

# Protists (Eukarya)

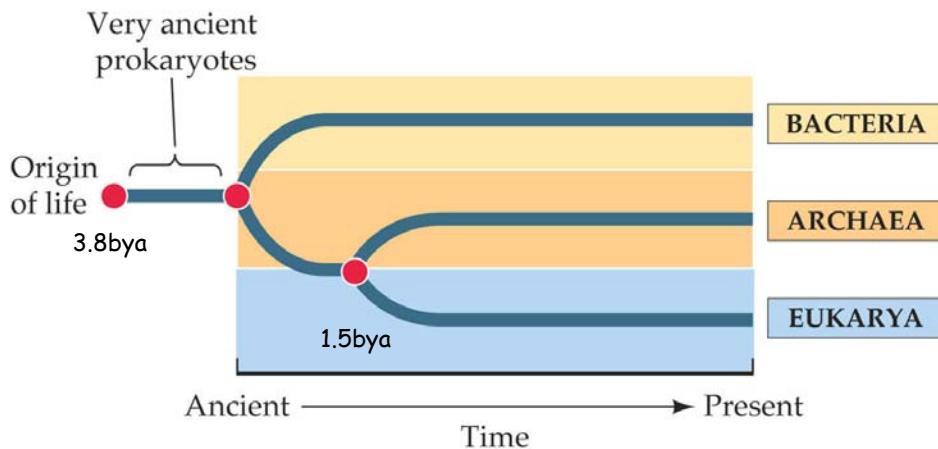


Ch 29

26 Feb 2009  
ECOL 182R UofA  
K. E. Bonine

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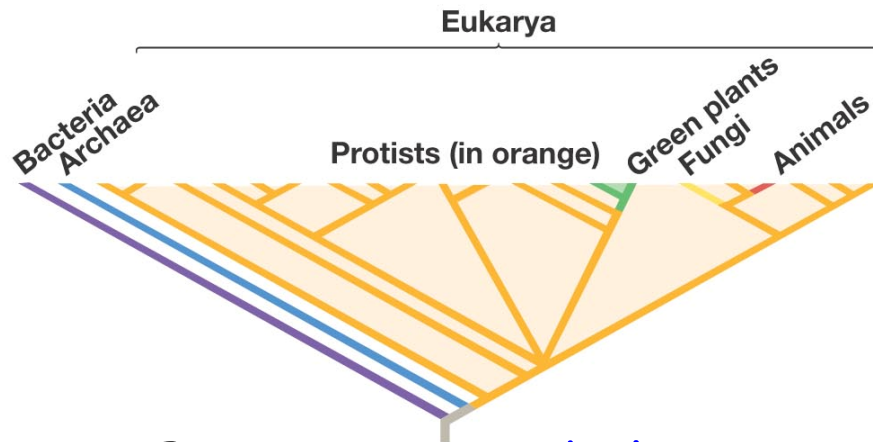
Life can be divided into 3 domains



- Prokaryotes = bacteria + archaea
- Prokaryote was ancestral and only form for billions of years

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# Eukarya

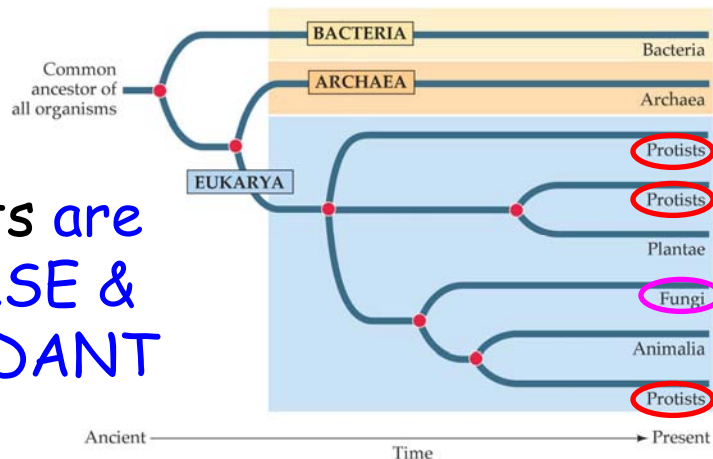


are Protists **monophyletic**,  
**paraphyletic**, **polyphyletic**?

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Where are microbes on tree of life?

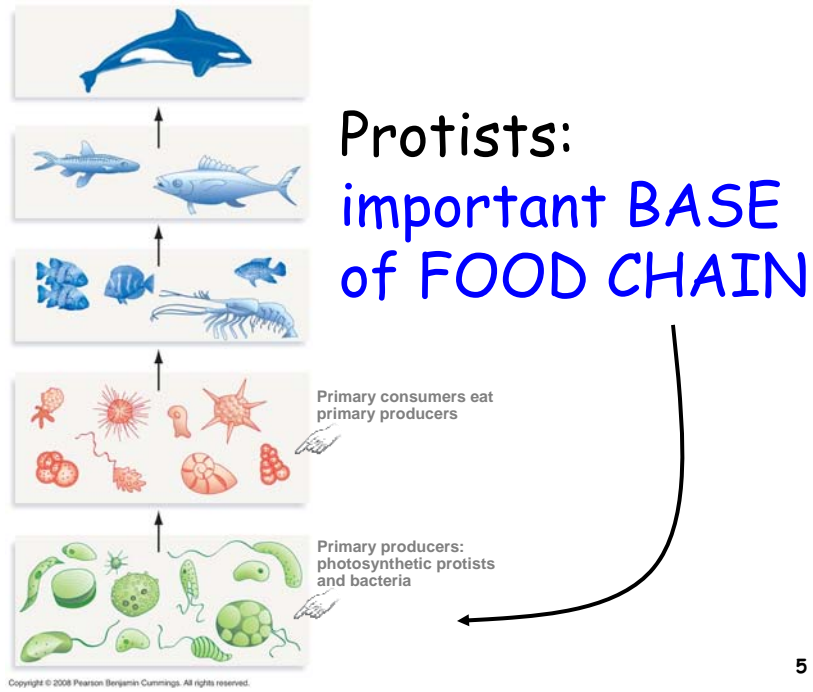
Protists are  
**DIVERSE &  
ABUNDANT**



- **Protists** are eukaryotes that are *not* animals, plants or fungi. **paraphyletic** group
- **Yeast** are unicellular fungi

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Figure 29-5

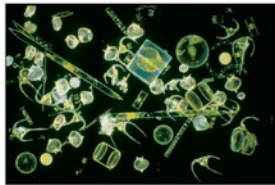


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## Protists

**(a) Open ocean:**

Surface waters teem with microscopic protists, such as these diatoms.



