

# Protists (Eukarya)



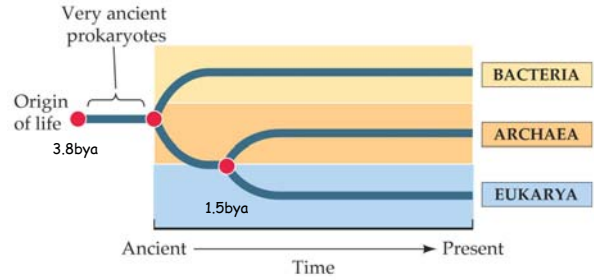
5 μm

Ch 29

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

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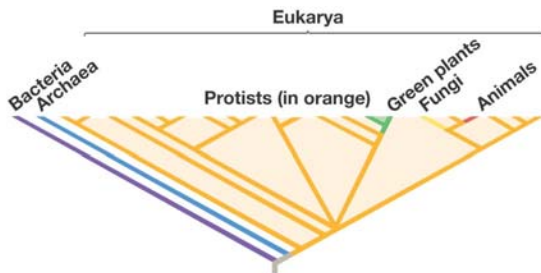
# Life can be divided into 3 domains



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

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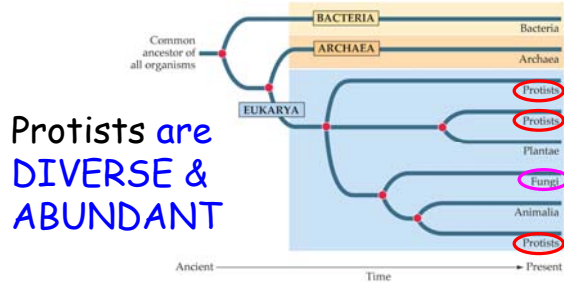
# Eukarya



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

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# Where are microbes on tree of life?

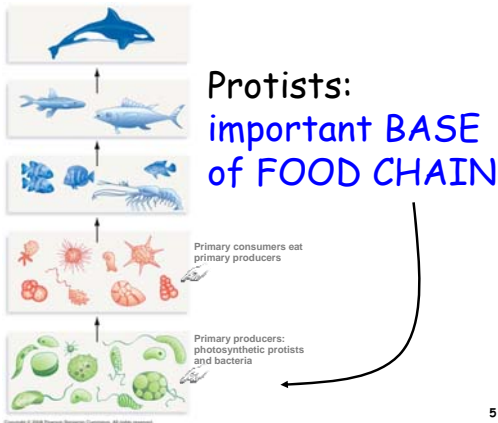


Protists are **DIVERSE & ABUNDANT**

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

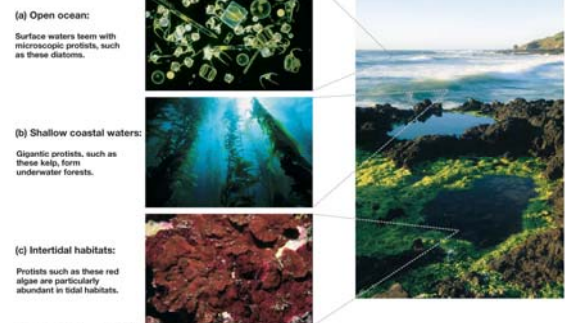
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Figure 29-5



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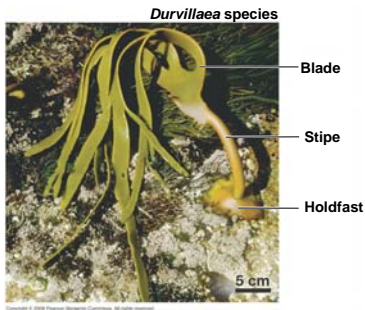
# Protists



Very common in aquatic habitats

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# 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

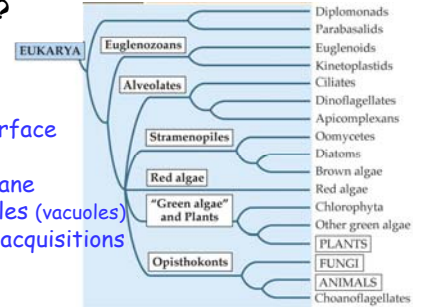
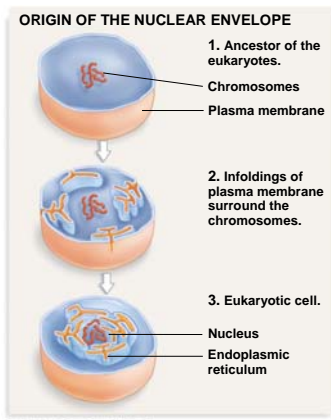
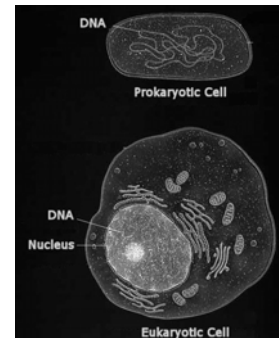


