PROTISTS

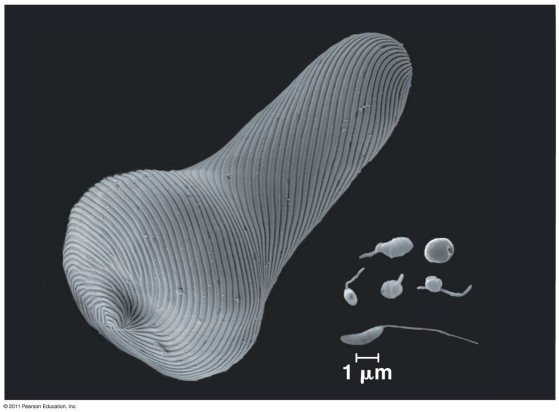
Objectives

1. List the characteristics shared among the protists.
2. Describe secondary endosymbiosis and the evidence for this hypothesis.
3. List the five major taxa of protists and provide the defining characteristics.
4. Identify the group of protists based on the characteristics listed.
5. Describe the life cycle of *Plasmodium*.
6. Describe alternation of generations.
7. Compare the two hypotheses regarding the root of the Eukarya.
8. List the main ecological niches of protists.

Outline

A. Characteristics
    1. Secondary Endosymbioses
B. Major Taxa of Protists
C. Excavata
    1. Diplomonadida
    2. Parabasalia
    3. Euglenozoa
D. Chromalveolata
    1. Alveolata
        a. Dinoflagellata
        b. Apicomplexa
        c. Ciliates (Ciliophora)
    2. Stramenopiles (Heterokonphyta)
        a. Diatoms (Bacillariophyceae)
        b. Brown Algae (Phaeophyceae)
        c. Oomycota
E. Rhizaria
    1. Radiolaria
    2. Foraminifera
F. Archaeplastida
    1. Red Algae (Rhodophyta)
    2. Green Algae (Chlorophyta)
G. Unikonta
    1. Amoebozoa
        a. Slime Molds (Mycetozoa)
    2. Opisthokonta
H. Root of the Eukarya
I. Ecological Niches

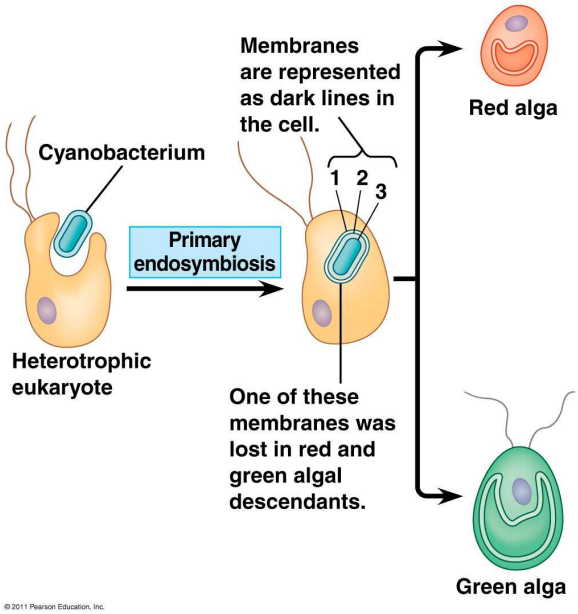
A. Characteristics



- Eukaryotic
- Poorly defined/differentiated group
- Most diverse group of eukaryotes
- Most unicellular
  - Some form specialized colonies
  - Some multicellular
- Organelles
  - Some unique to this “group”

