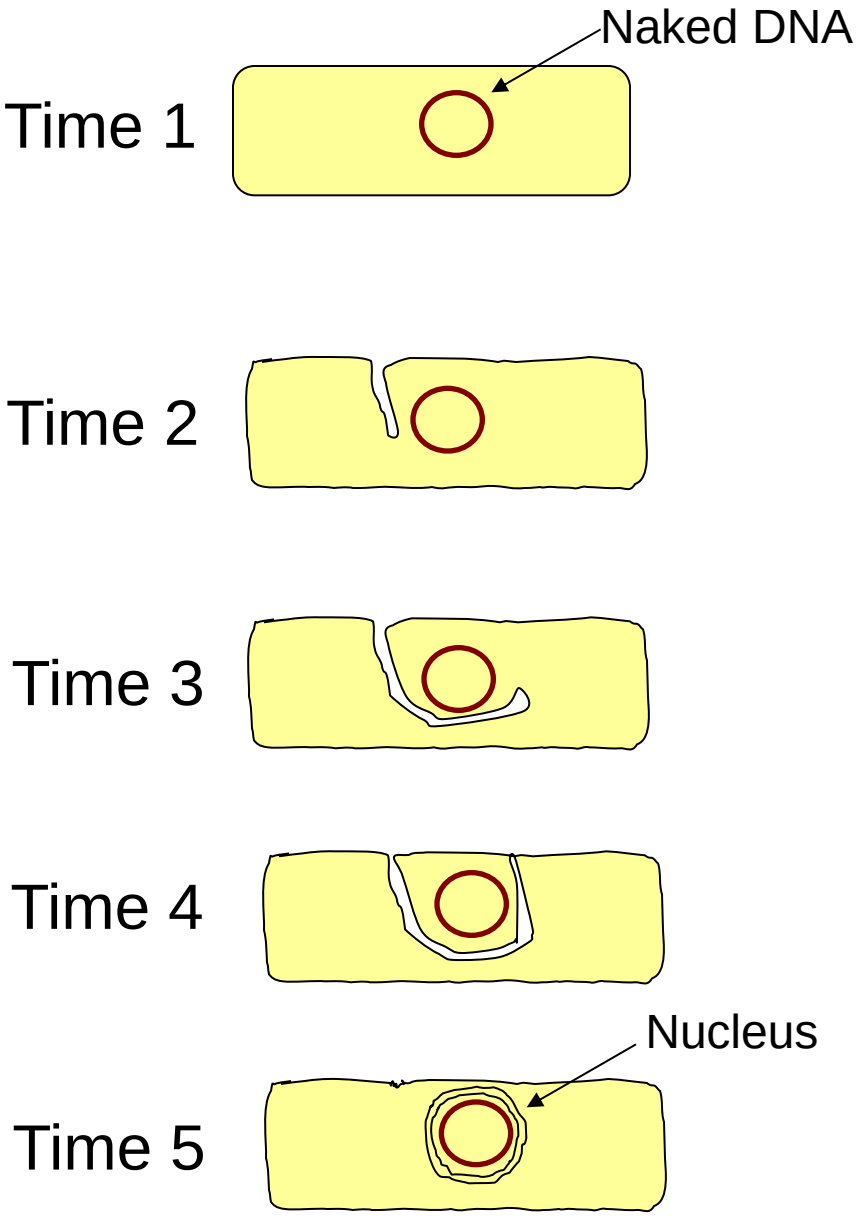
# Chapter 16

## Protists

# The origin of eucaryotes

- Earliest eucaryote fossils are 2 billion years old
- Believed to have arisen from procaryotes
- Evidence to support this theory is the existence of intermediate organisms
- Eucaryote nuclei could have arisen by membrane infolding



# Origin of other organelles

- If a larger procaryote engulfed a smaller procaryote but did not digest it
  - Then the larger procaryote would be able to do what the smaller one could do
- Believed to be the origin of chloroplasts and mitochondria in eucaryotes
  - Chloroplasts do photosynthesis
  - Mitochondria do cellular respiration
- Called the Endosymbiotic Theory
  - Because it is endosymbiosis when one organism lives inside another

# Evidence for the Endosymbiotic Theory

- Mitochondria and chloroplasts are quite similar to procaryotes
  - Have their own DNA
    - Is circular and “naked”
  - Divide by binary fission before the larger cell divides
    - Ensures each daughter cell will get chloroplasts and mitochondria
  - Mitochondria and chloroplasts have their own ribosomes
    - Are different from the ribosomes in the rest of the cell
      - Are like procaryote ribosomes

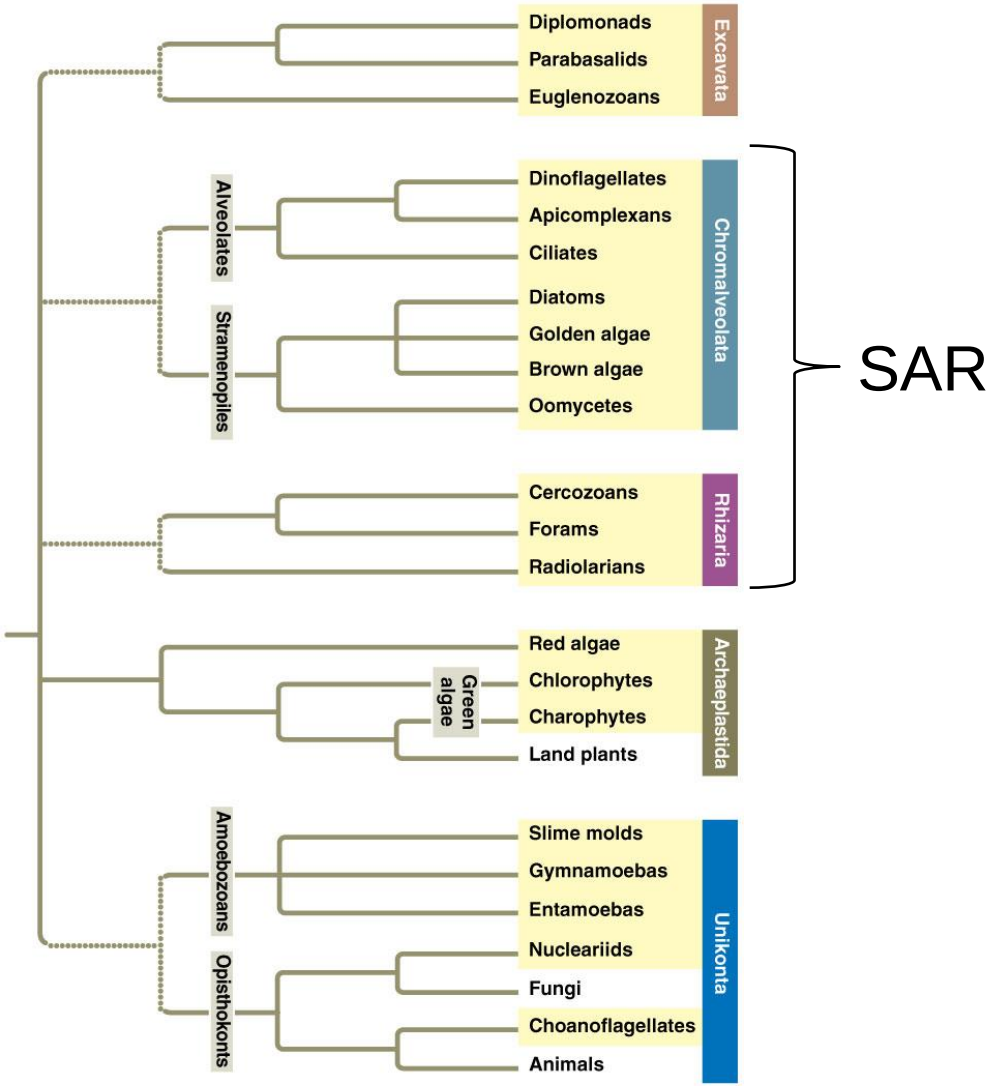
# Protists are a group of diverse eucaryotes

- Oldest eucaryote fossils are protists
- Many still exist today, and even though many are unicellular
  - ALL belong to Domain Eucarya
- Often are smaller organisms, but can be quite complex
  - Have organelles
  - Some can do photosynthesis (algae or phytoplankton)
  - Some are heterotrophic (protozoans or zooplankton)
- Many are motile
  - May have flagella or cilia (singular—cilium)
    - Cilia are short appendages similar to flagella, but move like oars

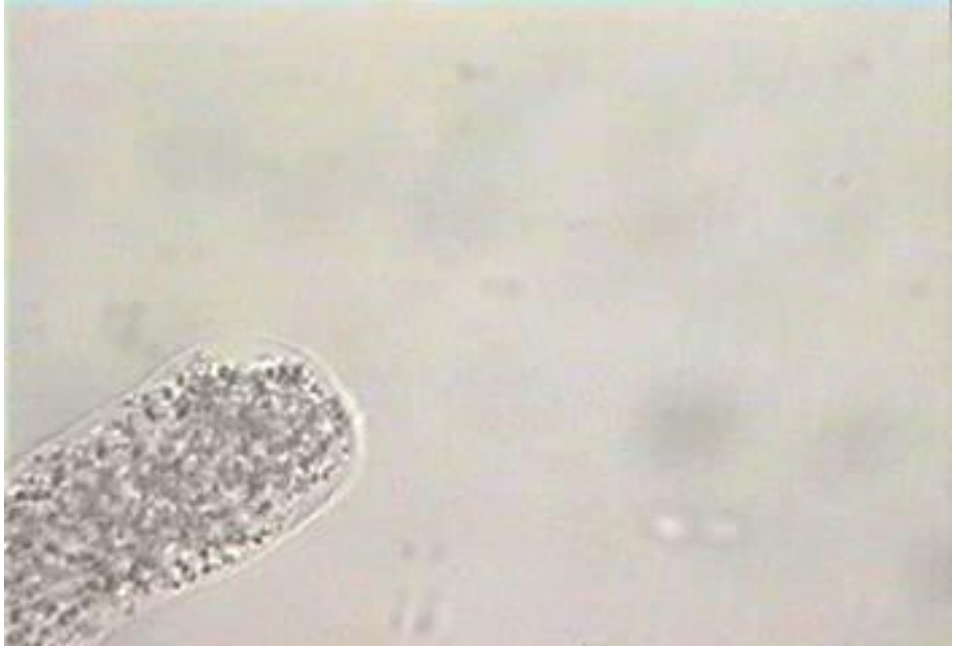
# Domain Eucarya has several Supergroups (4-6)

1. Excavata
   - All are protists
2. a) Chromalveolata
   - All are protists

   b) Rhizaria
   - All are protists
3. Archaeplastida
   - Protists and plants
4. Unikonta
   - Protists, fungi and animals