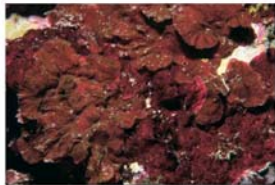
**(b) Shallow coastal waters:**

Gigantic protists, such as these kelp, form underwater forests.



**(c) Intertidal habitats:**

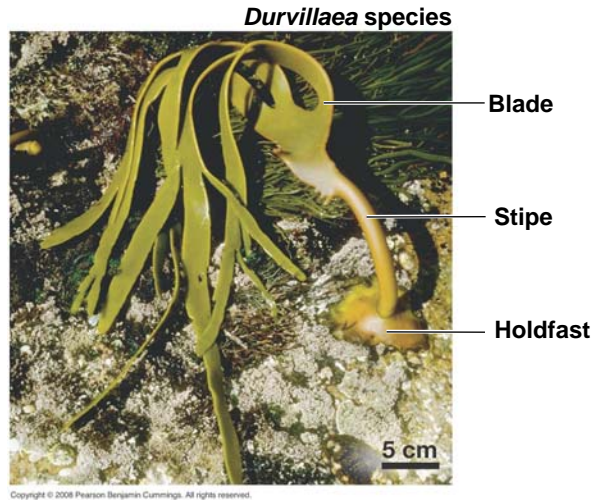
Protists such as these red algae are particularly abundant in tidal habitats.



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Very common in aquatic habitats 6

# KELP



Multicellularity evolved multiple times in eukaryotes 7

## How are eukaryotes different?

What happened during the evolution of eukaryotes?

- flexible cell surface
- cytoskeleton
- nuclear membrane
- digestive vesicles (vacuoles)
- endosymbiotic acquisitions

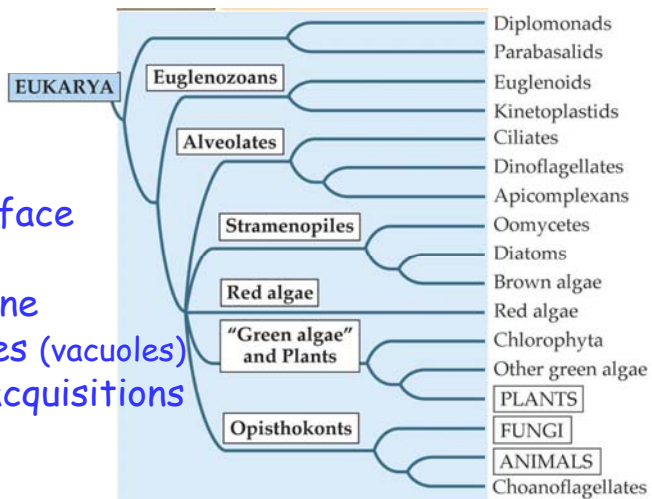
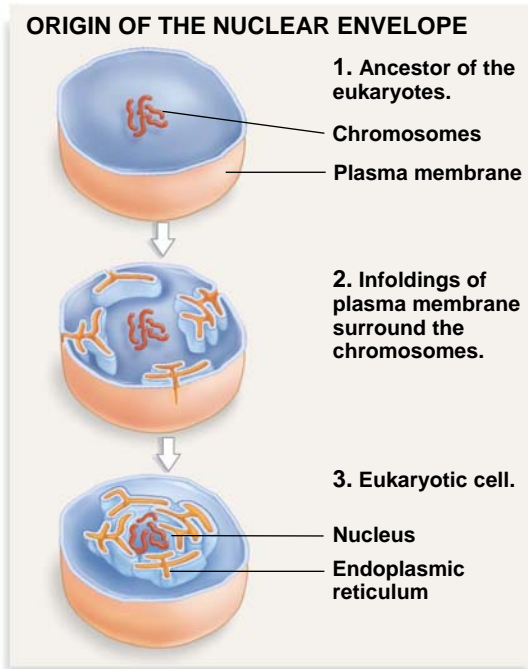
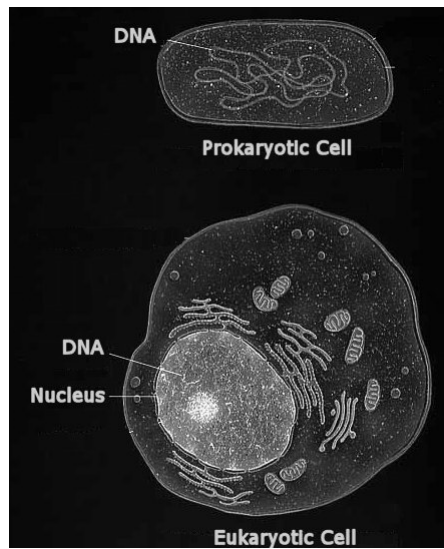