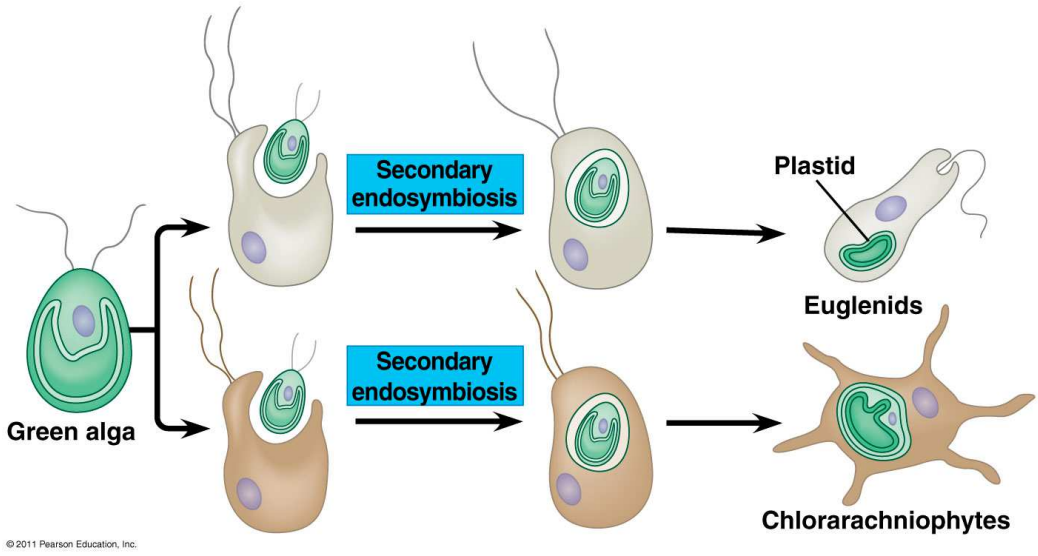
1. Secondary Endosymbioses

- Theory regarding diversity of protists
- Primary endosymbioses
  - First – alpha proteobacteria
    - Ancestor of mitochondria
    - Many genes moved to nucleus



- Second – cyanobacterium
    - Ancestor of chloroplasts
    - red and green algae
        - double membrane chloroplast

- Secondary endosymbioses
    - Protists ingest/incorporate algae
    - Happened independently at least 3x
    - Nucleomorph present in chloroplast
        - Most similar to algae nuclear genes
    - Three or four membranes present