# 1. Supergroup Unikonta

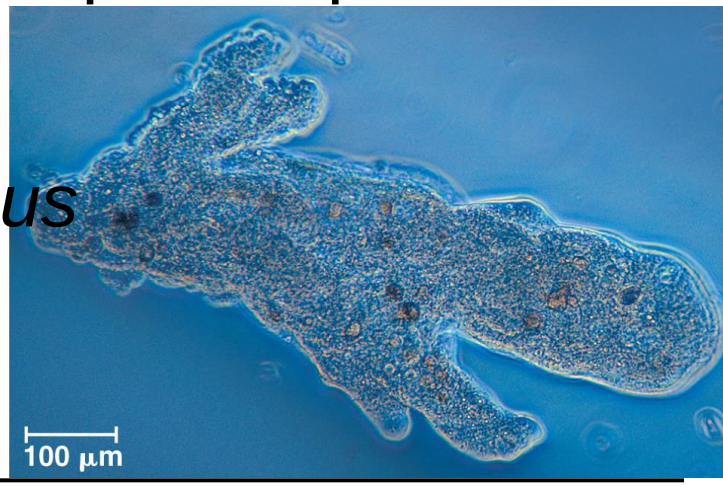


## a) Amoebozoans

- Mostly free-living & some parasites
- Live anywhere moist

**See also Figure 16.17A**

- All have amoeboid cells with lobed pseudopodia (singular—pseudopodium)
- Like the “blob’ eg. *Amoeba proteus*
- Pseudopodia used for phagocytosis and movement



## b) Plasmodial slime molds

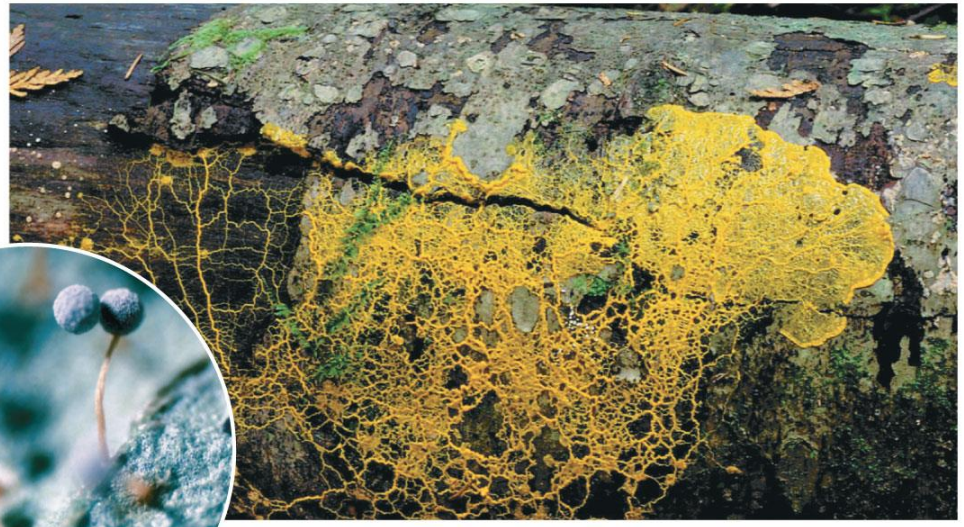


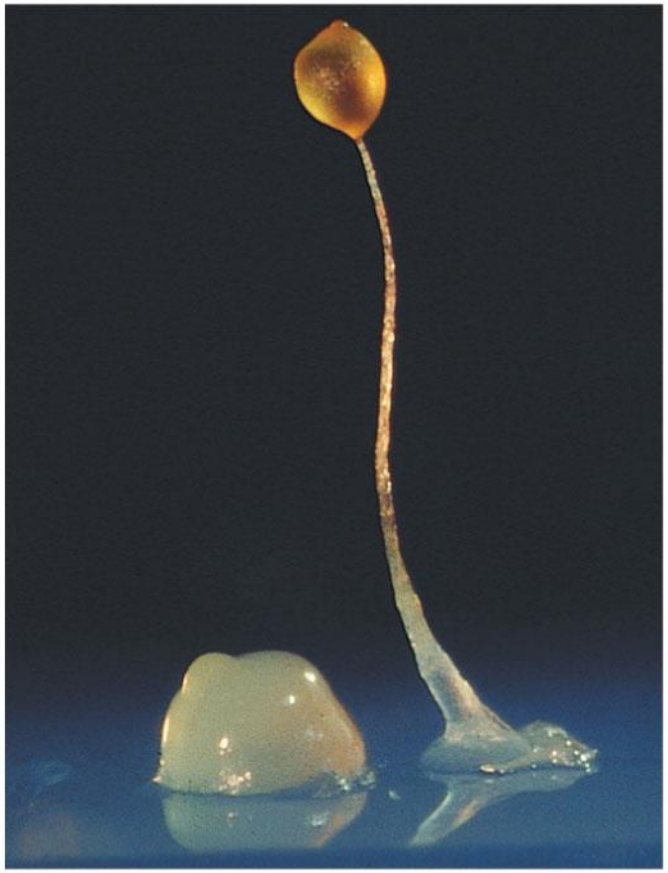


Figure 16.17B

- Decomposers
- Often brightly colored
- Each is a single, multinucleate amoeboid cell called a plasmodium
- When conditions dry they form sclerotia that form spores
- Two spores can later fuse to form a zygote
- The zygote would divide to form another plasmodium

## c) Cellular slime molds

Figure 16.17C





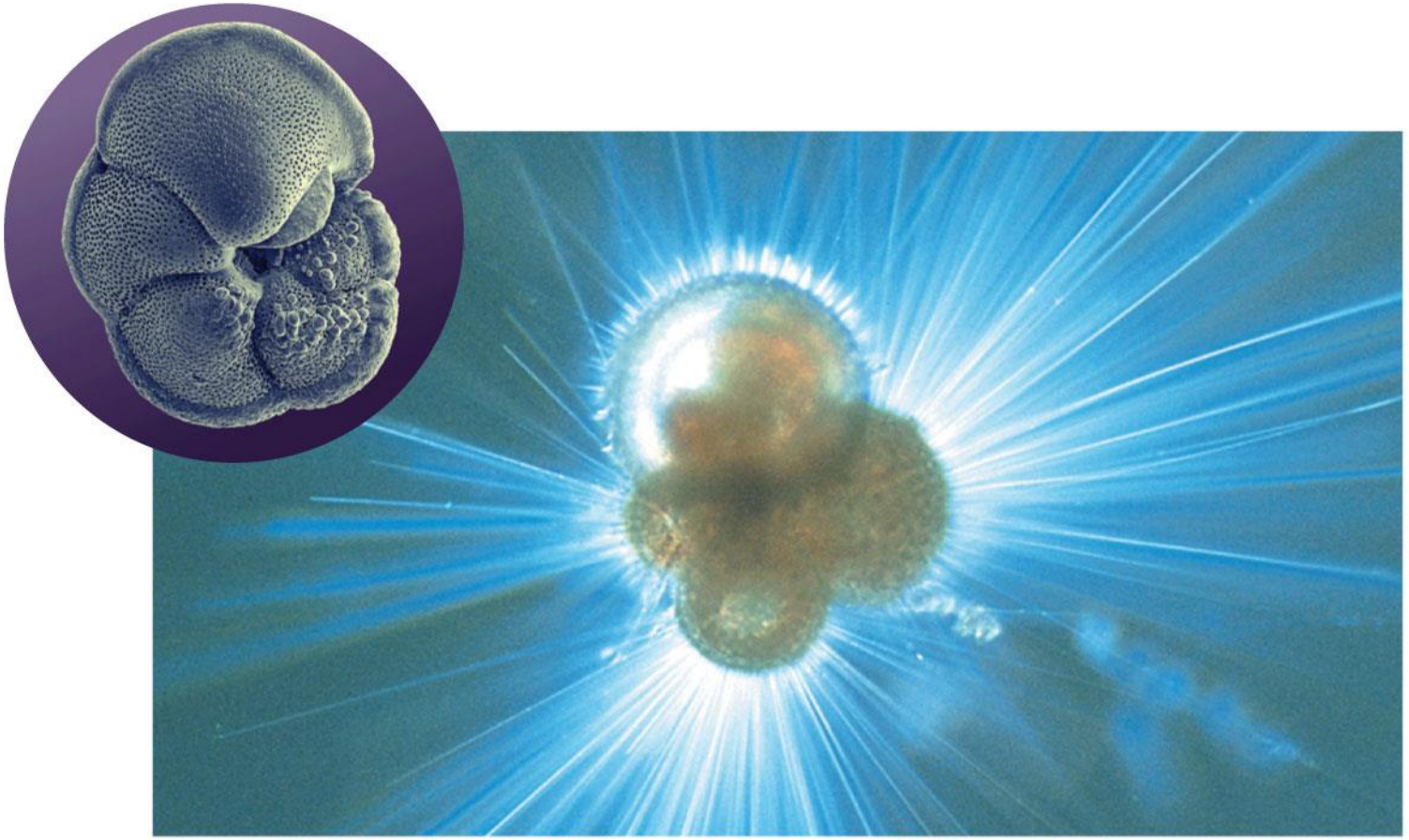
- Decomposers
- Exist as solitary amoeboid cells
- When food is scarce many cells swarm together
  - Forms a multicellular aggregate
  - Called a pseudoplasmodium
- This moves to a new location, and some of the cells dry up
- A reproductive structure forms that will release spores which eventually become new amoeba

# 2. Supergroup Rhizaria

## a) Foraminiferans

- Amoeboid cell secretes an organic test hardened with calcium carbonate
- Cells have thread-like pseudopodia
- Stick pseudopodia out through holes in test
- Tests persist after cell dies
- Fossils have paleontology uses eg. can date rocks with them

Figure 16.14F



## b) Radiolarians

- Amoeboid cell secretes an organic test
- Has an inner support of silica
- Also have thread-like pseudopodia which stick out through holes in test

