How Cells Arose; Microbial Life

- No one knows for sure
- Earliest life thought to be like today's bacteria
- The earth formed 4.5 bya
- The first life originated around 2.5 bya

- at least 3 possibilities for origin of life on earth
  - extraterrestrial origin
  - special creation
  - evolution

- When life formed, the earth's atmosphere contained
  - ❖ little or no O2
  - ❖ but lots of hydrogen-rich gases,
  - ❖ hydrogen sulfide (SH_2), ammonia (NH_3), and methane (CH_4)

Stanley Miller & Harold Urey

- ❖ reconstructed the O2 free atmosphere of early earth in their lab
- ❖ subjected it to lightning & UV radiation that it would have experienced then
- ❖ many of the building blocks of organisms formed spontaneously
- ❖ Conclusion: life may have evolved in a "primordial soup" of biological molecules formed in the early earth's oceans

Critics of the Miller-Urey experiment say

- ❖ If no O2 in early atmosphere, then no protection from ozone against UV
- ❖ The UV radiation would have destroyed ammonia and methane in the atmosphere,
- ❖ Cannot synthesize building blocks w/o CH4 and ammonia

alternative to Miller-Urey: bubble model

- ❖ key chem. Processes occurred in bubbles on ocean's surface
- ❖ Bubbles made by wind/wave action/the impact of rain drops, and volcanic action.
- ❖ Chem rxns proceeded fast inside the bubbles where polar reactants would be concentrated.
- ❖ Bubbles provided protection from UV radiation.

Prokaryotes: The Simplest Organisms

- ❖ simplest, most abundant organisms on earth
- ❖ small, unicellular, no nucleus
- ❖ cell's plasma membrane encased in cell wall
- ❖ Bacteria: cell wall made of peptidoglycan
- ❖ Archaea: cell wall lacks peptidoglycan. made of either protein and/or polysaccharides

bacteria gram-negative bacteria:	**gram-positive bacteria:**
cell wall has outer layer of *lipopolysaccharide* covering a thinner layer of peptidoglycan	this membrane is absent, but its peptidoglycan layer is much thicker

•In addition to cell memb & wall, many bacteria have a gelatinous layer

- ➢ this layer is called the capsule

Additional features of some bacteria:

- ❖ Flagella: long protein strands used in swimming/ locomotion
- ❖ Pili: shorter strands (act as docking cables)
- ❖ Endospores: thick-walled enclosures of DNA and a small bit of cytoplasm that are extremely resistant to environmental stress

All prokaryotes reproduce via binary fission

- ❖ replicate DNA,
- ❖ lpasma membrane & cell wall grow inward and eventually divide the cell
- ❖ Some bacteria exchange genetic info via plasmids passed from one cell to another

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- ❖ Conjugation: the transfer via a special pilus (conjugation bridge) making contact with another cell

Comparing Prokaryotes to Eukaryotes

photoautotrophs	perform photosynthesis
chemoautotrophs	obtain energy by oxidizing inorganic substances
photoheterotrophs	are purple non-sulfur bacteria that use light as an energy source but obtain carbon from organic molecules produced by other organisms
chemoheterotrophs	obtain both energy and carbon from organic molecules produced by other organisms

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Viruses Infect Organisms

What is a virus?

- ❖ parasitic chemicals/segments of DNA (or sometimes RNA) wrapped in protein coat
- ❖ cannot reproduce on their own
- ❖ occur in all organisms
- ❖ Viruses that infect bacteria: bacteriophages
- ❖ many viruses form an additional layer around their DNA core; called a capsid
- ❖ capsid may be encased by a membrane-like envelope (rich in proteins, lipids, glycoproteins)

Be sure to check out in your text book the images describing the structure of bacterial, plant, and animal viruses

The Origin of Eukaryotic Cells

Eukaryotic cells possess an internal structure called a nucleus

The endosymbiotic theory suggests that at a critical stage in the evolution of eukaryotic cells, energy-metabolizing bacteria came to reside symbiotically within larger early eukaryotic cells

The theory of endosymbiosis

What unites protists: they are not fungi, plants, or animals
–otherwise, extremely variable eukaryotes

Characteristics of Protists

- protists have varied types of cell surfaces
- all have a cell memb but many have cell walls or glass shells
- movt in protists: diverse mechanisms
  - cilia, flagella, pseudopods, or gliding mechanisms

