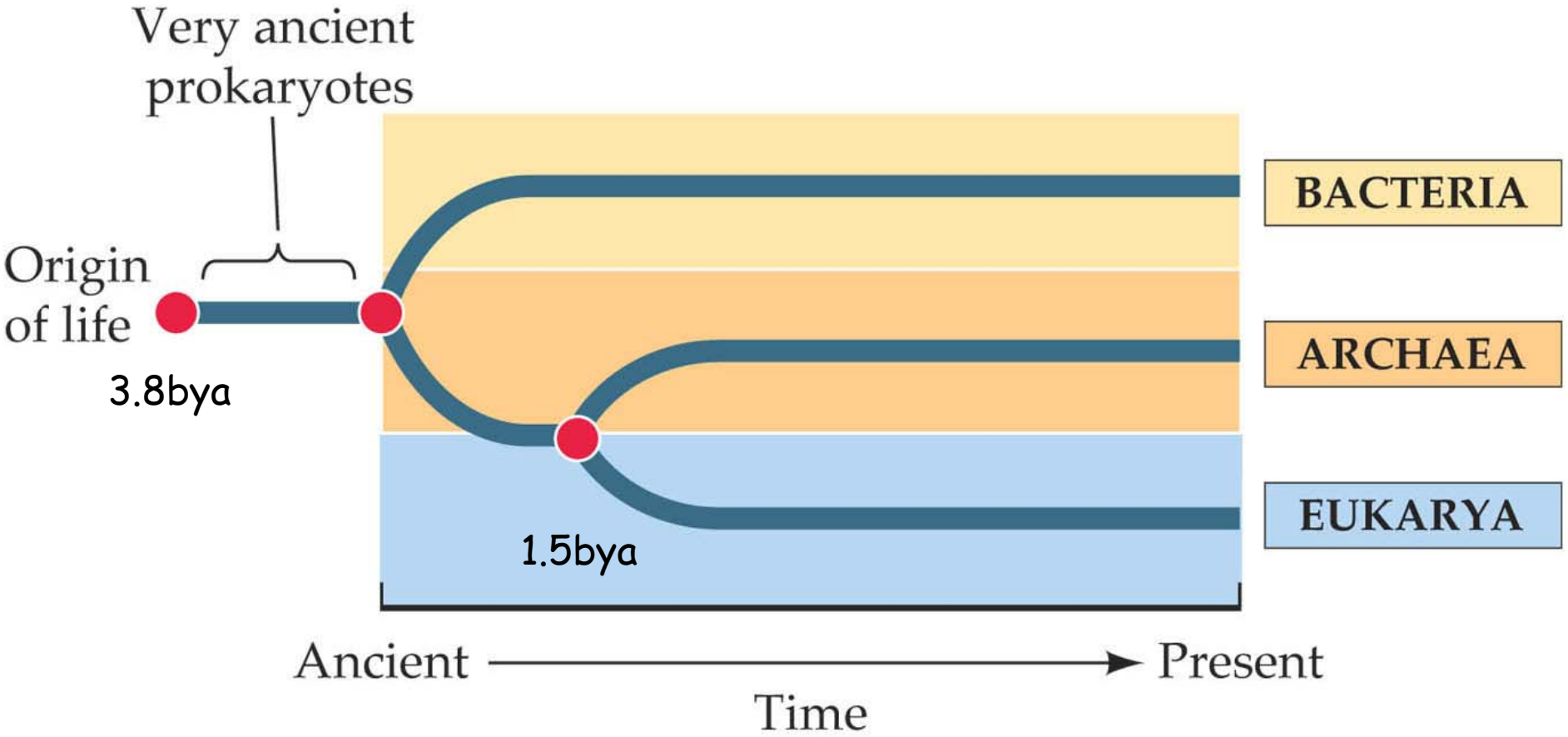
Protists (Eukarya)

Ch 29

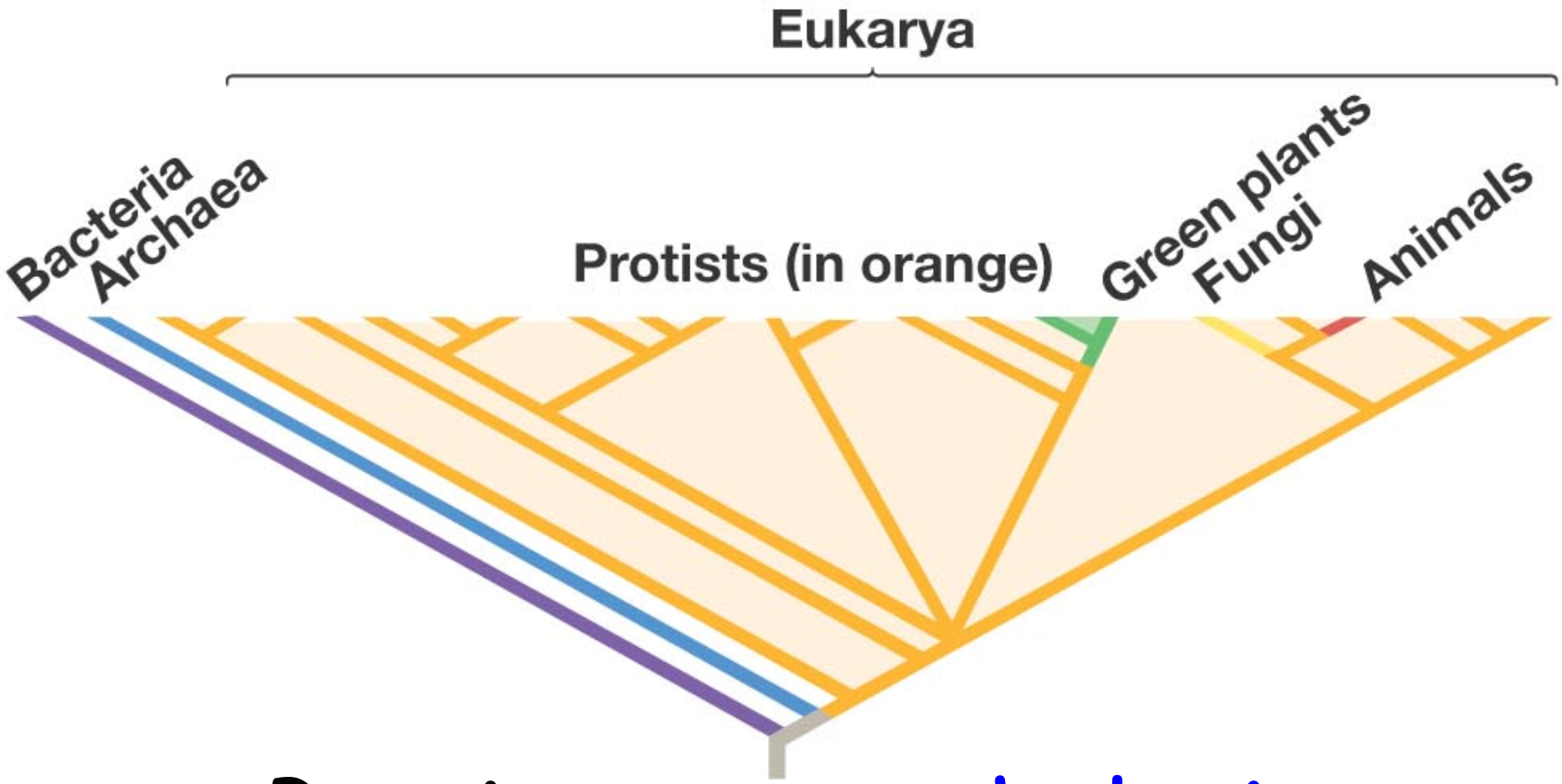
26 Feb 2009
ECOL 182R UofA
K. E. Bonine

Life can be divided into 3 domains



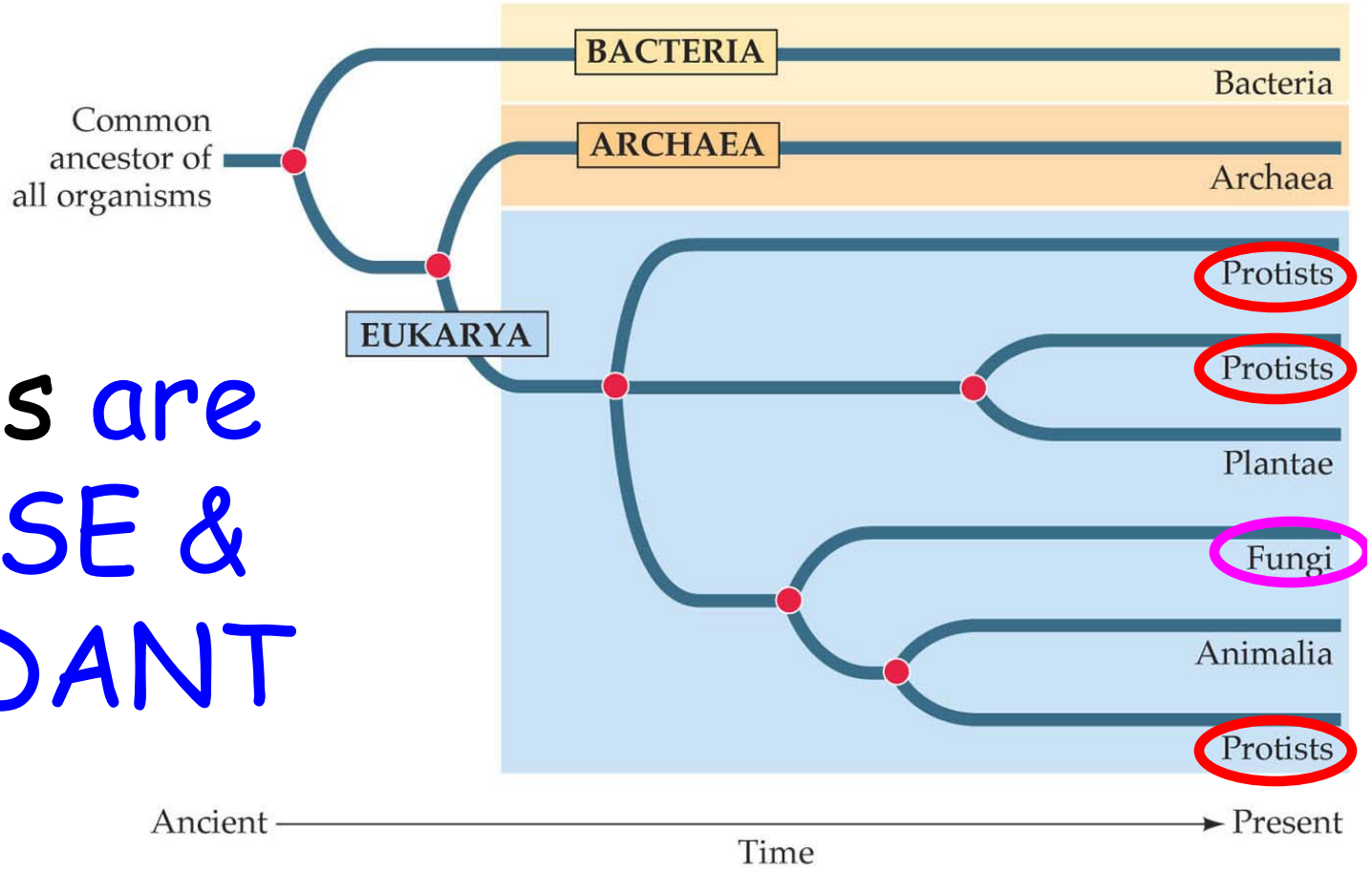
- Prokaryotes = bacteria + archaea
- Prokaryote was ancestral and only form for billions of years

Eukarya



are Protists monophyletic, paraphyletic, polyphyletic?

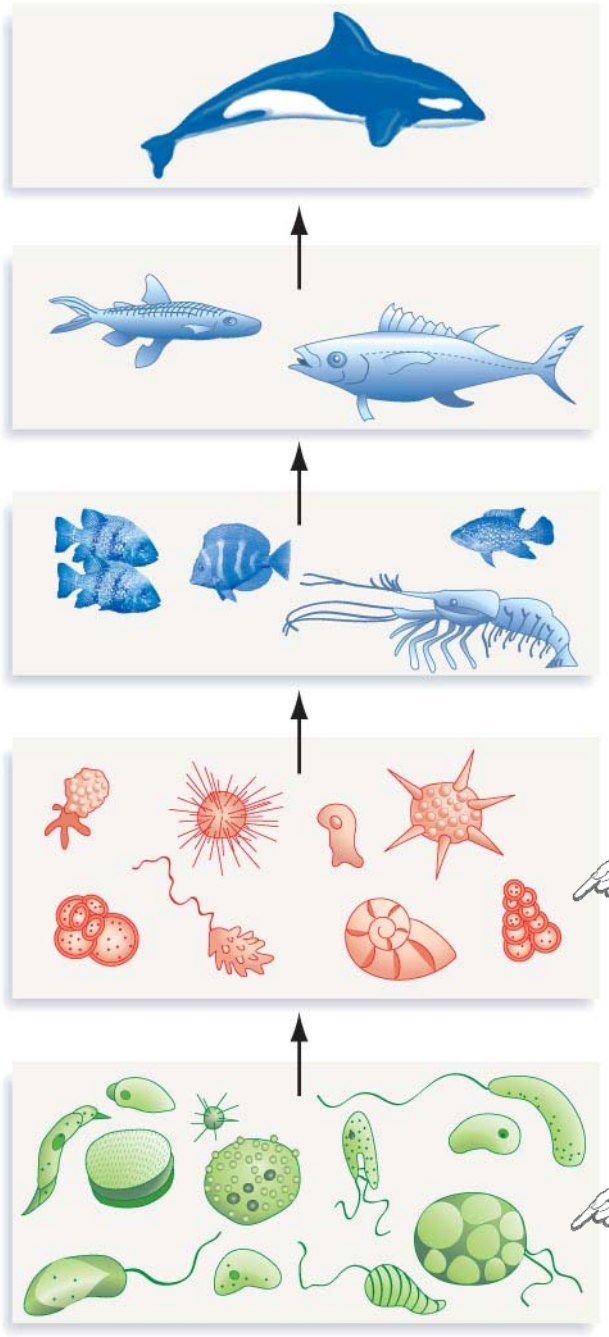
Where are microbes on tree of life?



