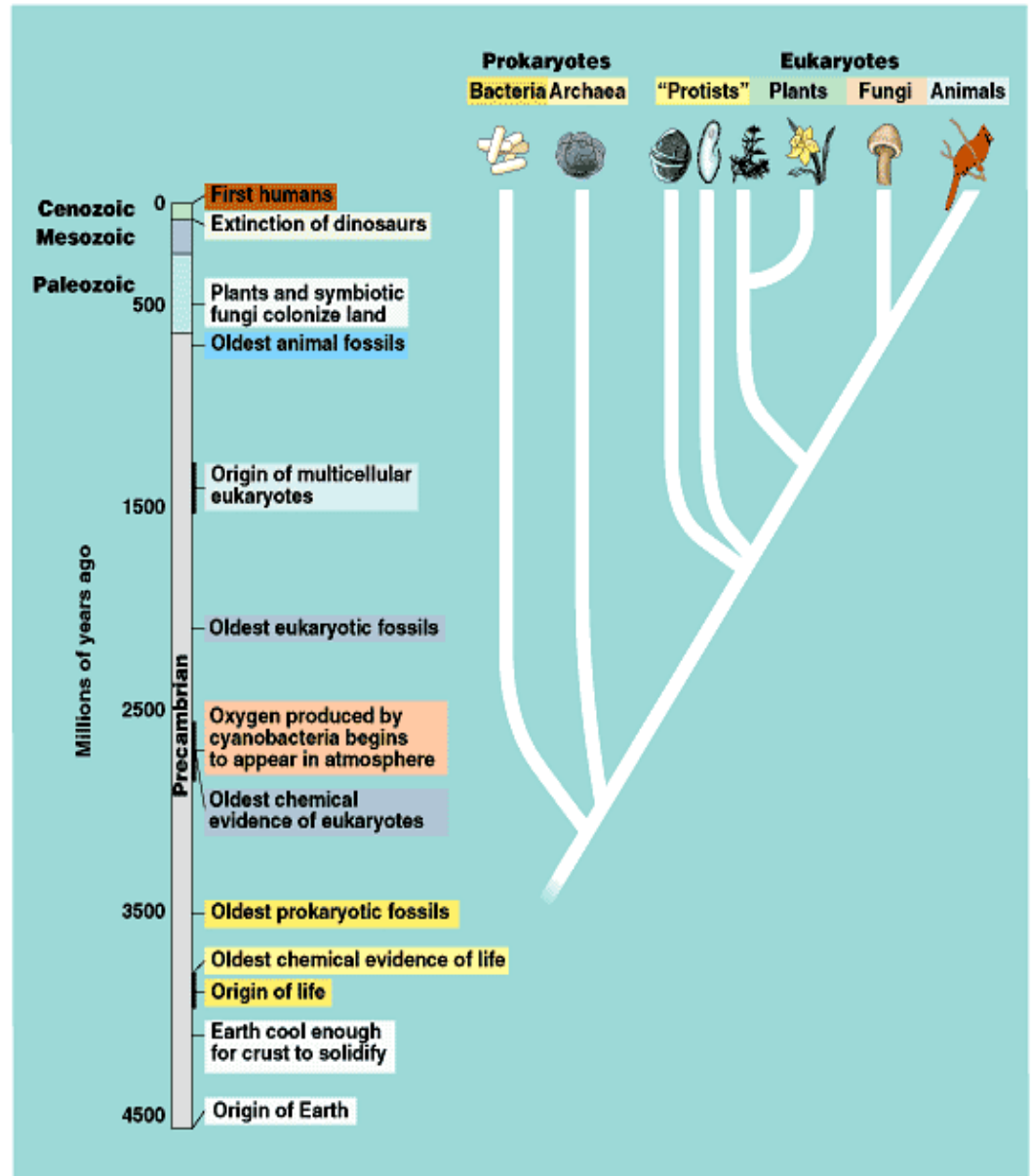




- Chapter 26 ~ *Early Earth and The Origin of Life*

Early history of life

- Solar system ~ 12 billion years ago (bya)
- Earth ~ 4.5 bya
- Life ~ 3.5 to 4.0 bya
- Prokaryotes ~ 3.5 to 2.0 bya *stromatolites*
- Oxygen accumulation ~ 2.7 bya *photosynthetic cyanobacteria*
- Eukaryotic life ~ 2.1 bya
- Multicellular eukaryotes ~ 1.2 bya
- Animal diversity ~ 543 mya
- Land colonization ~ 500 mya



