Protists

Protists

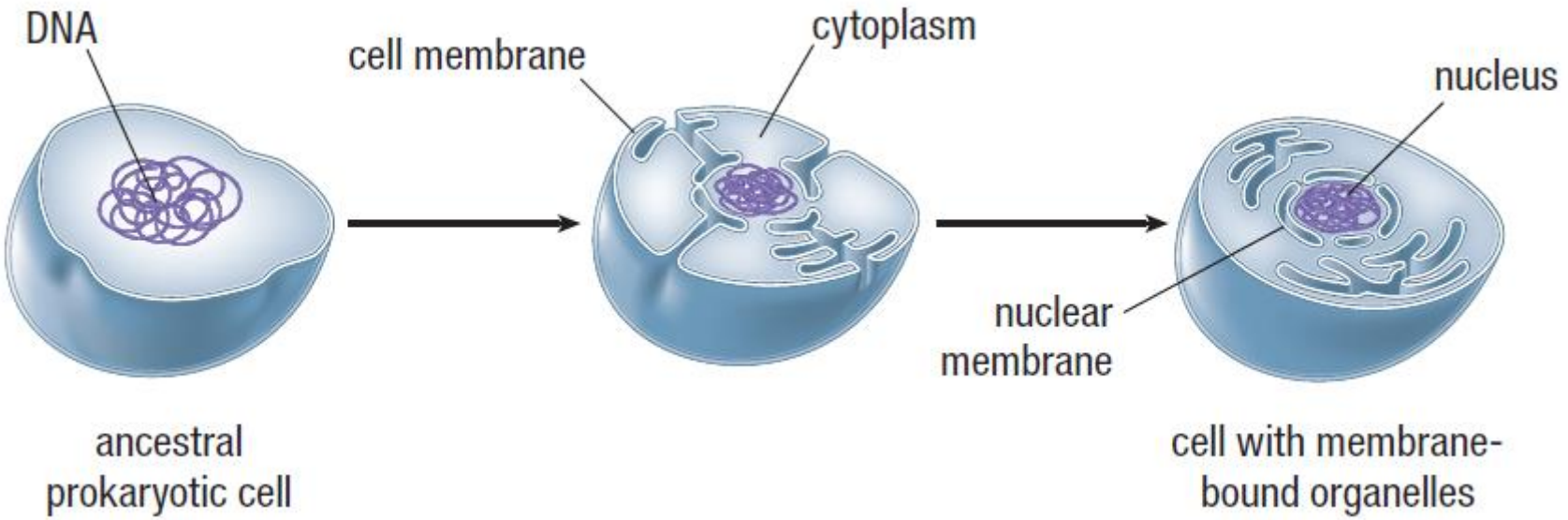
- The kingdom Protista is a very diverse kingdom. Eukaryotes that are not classified as fungi, plants, or animals are classified as protists.
- However, even though they are officially in the kingdom Protista, they can still be separated into groups of animal-like protists, plant-like protists, and fungus-like protists.
- Many protists are tiny, single-celled organisms. There are some that are very large such as kelp.

Importance of Protists

- Photosynthetic protists are a major producer in the world's oceans.
- Heterotrophic protists are essential parts of many ecosystems.
- Parasitic protists live in, or on, other organisms and may cause serious disease.
  - Malaria is caused by *Plasmodium*
  - Diarrhea can be caused by *Giardia*
- Protists can also be used by humans
  - *Porphyra* is a multicellular protest that is commonly known as the seaweed nori.
  - Extracts from seaweed have also been used as additives in different industries.