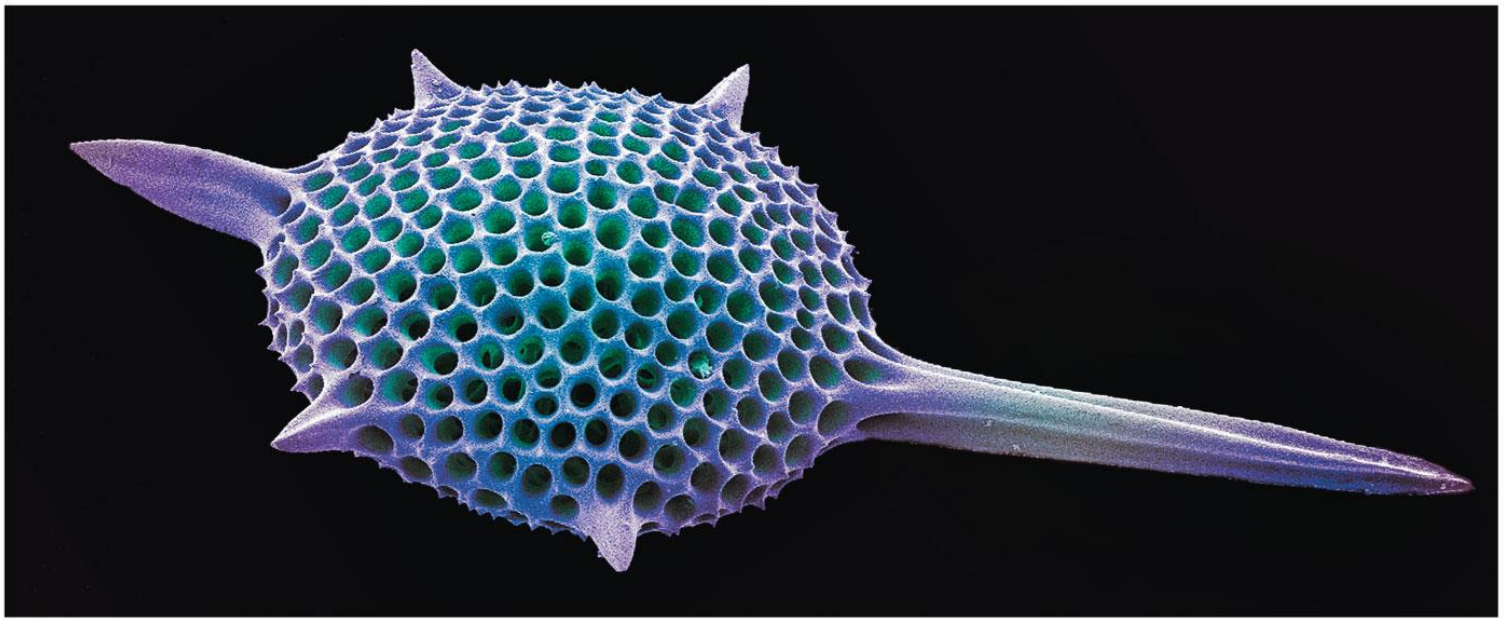


Figure 16.14G

# 3. Supergroup Excavata

a) Diplomonads

- Each cell has 2 equal-sized nuclei & multiple flagella
- Some are free-living, commensal, or parasitic

b) Parabasalids

- Each cell has 1 nucleus & multiple flagella
- Beneficial, commensal or parasitic