Protists are DIVERSE & ABUNDANT

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

Figure 29-5



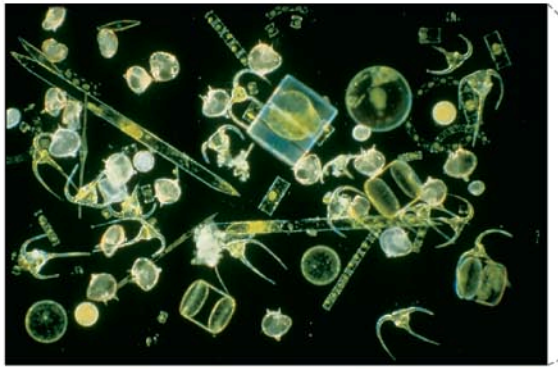
Protists:

important BASE of FOOD CHAIN

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.

Very common in aquatic habitats

KELP

***Durvillaea* species**

Multicellularity evolved multiple times in eukaryotes

How are eukaryotes different?

What happened during the evolution of eukaryotes?

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

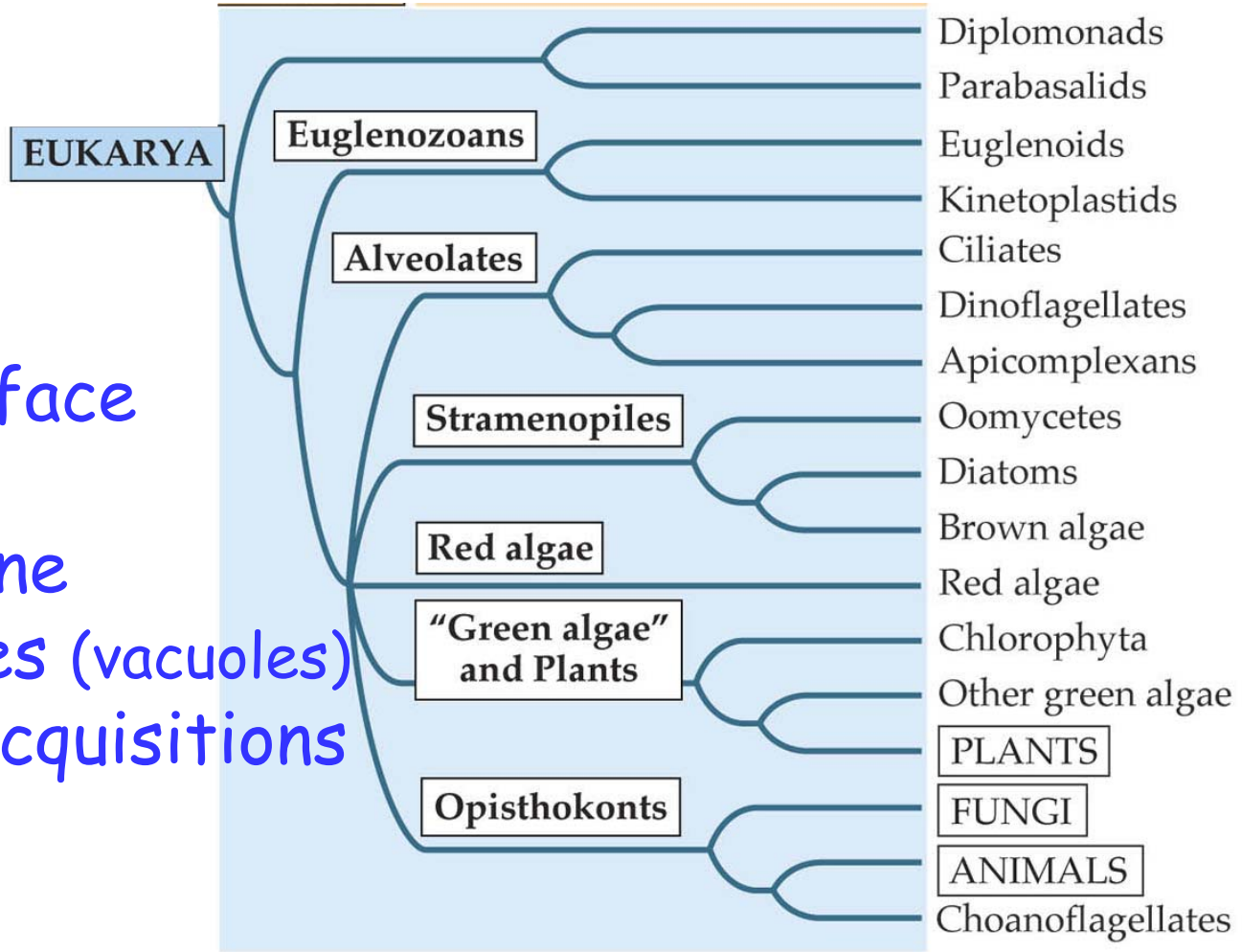
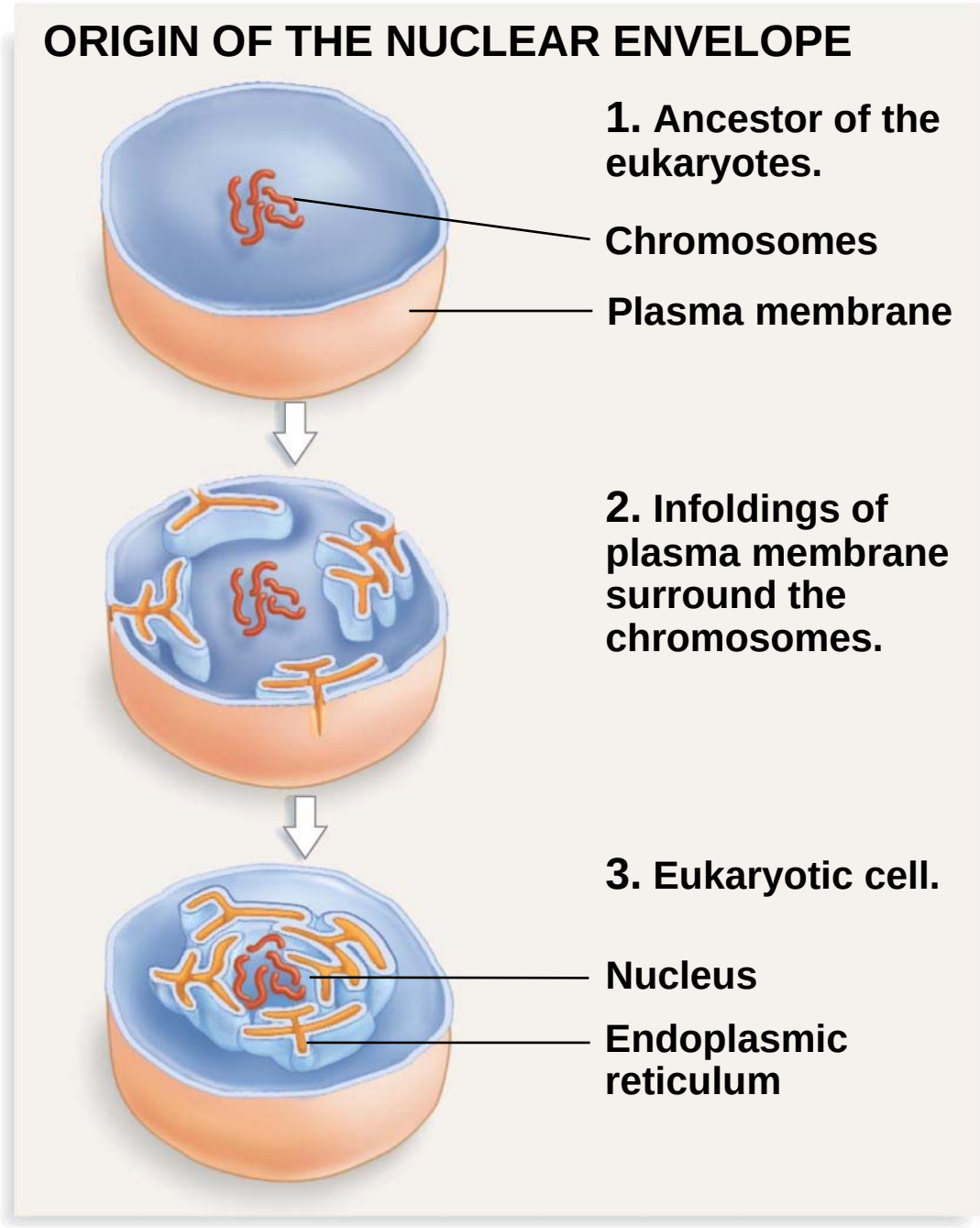
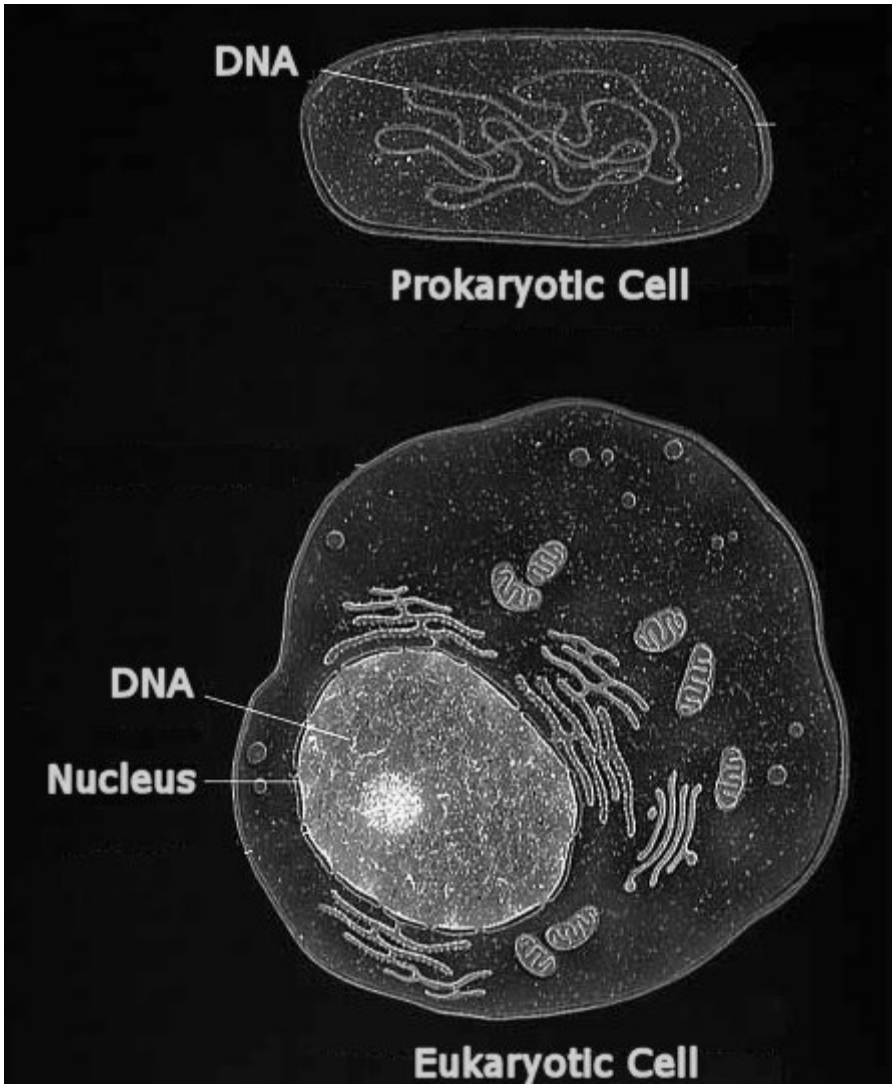