Figure 29-10



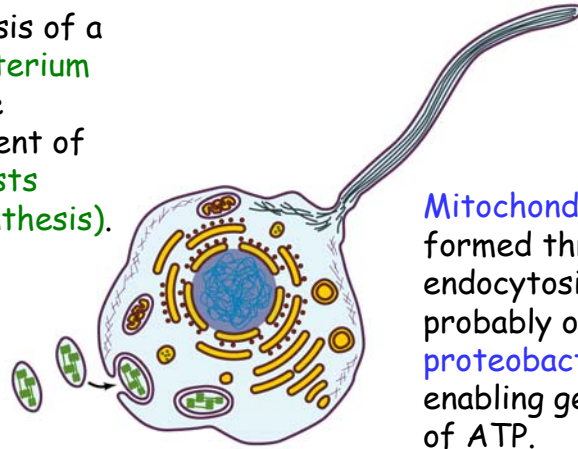
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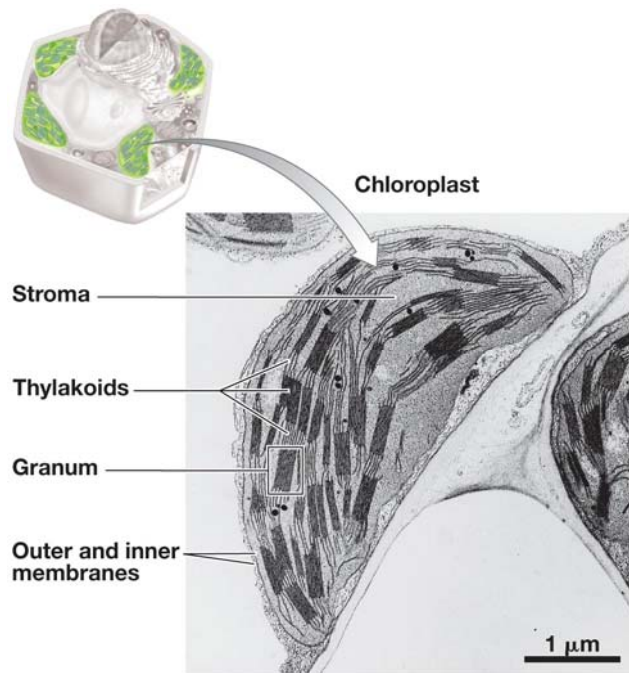
# Eukaryotes contain **organelles** that were once independent **prokaryotes**

Endocytosis of a **cyanobacterium** led to the development of **chloroplasts** (photosynthesis).



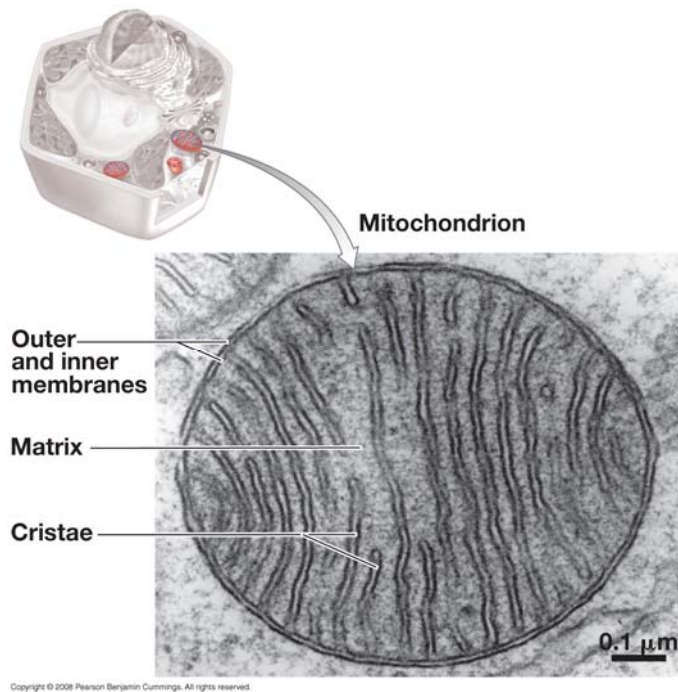
**Mitochondria** formed through endocytosis, probably of a **proteobacterium**, enabling generation of ATP.

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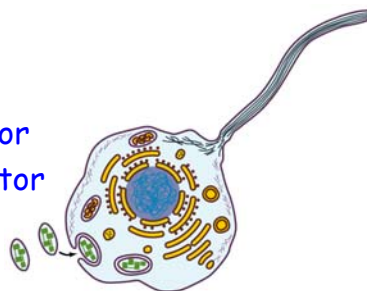
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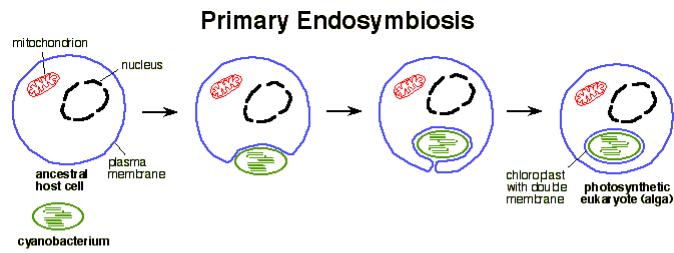


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## Endosymbiosis

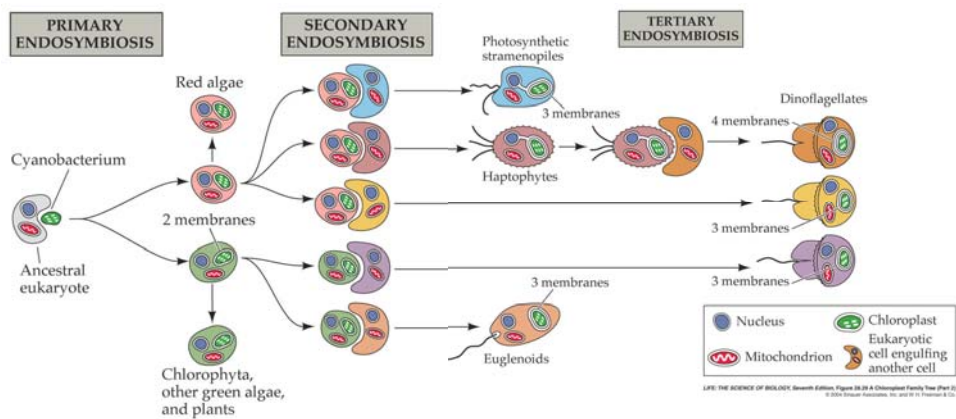
- One organism lives inside another
- Eukaryotic cell took in (endocytosis) prokaryotic ancestors of mitochondria and chloroplasts
- Organelles have
  - own DNA
  - 2 membranes
    - one from eukaryotic ancestor
    - one from prokaryotic ancestor