B. Major Taxa of Protists

- Groupings are decently supported

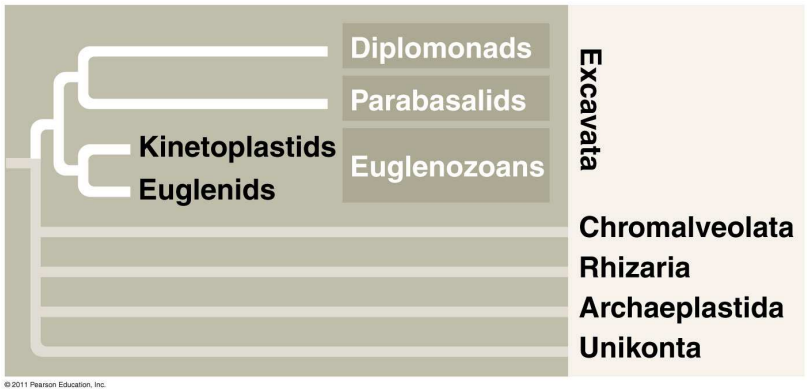
- Phylogeny among groups is weak

C. Excavata

- Named after “excavated” feeding tube

- Grouped based on cytoskeleton

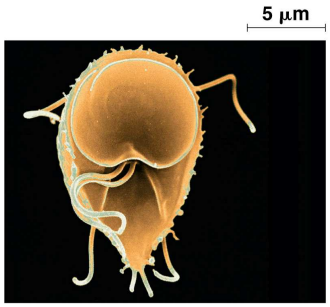
    - Relatedness of groups tenuous



1. Diplomonadida

- Mitosomes, not mitochondria

    - No electron transport chain

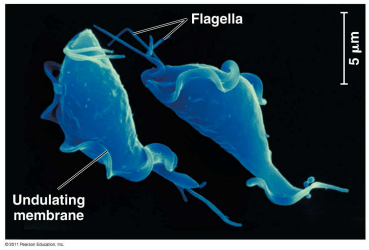


***Giardia intestinalis*, a diplomonad parasite**

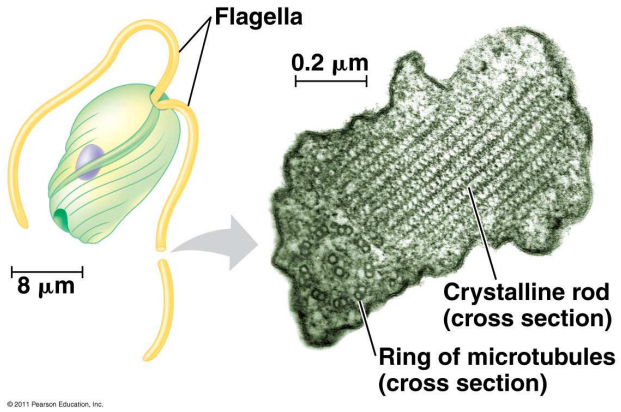
2. Parabasilia

- Hydrogenosomes, not mitochondria

    - Produce hydrogen gas

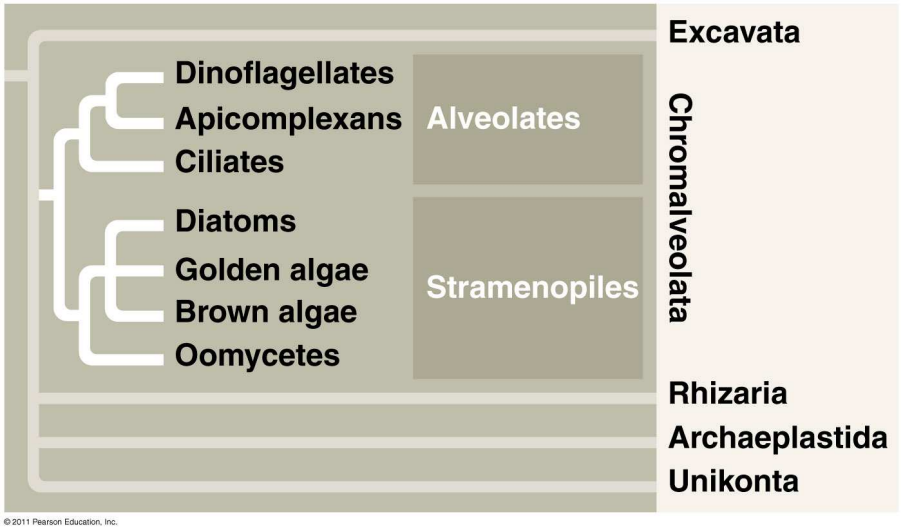


3. Euglenozoa



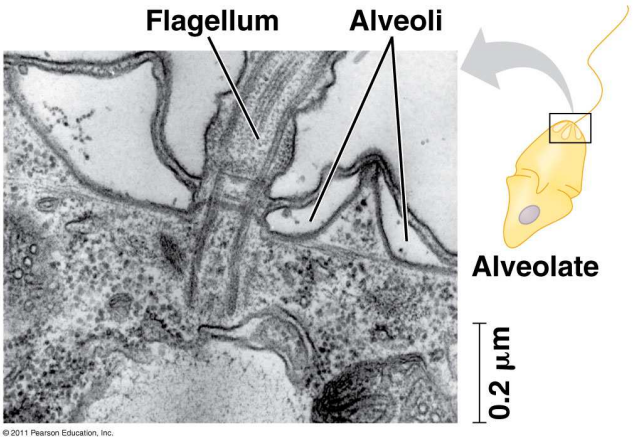
- Contain special rod inside flagellum
- Mixotrophs
  - photoautotrophs in light
  - heterotrophs without light
- Pellicle beneath plasma membrane
  - provides strength and flexibility

D. Chromalveolata



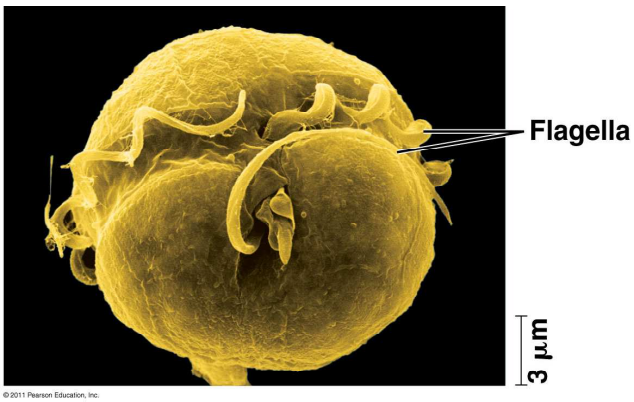
- May/may not be monophyletic
- Derived from secondary endosymbiosis with red alga?
  - Red algal genes in chloroplasts
  - Red algal genes in nucleus
  - Some missing plastids

1. Alveolata



- Group strongly supported
- Grouped due to presence of alveoli
    - Found under plasma membrane
    - Function uncertain