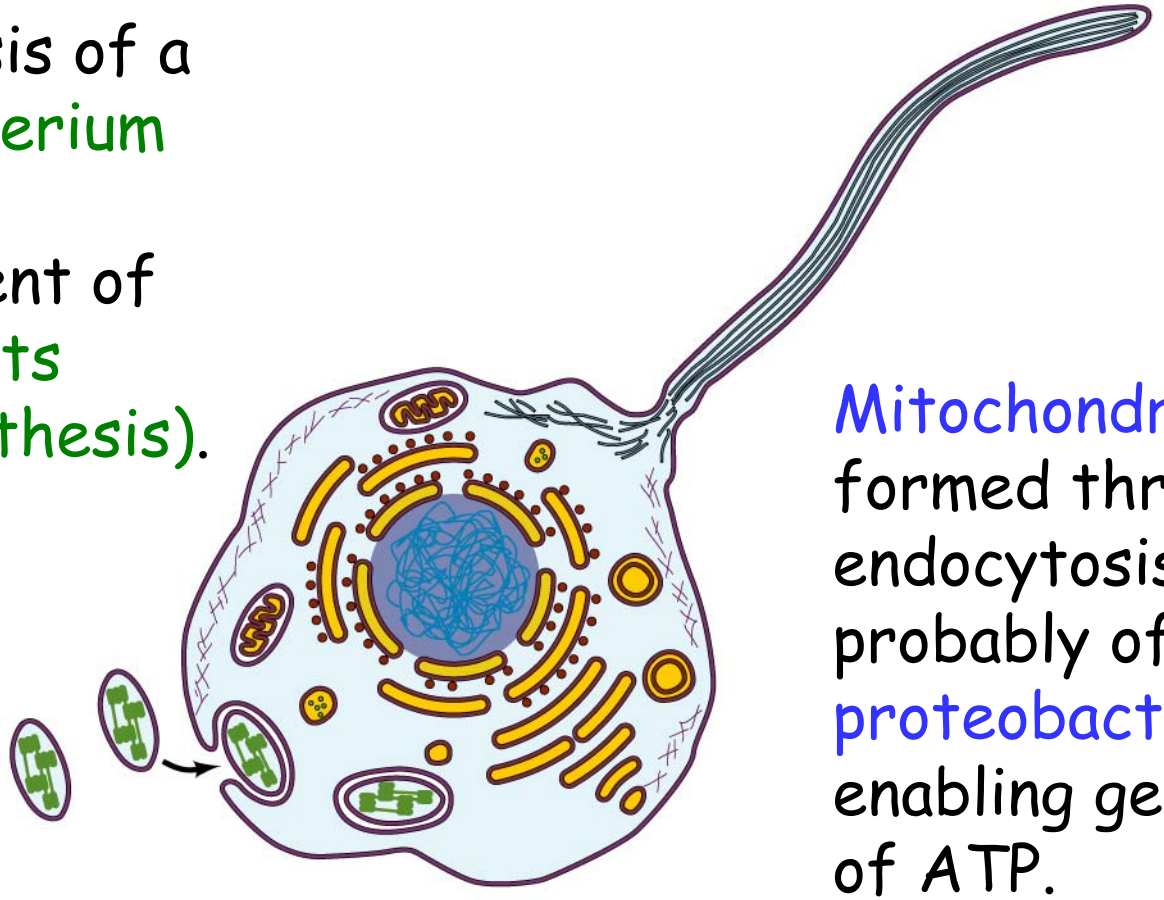
Figure 29-10



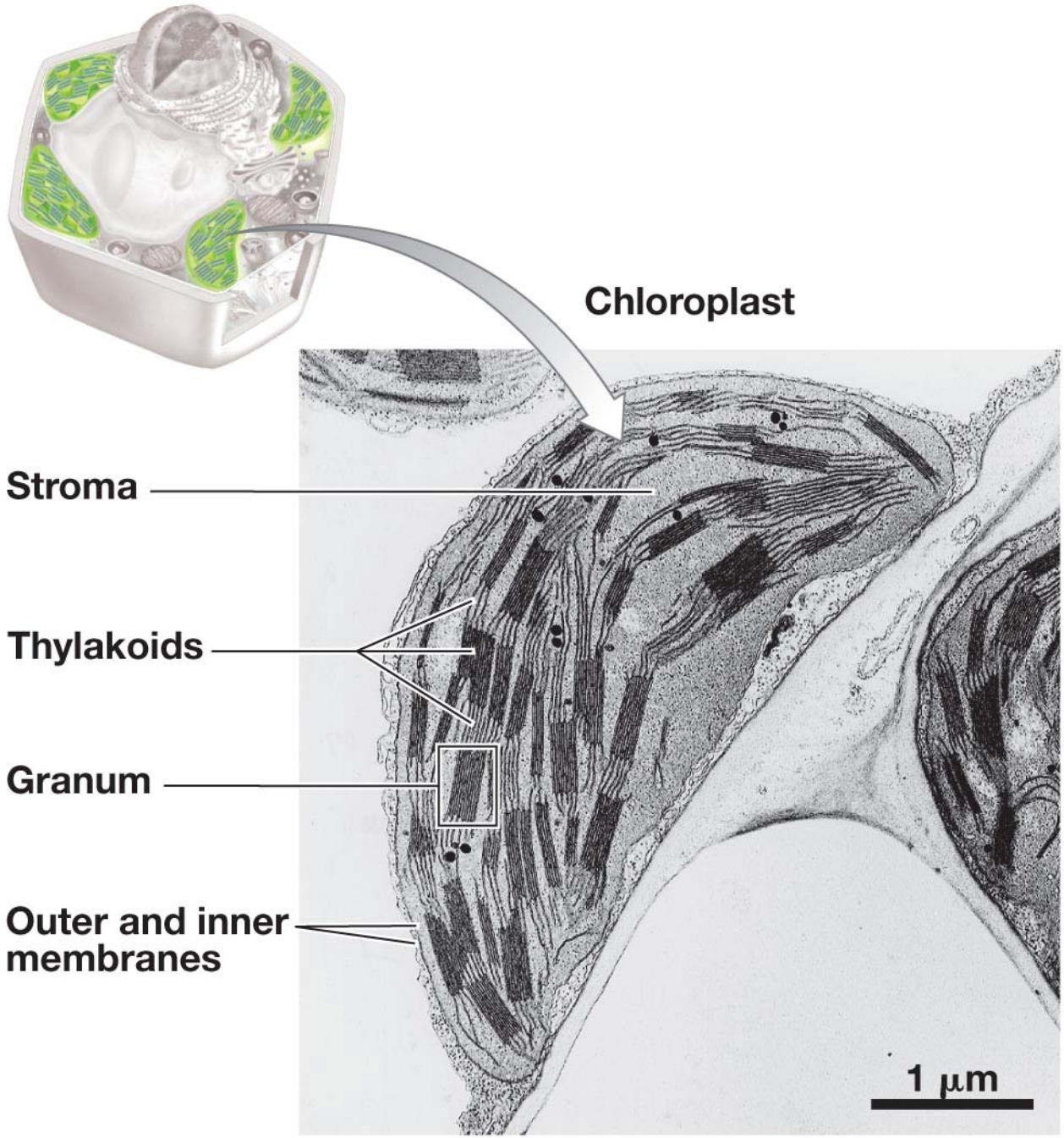

DNA
Prokaryotic Cell
DNA
Nucleus
Eukaryotic Cell

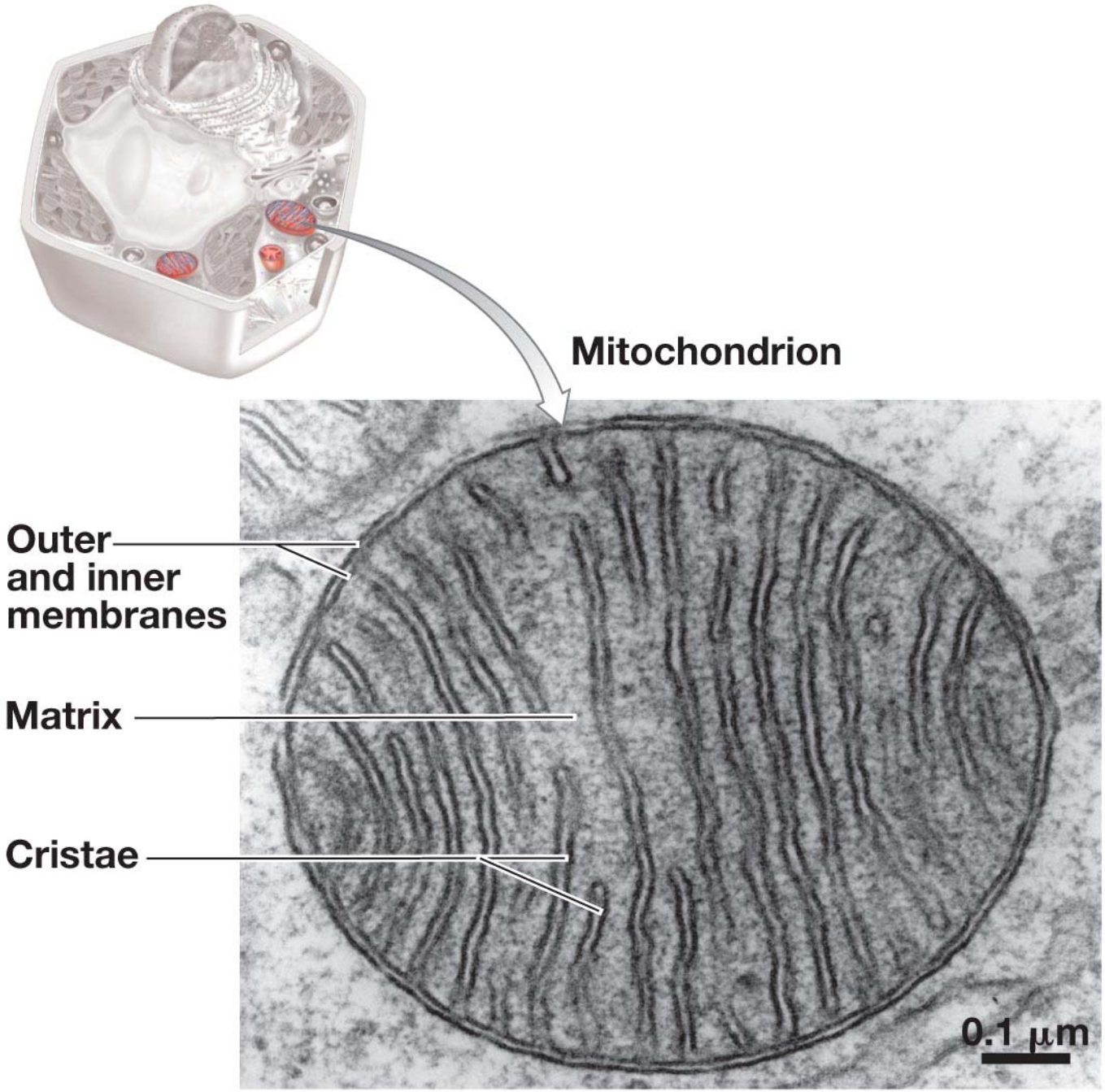
Eukaryotes contain organelles that were once independent prokaryotes

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



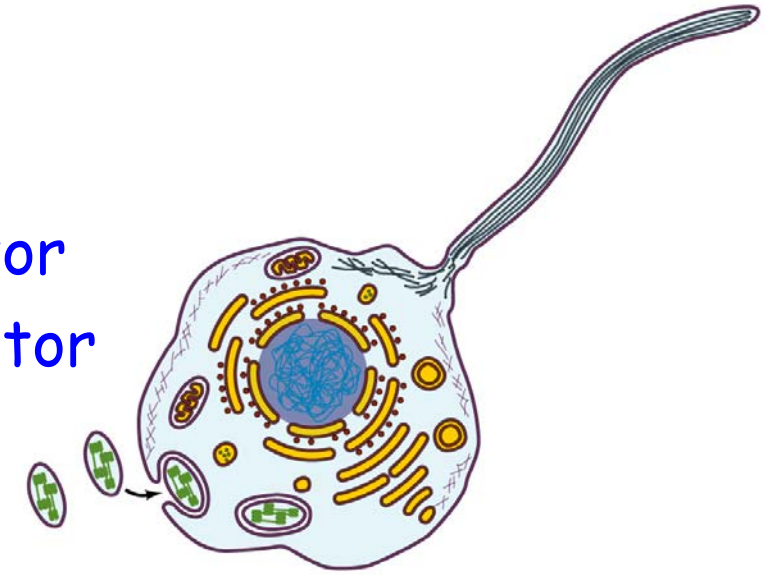
Mitochondria formed through endocytosis, probably of a proteobacterium, enabling generation of ATP.



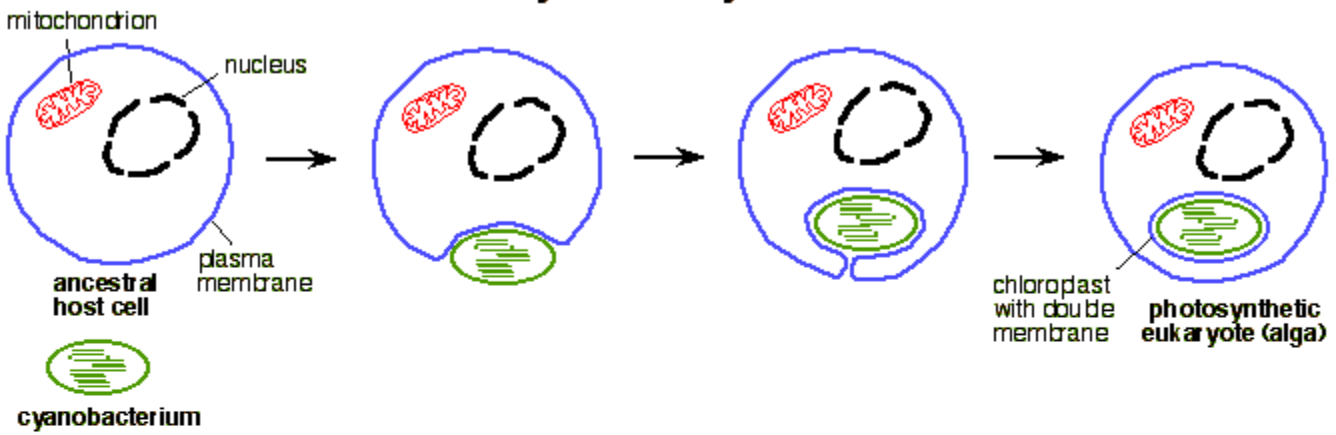


Endosymbiosis

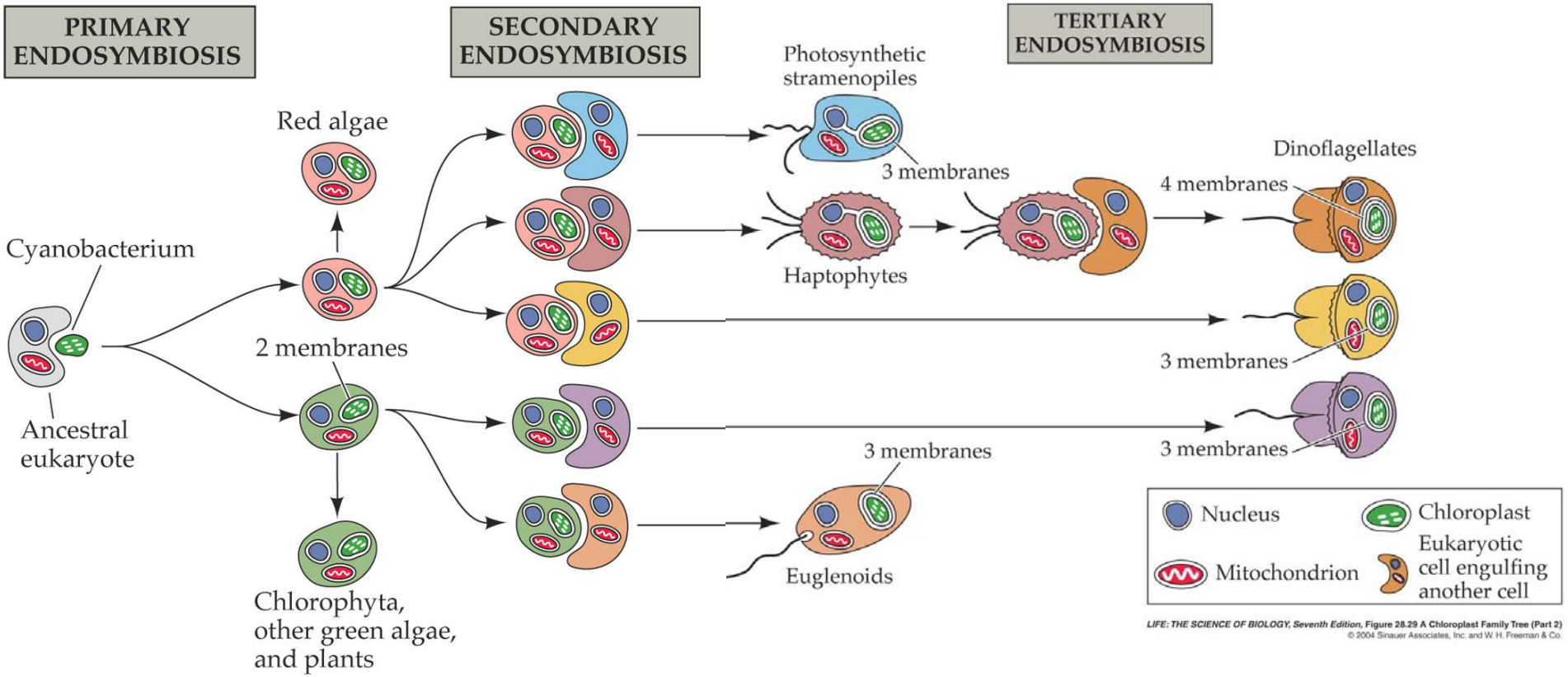
- One organism lives inside another
- Eukaryotic cell took in (endocytosis) prokaryotic ancestors of mitochondria and chloroplasts
- Organelles have
  - own DNA
  - 2 membranes
    - one from eukaryotic ancestor
    - one from prokaryotic ancestor