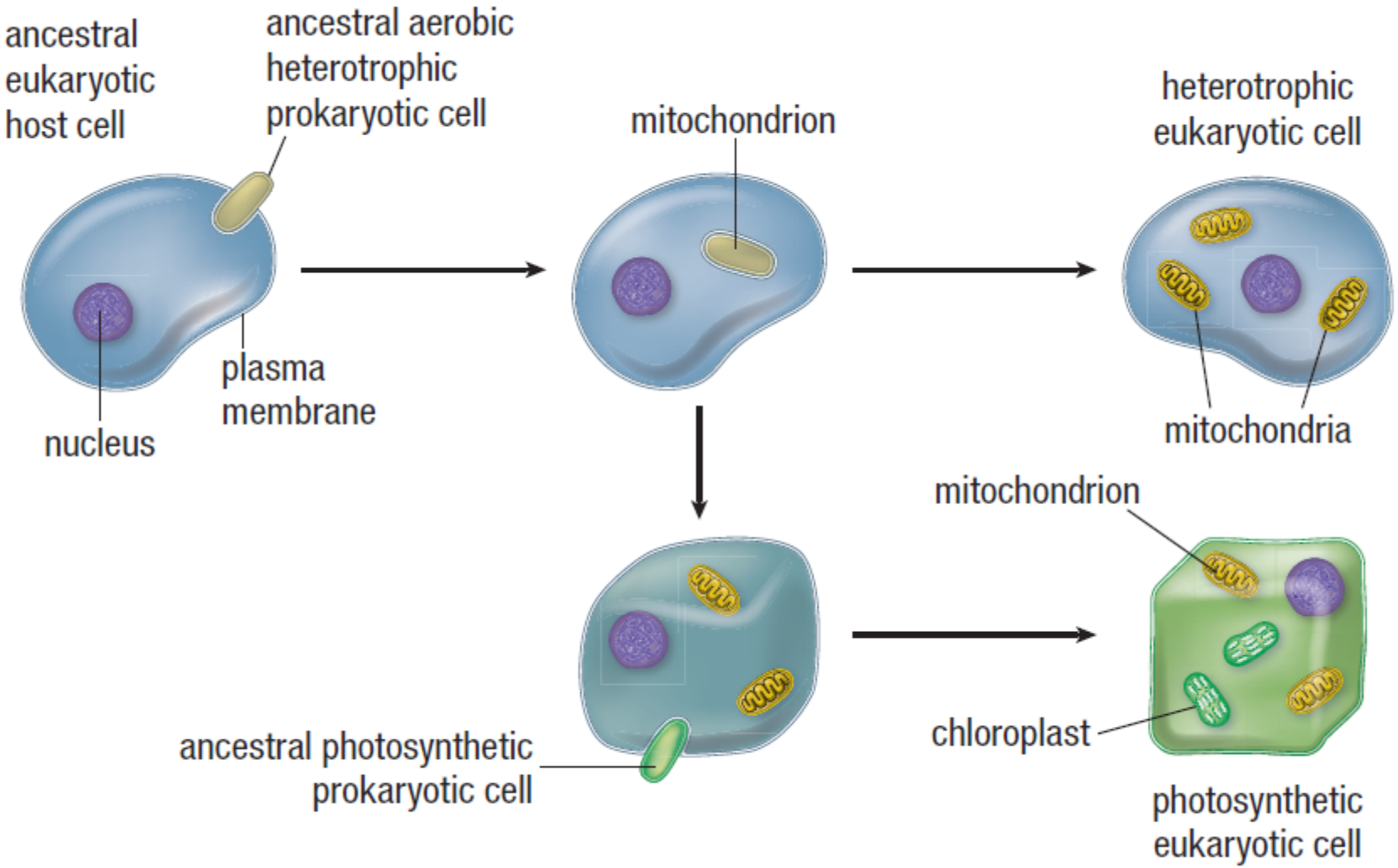
Origin of Eukaryotes

- There are two commonly accepted theories for how eukaryotic cells evolved: infolding and endosymbiosis.
- Infolding
  - Process during which cell membranes folded inwards and eventually formed membrane bound organelles such as the endoplasmic reticulum, the nucleus, and the Golgi apparatus.
  - This could have originally occurred to increase cell surface area for exchange of materials with the environment.


DNA
cell membrane
cytoplasm
nucleus
nuclear membrane
ancestral prokaryotic cell
cell with membrane-bound organelles