***Giardia intestinalis***

Figure 16.12A

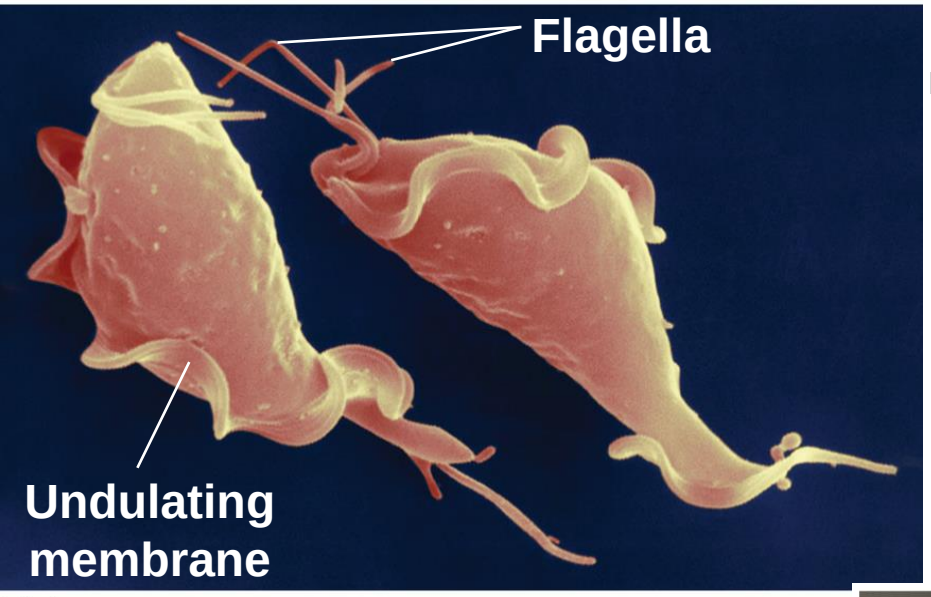



Figure 16.16A



*Trichomonas vaginalis*

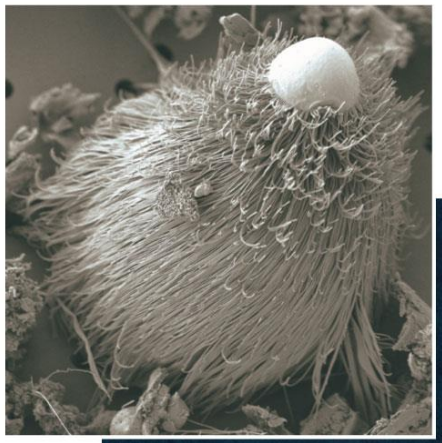
↑

- Sexually transmitted parasite of humans

- Lives in gut of termites and helps to digest cellulose

↓

*Trichonympha sphaerica*



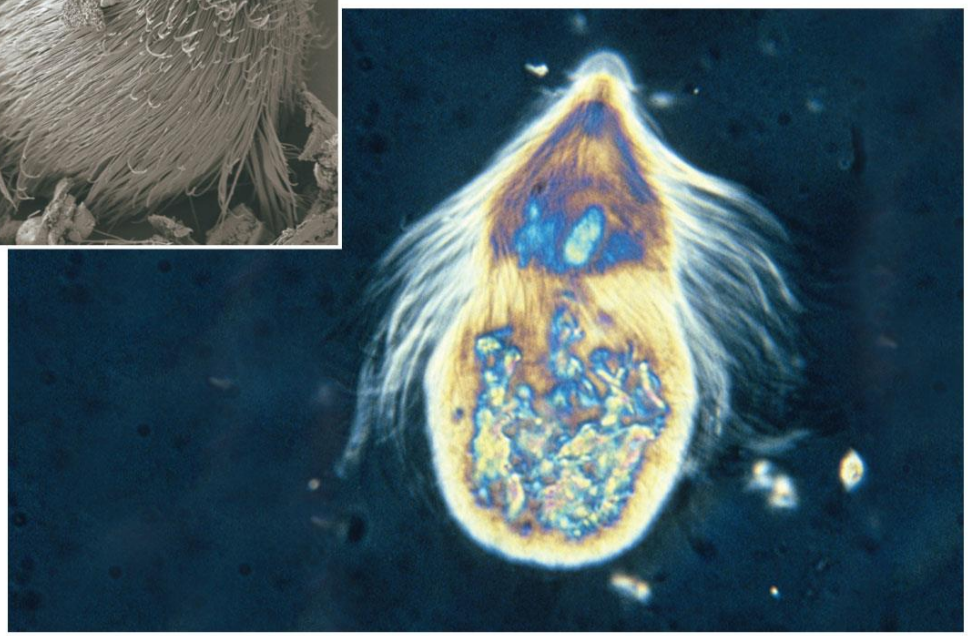


Figure 16.12B

## c) Kinetoplastids

- Each cell has 1 nucleus & 1 or 2 flagella
- Some are free-living, or parasitic

eg. African sleeping sickness is caused by *Trypanosoma brucei*

- It is transmitted by tse-tse flies

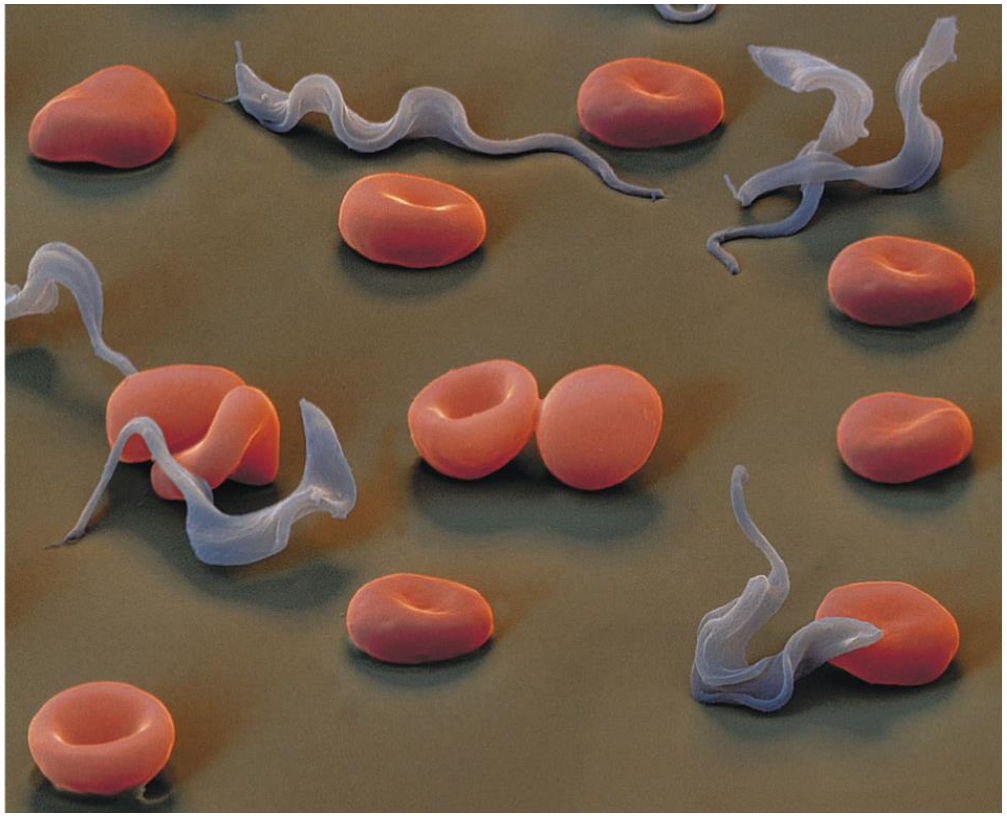


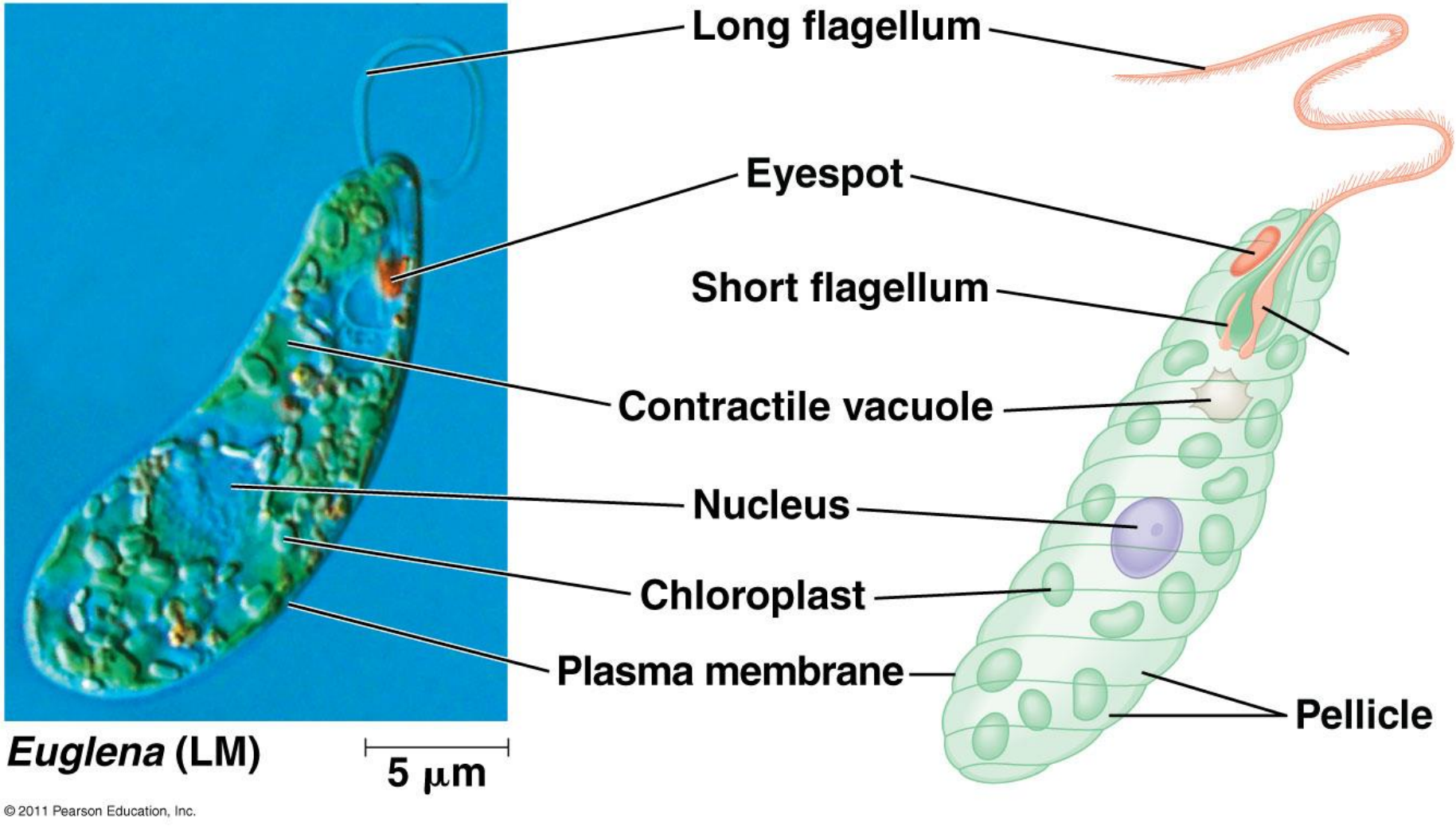
Figure 16.16B

## d) Euglenids

- Each cell has 1 nucleus & 1-3 flagella
- Many are mixotrophic
- Live mostly in freshwater
- Have a flexible outer covering called a pellicle
- Contractile vacuole to rid themselves of excess water
- Eyespot to detect light
- Reproduce by dividing in half longitudinally (mitosis)

*Euglena gracilis*

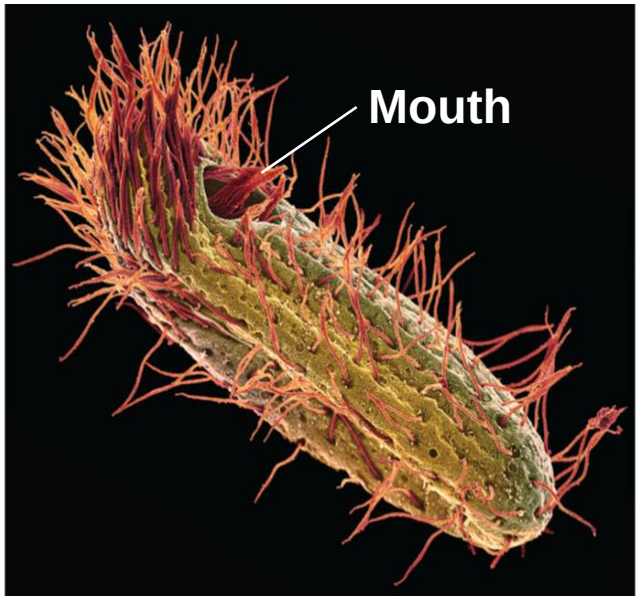
Similar to Figure 16.12A






*See also Figure 16.12A*

# 4. Supergroup Chromalveolata

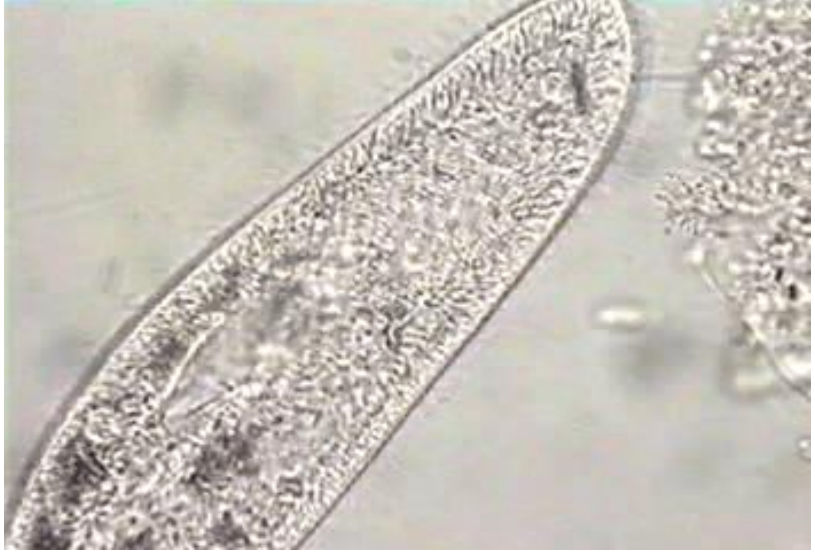



a) Ciliates

- Some or all of the cell is covered by cilia
  - Function in locomotion and feeding
- May be heterotrophic or mixotrophic
- Some are symbiotic in termite and cockroach intestines
- Nearly all are free-living in water, and these are often predators
  - Some called “sharks of the microscopic world” eg. *Paramecium*
  - Consume other small organisms

*See also Figure 16.14E*

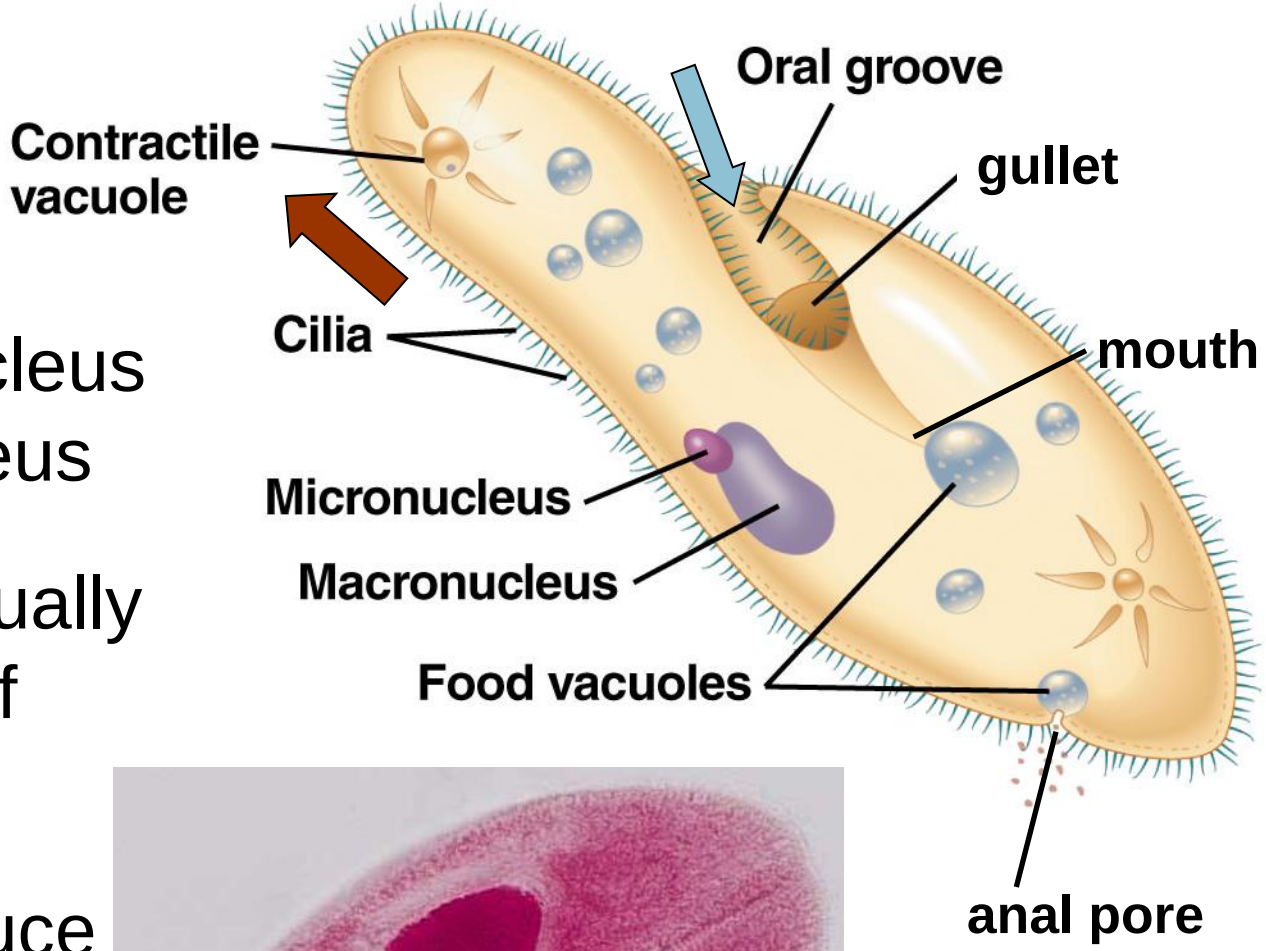
# *Paramecium*



- Entire cell is covered with a pellicle and cilia
- Torpedo-shaped and very motile
- Have contractile vacuoles
- Cilia move the cell around
  - Also create water currents for feeding
    - Flows into the oral groove, down the gullet, into the mouth
    - Food vacuole forms at the mouth
    - Contents of food vacuole are digested inside the cell
    - Wastes discharged at the anal pore

# *Paramecium*

- Have 2 types of nuclei: macronucleus and a micronucleus
- Reproduce asexually by splitting in half transversely
- Can also reproduce sexually by conjugation