Primary Endosymbiosis



Lots of endosymbiosis



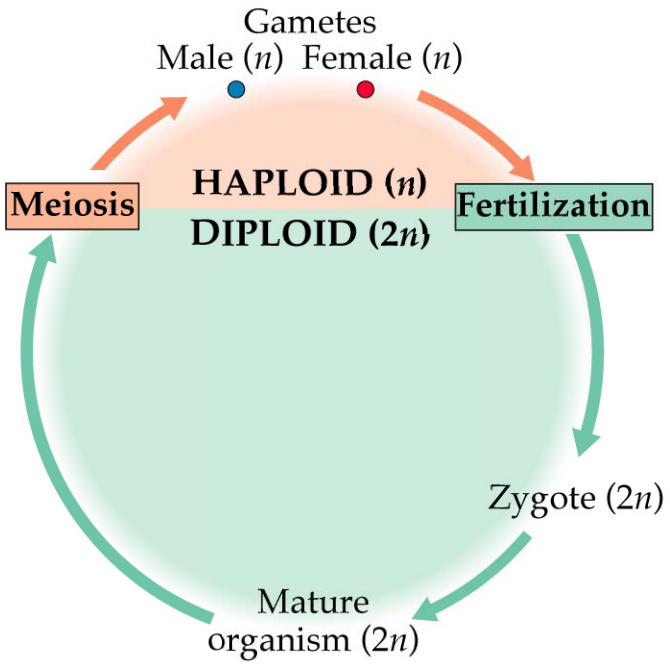
LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 28.29 A Chloroplast Family Tree (Part 2)

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

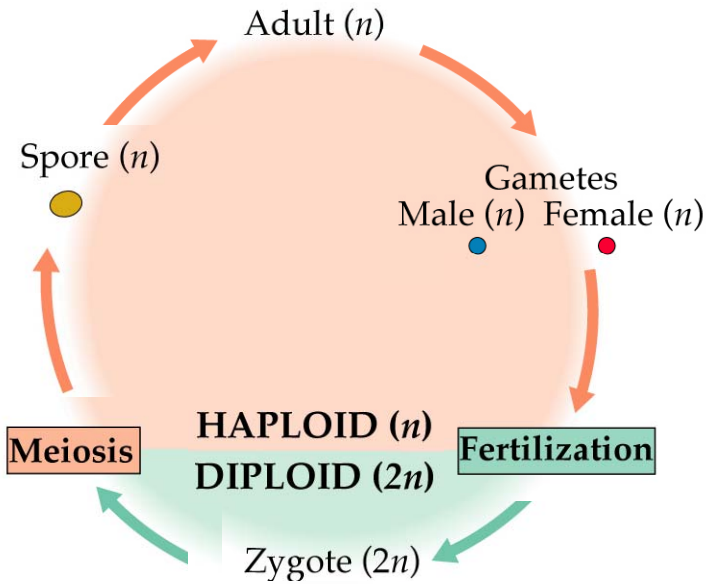
- Mitosis simply copies eukaryotic DNA, without shuffling it or changing the chromosome number: asexual reproduction, produces clones
- Haploids and diploids can both replicate by mitosis

Diplontic life cycle



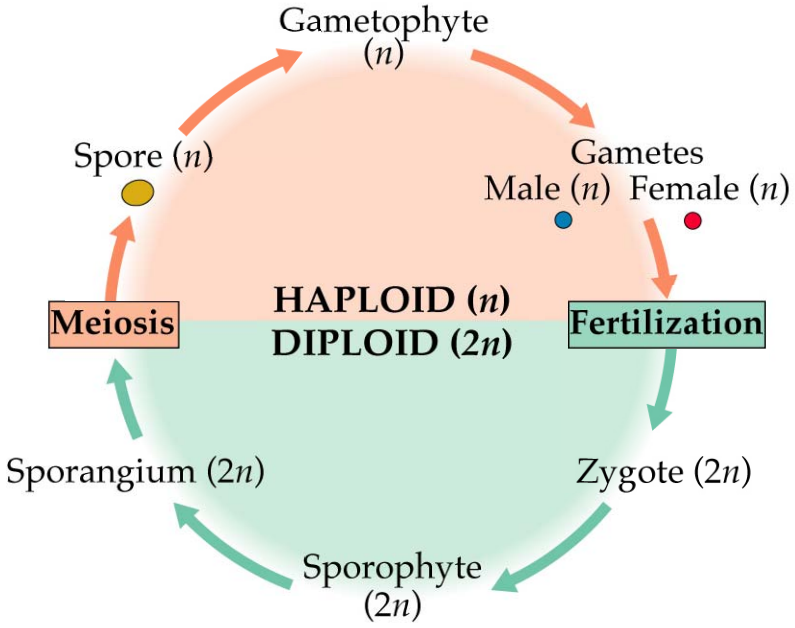
only diploid is multicellular

Haplontic life cycle



only haploid is multicellular

Alternation of generations



haploid and diploid have independent multicellular forms

SEX ≠ REPRODUCTION

Asexual:

via mitosis in eukaryotes

via fission in prokaryotes (always haploid)

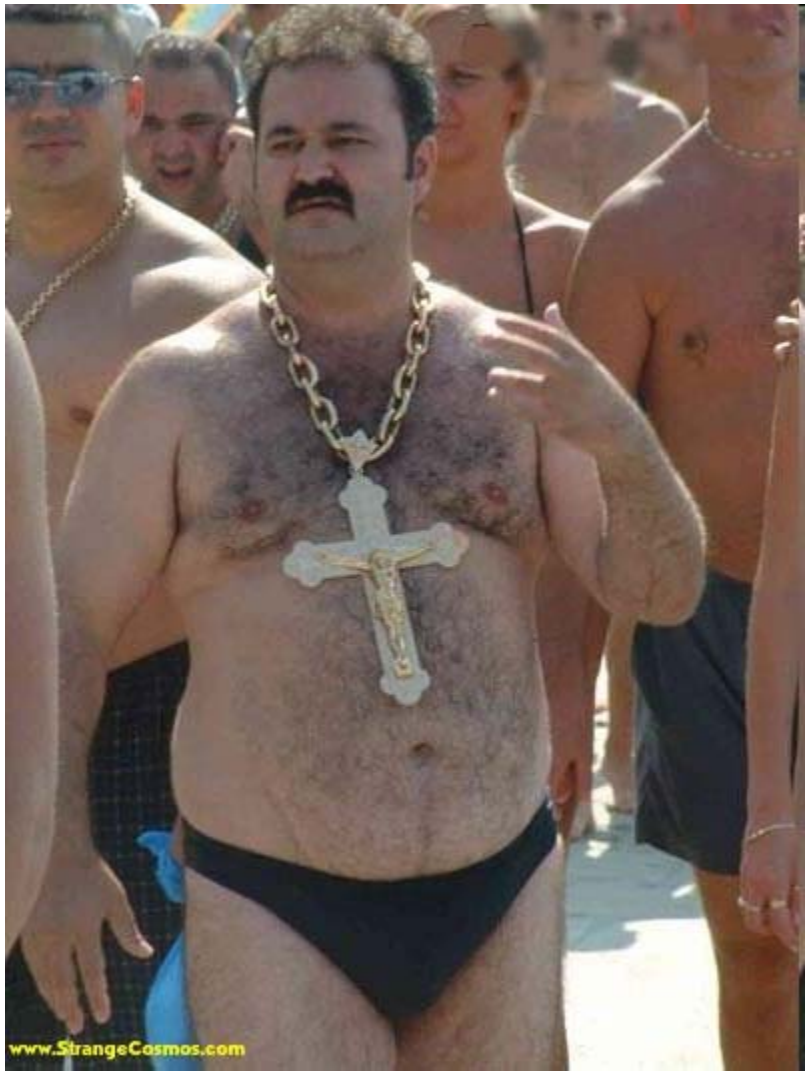
offspring genetically identical

Sexual:

genetically different from parents and each other

[meiosis (2N -> N), then fusion of gametes]

But, males are expensive…



Why did sex evolve?

Combat disease and pathogens?

Introduce more variation for selection to act on?

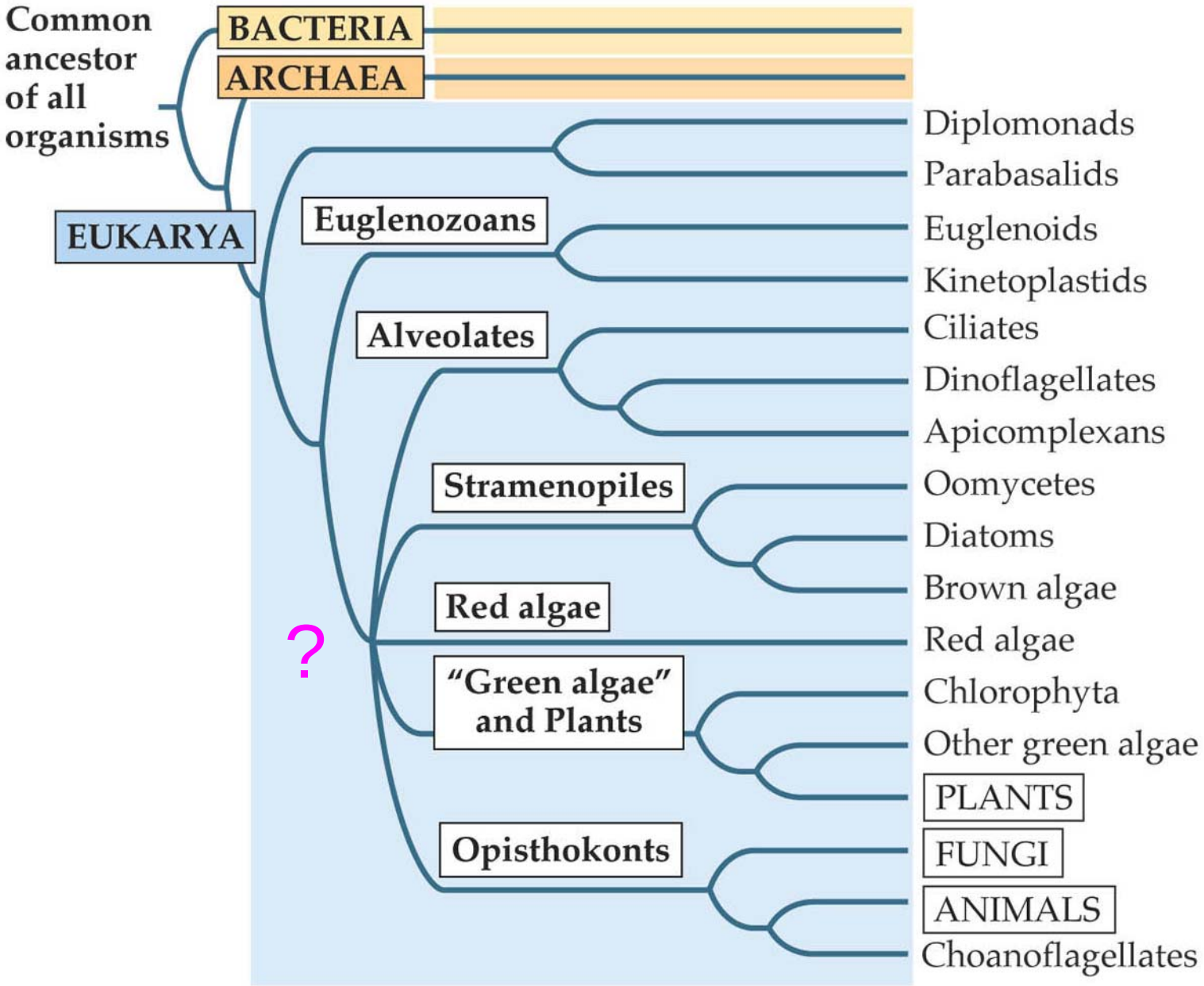
Fight oxidative damage in copying fidelity?