Figure 29-10



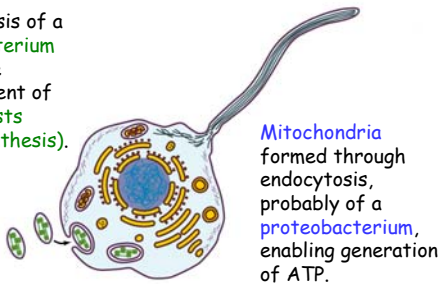
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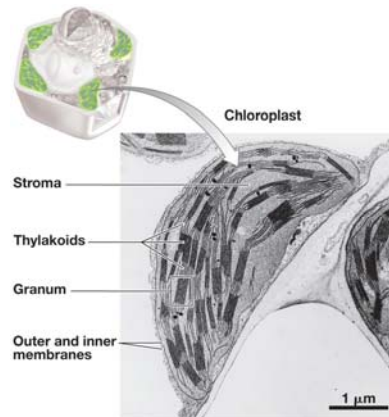
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## Eukaryotes contain organelles that were once independent prokaryotes

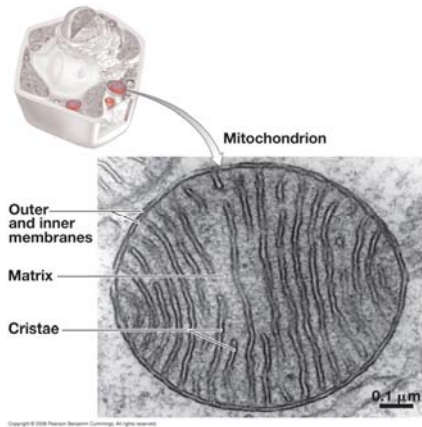
Endocytosis of a cyanobacterium led to the development of chloroplasts (photosynthesis).



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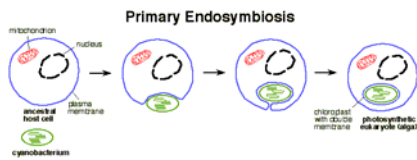
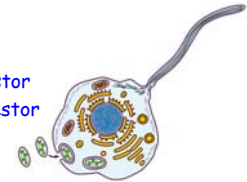
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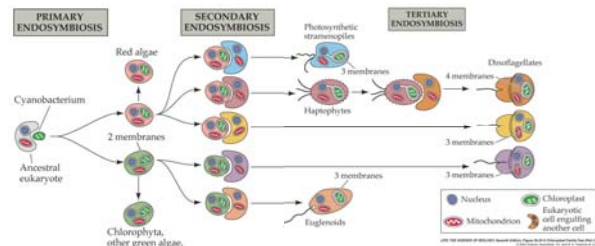
## Endosymbiosis

- 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



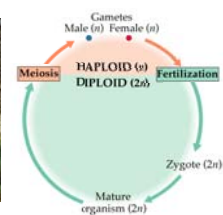
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## Most Eukaryotes: Sexual lifecycle with meiosis

- 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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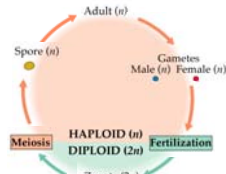
## Diplontic life cycle



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 → 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...

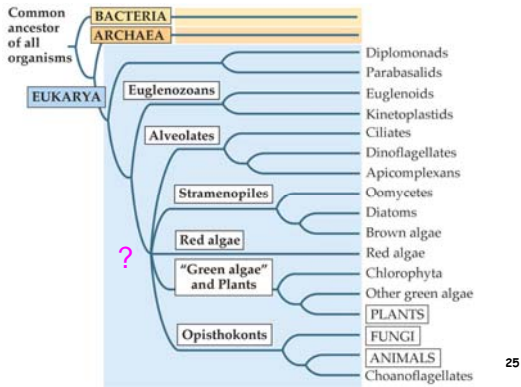
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## Biology of protists