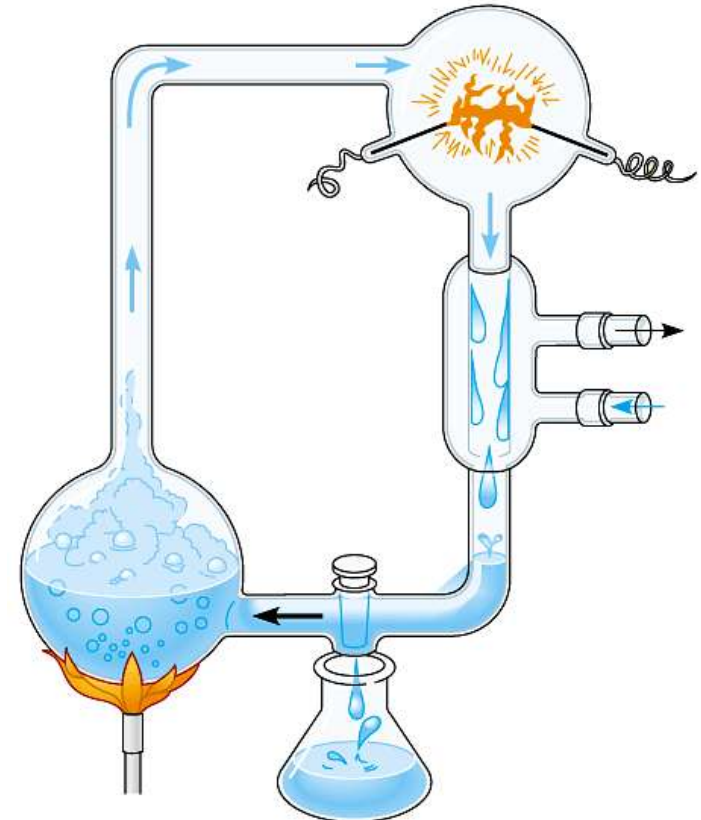
The Origin of Life

- **Spontaneous generation vs. biogenesis (Pasteur)**
- **The 4-stage Origin of life Hypothesis:**
 - **1- Abiotic synthesis of organic monomers**
 - **2- Polymer formation**
 - **3- Origin of Self-replicating molecules**
 - **4- Molecule packaging (“protobionts”)**



Organic monomers/polymer synthesis

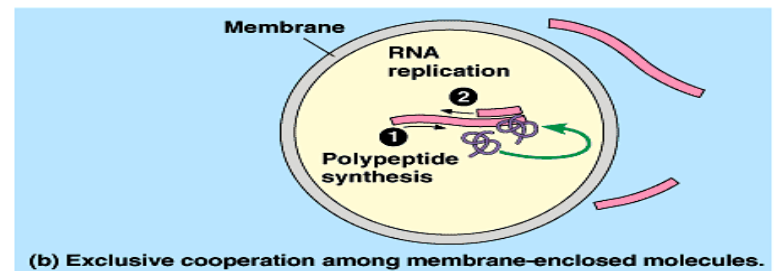
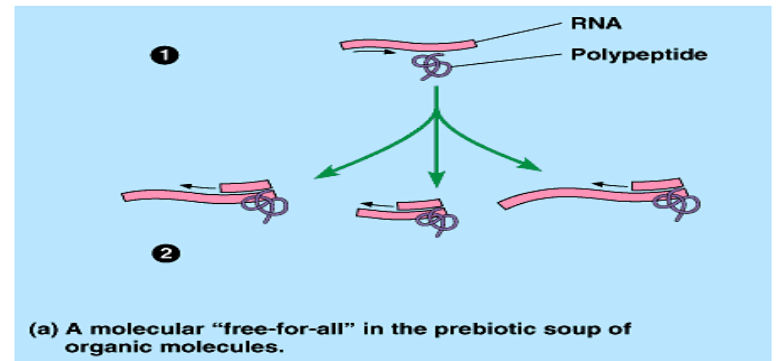
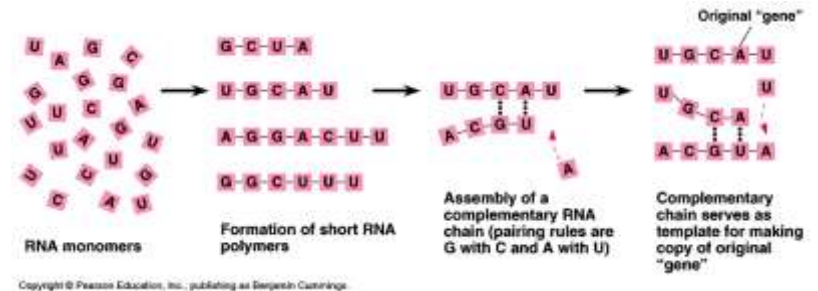
- Oparin /Haldane hypothesis (primitive earth): volcanic vapors (reducing atmosphere) with lightning & UV radiation enhances complex molecule formation (no O₂)
- Miller/Urey experiment:
- water, hydrogen, methane, ammonia
- all 20 amino acids, nitrogen bases, & ATP formed
- Fox proteinoid formation (abiotic polypeptides) from organic monomers dripped on hot sand, clay or rock
- Oparin (coacervates) protobionts (aggregate macromolecules; abiotic) surrounded by a shell of H₂O molecules coated by a protein membrane



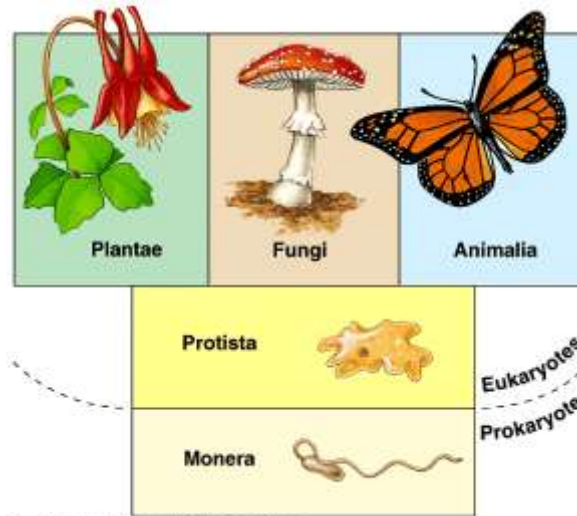
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Abiotic genetic replication

- First genetic material
- Abiotic production of ribonucleotides
- Ribozymes (RNA catalysts)
- RNA “cooperation”
- Formation of short polypeptides (replication enzyme?)
- RNA ~ DNA template?



The Major Lineages of Life



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(a) The five-kingdom system



(b) The three-domain system



(c) How many kingdoms?

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