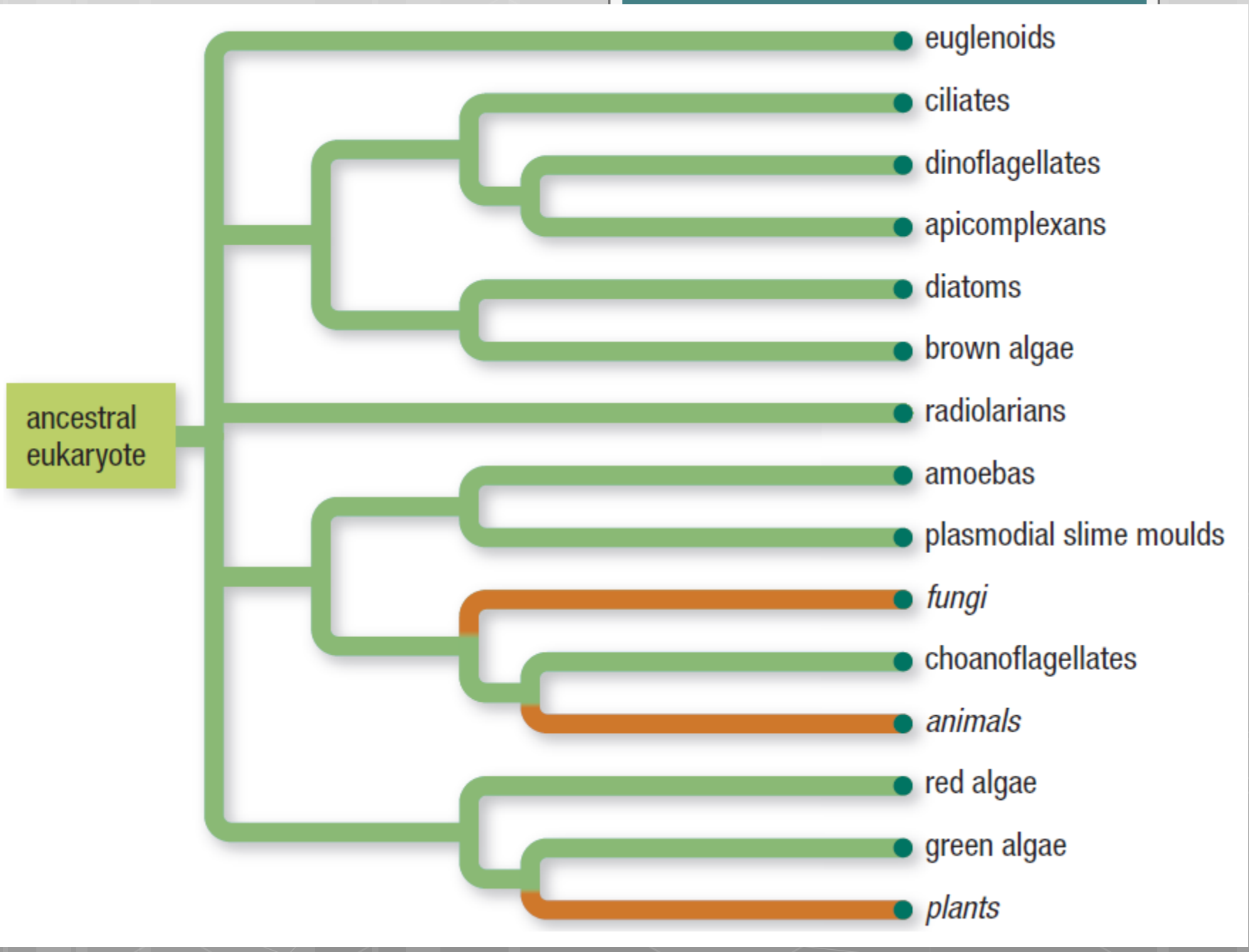
Origin of Eukaryotes

- Endosymbiosis
  - Engulfment of single cellular bacteria which formed a symbiotic relationship
- Evidence for endosymbiosis
  - Both mitochondria and chloroplasts have two membranes
  - The inner membrane is similar to ancestral prokaryotes while the outer membrane is similar to eukaryotes
  - Mitochondrial DNA and chloroplast DNA is similar to prokaryotic chromosomes
  - Mitochondria and chloroplasts reproduce through binary fission, similar to prokaryotes
- It is hypothesized that aerobic bacteria evolved to form mitochondria while photosynthetic bacteria evolved to form chloroplasts.


ancestral eukaryotic host cell
ancestral aerobic heterotrophic prokaryotic cell
plasma membrane
nucleus
mitochondrion
heterotrophic eukaryotic cell
mitochondria
mitochondrion
ancestral photosynthetic prokaryotic cell
chloroplast
photosynthetic eukaryotic cell

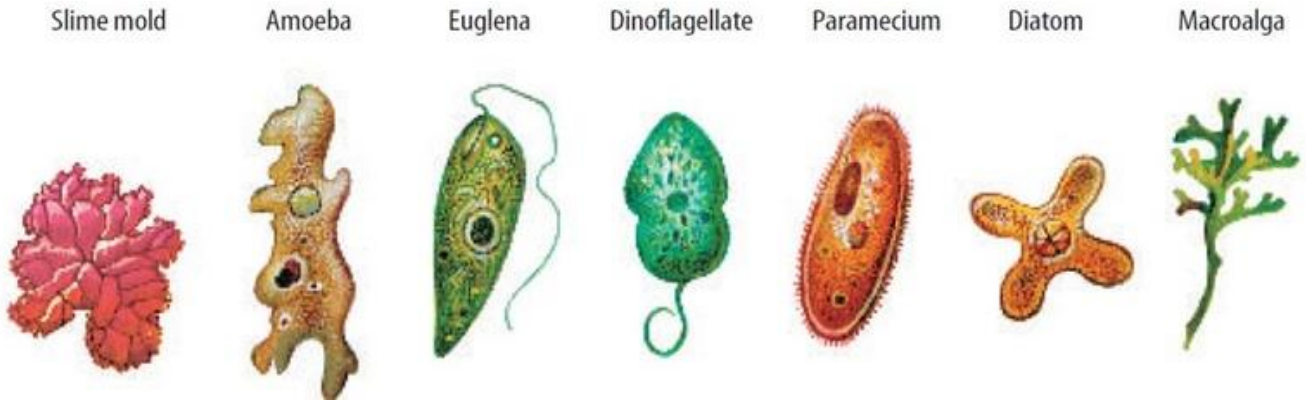
Classification and Phylogeny

- The kingdom Protista is the most diverse kingdom of eukaryotes.
- Traditionally, these organisms were grouped together as a taxonomic group if they did not fit into the other groups.
- However, evolutionarily, the organisms in the kingdom Protista do not form a distinct clade.
- With further research into this area, further improvements could be made to classify these organisms.