- 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

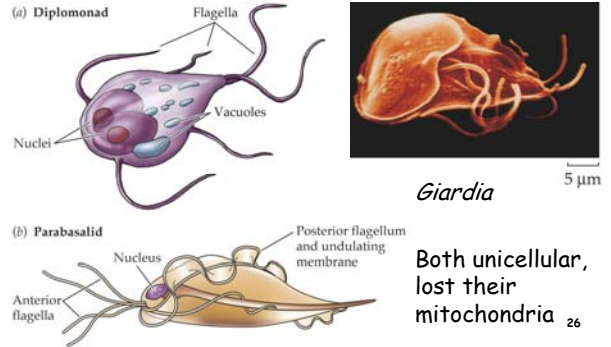
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## Evolutionary history of protists

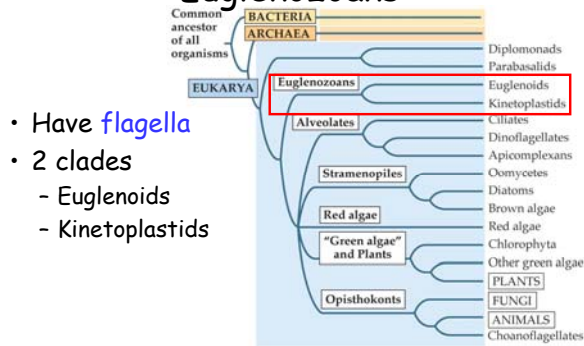


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## Diplomonads and Parabasalids



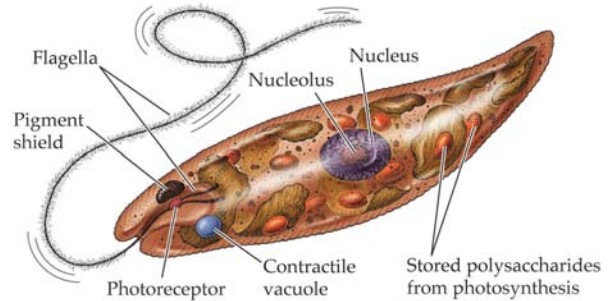
## Euglenozoans



- Have **flagella**
- 2 clades
  - Euglenoids
  - Kinetoplastids

## Euglenoids

often photosynthetic, but very flexible about nutrition



## Kinetoplastids

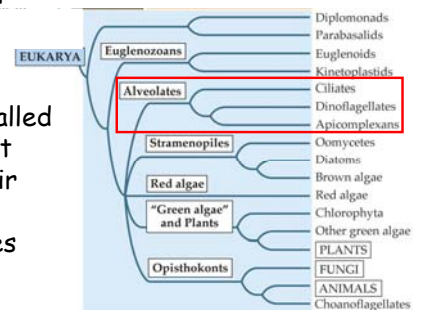
- parasitic
- **trypanosomes** cause sleeping sickness, leishmaniasis, Chagas' disease, and East Coast fever
- single large mitochondrion with **kinetoplast** housing multiple, circular DNA molecules: edits own RNA



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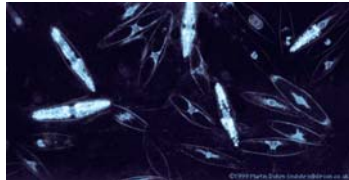
## Alveolates

- 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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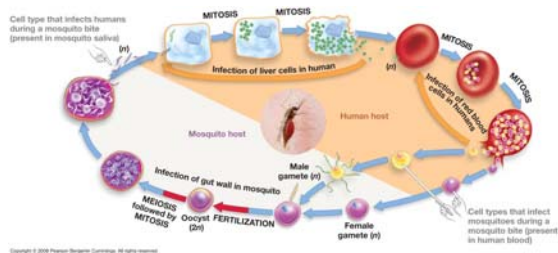
## Apicomplexans

- 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

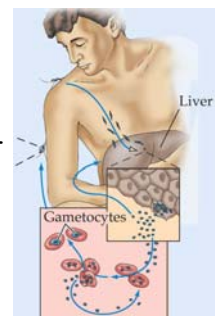


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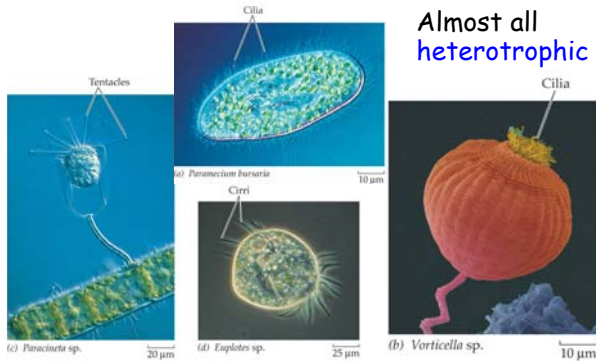
What part of the *Plasmodium* life cycle does chloroquine interfere with?