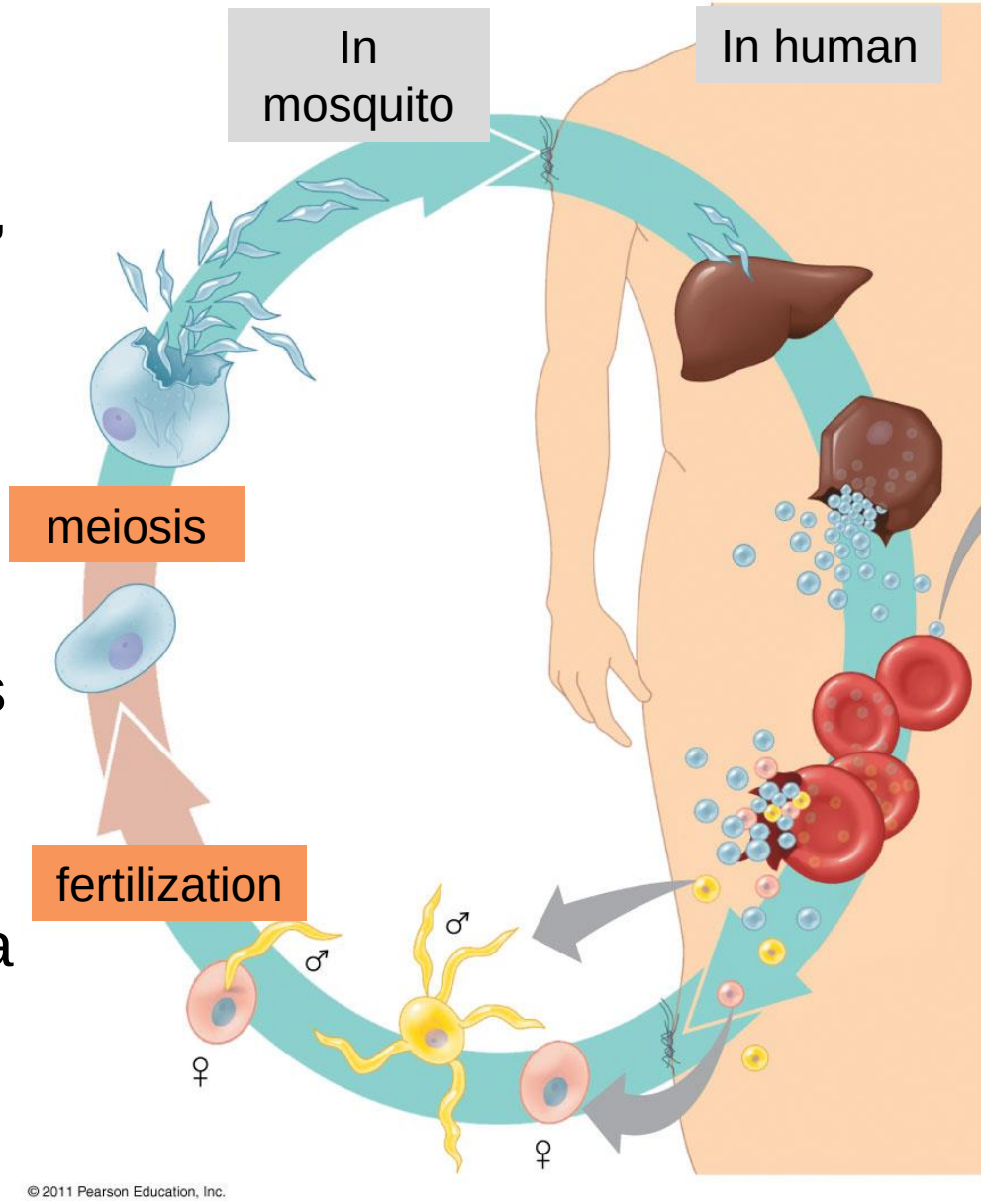



## b) Apicomplexans

- All are parasites!
- Apex of cell has a “complex” of organelles to help it enter its host
- No independent means of locomotion
- Have complicated life cycles involving more than one host

eg. *Plasmodium* causes malaria

- Body shape is variable depending on stage in life cycle



## c) The water molds

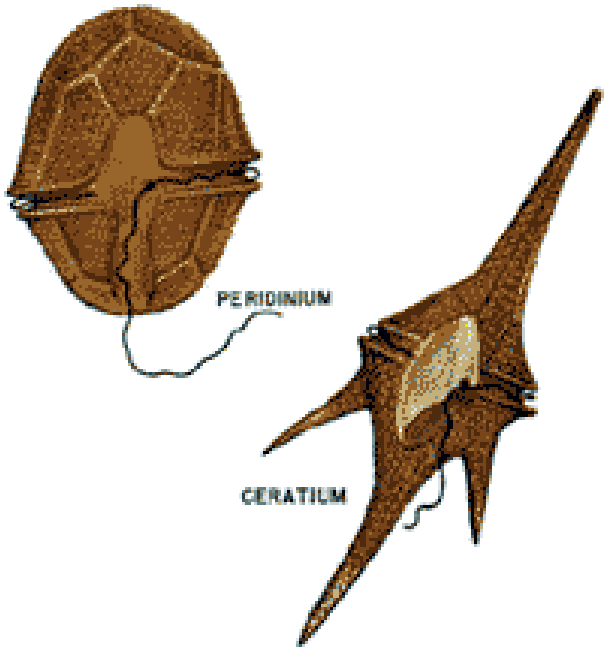
- Are heterotrophic and unicellular, but multinucleate
- Have cellulose cell walls
- Are fungus-like

*See also Figure 16.14C*

- Most decompose dead plants and animals

eg. Late blight of potato (*Phytophthora infestans*)

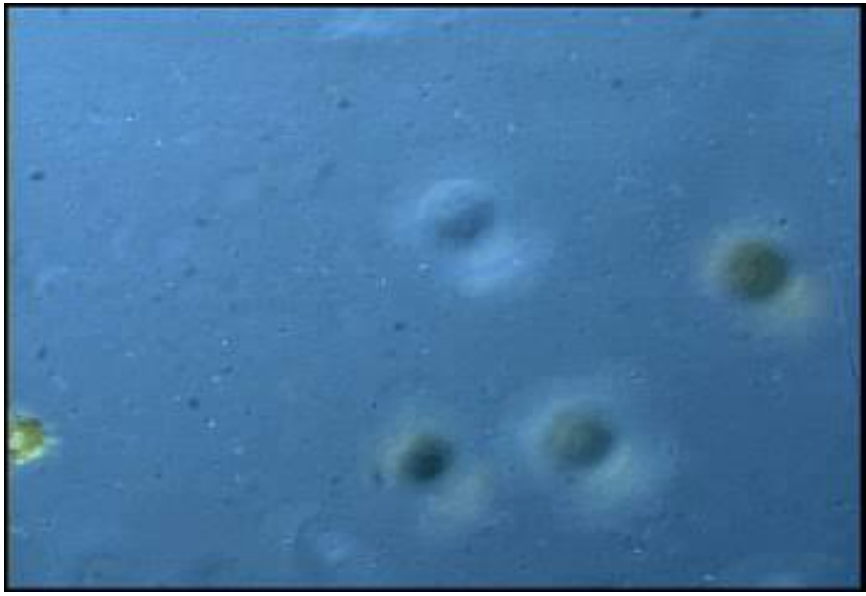
## d) Dinoflagellates




- All are unicellular
- Mainly autotrophic and mixotrophic
- Many have a hard covering of cellulosic cell plates
- All have 2 flagella which produce a spinning motion
- One wound around middle and one trailing
- Some are bioluminescent
- Some are brightly colored and live symbiotically with coral animals

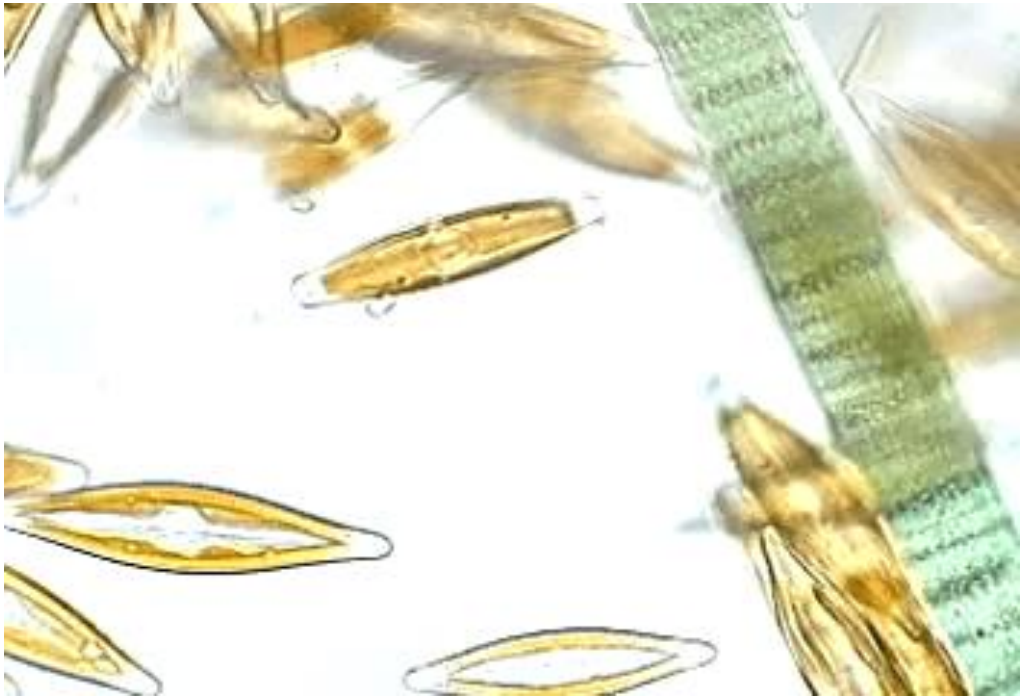
- *Gymnodinium* is a dinoflagellate that causes red tide
- Organism produces a nerve toxin
- Fish suffocate, but clams and other bivalves feast
- Nerve poison concentrated in tissues
- Animals eating the clams can be poisoned eg. humans