ancestral eukaryote
euglenoids
ciliates
dinoflagellates
apicomplexans
diatoms
brown algae
radiolarians
amoebas
plasmodial slime moulds
fungi
choanoflagellates
animals
red algae
green algae
plants

Structure

- Protists vary widely in structure.
- Most protists are unicellular and non-parasitic.
- However, some are colonial, living in groups of similar or identical cells. Some are even multicellular.
- In terms of similarities protists, their cell structure is that of a typical eukaryote. They contain membrane-bound organelles.

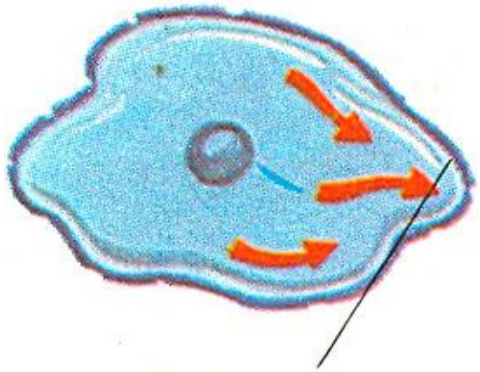


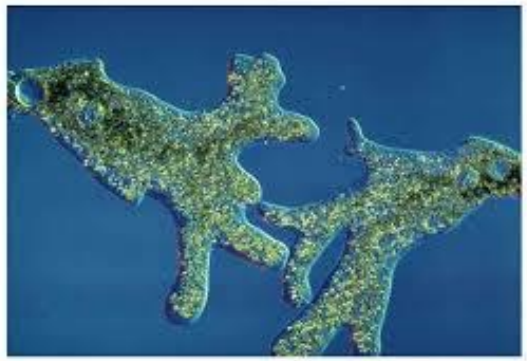
Function

- As with their structure, protists vary greatly in function. They live in a variety of environments, filling many ecological niches.

Motility

- The following are common methods of motility in protists.
  - Pseudopodia
    - Rearranging cytoplasm to form pseudopodia (false feet) which can be used to move in the direction of the extended pseudopodia





Motility

- Flagella
  - Whip-like projections that extend out of the cell membrane and produce motion through a waving motion

Motility

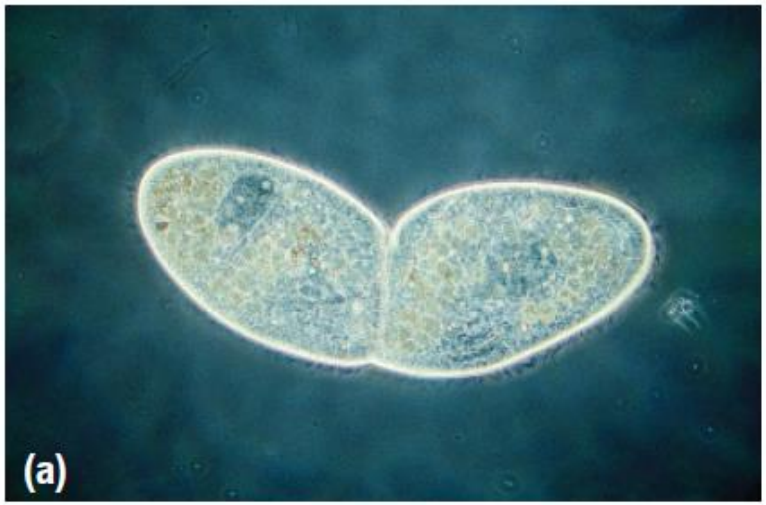
- Cilia
  - Hair-like projections of the cell membrane that pulse in waves to produce movement.
  - Shorter than flagella and more numerous on a cell