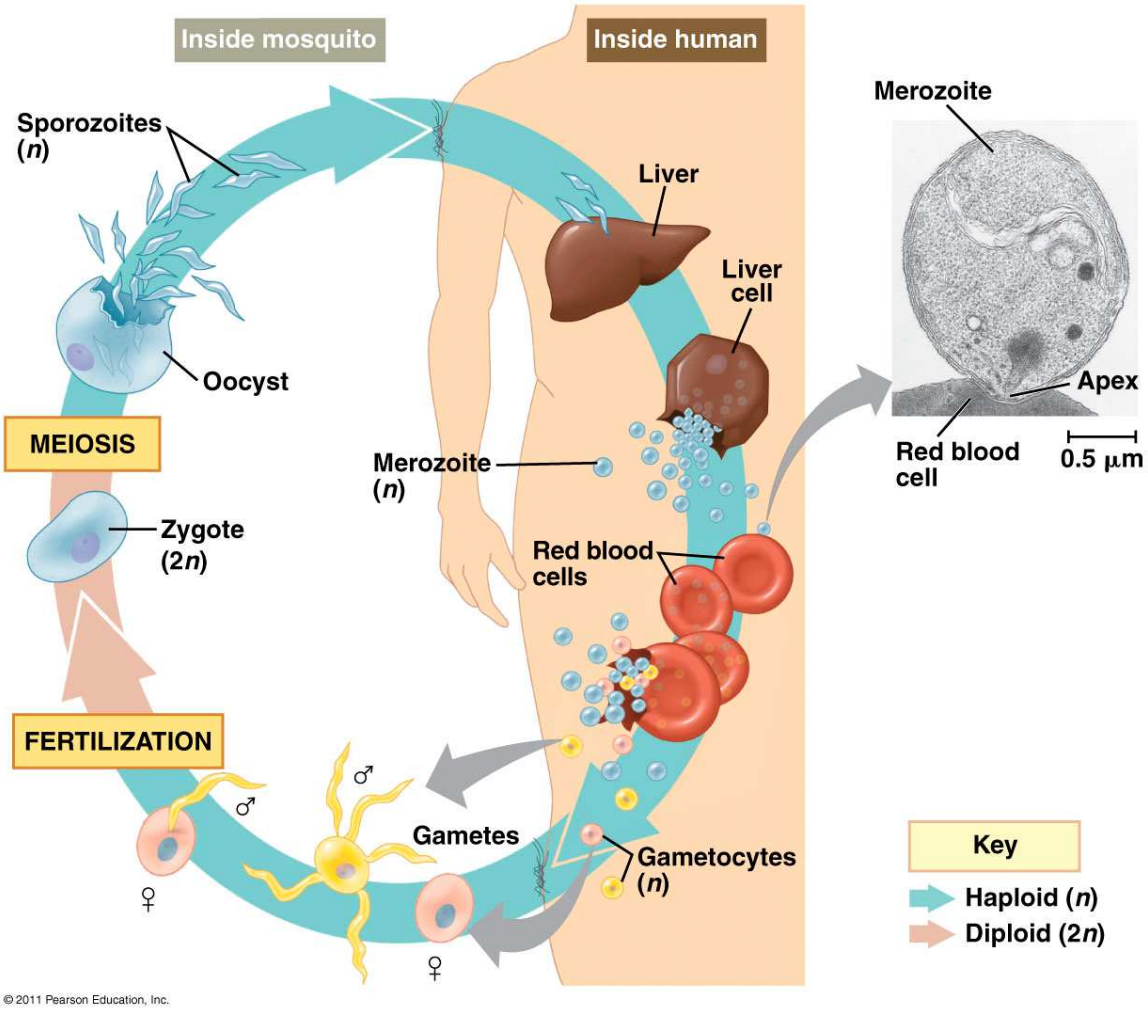
a. Dinoflagellata



- Extremely important phytoplankton
    - Producers in water ecosystems
- Covered by cellulose plates
- Groove between plates
    - Flagella within grooves
    - Causes cells to spin
- Some bioluminescent
- Cause of red tides

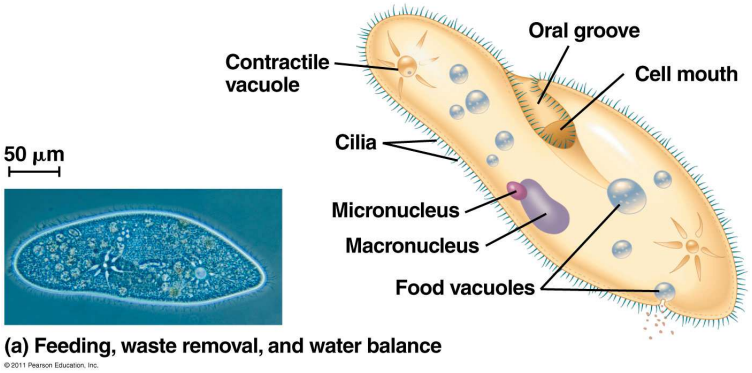
b. Apicomplexa

- Named after complex of organelles at apex of cell
    - contain penetrating enzymes
- form spores (sporozoite stage)
- Intracellular parasites of animals
- Apicoplast – modified chloroplast



c. Ciliates (Ciliophora)