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

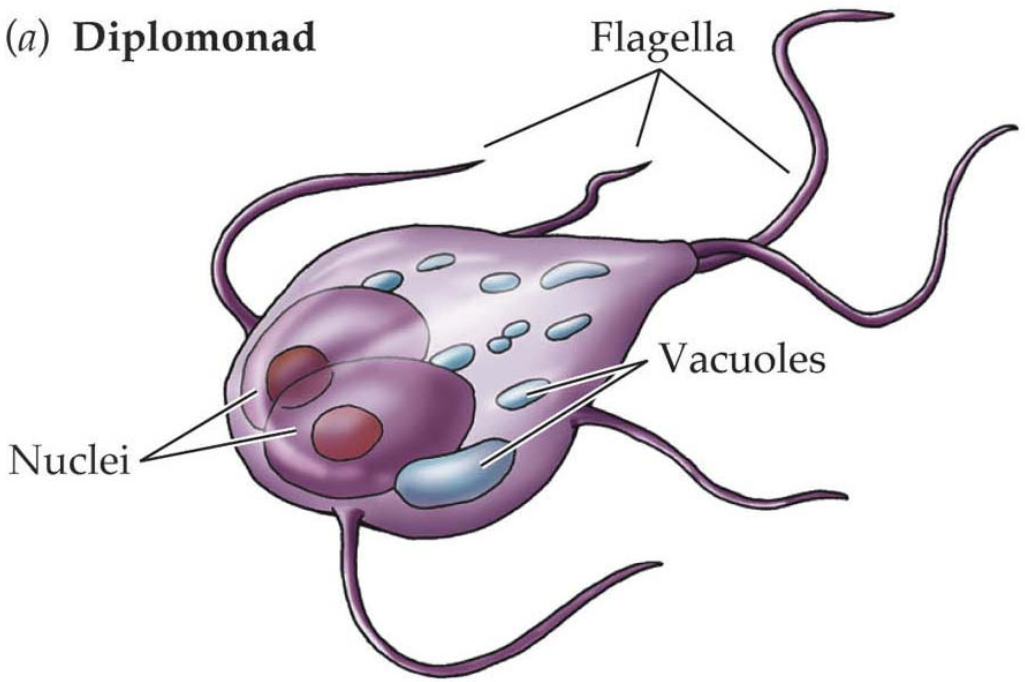
Biology of protists

- 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

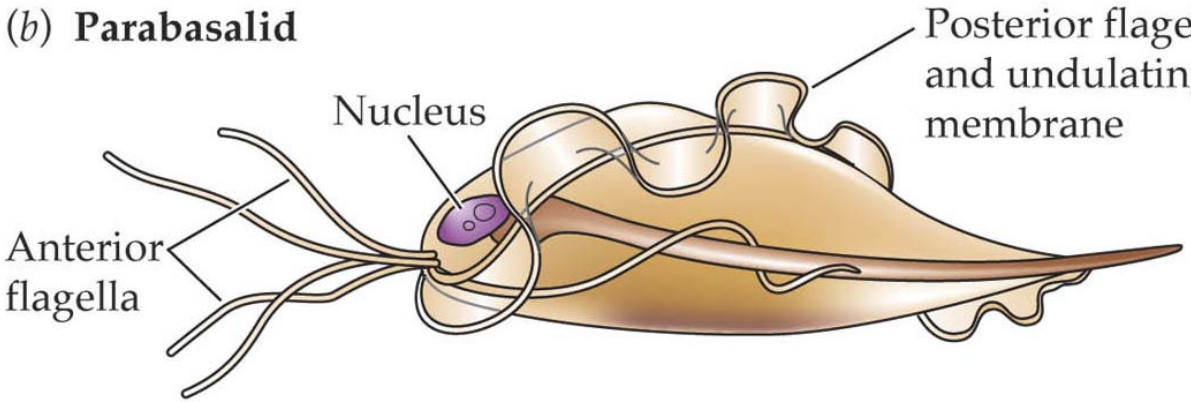
Evolutionary history of protists



Diplomonads and Parabasalids



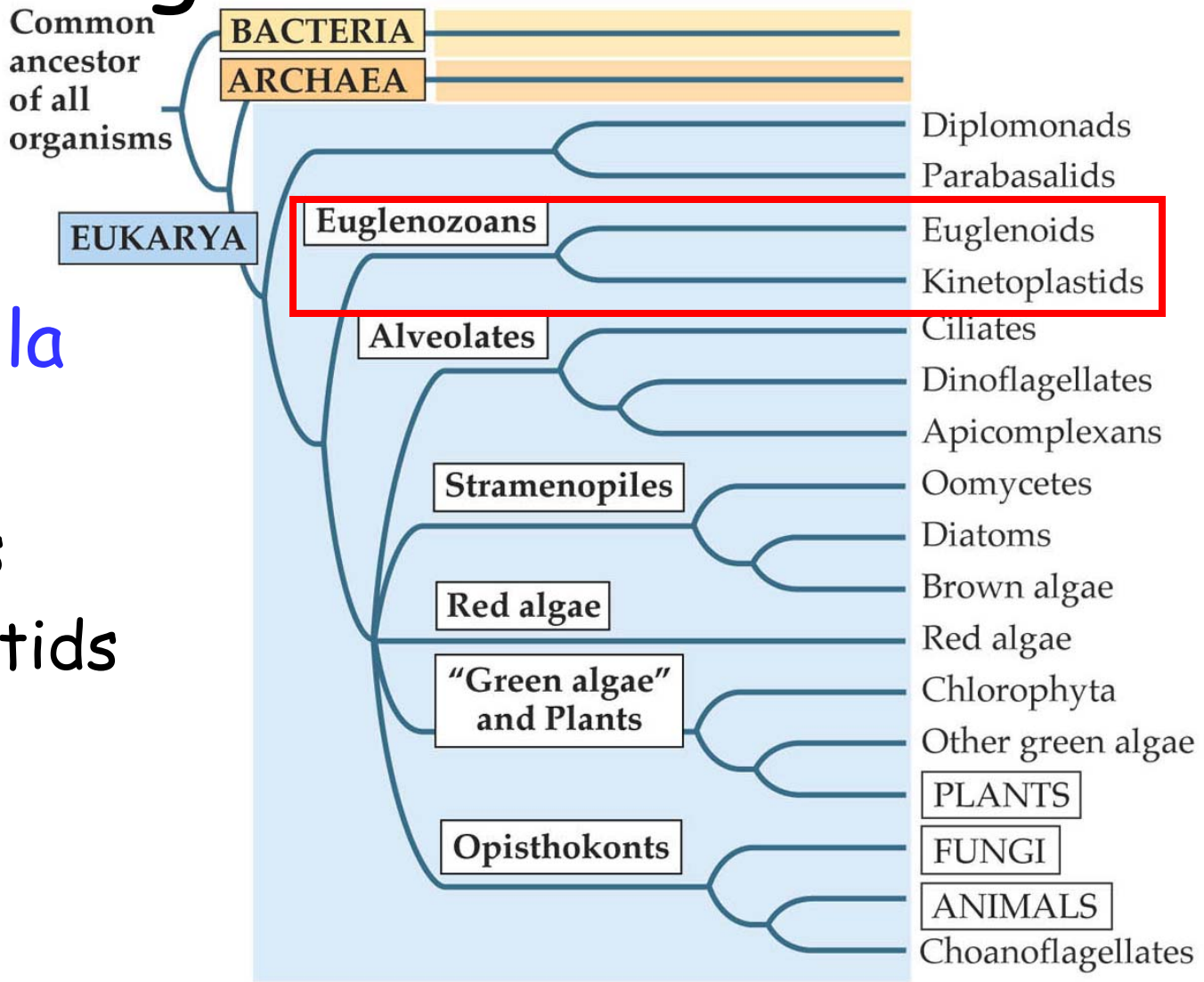
Giardia



Both unicellular, lost their mitochondria

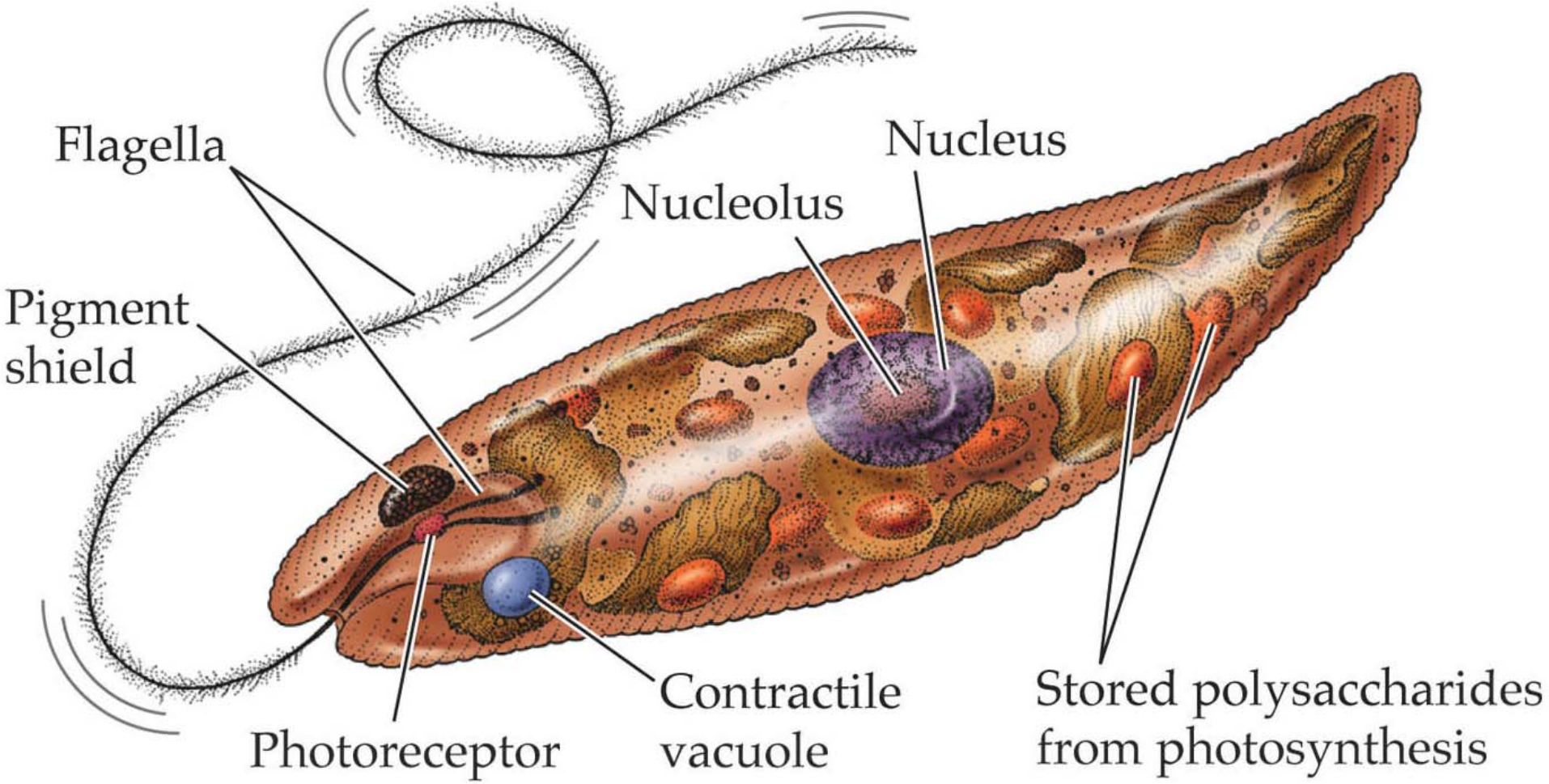
Euglenozoans

- Have flagella
- 2 clades
  - Euglenoids
  - Kinetoplastids



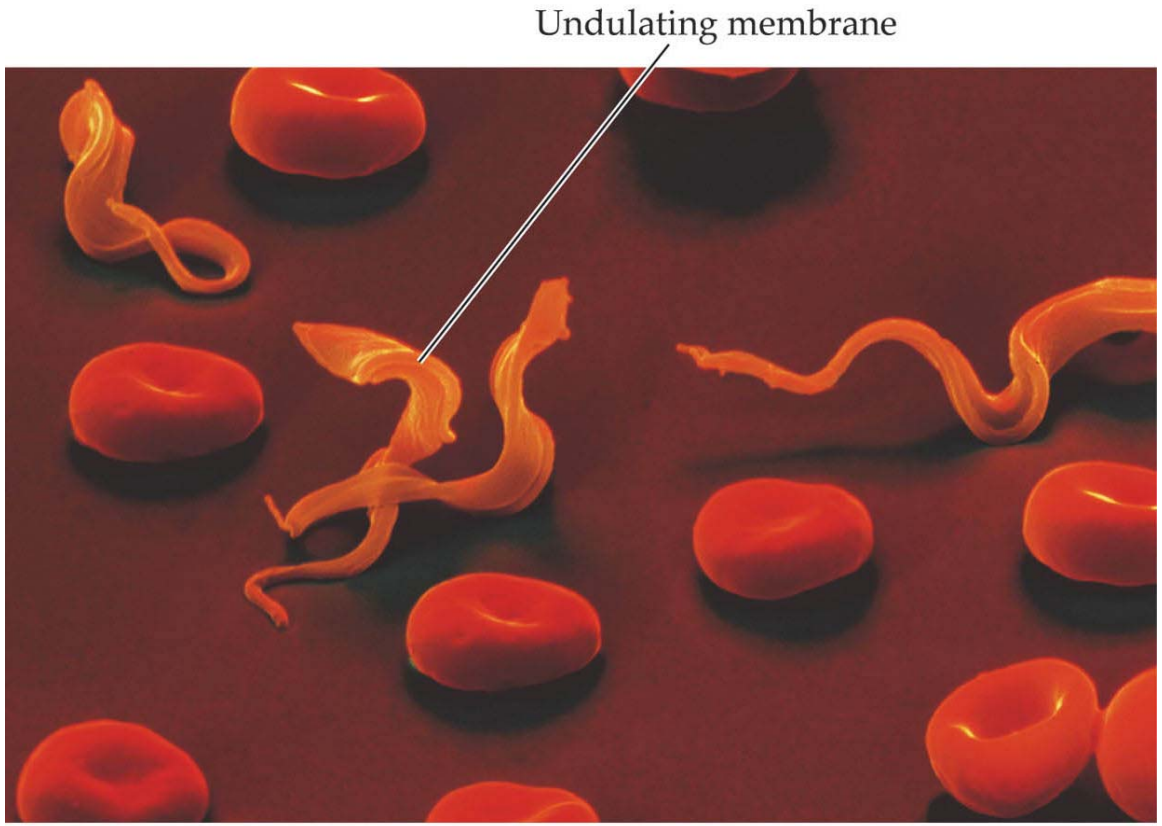
Euglenoids

often photosynthetic, but very flexible about nutrition



Kinetoplastids

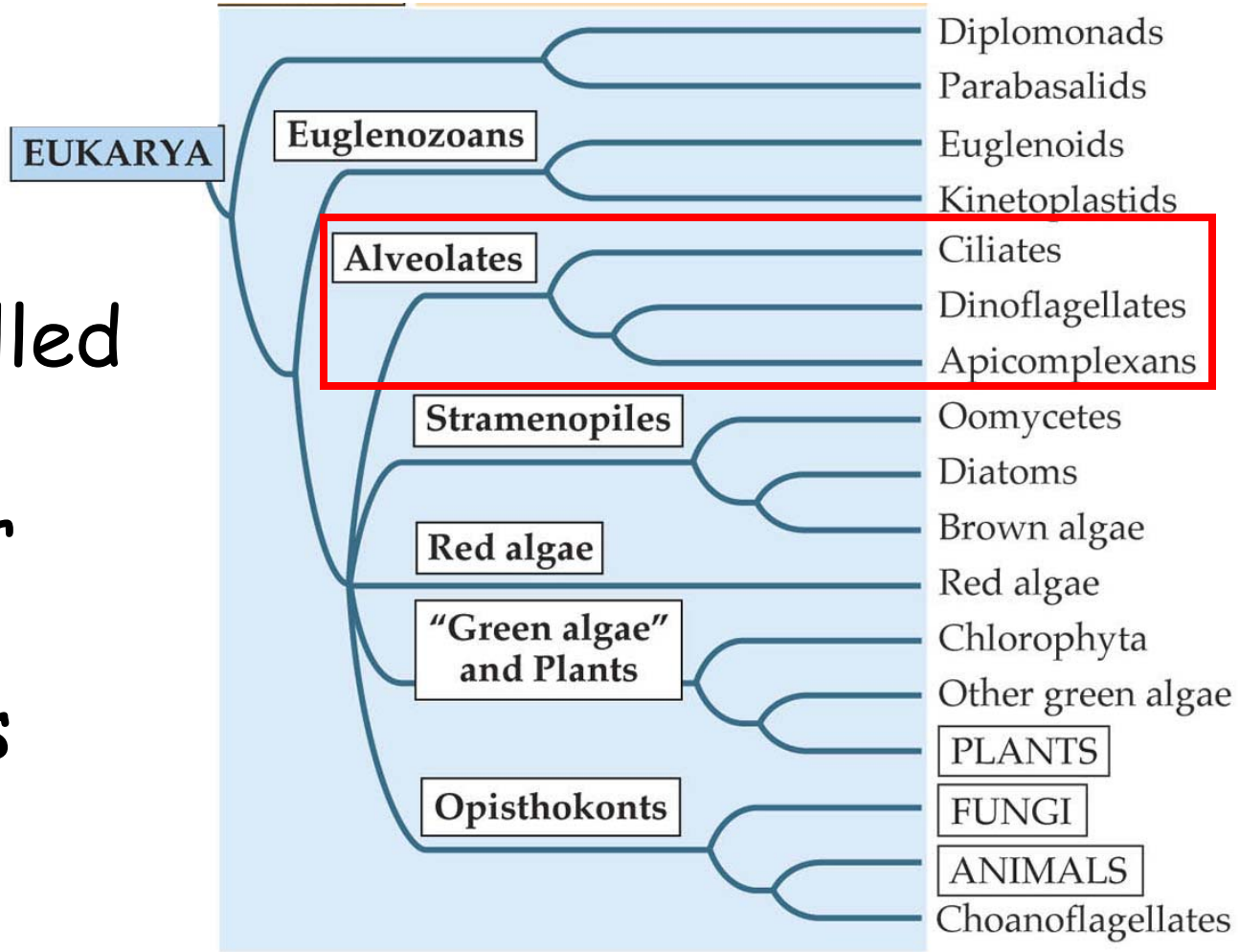
- parasitic
- trypanosomes cause sleeping sickness, leishmaniasis, Chagas' disease, and East Coast fever
- single large mitochondrion with kinetoplast housing multiple, circular DNA molecules: edits own RNA



