The Origin of Life

Today's Topics
- Origin of the Earth
- RNA world
- Three Domains of life:
  - Bacteria, Archaea, Eukarya
  - The last universal common ancestor
- Origin of Cells
  - Properties of cell membranes
- Origin of Eukaryotes
  - Mitochondria & Chloroplasts

March 16, 2009

In the beginning…..

http://www.mbio.ncsu.edu/JWB/PrimordialSoup.jpeg

Origin of the Earth

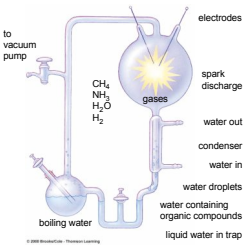
about 4.5 bya

- What was the early earth like?

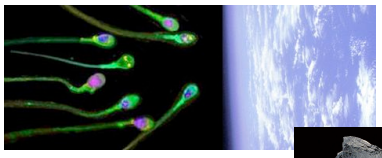
Origin of Organic Molecules

about 4 bya

Urey-Miller experiment 1953



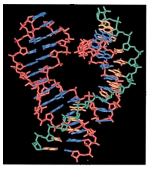
Or maybe from outer space?

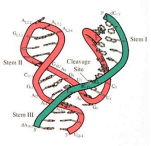


- On Sept 28 1969 a meteorite landed in Murchison, Australia that contained many amino acids

RNA World

about 3.8 bya



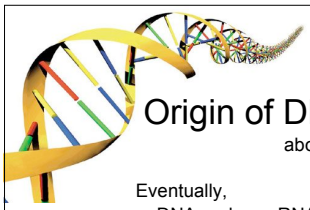


- "Ribozymes"
  - E.g. RNA intron in Tetrahymena is self-splicing
- Test-tube evolution experiments
  - RNA molecules can evolve catalytic functions

Evidence for RNA world

- RNA can both store information and serve as an enzyme
- Many important processes are still carried out by RNA
  - Translation
    - RNA Message
    - Catalytic subunit of ribosome (rRNA)
    - tRNA
  - Intron splicing
  - DNA replication requires RNA primers
  - RNA can block gene expression

Even ATP is a building block of RNA



Origin of DNA/Protein Life

about 3.6 bya

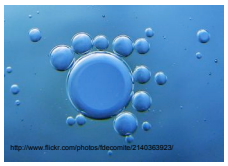
Eventually,

- DNA replaces RNA as the genetic material
  - Why?
- Proteins replace RNA as the primary enzymes
  - Why?

These were probably the first organisms we might recognize

The first cells

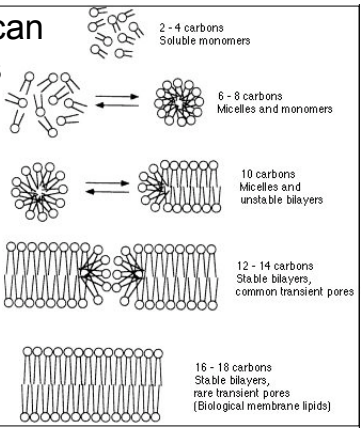
- Lipid membrane concentrates organic molecules
- Membranes define "inside" and "outside"



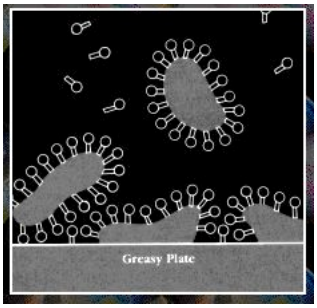
oil droplets in water

Fatty acids can form various structures

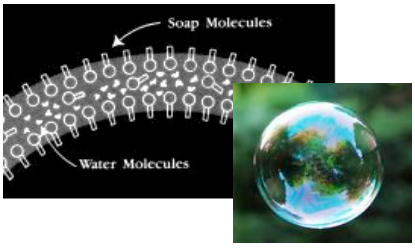
- depends on length



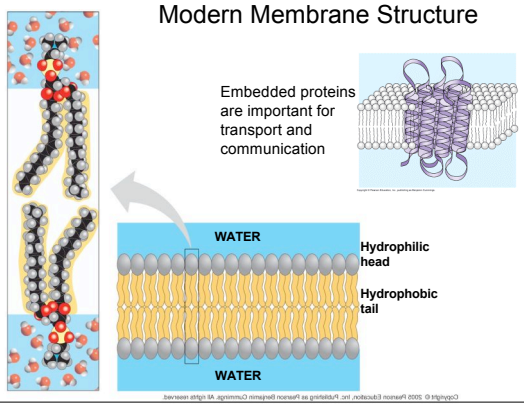
Soap function relates to membrane structure.



Soap bubbles are inside-out lipid bilayers (protecting water from evaporation, so it persists as a liquid in the air longer).

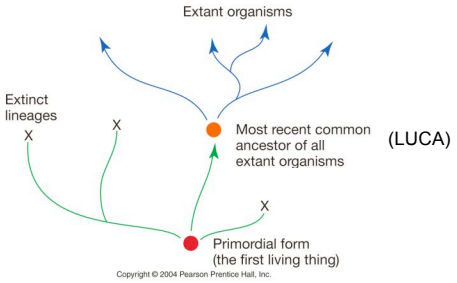


Modern Membrane Structure



Last Universal Common Ancestor

about 3.5 bya

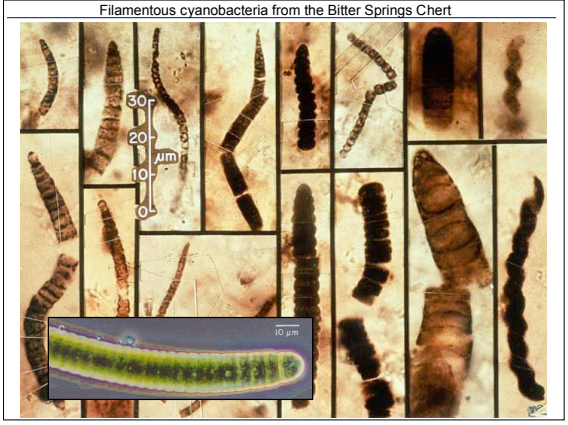


Cyanobacteria - among the oldest fossils

Stromatolite section

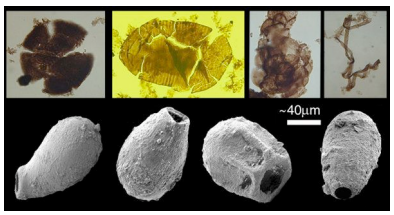
Stromatolites: colonies of cyanobacteria

Filamentous cyanobacteria from the Bitter Springs Chert

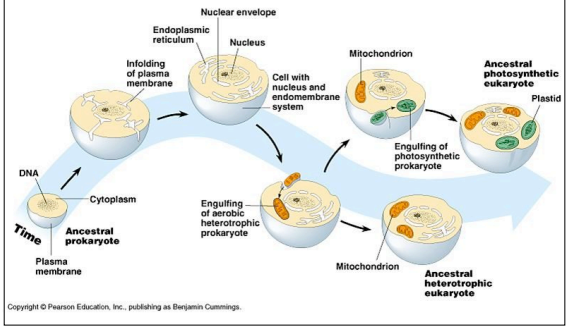


Origin of Eukaryotes

2.7 to 1.8 bya



Mitochondria and Chloroplasts arose through endosymbiosis



Many Eukaryotes remain single-celled