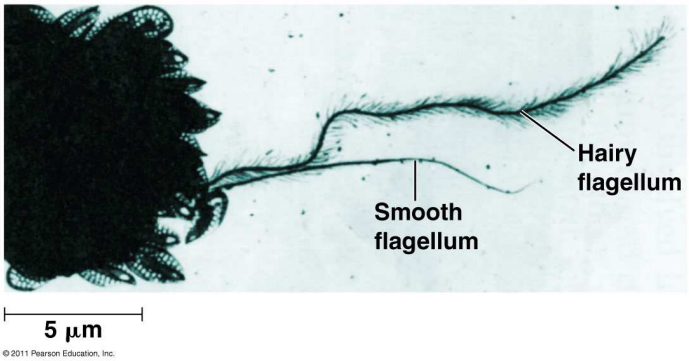
- Defined by presence of cilia
    - Use cilia to move and feed
- contain two nuclei
    - micronucleus – “original” copy
    - macronucleus – “working” genes
- reproduce by fission, conjugation



(a) Feeding, waste removal, and water balance

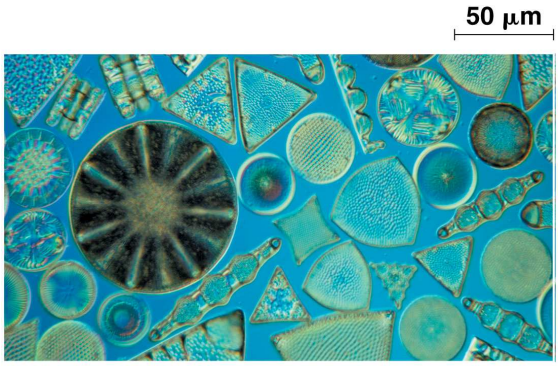
2. Stramenopiles (Heterokonphyta)

- Defined by straw-like hairs on flagella
    - Often paired with nonhairy flagellum



a. Diatoms (Bacillariophyceae)

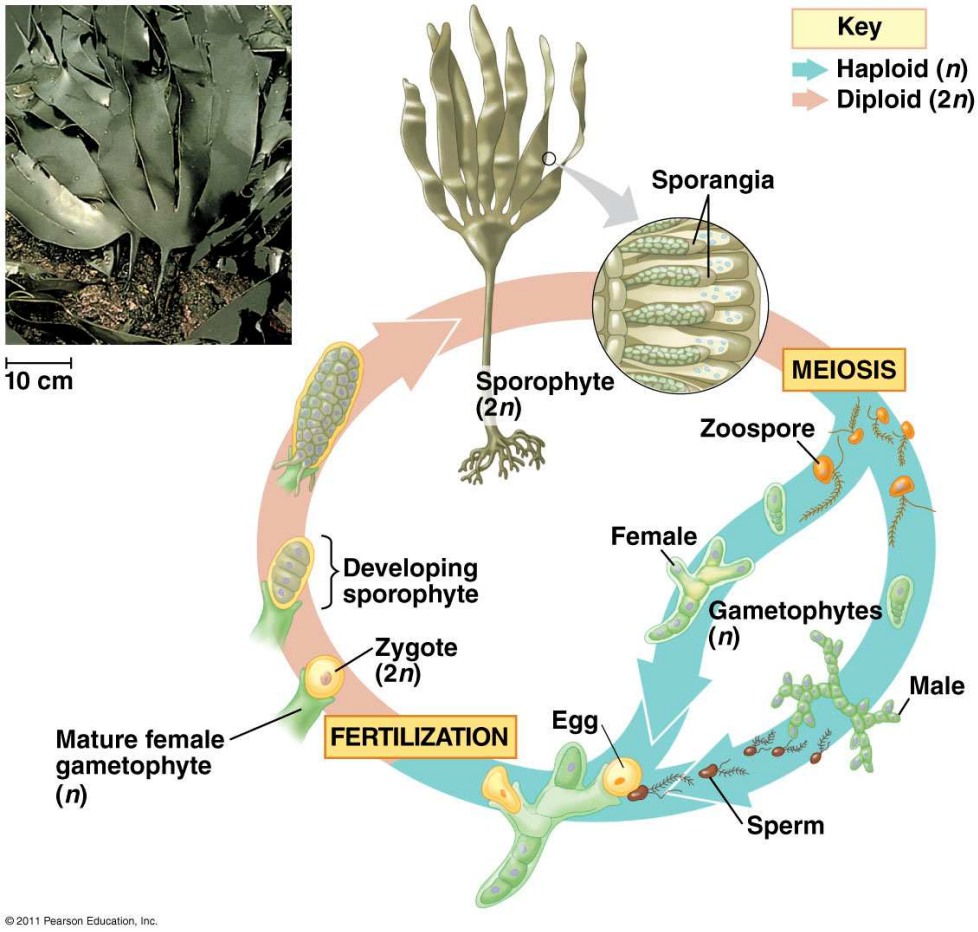
- Defined by silica (SiO_2) cell wall
    - Provides protection from predators
- Major producers in aquatic systems
- Flagella only on male gamete



