

## Diplomonadida and Parabasala: Diplomonads and parabasalids lack mitochondria

- A few protists, including the diplomonds and the parabasalids, lack mitochondria.
- Current evidence suggests that these protists *lost* their mitochondria during their evolution.
- Systematics place the diplomonads and parabalstids on the phylogenetic branch that diverged earliest in eukaryotic history.
- The **diplomonads** have multiple flagella, two separate nuclei, a simple cytoskeleton, and no mitochondria or plastids.
- One example is *Giardia lamblia*, a parasite that infects the human intestine, causing abdominal cramps and severe diarrhea
  - The most common method of acquiring *Giardia* is by drinking water contaminated with feces containing the parasite in a dormant cyst stage.

## Euglenozoa:

### The euglenozoa includes both photosynthetic and heterotrophic flagellates

- Several protistan groups, including the euglenoids and kinetoplastids, use flagella for locomotion.
- The **euglenoids** are characterized by an anterior pocket from which one or two flagella emerge.
- Some euglenoids are mainly autotrophic (euglena)
- Many euglenoids are mixotrophic or heterotrophic
  - Absorbing organic molecules from their surroundings
  - Engulfing prey by phagocytosis
- The **kinetoplastids** (Kinoplastida) have a single large mitochondrion associated with a unique organelle, the kinetoplast.
  - The kinetoplast houses extranuclear DNA.
- Kinetoplastids are symbiotic and include pathogenic parasites.
- For example, *Trypanosoma* causes African sleeping sickness.
  - *Trypanosoma* is spread by the bite of the tsetse fly

## Alveolata:

### The alveolata are unicellular protists with subcellular cavities (alveoli)

- The **Alveolata** combines flagellated protists (dinoflagellates), parasites (apicomplexans), and ciliated protists (the ciliates).
  - This clade has been supported by molecular systematics.
- Members of this clade have alveoli, small membrane-bound cavities, under the cell surface.
  - Their function is not known, but they may help stabilize the cell surface and regulate water and ion content.
- The **dinoflagellates** are abundant components of the phytoplankton that are suspended near the water surface.
  - Dinoflagellates and other phytoplankton form the foundation of most marine and many freshwater food chains.
  - Other species of dinoflagellates are heterotrophic.
  - Most dinoflagellates are unicellular, but some are colonial.
- Each dinoflagellate species has a characteristic shape, often reinforced by internal plates of cellulose.
- Two flagella sit in perpendicular grooves in the “armor” and produce a spinning movement.
- Dinoflagellate blooms, characterized by explosive population growth, cause red tides in coastal waters.
  - The blooms are brownish-red or pinkish-orange because of the predominant pigments in the plastids.
  - Toxins produced by some red-tide organisms have produced massive invertebrate and fish kills.
  - These toxins can be deadly to humans as well.
- One dangerous dinoflagellate, *Pfiesteria piscicida*, is actually carnivorous.
  - This organism produces a toxin that stuns fish.
  - The dinoflagellate can then feed on the body fluids of its prey.
  - In the past decade, the frequency of *Pfiesteria* blooms and fish kills have increased in the mid-Atlantic states of the U.S.
  - One hypothesis for this change is an increase in pollution of coastal waters with fertilizers, especially nitrates and phosphates.
- Some dinoflagellates form mutualistic symbioses with cnidarians, animals that build coral reefs.
  - Photosynthetic products from the dinoflagellates provide the main food resource for reef communities.
- Some dinoflagellates are bioluminescent.
  - An ATP-driven chemical reaction gives off light when dinoflagellates are disturbed by water movements.
  - The function of bioluminescence may be to attract predators that may eat the smaller predators that feed on phytoplankton.

- All **apicomplexans** are parasites of animals and some cause serious human diseases.
  - The parasites disseminate as tiny infectious cells (**sporozoites**) with a *complex* of organelles specialized for penetrating host cells and tissues at the *apex (one end)* of the sporozoite cell.
  - Most apicomplexans have intricate life cycles with both sexual and asexual stages and often require two or more different host species for completion.
- *Plasmodium*, the parasite that causes malaria, spends part of its life in mosquitoes and part in humans.
- The Ciliophora (**ciliates**), a diverse protist group, is named for their use of cilia to move and feed.
- Most ciliates live as solitary cells in freshwater.
- Their cilia are associated with a sub membrane system of microtubules that may coordinate movement.
  - Some ciliates are completely covered by rows of cilia, whereas others have cilia clustered into fewer rows or tufts.
  - The specific arrangement of cilia adapts the ciliates for their diverse lifestyles.
- In a *Paramecium*, cilia along the oral groove draw in food that are engulfed by phagocytosis.
- Like other freshwater protists, the hyperosmotic *Paramecium* expels accumulated water from the contractile vacuole.
- Ciliates have two types of nuclei, a large macronucleus and usually several tiny micronuclei.
  - The macronucleus has 50 or more copies of the genome.
  - The macronucleus controls the everyday functions of the cell by synthesizing RNA and is also necessary for asexual reproduction.
  - Ciliates generally reproduce asexually by binary fission of the macronucleus, rather than mitotic division.
  - The micronuclei (with between 1 and 80 copies) are required for sexual processes that generate genetic variation.

## Stramenopila:

### The stramenopila clade includes the water molds and heterokont algae

- The **Stramenopila** includes both heterotrophic and photosynthetic protists.
  - The name of this group is derived from the presence of numerous fine, hairlike projections on the flagella.
  - In most cases, the hairy flagellum is paired with a smooth flagellum
- The heterotrophic stramenopiles, the **oomycotes**, include **water molds**, **white rusts**, and **downy mildews**.
  - Some are unicellular, others have a fine network of multi-nucleated hyphae (fine, branching filaments).
    - These hyphae have cellulose cell walls and are analogous with the hyphae of true fungi (with chitin cell walls).
  - These filamentous bodies have extensive surface area, enhancing absorption of nutrients.
- Water molds are important decomposers, mainly in fresh water.
  - They form cottony masses on dead algae and animals.
  - Some water molds are parasitic, growing on the skin and gills of injured fish.
- White rusts and downy mildews are parasites of terrestrial plants.
  - They are dispersed by windblown spores.
  - One species of downy mildew threatened French vineyards in the 1870's and another species causes late potato blight, which contributed to the Irish famine in the 19th century.
- The photosynthetic stramenopile taxa are known collectively as the heterokont algae.
  - “Hetero” refers to the two different types of flagella.
- The heterokont algae include diatoms, golden algae, and brown algae.
- **Diatoms** (Bacillariophyta) have unique glasslike walls composed of hydrated silica embedded in an organic matrix.
  - The wall is divided into two parts that overlap like a shoe box and lid.
  - Diatoms are abundant members of both freshwater and marine plankton.
  - Massive accumulations of fossilized diatoms are major constituents of diatomaceous earth.

- **Golden algae** (Chrysophyta), named for the yellow and brown carotene and xanthophyll pigments, are typically biflagellated.
- Some species are mixotrophic and many live among freshwater and marine plankton.
- While most are unicellular, some are colonial.
- At high densities, they can form resistant cysts that remain viable for decades.
- **Brown algae** (Phaeophyta) are the largest and most complex algae.
  - Most brown algae are multicellular.
  - Most species are marine.
- Brown algae are especially common along temperate coasts in areas of cool water and adequate nutrients.
- They owe their characteristic brown or olive color to accessory pigments in the plastids.