Animal-like Protista

The Evolution of Eukaryotes

The small size and simpler construction of the prokaryotic cell has many advantages but also imposes a number of limitations:

- The number of metabolic activities that can occur at any one time is smaller
- The smaller size of the prokaryotic genome limits the number of genes which code for enzymes controlling these activities

While prokaryotes are extremely successful, selection resulted in increasing complexity in some groups.
Two trends were:

- Toward multicellular forms such as cyanobacteria which have different cell types with specialized functions
- The compartmentalization of different functions within cells; the first eukaryotes resulted from this solution

The evolution of the compartmentalized nature of eukaryotic cells may have resulted from two processes

- Specialization of plasma membrane invaginations.
- Endosymbiotic associations of prokaryotes may have resulted in the appearance of some organelles.
-

The **endosymbiotic theory,** proposes that certain prokaryotic species, called **endosymbionts** lived within larger prokaryotes

The theory focuses mainly on the origins of chloroplasts and mitochondria:

- Chloroplasts are descended from endosymbiotic photosynthesizng prokaryotes, such as cyanobacteria, living in larger cells
- Mitochondria are postulated to be descendents of prokaryotic areobic heterotrophs.

Evidence for the endosymbiotic origin of mitochondria and chloroplasts includes the similarities between these organelles and eubacteria

- They are of the appropriate size to be descendents of eubacteria
- They have inner membranes containing several enzymes and transport systems similar to those of prokaryotic plasma membranes
- They replicate by splitting processes similar to binary fission present in prokaryotes
- They have DNA which is circular and not associated with histones or other proteins, as in prokaryotes
- They contain their own tRNA, ribosomes and other components for DNA transcription and translation into proteins
- Chloroplasts have ribosomes more similar to prokaryotic ribosomes (with regards to size, biochemical characters, etc) than to eukaryotic ribosomes
- Mitochondrial ribosomes vary, but are also more similar to prokaryotic ribosomes

- The RNA of chloroplasts is more similar in basic sequence to RNA from certain photosynthetic eubacteria than to rRNA in eukaryotic cytoplasm
- Chlorplast rRNA is transcribed from genes in the chloropast while eukaryotic rRNA is transcribed from nuclear DNA
- Mitochondrial rRNA also has a base sequence which supports the eubacterial origin

Archezoans (=escavates) provide clues to the early evolution of eukaryotes

An ancient lineage of eukaryotes – **archezoa -** branched away from the eukaryotic tree very early, perhaps as long as 2 billion years ago

These organisms lack mitochondria and plastids; their ribosomes have some characteristics more closely aligned with prokaryotes than with eukaryotes

Additional clues about the origin of eukaryotes - Mixotrichs

Mixotricha paradoxa means “unexpected combination of hairs” lives in the gut of termites from Australia

Mixotricha is interesting because it is also comprised of microorganisms!
The “cilia” on the surface of these organisms turn out to be spirochaetes

Each spirochaete has its own emplacement or “bracket”
Interestingly, each spirochaete has at its base a basal body-like structure that also turns out to be a bacterium

Protozoan Protists

Protozoans (Gr. *proto* = first; *zoa* = animal) are the single-celled animal-like members of the kingdom Protista
Protozoans can occur wherever there is moisture
Free-living protozoans are found in both marine and freshwater habitats, and in moist soil
In addition to many free-living species, many protozoans live in close association with other protozoans, with animals, and with plants either as **commensals** or as **parasites**
Protozoans are remarkably diverse in terms of size, morphology, mode of nutrition, mechanism of locomotion, and reproductive biology
Protozoans are regarded as being a polyphyletic group

General Characteristics

Cell membrane

The entire organisms is bounded by the **plasmalemma** (cell membrane)
It is often differentiated into a clear, outer gelatinous region (gel or semisolid), the **ectoplasm,** and an inner, more fluid region (fluid or sol state), the **endoplasm**

Locomotor Organelles

Cilia and Flagella

Cilia are shorter and more numerous, whereas, flagella are longer and less numerous
Cilia and flagella differ in their beating patterns but a similar structurally
Their microtubules are arranged in a ring of 9 microtubule doublets surrounding a central pair of microtubles (9+2 arrangement)
They are anchored to the cell by a **basal body**

Pseudopodia

Pseudopodia are temporary cell extensions
The most familiar are the **lobopodia,** broad cell processes containing ectoplasm and endoplasm and are used for locomotion and engulfing food

Nutrition and Digestion

Food particles are digested internally among protozoans; digestion is entirely intracellular
Ingested food particles generally become surrounded by a membrane, forming a distinct **food vacuole**

These vacuoles move about in the fluid cytoplasm of the body as the vacuole contents are digested by enzymes
Once solubilized, nutrients move across the vacuole wall and into the endoplasm of the cell
Indigestible solid wastes are commonly discharged to the outside through an opening in the plasma membrane

Excretion and Osmoregulation

Contractile vacuoles are organelles involved in expelling water from the cytoplasm
Fluid is collected from the cytoplasm by a system of membranous vesicles and tubules called **spongiome**

Reproduction

Asexual Reproduction

Protozoans reproduce asexually through **fission,** a controlled mitotic replication of chromosomes and splitting of the parent into two or more parts
Binary fission occurs when the protozoan splits into two individuals
In **multiple fission** many nuclear divisions precede the rapid differentiation of the cytoplasm into many distinct individuals
In **budding** a portion of the parent breaks off and differentiates into a new individual

Many protozoans possess the capacity for encystment and excystment
During **encystment,** substantial dedifferentiation of the organism takes place in the formation of a **cyst**
Once conditions improve **excystment** quickly ensues with the regeneration of all former internal and external structures

Sexual Reproduction

I will highlight one or two examples of sexual reproduction among protozoans when we get to specific groups

Classification

Phylum Retortamonada

Mitochondria and Golgi bodies are absent; usually with four flagella (three anterior, one recurrent); typically parasites of the intestinal tract or free-living in anoxic environments

Phylum Euglenozoa

Locomotion by means of flagella; possess a single type of nucleus.

The phylum is divided into two major groups:

Phytoflagellates - autotrophic forms containing chlorophyll
Possess one or two flagella

Zooflagellates – heterotrophic; e.g., trypanosomes

Amebas (formerly phylum Sarcodina)

Members of the former Phylum Sarcodina do not form a monophyletic group
These organisms use pseudopodia for feeding and locomotion; feed by a process known as **phagocytosis**.

The **radiolarians** and **foraminiferans** possess a **test**

Phylum Ciliophora

Possess cilia or ciliary organelles present in at least one stage
of the life cycle; possess 2 kinds of nuclei: a large **macronucleus** and one or more smaller **micronuclei**.
Ciliates generally reproduce asexually by binary fission.
Sexual reproduction occurs by a process known as **conjugation.**

Phylum Apicomplexa

Parasitic group lacking locomotory organelles; possess a characteristic set or organelles called the **apical complex,** which aids in penetrating host cells.
Causative agents of malaria (e.g., *Plasmodium vivax*) are members of this phylum.