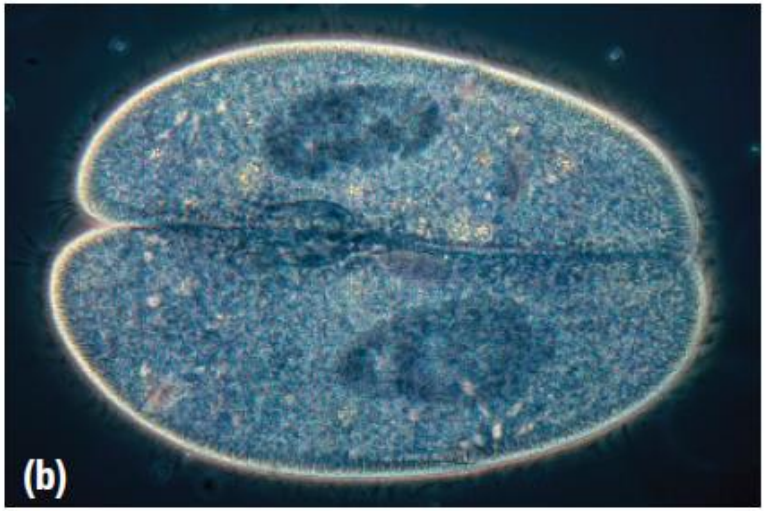
Motility

- Environment
  - Protists that lack motility are able to move passively through environmental factors such as currents, wind, and other organisms

Reproduction

- Methods of reproduction vary for the different types of protists.
- Single-celled ciliates generally reproduce through cell division which results in low genetic diversity. However, similar to bacteria, some of these single-celled protists can engage in conjugation.



