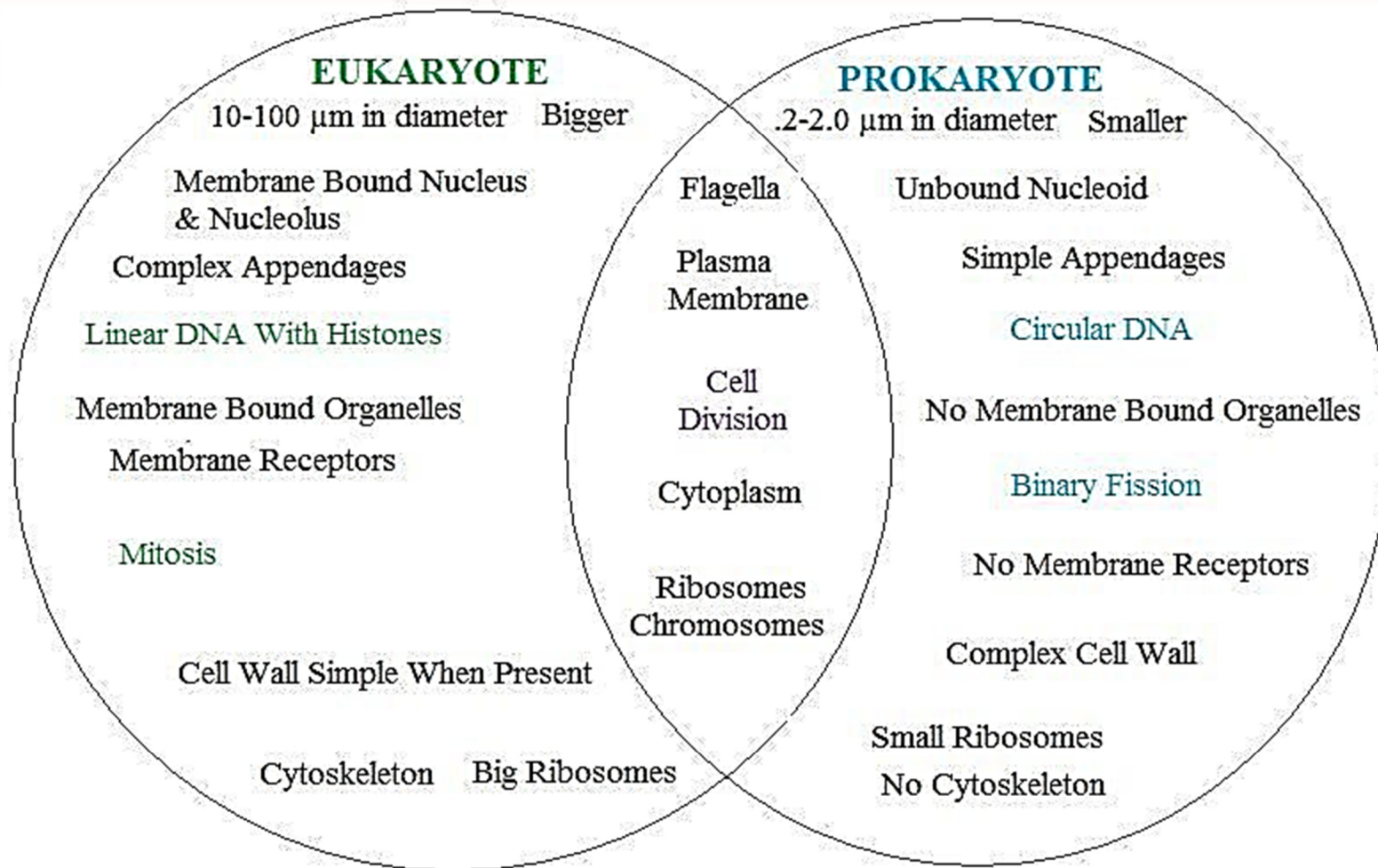


General structure of a prokaryote

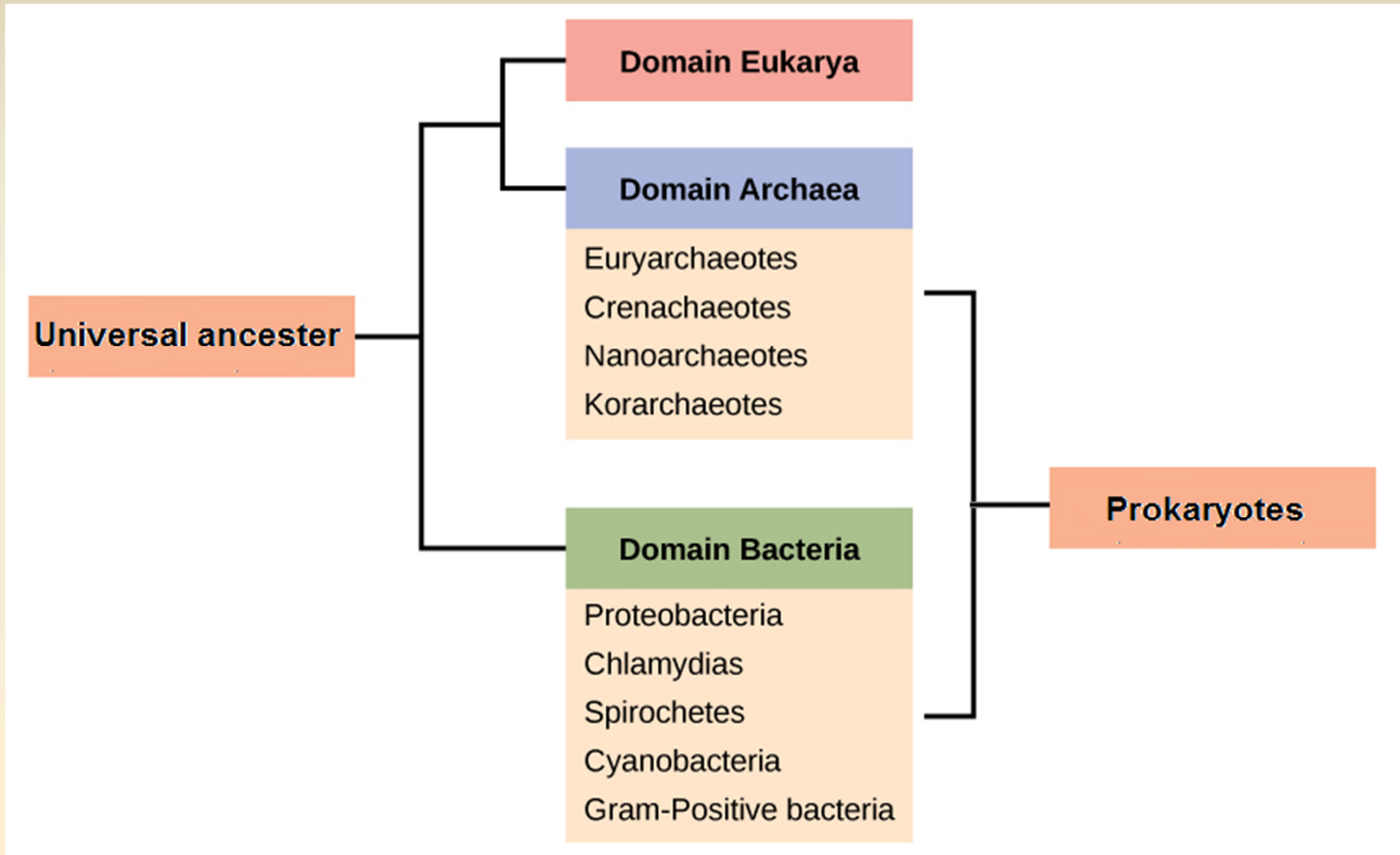


* Most studied prokaryote is *Escherichia coli*.

Difference between a prokaryotic and eukaryotic cell



Evolution & diversification of prokaryotes



Where the virus is?

Viruses are considered neither prokaryotes nor eukaryotes because they lack the characteristics of living things.



**Be positive & dispense
your duty always**



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