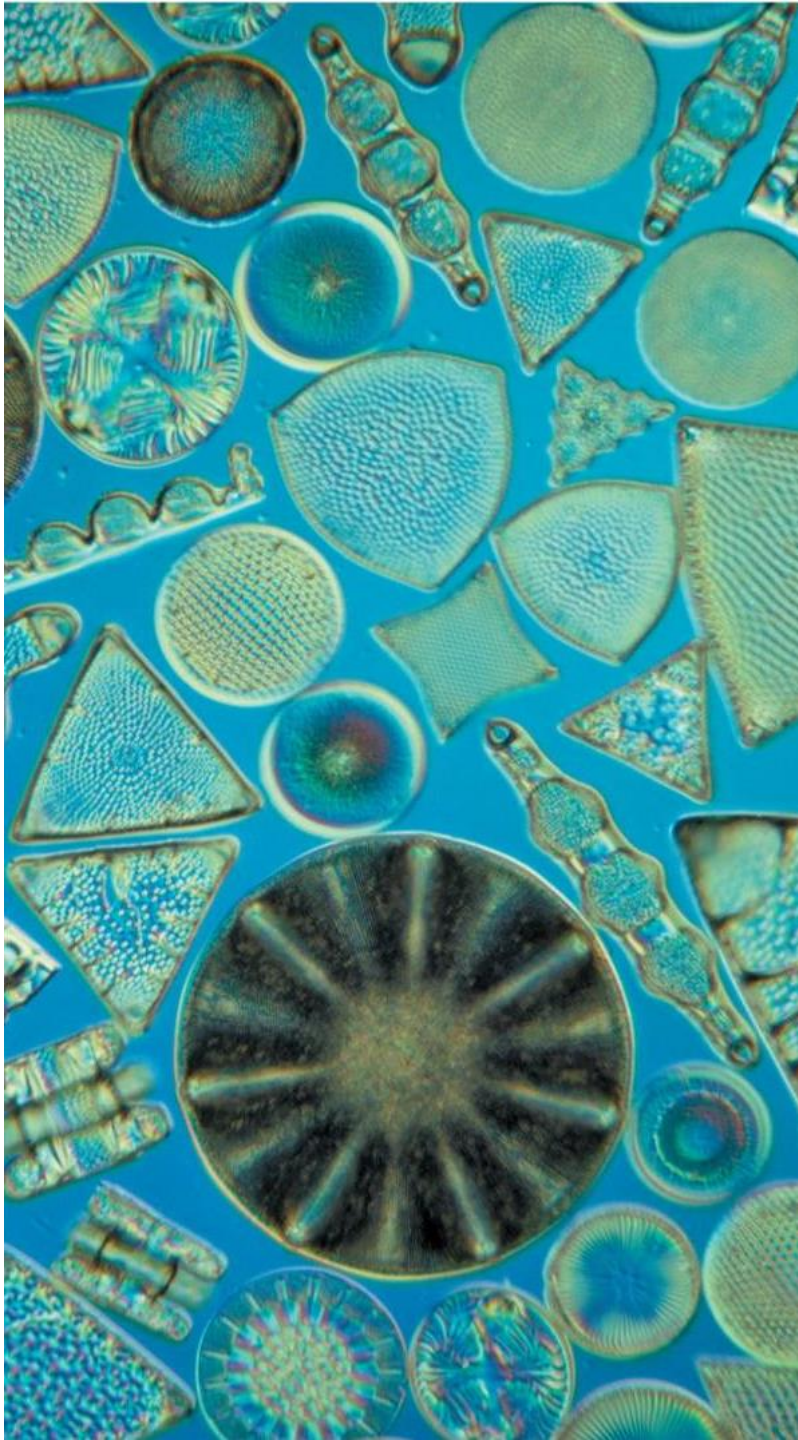
Figure 16.14D

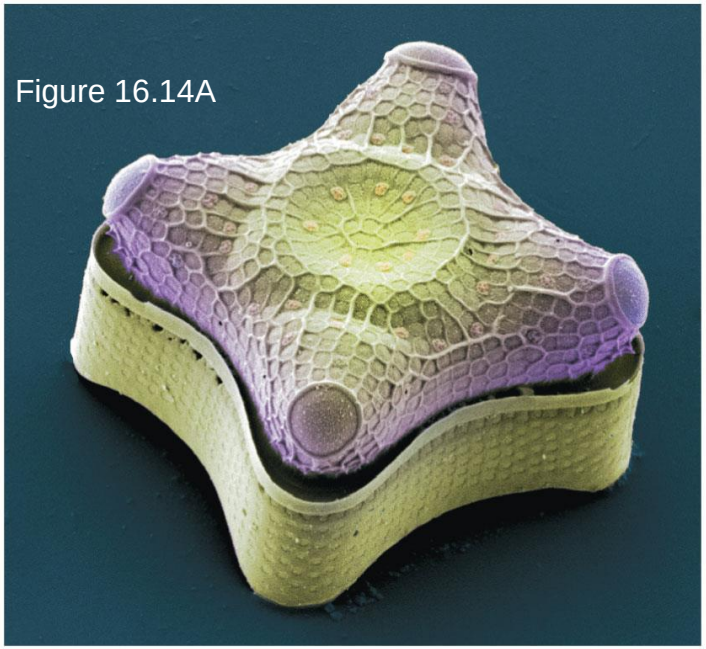


## e) Diatoms

- All are unicellular and autotrophic
  - Unicellular autotrophs are also known as phytoplankton
- Cells surrounded by an outer glassy wall of silica
  - Called a frustule
  - Each species has a unique frustule
- When alive, cell produces oils to make them buoyant
- Found in diatomaceous earth
  - Used for filtering, grinding and polishing







## f) Brown algae

- All are multicellular and autotrophic
  - All multicellular algae are also known as seaweed
- Have chlorophyll and xanthophylls
- Have cellulose in their cell walls
- Can be very large!
- Have bladders full of gas to help them float
- Often called “forests of the ocean”
- Usually found in cooler waters
- Some are edible eg. Kelp (*Laminaria*)

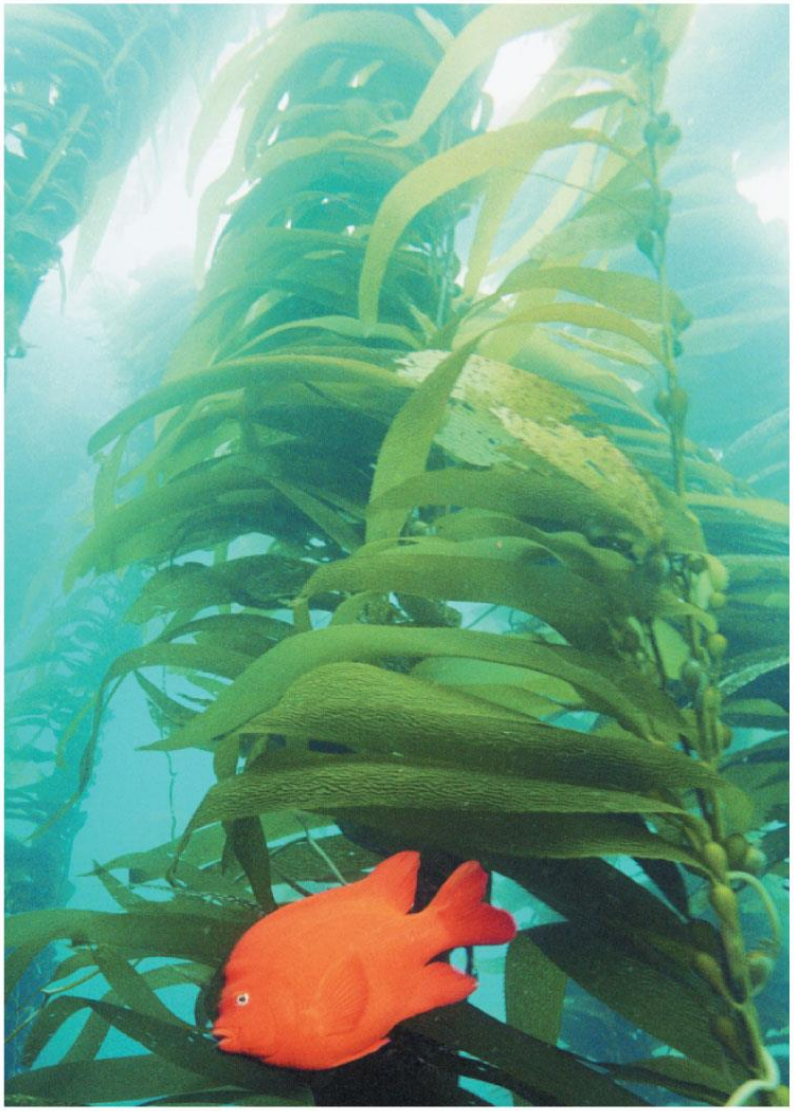




Figure 16.14B

# 5. Supergroup Archaeplastida

a) Red algae

- All are autotrophic
- Most are multicellular
- Have chlorophyll and phycoerythrin
- Some have calcium carbonate in their cell walls in addition to cellulose
- Some are edible eg. nori (*Porphyra*), dulse (*Palmaria*)
- Some are harvested for a gelatinous material called carrageenan or agar

**Encrusted red algae** ie. Have calcium carbonate in cell walls in addition to cellulose (See also Figure 16.18A)

## b) Green algae

- Are unicellular, colonial or multicellular
- All are autotrophic, contain chlorophyll and have cellulose in their cell walls

## i. Unicellular green algae

eg. *Chlamydomonas*

Figure 16.18B

- Each cell is motile with 2 flagella
- Each also contains one cup-shaped chloroplast
- Reproduce both asexually and sexually

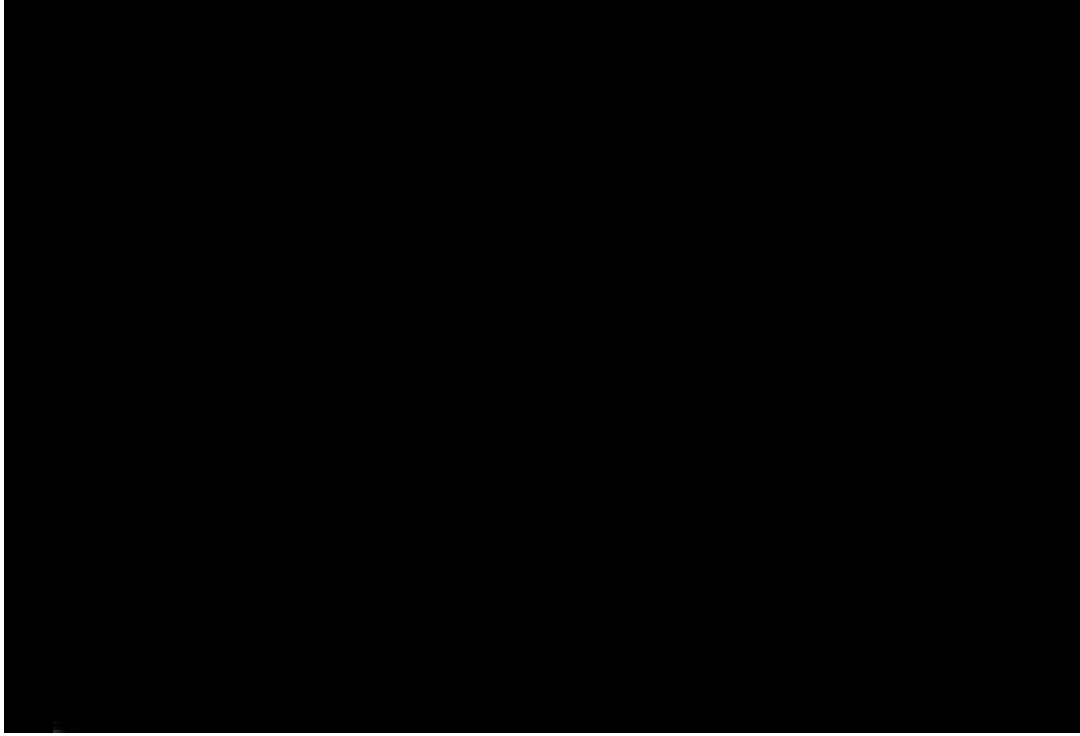
## ii. Colonial green algae

eg. *Volvox*

- Is a hollow ball of cells
  - Cells held together with a jelly-like material
- Each cell looks like *Chlamydomonas*
- Flagella are oriented to the outside
  - Entire ball is motile