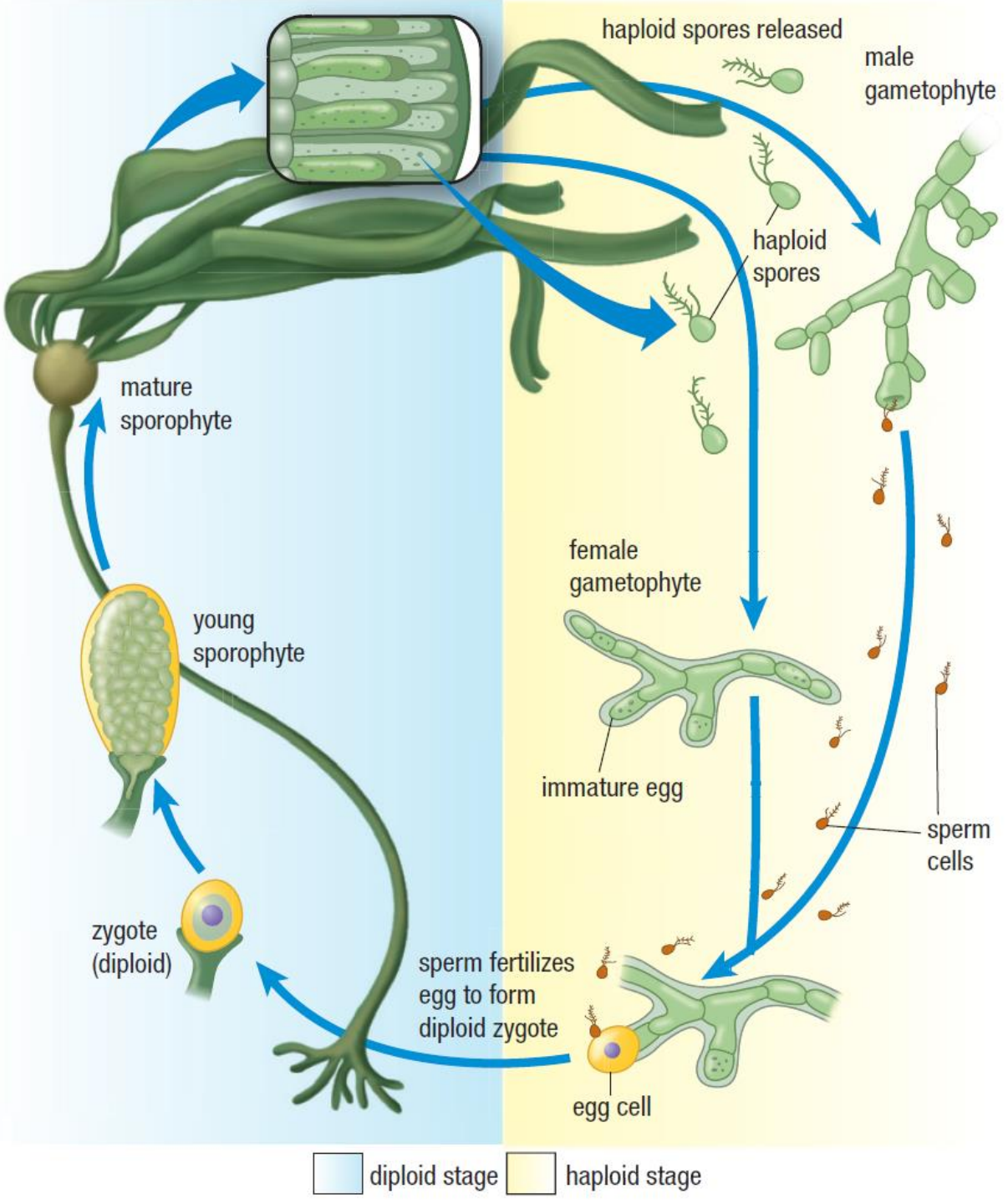


Reproduction

- Multicellular protists can have complex life cycles that alternate between a diploid phase and a haploid stage.
- For example, in the large brown alga, the cells are diploid upon fertilization and formation of a zygote. The zygote then matures into an adult diploid sporophyte which releases single-celled haploid spores.
- This begins the haploid phase where the spores attach to a surface and begin dividing into a multicellular gametophyte which is also haploid.
- The gametophyte than produces haploid sperm and egg gametes which lead to fertilization and the diploid stage of the life cycle.

Alternation of generations

- A life cycle in which diploid individuals produce spores that create haploid individuals; the haploid individuals reproduce sexually, producing sporophyte individuals and completing the cycle



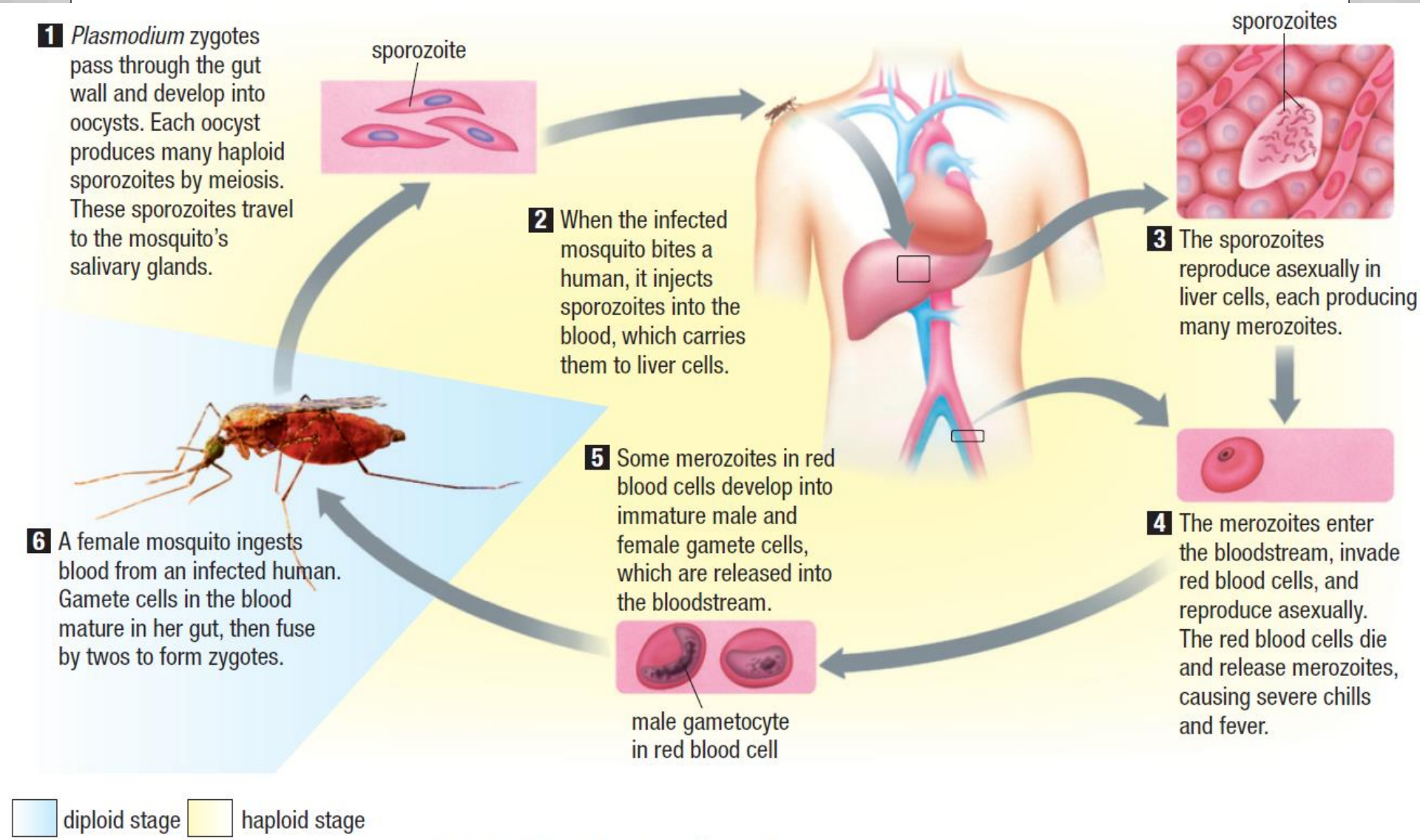
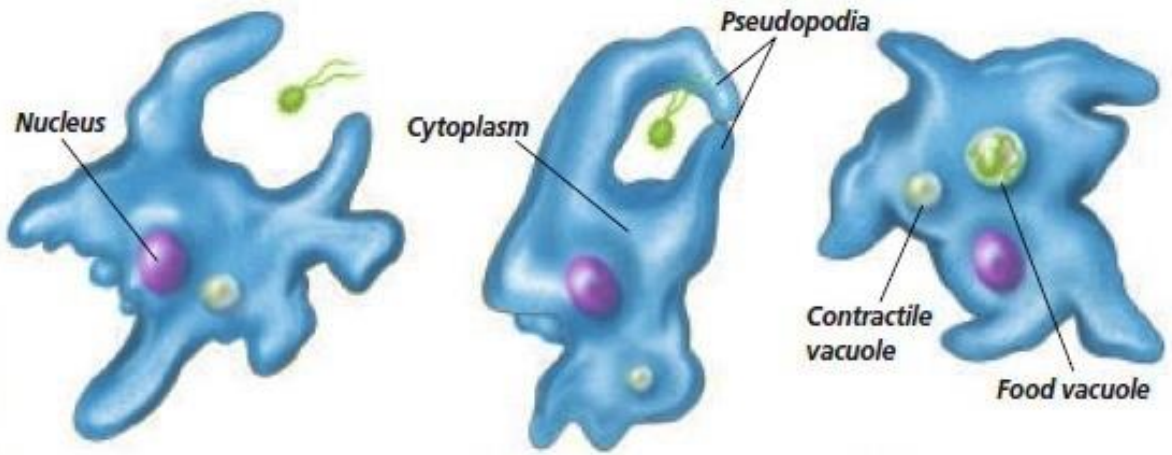