Diatom diversity

b. Brown Algae (Phaeophyceae)

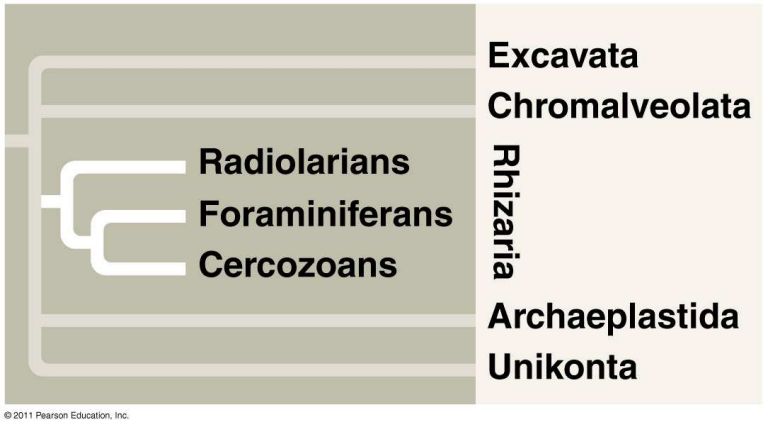
- Multicellular alga
    - can grow quite large (60 m)
    - one type of “seaweed”
- Color from carotinoids and fucoxanthin
- Chloroplasts have four membranes
- Have blade, stipe, and holdfast
- Display alternation of generations
    - sporophyte (2n) makes spores (n)
        - spores have flagella (zoospores)
    - gametophytes (n) make gametes (n), which fuse to form sporophyte
    - heteromorphic v. isomorphic



c. Oomycota

- "water molds" and downy mildews
- growth similar to fungi
- cellulose cell walls
- have lost plastids

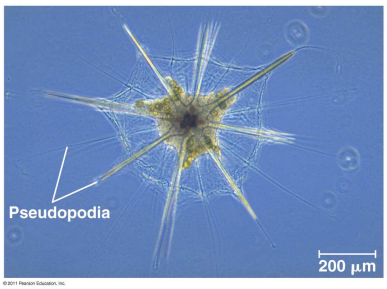
E. Rhizaria



- Grouped by DNA similarity
- Mostly amoebas with threadlike pseudopodia
- May be member of Chromalveolata