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## Lots of endosymbiosis



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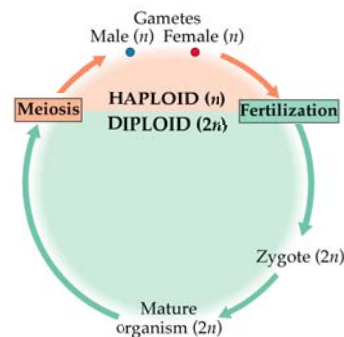


## Most Eukaryotes: Sexual lifecycle with meiosis

- During meiosis, diploid cells produce haploids.
  - Recombination of homologous chromosomes mixes up DNA.
  - Two haploids fuse by fertilization to form a new diploid
- 
- Mitosis simply copies eukaryotic DNA, without shuffling it or changing the chromosome number: asexual reproduction, produces clones
  - Haploids and diploids can both replicate by mitosis

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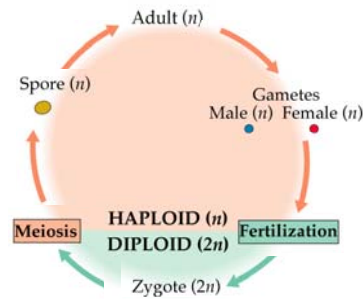
## Diplontic life cycle



only diploid is multicellular

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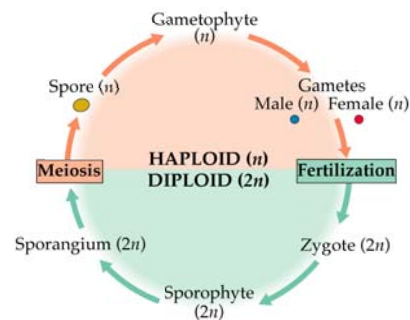
# Haplontic life cycle



only haploid is multicellular

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# Alternation of generations



haploid and diploid have independent multicellular forms

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# SEX ≠ REPRODUCTION

## Asexual:

via **mitosis** in **eukaryotes**

via **fission** in **prokaryotes** (always haploid)

offspring **genetically identical**

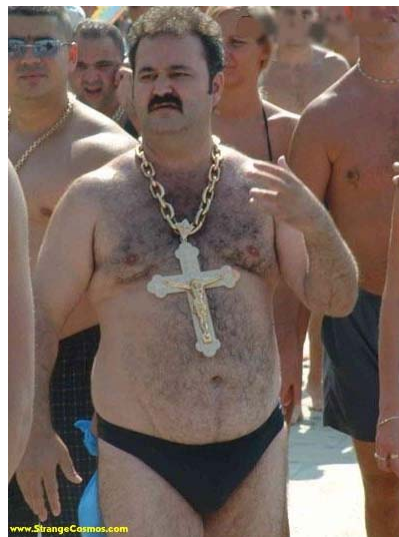
## Sexual:

genetically **different** from parents and each other

[**meiosis** ( $2N \rightarrow N$ ), then **fusion** of gametes]

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But, males are expensive...



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# Why did sex evolve?

Combat disease and pathogens?

Introduce more variation for selection to act on?

Fight oxidative damage in copying fidelity?

See Rick Michod Lab (EEB, UA) for more...

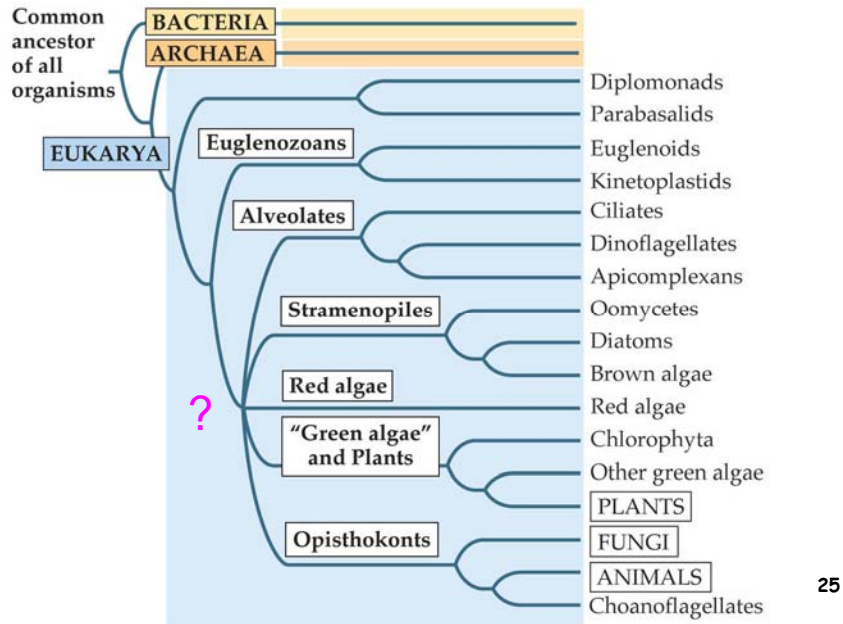
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# Biology of protists