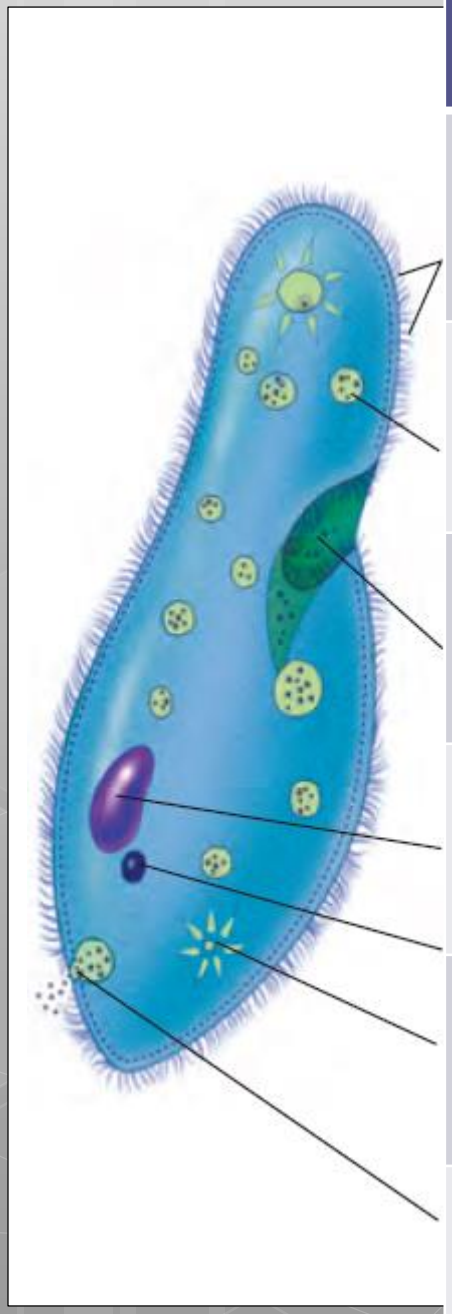
Figure 14 The life cycle of *Plasmodium*

Classification –Animal-like Protists

- Animal-like protists are heterotrophs
- Examples include the amoeba and paramecium
- The amoeba uses pseudopodia for locomotion and capturing of food.