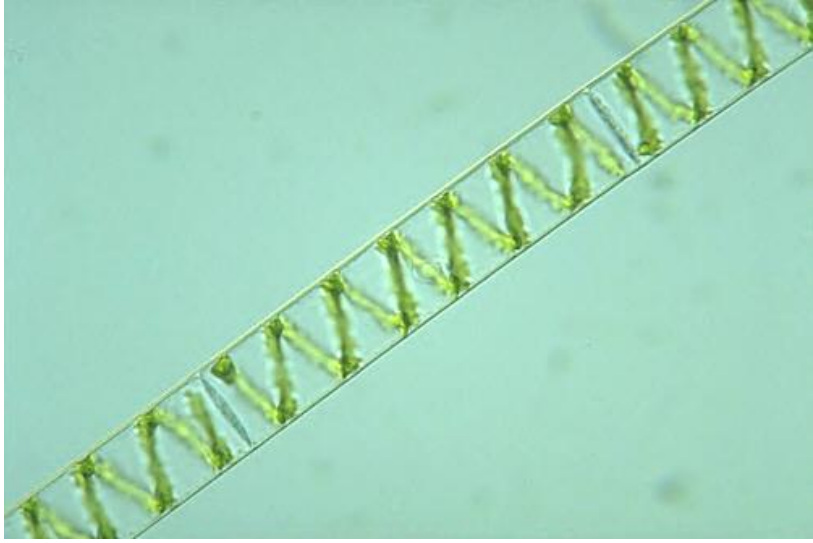
See also Figure 16.18B

# *Volvox*

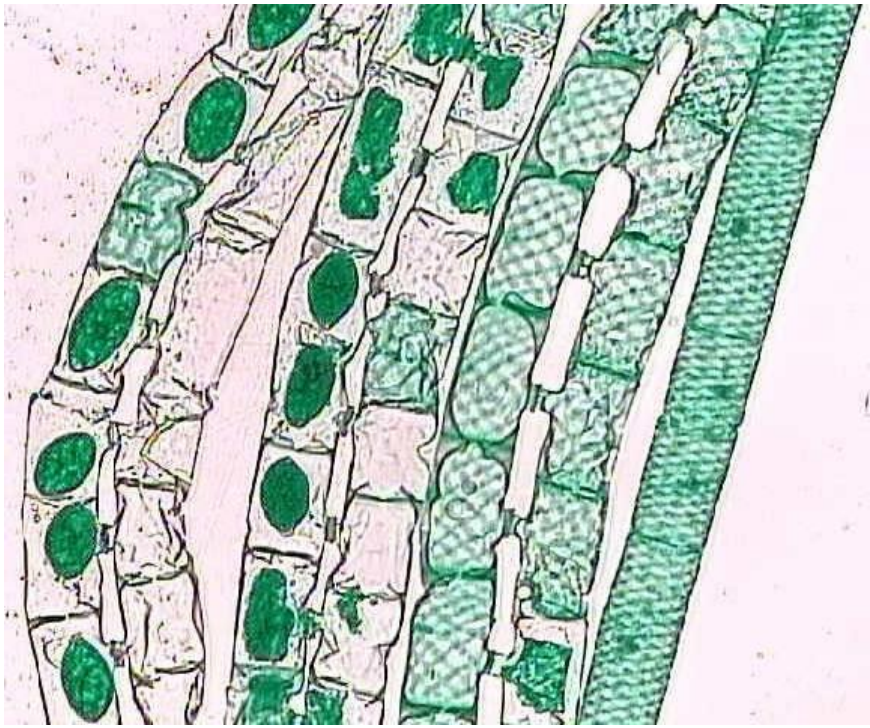


- Reproduce by producing new daughter colonies inside the parent colony
  - Are also hollow balls of cells
  - Eventually ball opens to release daughter colonies

eg. *Spirogyra*
(another type of colonial green algae)



- Is a chain of cells with spiral chloroplasts



- Can reproduce by fragmentation (asexual) **or** by conjugation (sexual)

## iii. Multicellular green algae

- Also called green seaweed
- Very plant-like in appearance
- True plants believed to have evolved from this group

What are their plant similarities?

- Have cellulose cell walls
- Have the Haplo-Diplontic life cycle
  - Is the plant life cycle

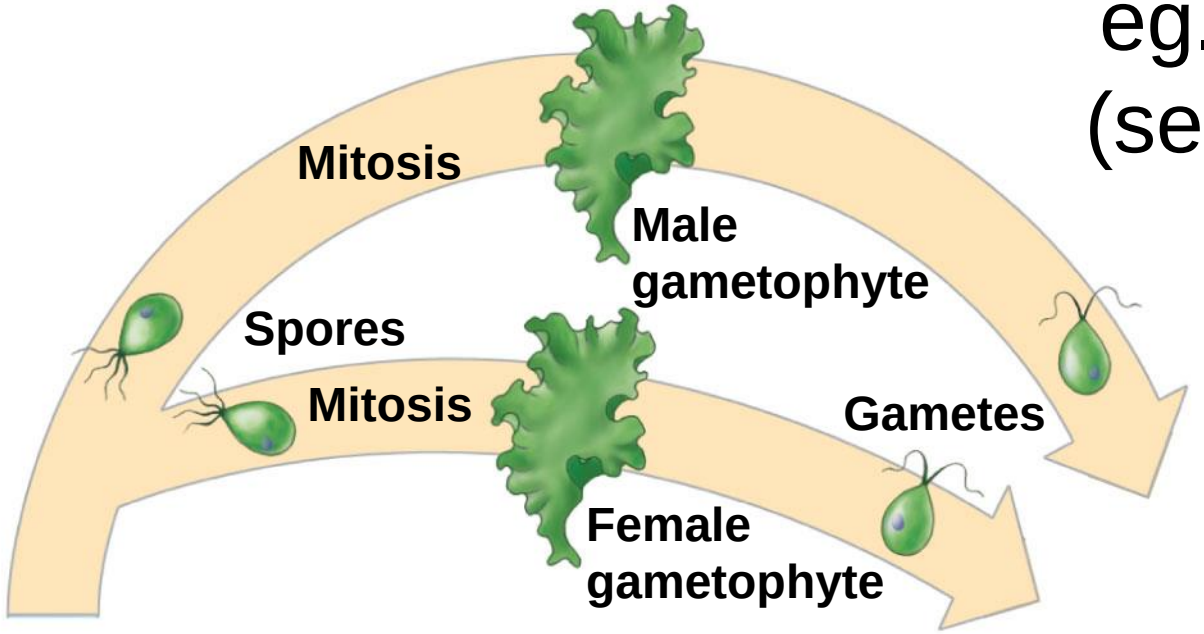
eg. *Caulerpa*



Figure 16.12A

Figure 16.18C

eg. *Ulva*
(sea lettuce)




**Key**
- **Haploid (*n*)**
- **Diploid (2*n*)**

Figure 16.18C

eg. *Ulva*
(sea lettuce)

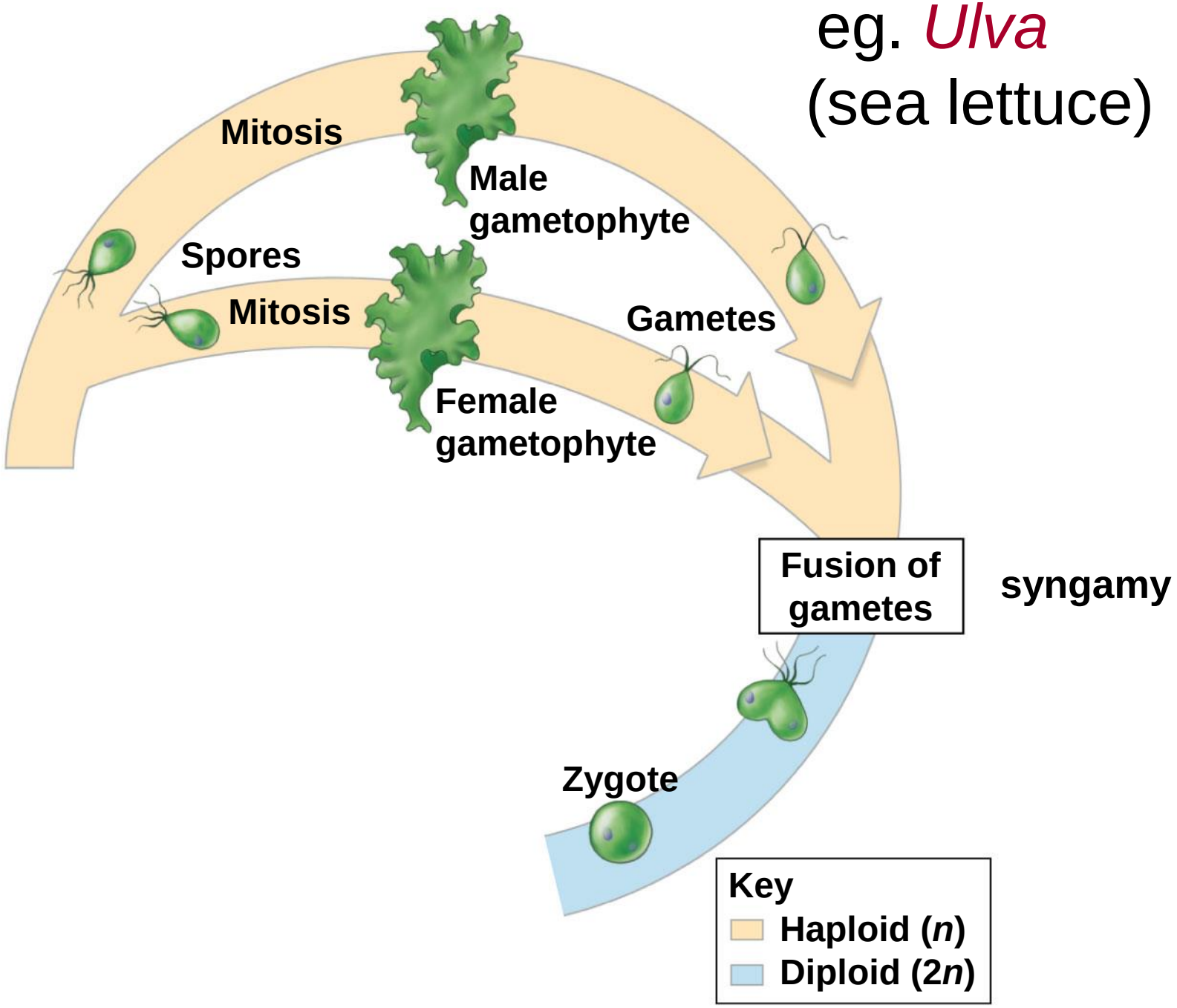
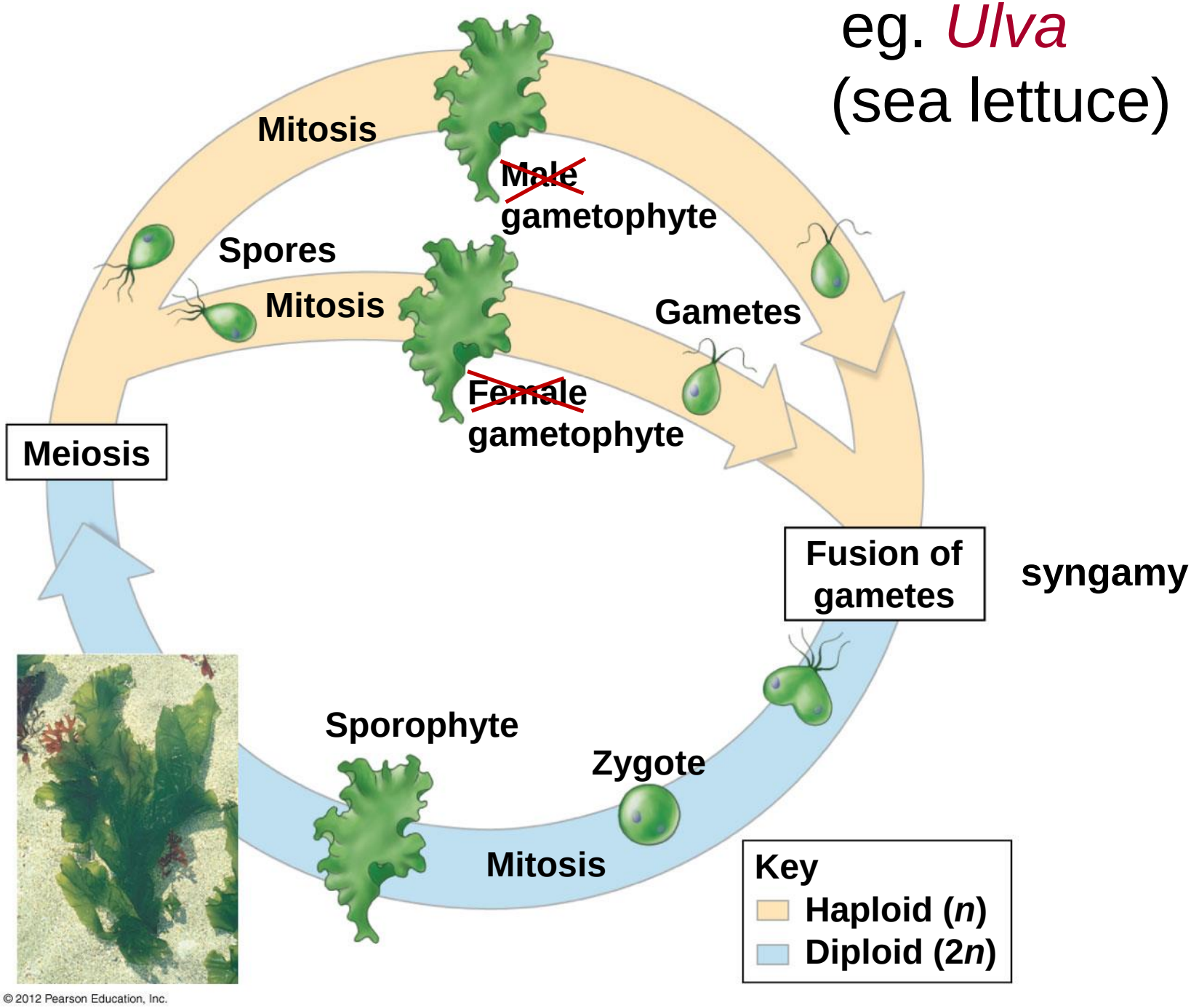