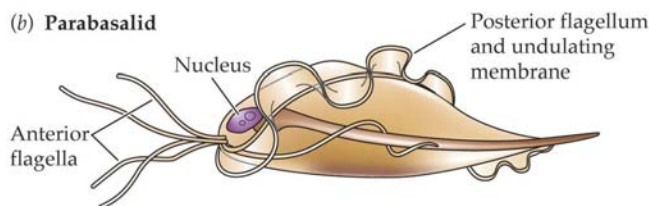
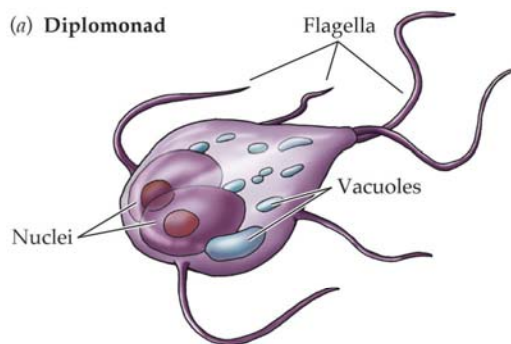
- Most are **aquatic**
- Most are unicellular, some are multicellular, a few are large
- Some are **heterotrophs**, some are **autotrophs**, and some switch
- **More diverse than prokaryotes in morphology, less diverse in metabolism**
- Use **membrane vesicles** for many things
- Most reproduce both **sexually and asexually**
- "Protozoan" and "algae" lump together many phylogenetically distant protist groups
- Some responsible for human suffering

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# Evolutionary history of protists



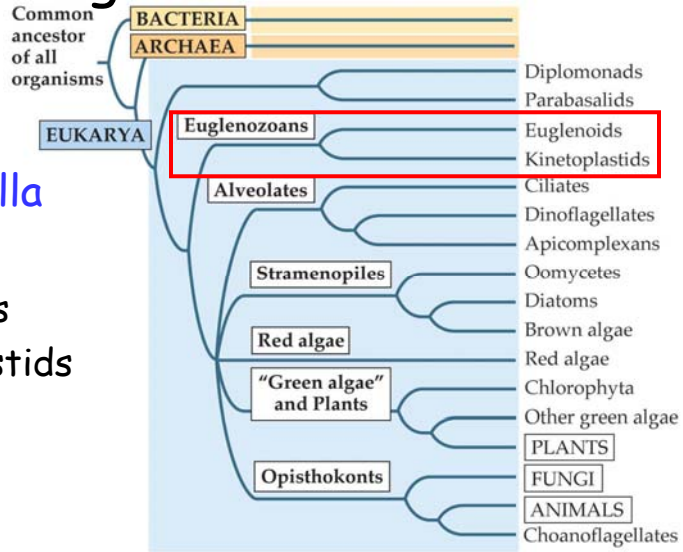
## Diplomonads and Parabasalids



Both unicellular,  
lost their  
mitochondria

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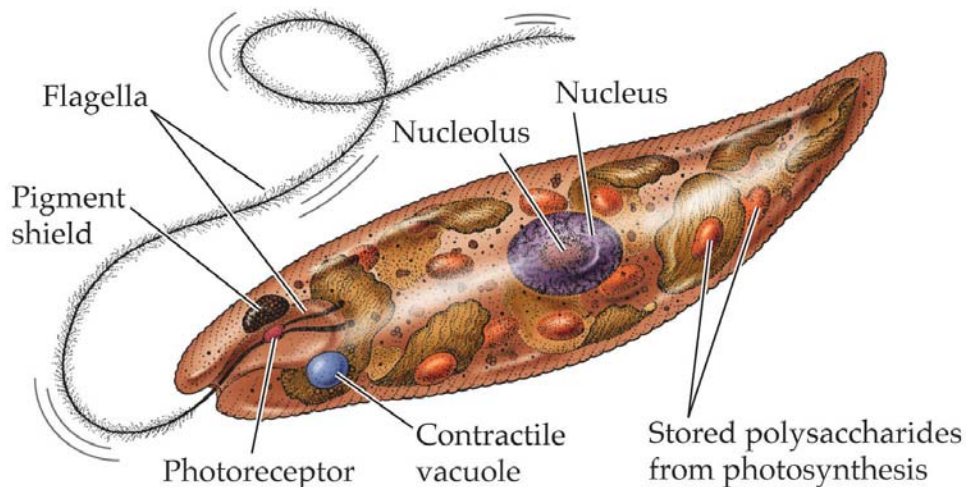
# Euglenozoans