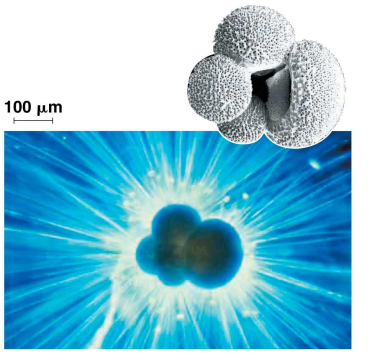
1. Radiolaria

- Skeleton made of silica or strontium sulfate



2. Foraminifera

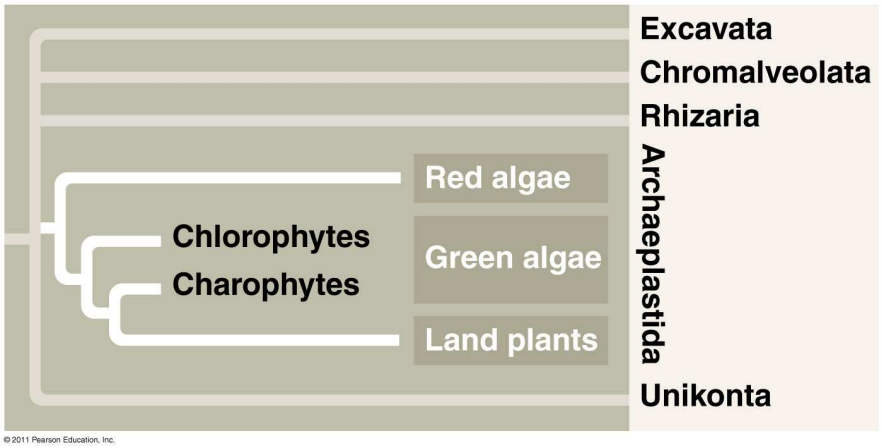
- unicellular
  - can grow to several cm in width
- porous shells hardened by calcium carbonate
  - provide home for algae



Globigerina, a foram in the supergroup Rhizaria

F. Archaeplastida

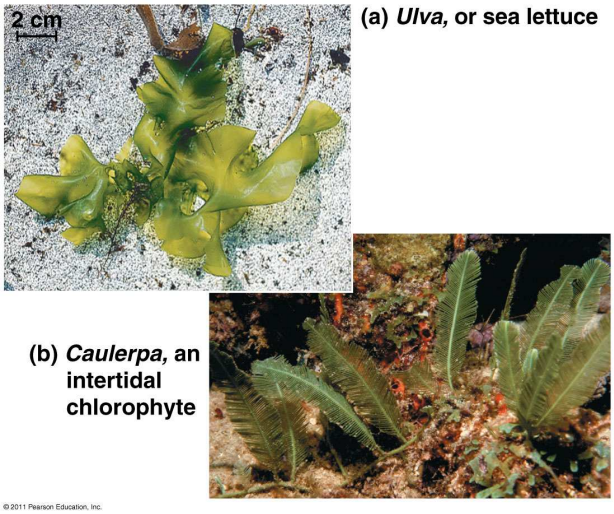
- Well defined group
- Group containing kingdom Plantae



1. Red Algae (Rhodophyta)

- Grouped by presence of phycoerythrin
    - Allows absorption of blue-green light
    - penetrates deeper into water
- Often multicellular
- No flagellated states

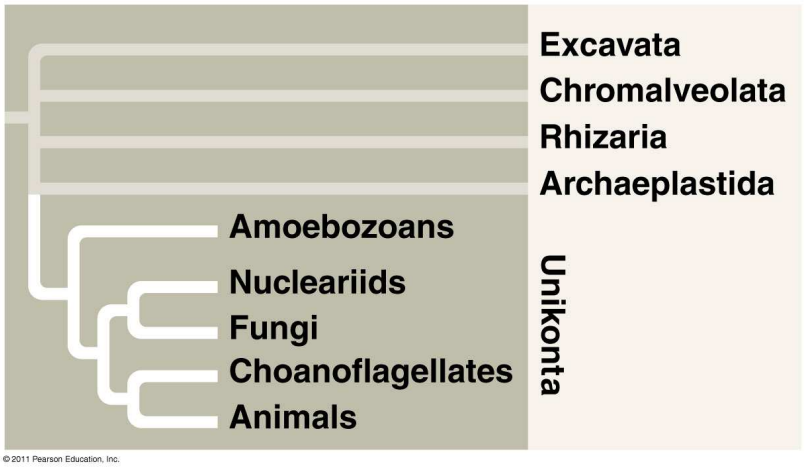
2. Green Algae (Chlorophyta)



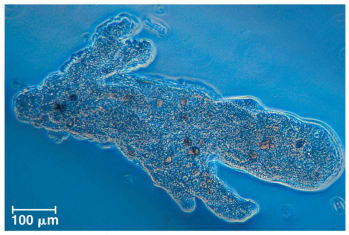
- three membrane chloroplast
- often multicellular or colonial
- display alternation of generations
- flagella present in gametes
    - often in unicellular cells also
- closest relative of land plants
    - often included in kingdom Plantae