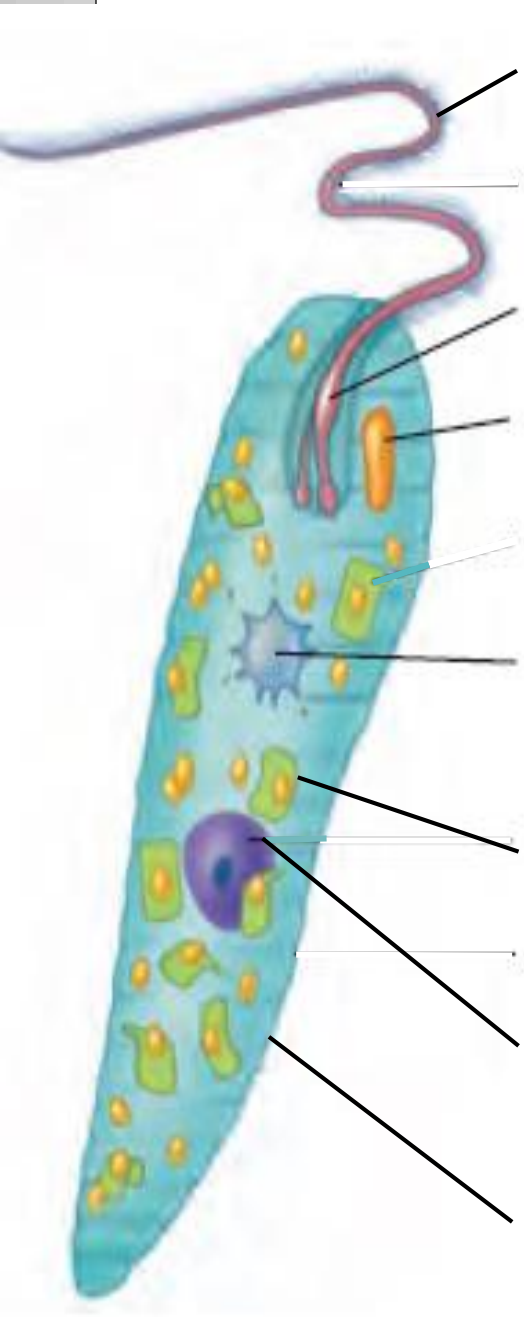
- The paramecium uses cilia for locomotion and ingestion of food particles.



Structure	Function
Cilia	• Waves for locomotion • Also propels food particles towards oral groove
Food vacuole	• Contains food particles • Combines with lysosomes to digest food
Oral groove	• Allow entry of food particles into cell with the aid of sweeping cilia
Macronucleus and micronucleus	• Controls cell functions • Micronucleus is necessary for reproduction
Contractile vacuole	• Controls amount of water in the cell through contractions
Anal pore	• Controls release of wastes out of the cell

Classification –Plant-like Protists

- Algae are autotrophic protists
- They contain chloroplasts and can carry out photosynthesis like plants.
- Algae can be unicellular, colonial, or multicellular.
- They can reproduce sexually or asexual.
- For classification, they can be classified by types of cell walls, types of photosynthetic pigments, types of storage, and DNA sequences.
- Euglena is a common example of a plant-like protist.
- These unicellular protists make up communities of plankton and phytoplankton.



Structure	Function
Flagellum	• Whip-like motion for locomotion of the cell
Light detector (photoreceptor)	• Photosensitive organelle that senses light for the cell
Eyespot (Stigma)	• Filters light before it reaches the light detector
Contractile vacuole	• Controls amount of water in the cell through contractions
Chloroplast	• Site of photosynthesis
Nucleus	• Controls cell functions through genetic material
Plasma membrane	• Control entry and exit of materials into and out of the cell

Classification –Fungus-like Protists

- Fungus-like protists are heterotrophs that feed on decaying organic matter.
- Representative organisms in this category include plasmodial slime moulds, cellular slime moulds, and water moulds.

Classification –Fungus-like Protists

- Unlike large fungi, slime moulds are not multicellular. It is a plasmodium – a single mass of cytoplasm undivided by membranes or cell walls that contains many nuclei.
- It acts as a giant cell and uses pseudopodia, similar to the amoeba.

Table 1 Characteristics of Representative Protists

Group	Energy source	Key features
euglenoids	autotrophs, photosynthetic	• They are unicellular. • They usually have two flagella for moving. • Their outer surface covering consists of stiff proteins.
ciliates	heterotrophs	• They are unicellular. • They have very complex internal structures. • They have many cilia and no cell walls (**Figure 8**).
apicomplexa	heterotrophs	• They are unicellular. • They have no cell wall. • All are parasites of animals.
diatoms	autotrophs, photosynthetic	• They are unicellular (**Figure 9**). • They move by gliding. • They are covered by glass-like silica shells.
amoebas	heterotrophs	• Some have hard outer skeletons. • They move by extensions of the cytoplasm called pseudopods.
slime moulds	heterotrophs	• Their life cycles have unicellular stages and multicellular stages. • They move with flagella or pseudopods.
red algae	autotrophs, photosynthetic	• Almost all are multicellular. • They have no cilia or flagella. • Their cell walls are made of cellulose.