- Have flagella
- 2 clades
  - Euglenoids
  - Kinetoplastids

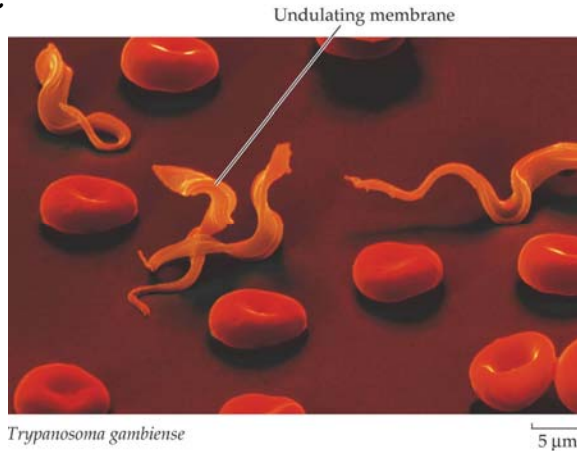
# Euglenoids

often photosynthetic, but very flexible about nutrition



# Kinetoplastids

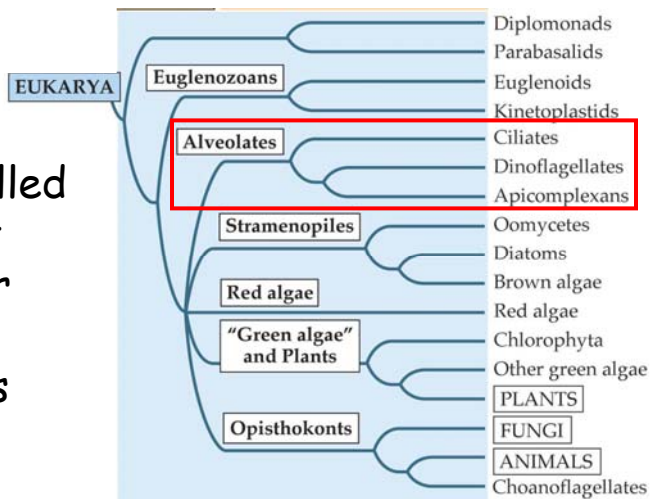
- parasitic
- **trypanosomes** cause sleeping sickness, leishmaniasis, Chagas' disease, and East Coast fever
- single large mitochondrion with **kinetoplast** housing multiple, circular DNA molecules: edits own RNA



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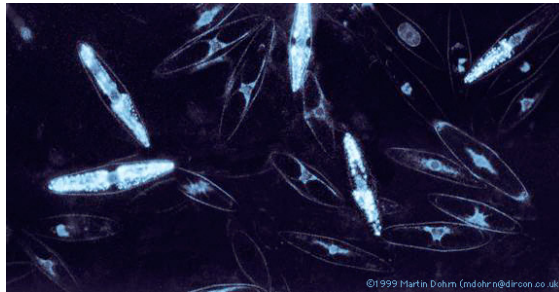
# Alveolates

- unicellular
- cavities called **alveoli** just below their plasma membranes



# Dinoflagellates

- Important primary producers in the oceans
- (part of the phytoplankton = photosynthetic free-floating microscopic organisms)
- Many are endosymbionts (e.g., in corals)
- Some are parasites of other marine organisms
- Many are bioluminescent



Dinoflagellates cause "red tides"



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## When and why do dinoflagellates bioluminesce?

- It's like a burglar alarm against predators.
- When a dinoflagellate is disturbed, it flashes.
- This **attracts a secondary predator**.
- The secondary predator is more likely to eat the larger burglar than the smaller dinoflagellate.
- Often the threat alone is enough to scare off the primary predator ("burglar").
- Breaking waves, running hand through water, or stepping on sand also disturb dinoflagellates

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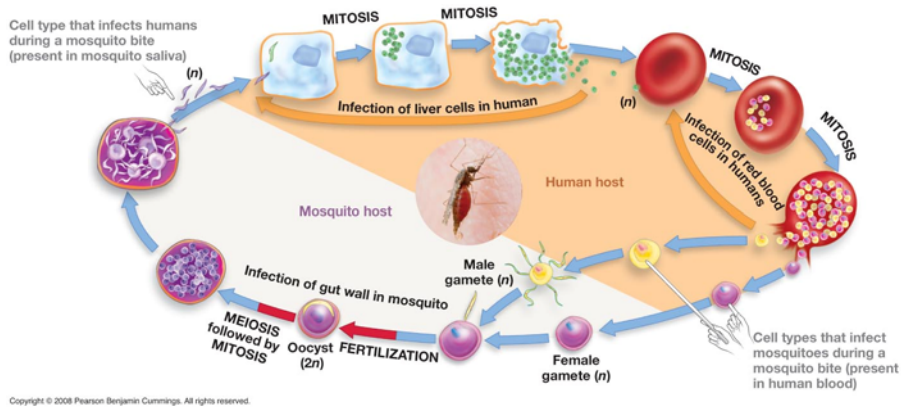
## Apicomplexans

- Apical complex = mass of organelles at apical end of spores
- All are **parasites**: apical complex organelles help spore invade host tissue
- *Plasmodium* are the cause of **malaria**
- Enters the human circulatory system by way of the *Anopheles* **mosquito**
- **Extracellular** parasite in the insect vector and an **intracellular** parasite in the human host

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# Apicomplexans

*Plasmodium* are the cause of malaria

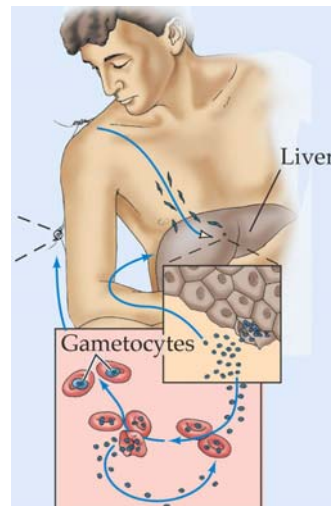


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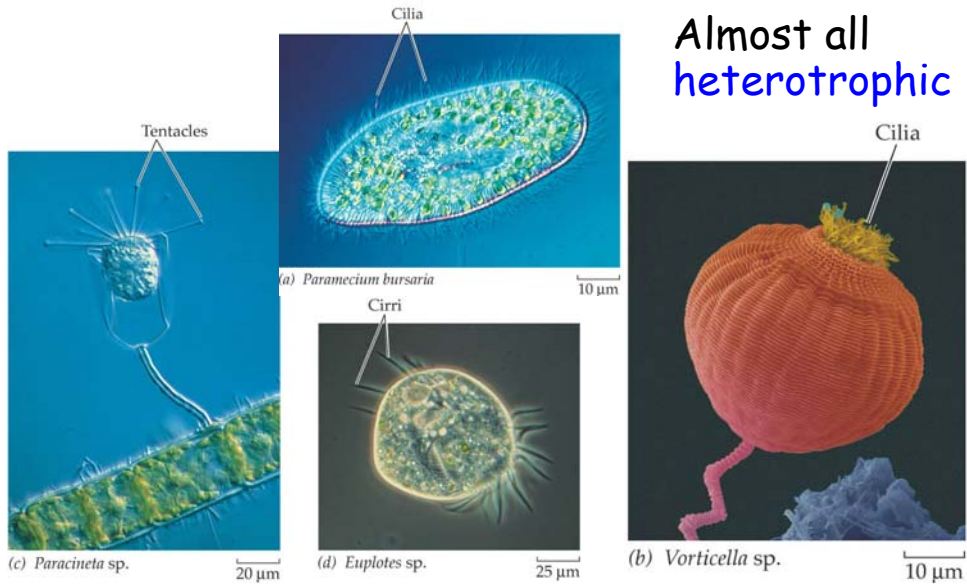
What part of the *Plasmodium* life cycle does chloroquine interfere with?