Trypanosoma gambiense

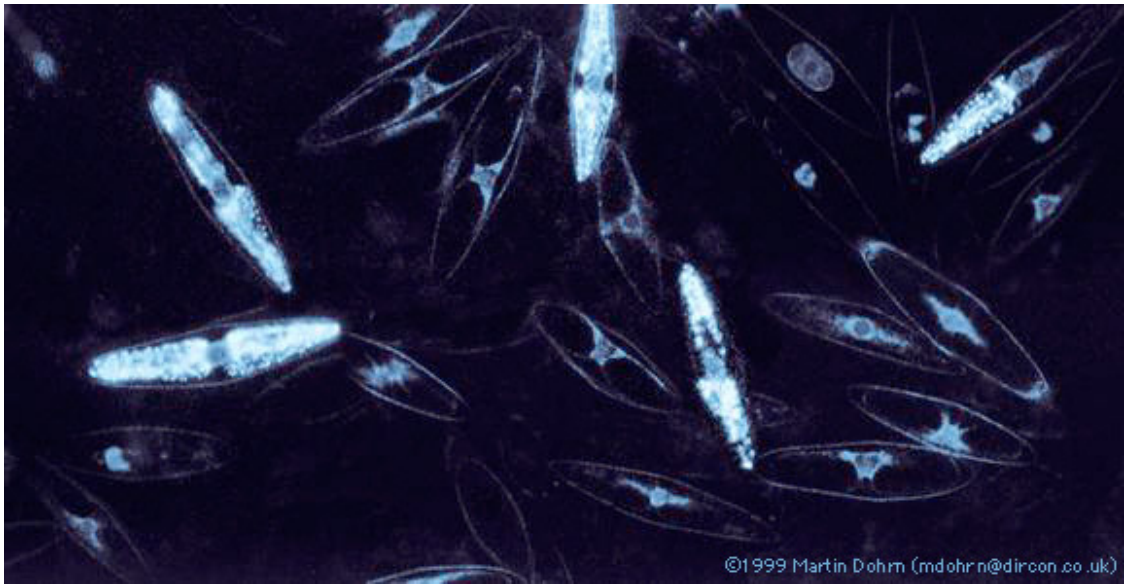
Alveolates

- 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"

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").

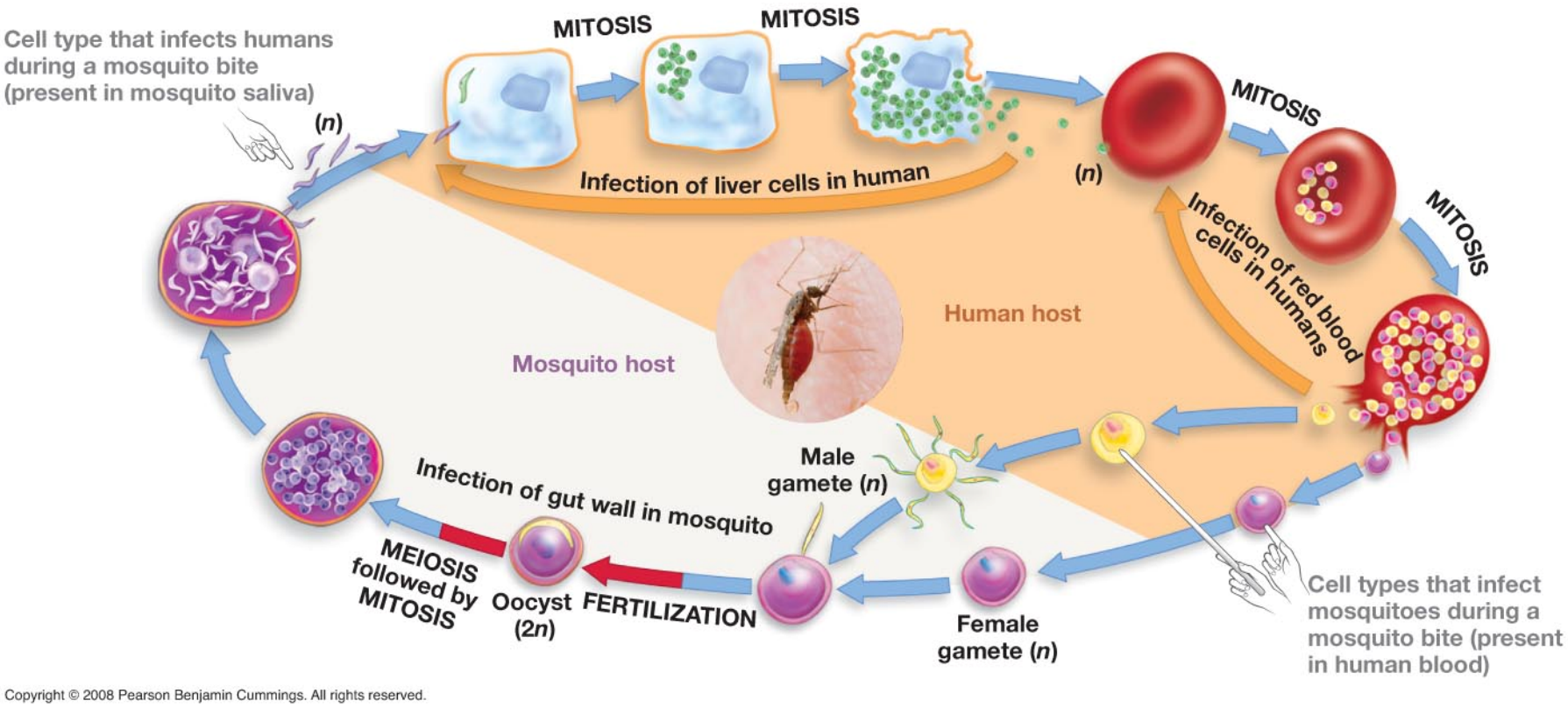
- Breaking waves, running hand through water, or stepping on sand also disturb dinoflagellates

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

Apicomplexans

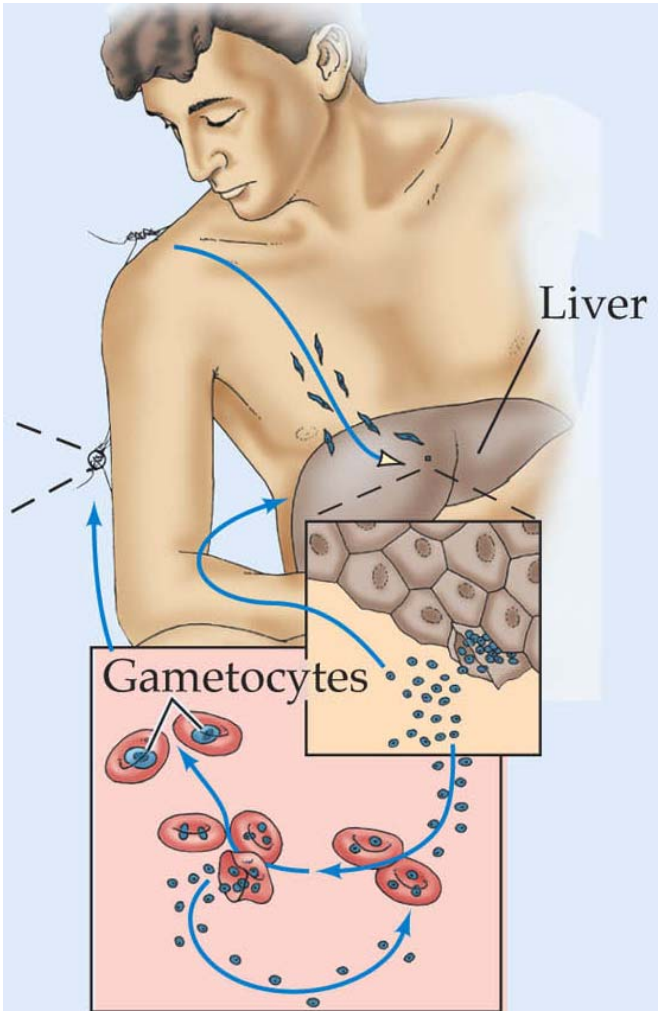
Plasmodium are the cause of malaria



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

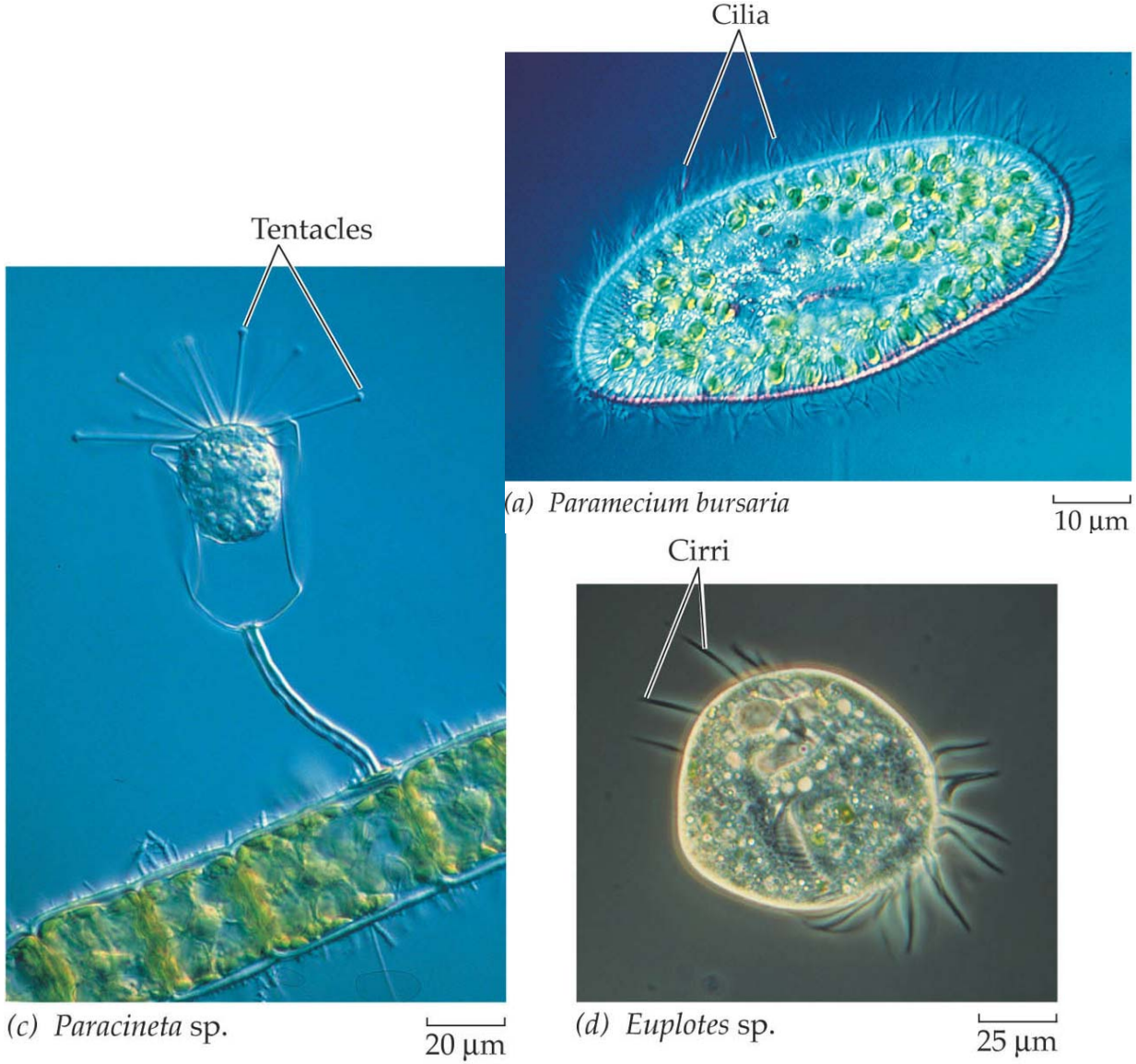
erythrocytic stage
(inside red blood cells)