G. Unikonta

- Group containing kingdom Animalia and Fungi



1. Amoebozoa

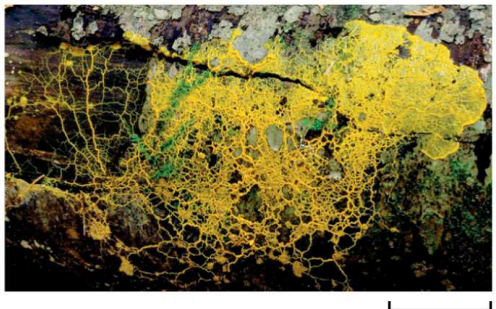


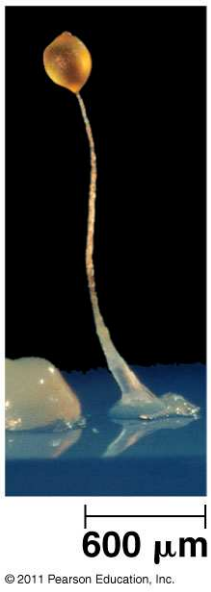
A unikont amoeba

- lobe and tube-shaped pseudopodia

a. Slime Molds (Mycetozoa)

- spreading, fungal-like body
- plasmodial slime molds
  - multinucleated, unicellular body
  - extend by pseudopodia
  - reproduce by powdery spores
- cellular slime molds
  - cells feed independently like amoebas
  - cells congregate when resources low
    - reproduces by powdery spores



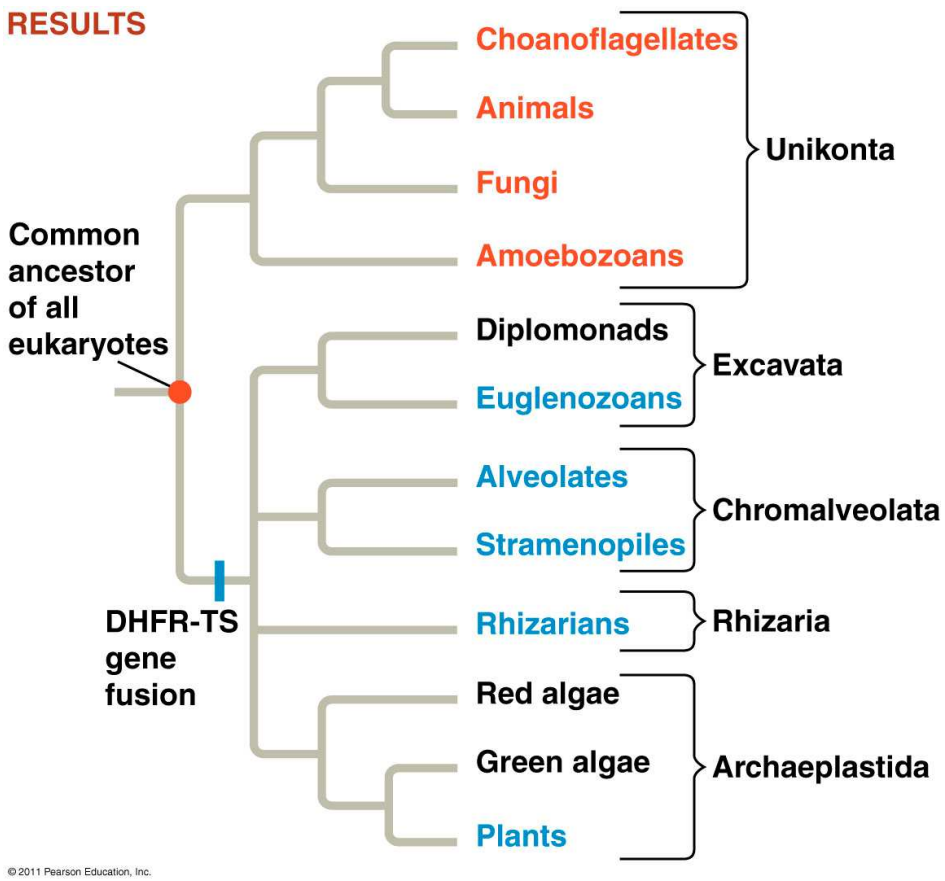


2. Opisthokonta

- Two small protist groups
- Closest relatives to Fungi, Animalia

H. Root of the Eukarya

- Two hypotheses
  - Groups lacking mitochondria
    - Amitochondriate protists
  - Groups with unfused DHFR-TS gene



I. Ecological Niches

- Symbionts
    - Mutualists
    - Parasites
- Producers