erythrocytic stage  
(inside red blood cells)

This treats the symptoms, but persistent liver infection can lead to relapses



Ciliates have complex and varied body forms with hairlike cilia



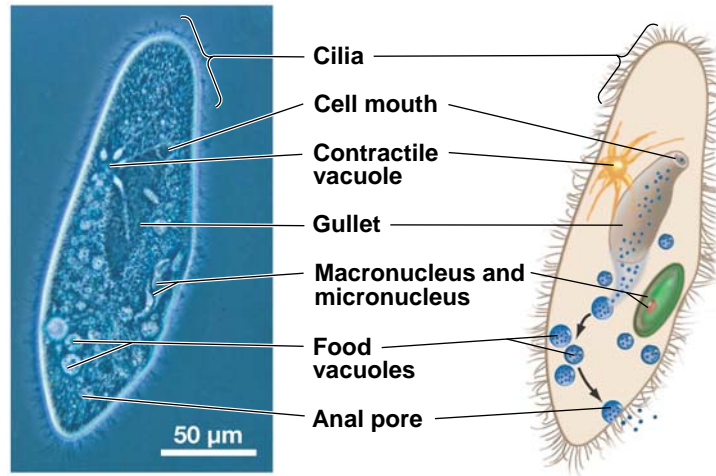
Large ciliate from termite gut moves using thousands of synchronized flagella (27-03)



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Figure 29-15

*Paramecium* uses **cilia** to generate current to carry prey to gullet



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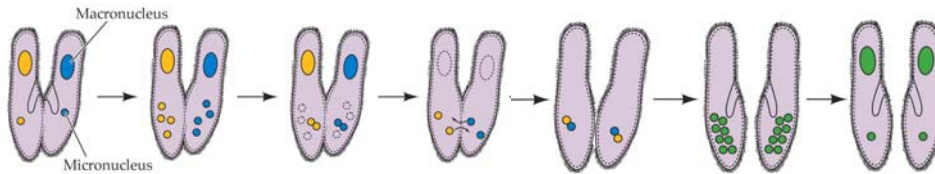
*Paramecium* uses **cilia** to generate current to carry prey to gullet



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# Paramecium conjugation

- Genetic recombination called **conjugation** (~sex)
- Haploid **micronuclei are exchanged**
- Fuse to form a new diploid micronucleus

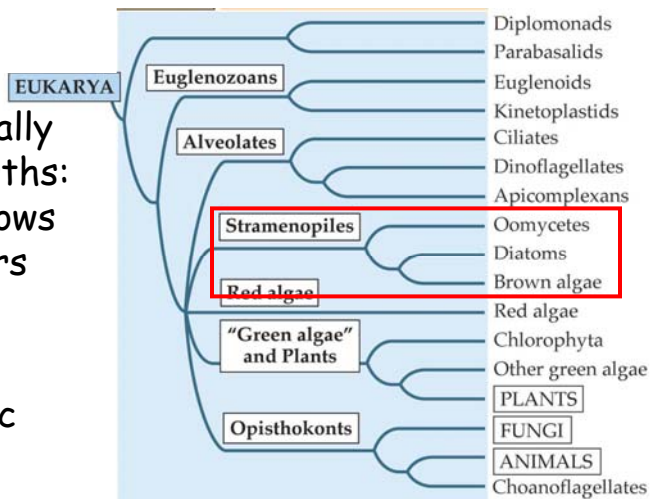


- *Not reproductive; no new cells are created: reproduction is asexual by binary fission*
- (SEX ≠ REPRODUCTION)**

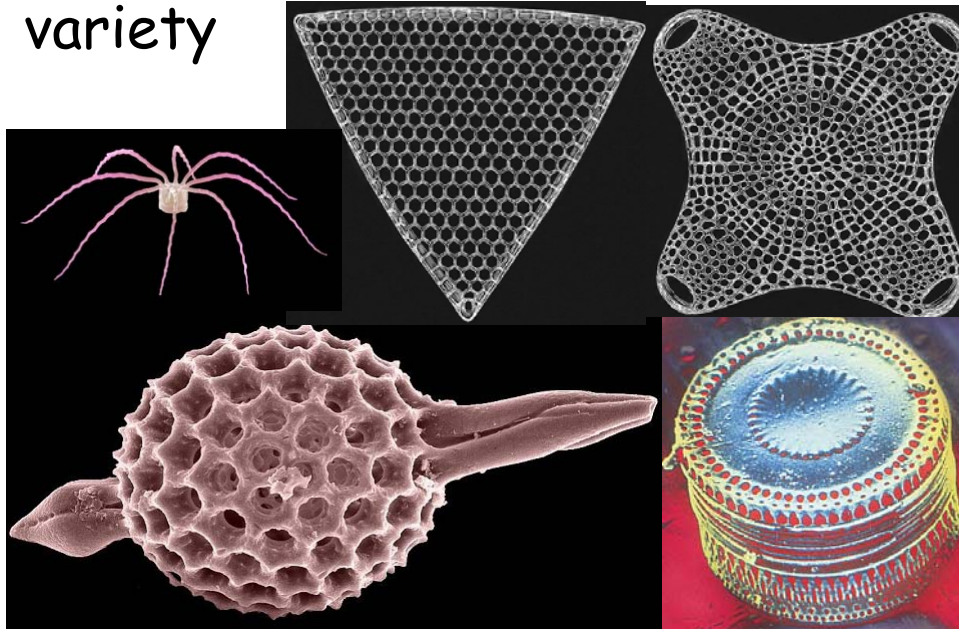
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# Stramenopiles