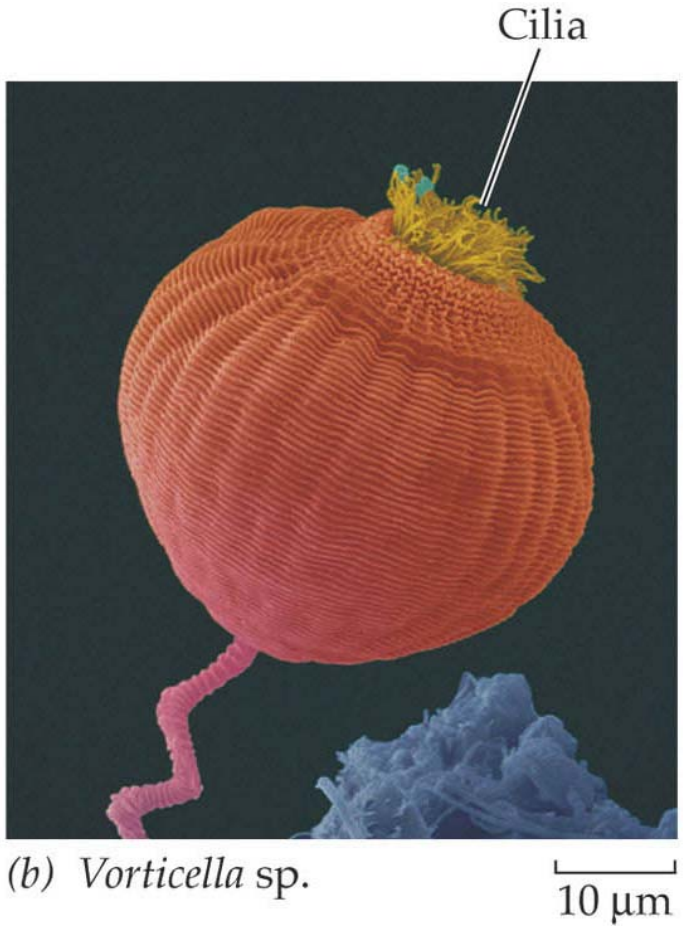
This treats the symptoms, but persistent liver infection can lead to relapses



Ciliates have complex and varied body forms with hairlike cilia

Almost all heterotrophic

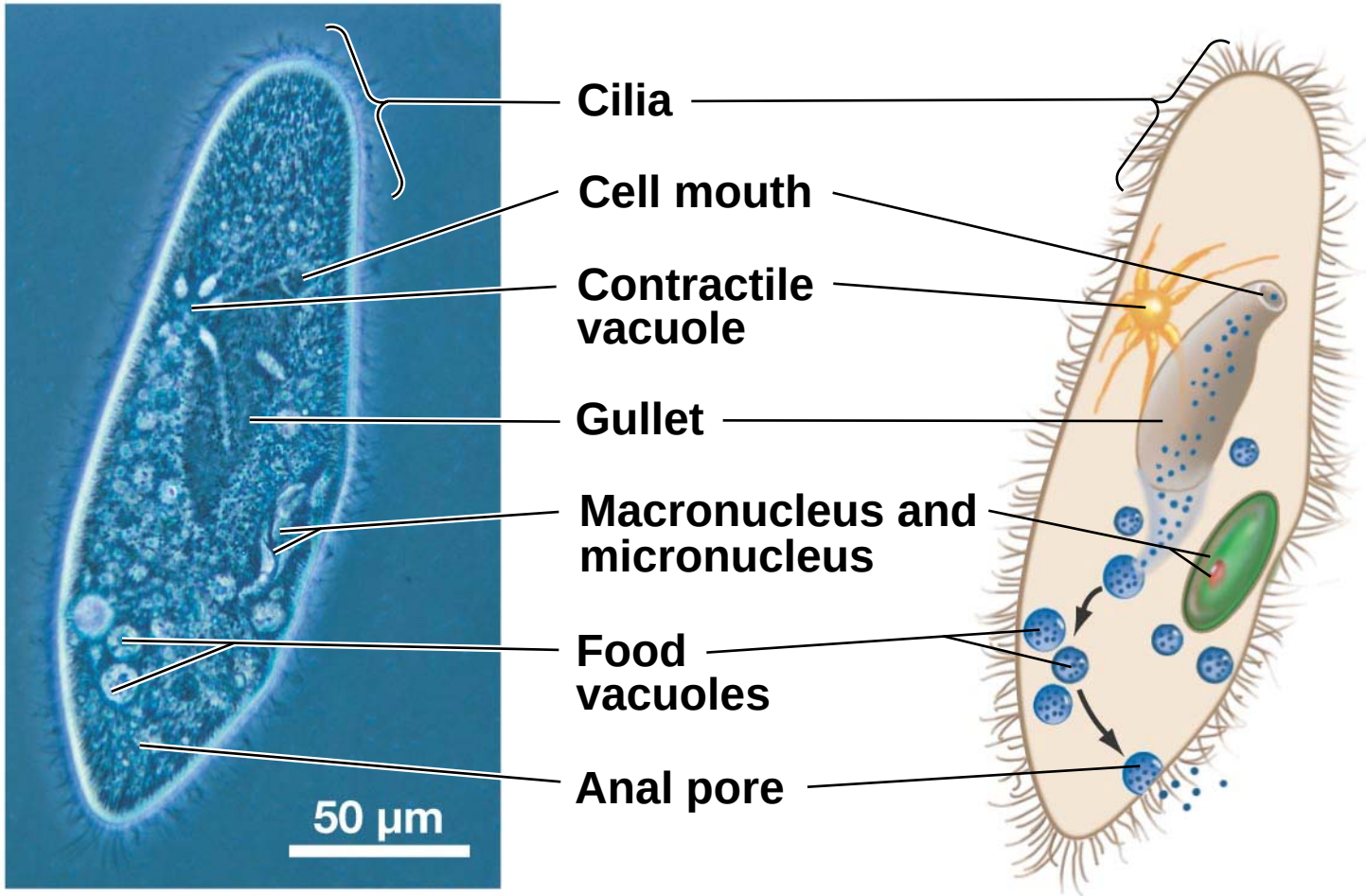




Large ciliate from termite gut moves using thousands of synchronized flagella (27-03)

Figure 29-15

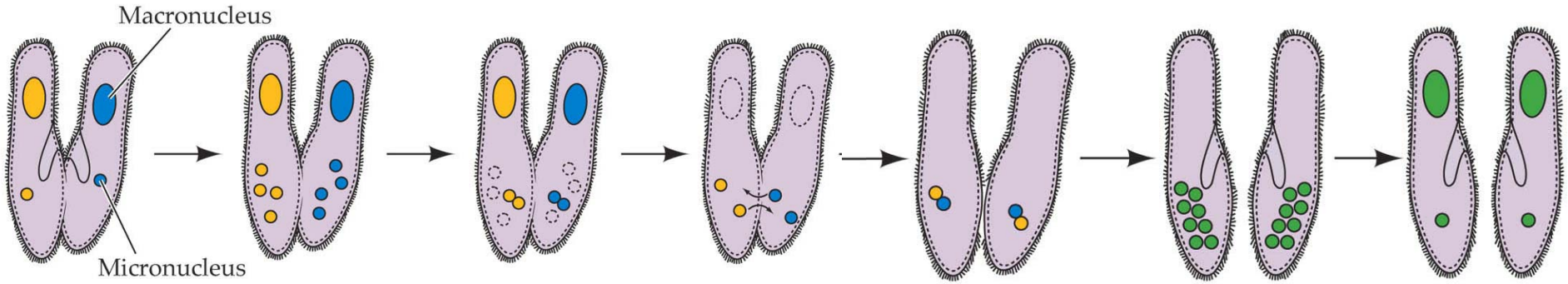
Paramecium uses cilia to generate current to carry prey to gullet



Paramecium uses cilia to generate current to carry prey to gullet

Paramecium conjugation

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

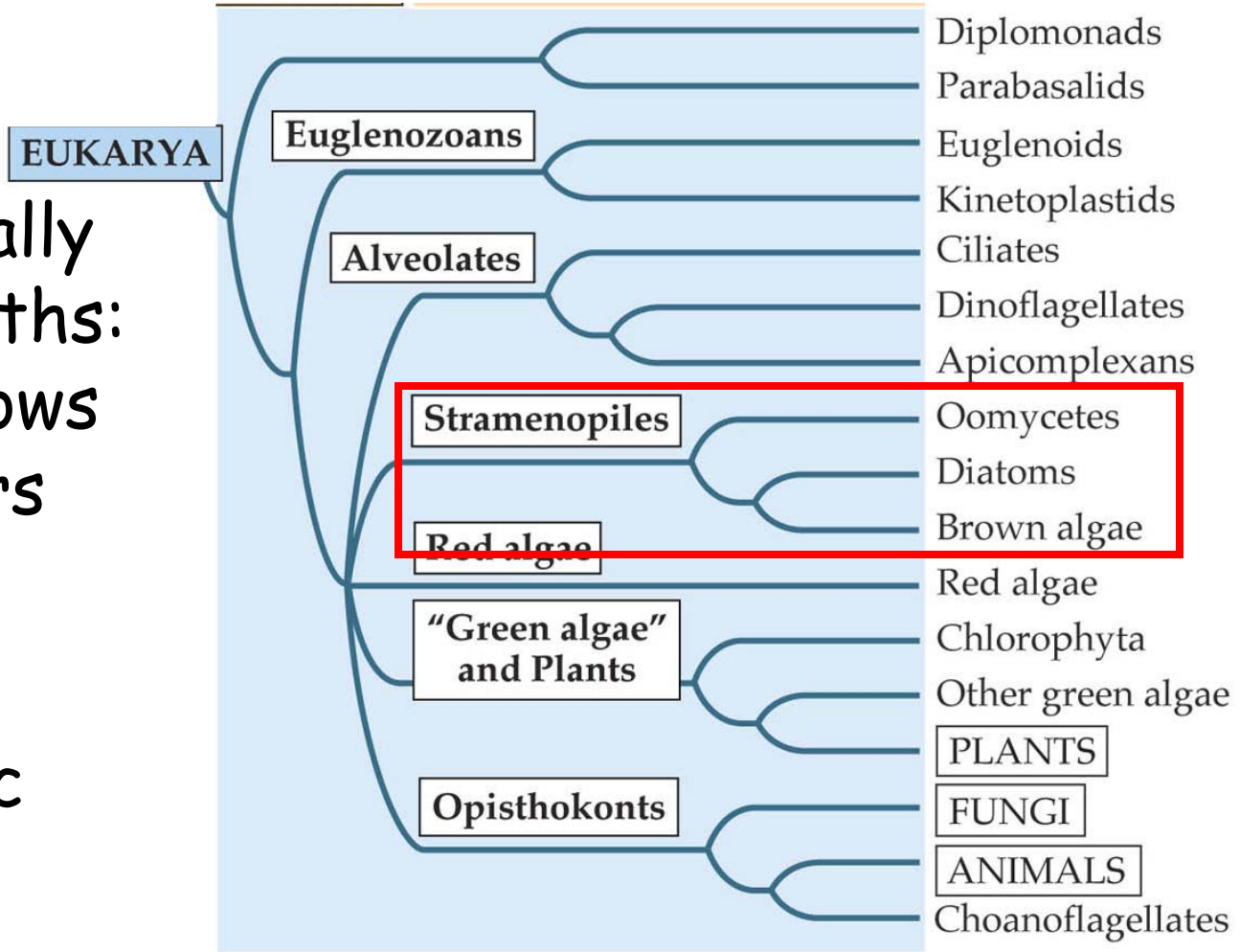


- *Not reproductive*; no new cells are created: reproduction is asexual by binary fission

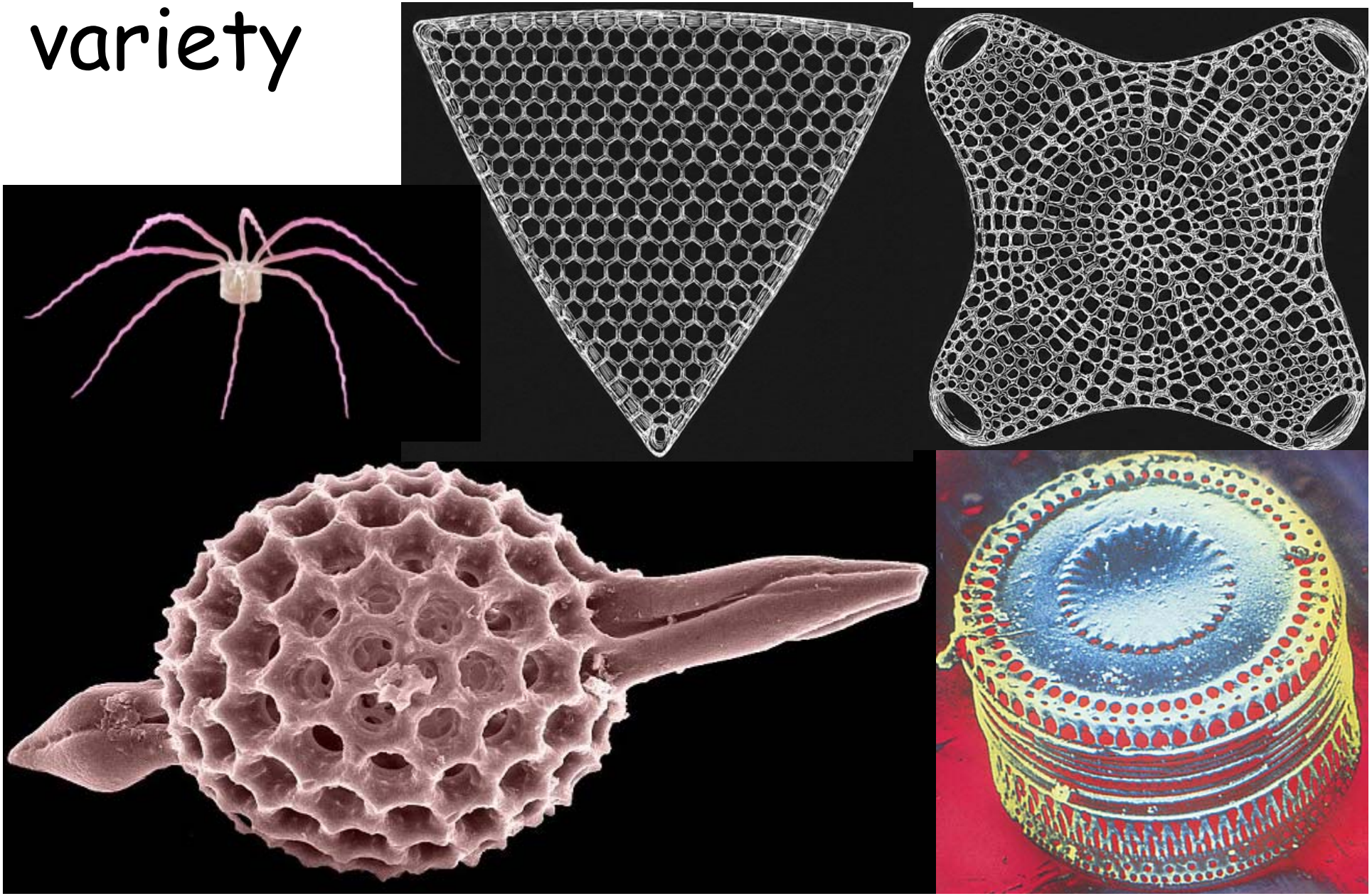
(SEX ≠ REPRODUCTION)