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



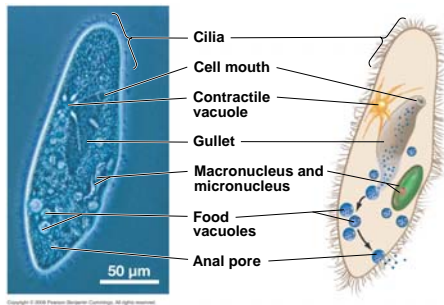
Large ciliate from termite gut moves using thousands of synchronized flagella (27-03)



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Figure 29-15

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



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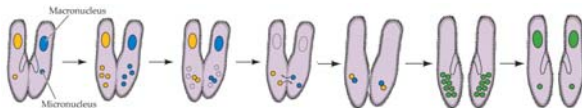
*Paramecium* uses cilia to generate current to carry prey to gullet



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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

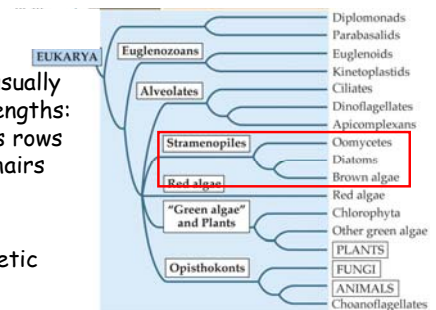
(SEX ≠ REPRODUCTION)

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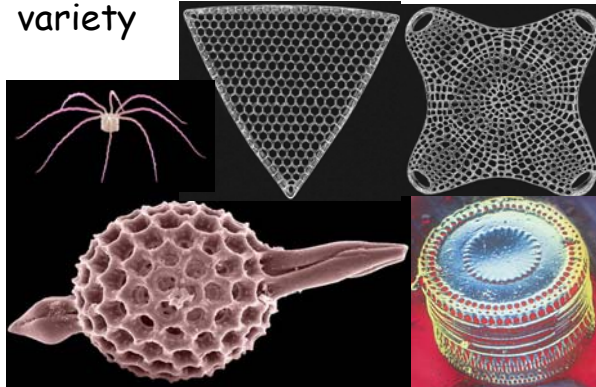
### Stramenopiles

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

- Some are photosynthetic



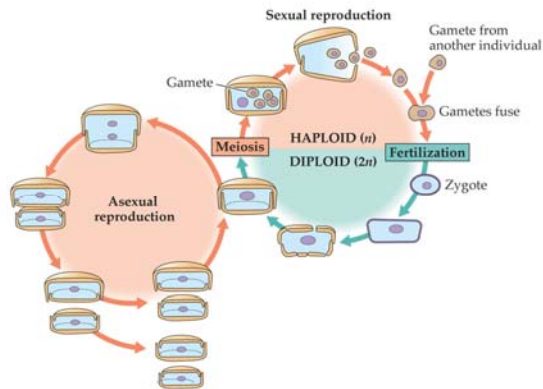
## Diatoms: best known for beauty & variety



## 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 44

Diatoms reproduce both sexually and asexually



## Brown algae

(27-16)

Can be big  
(60m. giant kelp)



Brown from  
carotenoid  
fucoxanthin in  
chloroplasts

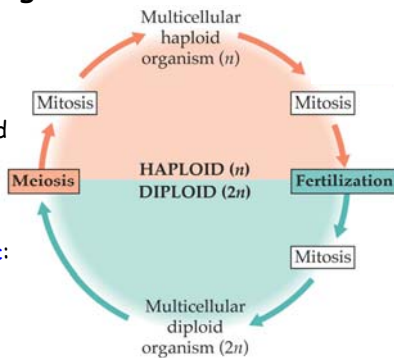
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## Brown algae have alternation of generations

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**



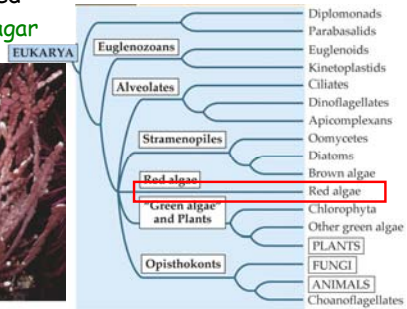


## Red algae

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



(a) *Bossiella orbignyana*



## Green stuff

- chlorophylls *a* and *b*