- 2 flagella, usually different lengths: long one has rows of tubular hairs
- Some are photosynthetic



## Diatoms: best known for beauty & variety

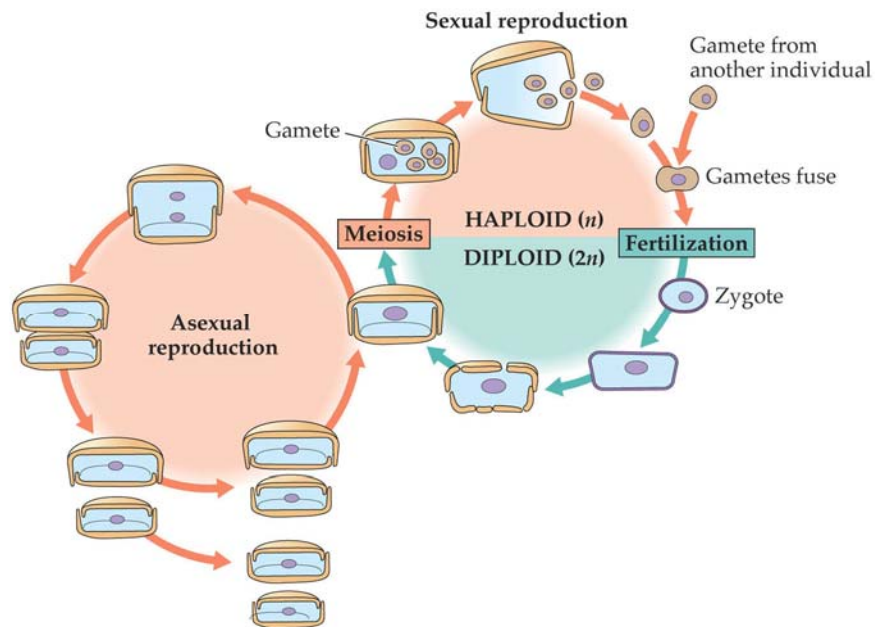


## Diatoms

- Found everywhere in marine environments, major photosynthetic producers (phytoplankton)
- Characteristic stramenopile flagella got lost
- Structure given by silicon-implanted cell walls, very strong
- Always symmetric (either radial or bilateral)
- Certain sedimentary rocks are almost entirely composed of diatom skeletons, called diatomaceous earth.
- Top part overlaps bottom like a Petri dish

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## Diatoms reproduce both sexually and asexually



## Brown algae

(27-16)

Can be big  
(60m. giant kelp)

Brown from  
carotenoid  
fucoxanthin in  
chloroplasts

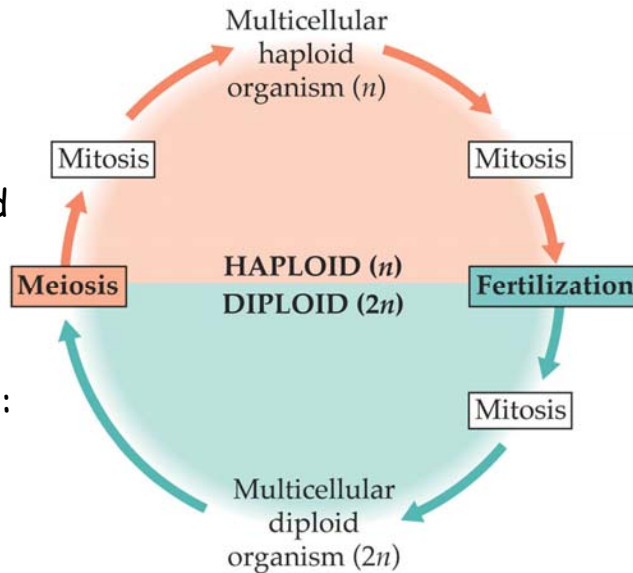


## Brown algae have alternation of generations

Can be either...

- **Isomorphic:**  
gametophyte and sporophyte look similar

- **Heteromorphic:**  
they look different



## Oomycetes (water mold)

- Secrete **enzymes to break down dead things**, absorb products
- "-mycete" because we used to think they were fungi, but they aren't
- *Phytophthora infestans* caused **Irish potato famine**

*Saprolegnia* sp.



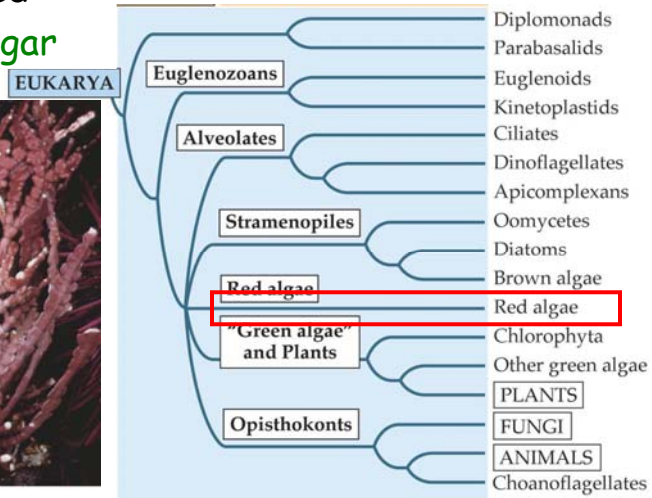


# Red algae

- photosynthetic pigment phycoerythrin, but they aren't always red
- Used to make agar



(a) *Bossiella orbigniana*



# Green stuff

- chlorophylls *a* and *b*