Stramenopiles

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



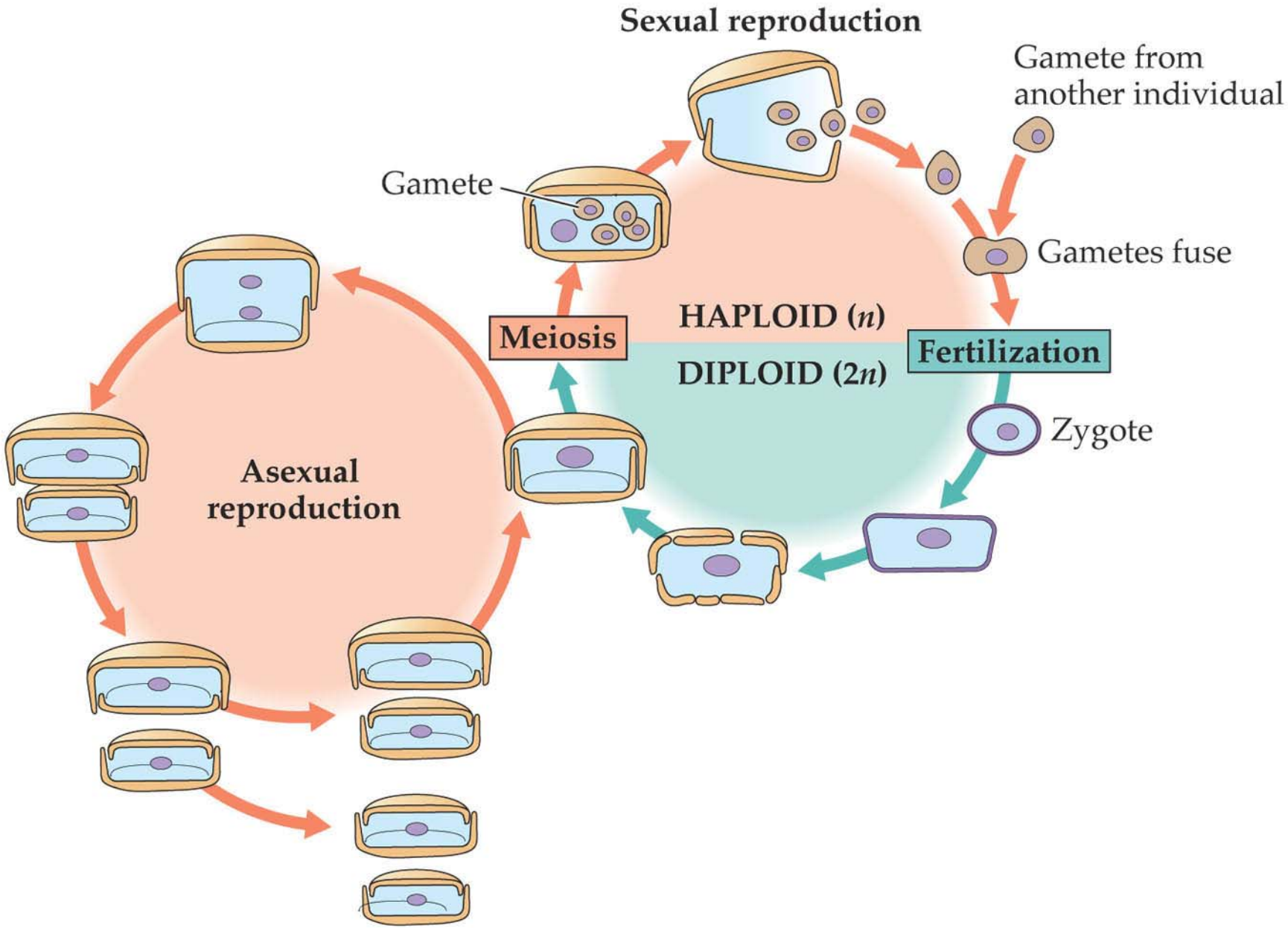
Diatoms: best known for beauty & variety



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

Diatoms reproduce both sexually and asexually



Brown algae

(27-16)

Can be big

(60m. giant kelp

Brown from carotenoid

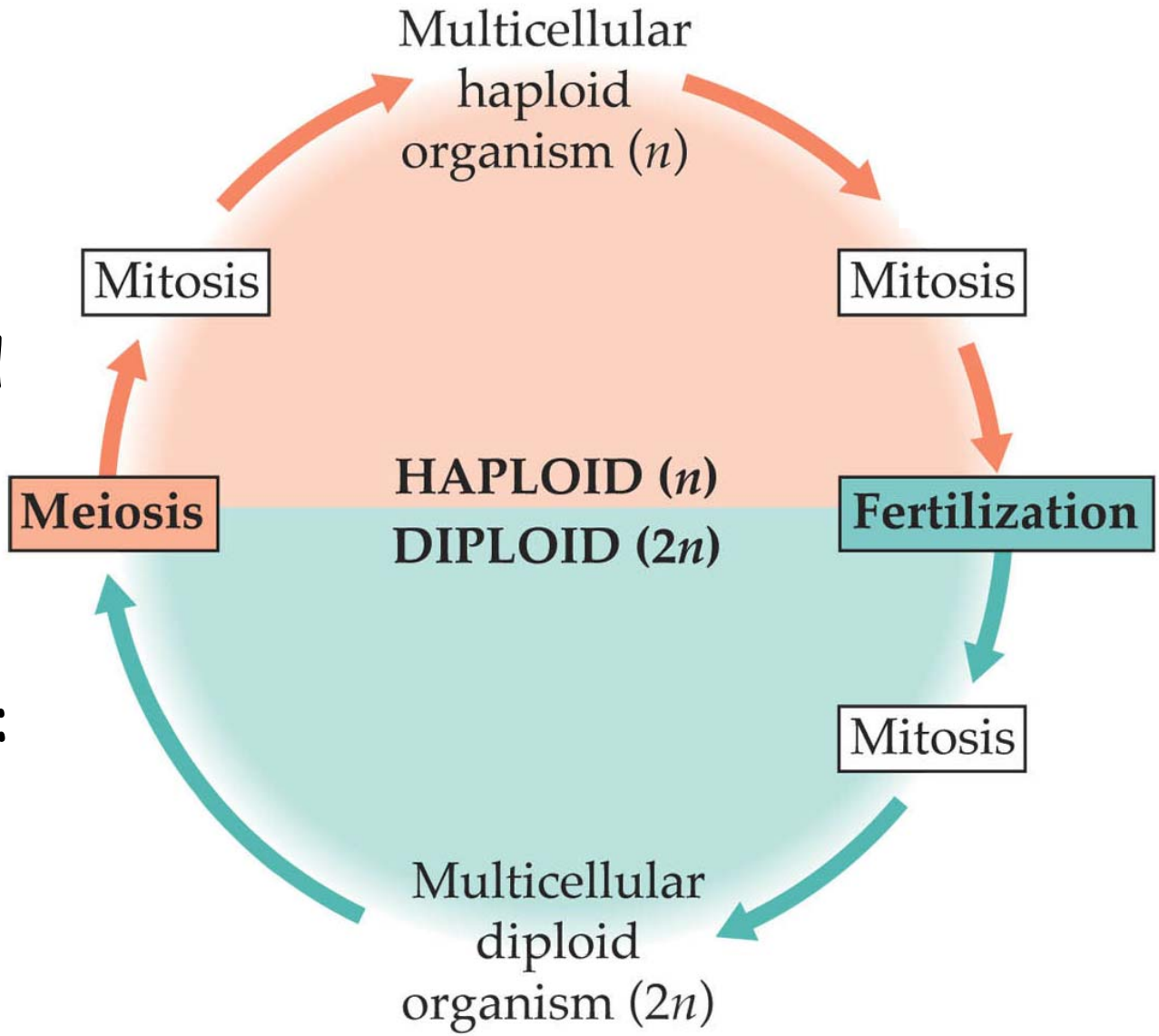
fucoxanthin in chloroplasts

Brown algae have alternation of generations

Can be either…

- Isomorphic: gametophyte and sporophyte look similar

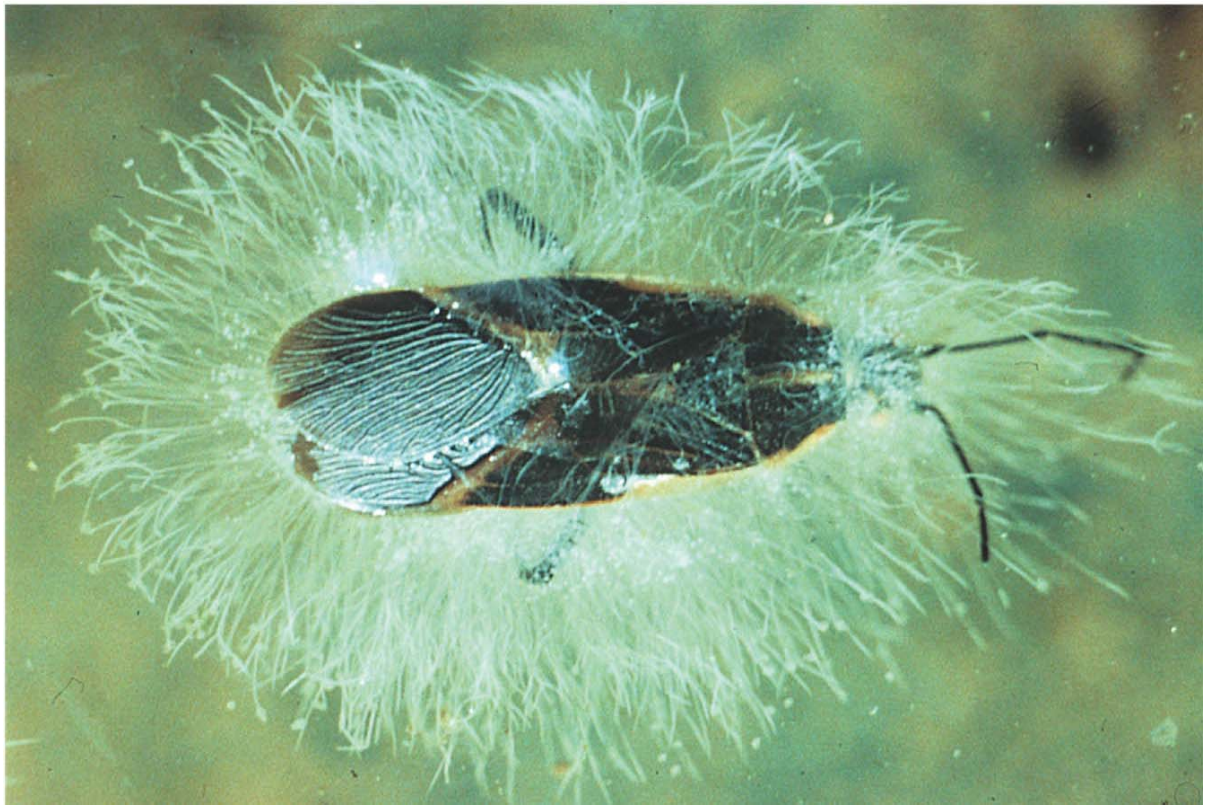
- Heteromorphic: they look different



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

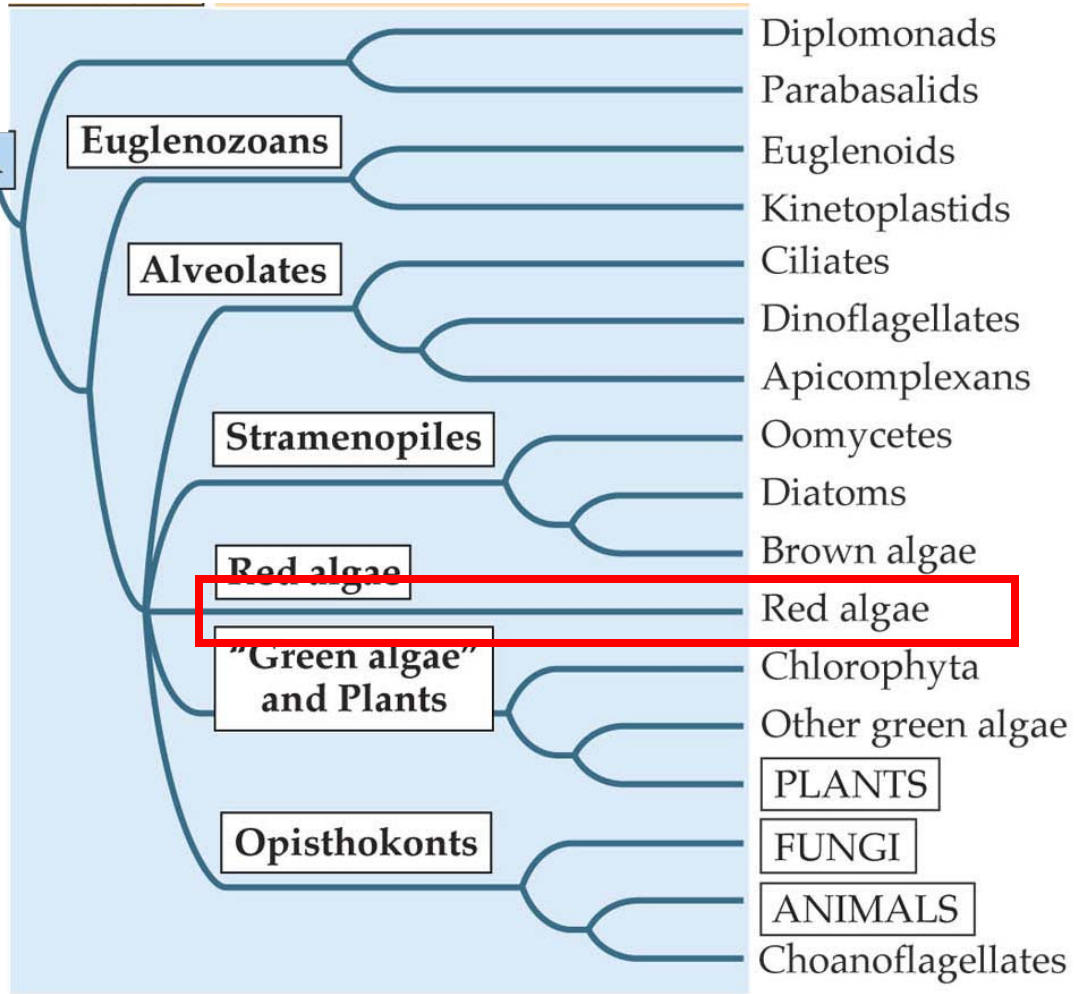
Saprolegnia sp.



Red algae

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

(a) *Bossiella orbigniana*



Green stuff

- chlorophylls *a* and *b*