- Some protists can survive harsh environmental conditions by forming cysts
- cysts are dormant forms of cells with a resistant outer covering in which cell metabolism is more or less completely shut down
- Protists employ every form of nutritional acquisition except chemoautrophy

Protists are metabolically diverse.

phototrophs	are photosynthetic autotrophs
phagotrophs	ingest visible particles of food –the ingested food is put into intracellular vesicles called food vacuoles that are then broken down by lysosomes
osmotrophs	ingest food by absorbing it in solution

Protists typically reproduce asexually, most reproducing sexually only in times of stress

- ❖ fission and budding: common forms of asexual reproduction

Some protists are **<u>colonial organisms</u>**:

- ❖ a collection of cells that are permanently associated but in which little or no integration of cell activities occurs

Others live as an **<u>Aggregation:</u>**

- ❖ a more transient collection of cells that come together for a period of time and then separate
- ❖ common in cellular slime molds when aggregations called slugs form to move to a new feeding location

Still others have evolved into **<u>multicellular organisms</u>**

- ❖ involves cells in contact with each other and coordinated in their activities

- ❖ 3 phyla of protists have evolved examples of mutlicellularity: brown, green, and red algae

The protists are the most diverse of the four kingdoms in the domain Eukarya

- ❖ the phyla of protists are only distantly related to each other
- ❖ there are 15 distinct phyla groups into five general groups based on some major shared characters

<u>Kindom Fungi</u>

Fungus Is Not a Plant

- ❖ Fungi lack chlorophyll & resemble plants by their general appearance and lack of mobility
- ❖ But fungi differ from plants

Fungi:

- o are heterotrophs
- o have filamentous bodies
- o Most have nonmotile sperm
- o have cell walls made of chitin: same as crab
- o have nuclear mitosis: nuclear env. Does NOT break down. All of mitosis occurs in the nucleus.
- o Fungi exist mainly in the form of slender filaments called hyphae (singular, hypha)
- o a mass of hyphae is called a mycelium (plural, mycelia)
- o fungal cells are able to exhibit a high degree of communication w/i a mycelium
- o cytoplasm is able to cross between adjacent hyphal cells by a process called cytoplasmic streaming
- o multiple nuclei can be connected through the shared cytoplasm

Mushrooms

- Most of body is below ground
- Above ground is the reproductive structure.
- Fungi reproduce both asexually and sexually
- Some w/ gametes
- Some w/ spores
  - a) Yellow morel
  - B) Amanita mushroom

Many fungi produce spores

- Spores are so light they can remain in the air a long time and travel a long way.
- All fungi are heterotrophs and externally digest food by secreting enzymes into their surroundings and then absorbing the nutrients back into the fungus
- some fungi are predatory, such as the oyster fungus.
- It attracts nematodes that will feed on the mushroom. The mushroom secretes an anesthetic chemical so the mushroom can ingest the worm!

Kinds of Fungi: 400 mil yrs old

There are nearly 74K described species spread across four phyla

- Some are harmful
- Some are commercially used in the production of beer and bread, pharmaceuticals (steroids)
- *Together with bacteria, fungi are the principal decomposers in the biosphere.*
- Some attack living and others attack dead

2 kinds of mutualistic associations between fungi and autotrophic organisms are ecologically important
In each association a photosynthetic organism fixes atmospheric CO_2 and makes organic material available to fungi

- **Mycorrhizae:**
  - are symbiotic associations that form between the roots of most plant species and fungi.
  - these interactions expedite the plant's absorption of essential nutrients, such as P, in the roots)
  - Fungus gets carbon from plant
  - Plant gets soil nutrients from the fungus
  - provides a critical linkage between the plant root and soil.
  - can lead to improved plant growth and reproduction. As a result, mycorrhizal plants are often more competitive and better able to tolerate environmental

- **Lichens**
  - fungal/algal or fungal/cyanobacterial associations
  - (behave as a single organism)
  - these can grow in harsh habitats, such as bare rock
  - Lichens act as a single photosynthetic organism
  - consists of a fungus & an algae or a bacteria
  - Usually green algae or cyanobacteria
  - They reduce atmospheric carbon dioxide into organic carbon sugars to feed both the fungus and themselves.
  - Both partners gain water and mineral nutrients mainly from the atmosphere, through rain and dust.
  - The fungal partner protects the alga by retaining water.