Figure 16.18C

eg. *Ulva*
(sea lettuce)



# Multicellularity and eukaryotes

- Multicellular organisms (seaweeds, plants, animals and most fungi) are fundamentally different from unicellular organisms
  - All of the activities of a unicellular organism occur in one cell
  - The cells of multicellular organisms are interdependent
    - Some cells become specialized for different functions
- There are three lineages of multicellular organisms:
  - red and green seaweed and plants evolved from archaeplastids
  - brown seaweed evolved from chromalveolates
  - fungi and animals evolved from unikonts
- Animals probably arose from colonial choanocytes and fungi from nucleariids

Figure 16.19A

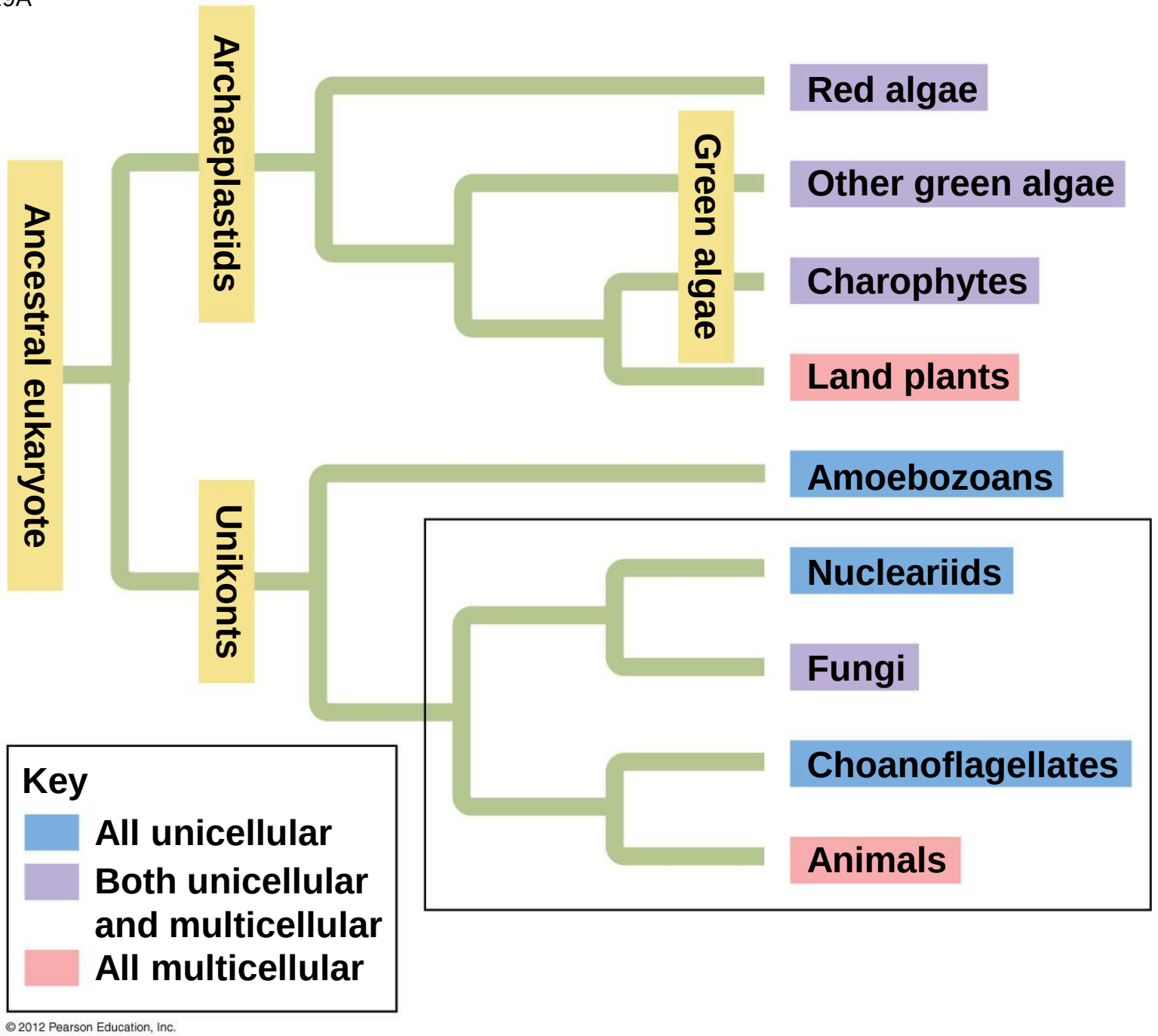
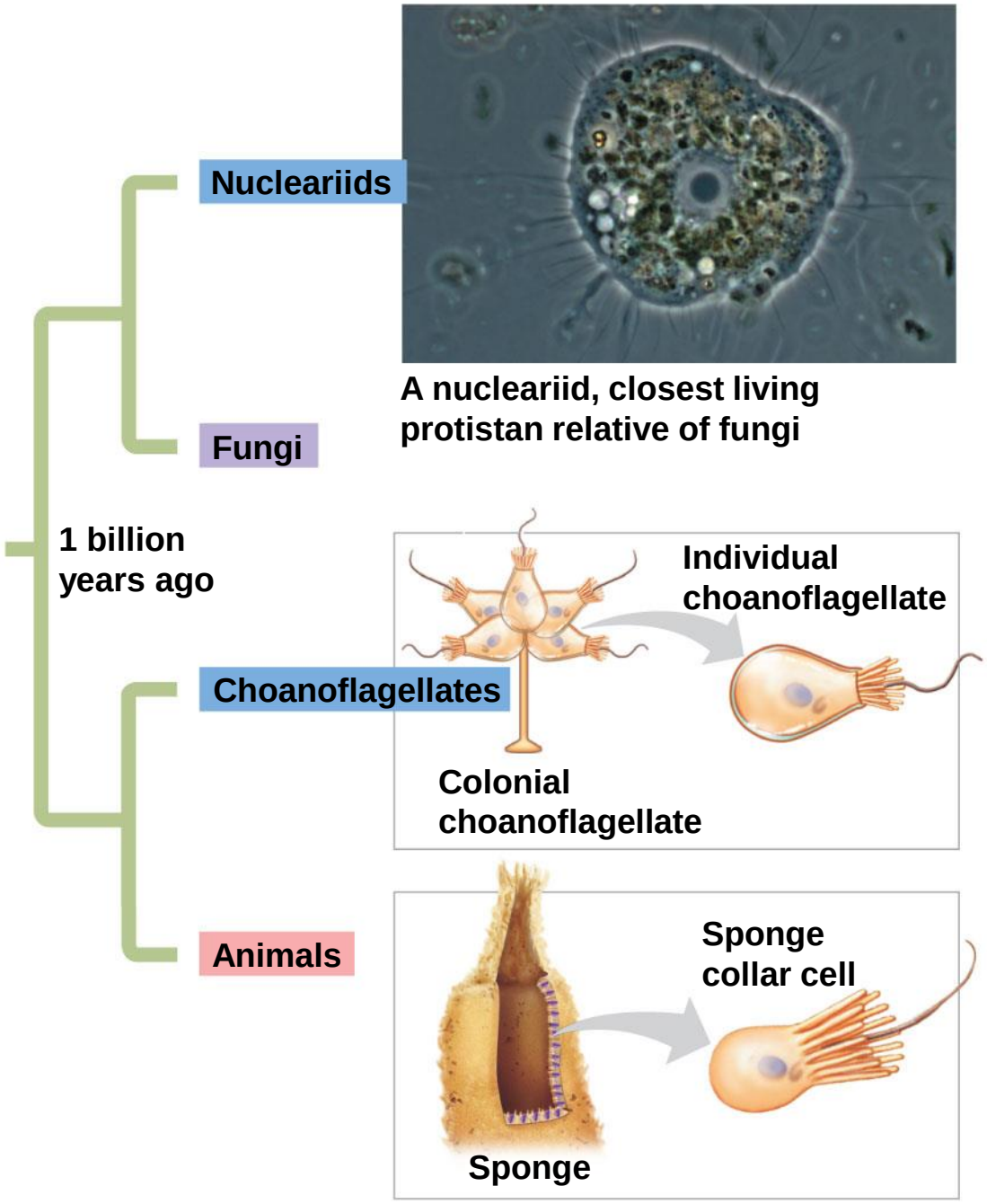


Figure 16.19B



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