Chapter 5:
THE EUKARYOTES OF MICROBIOLOGY

1. Unicellular Eukaryotic Parasites
2. Parasitic Helminths
3. Fungi
4. Algae & Lichens

New Classification of the Domain Eukarya

The domain Eukarya has undergone major reclassification based on 6 <u>supergroups</u>:

EXCAVATA

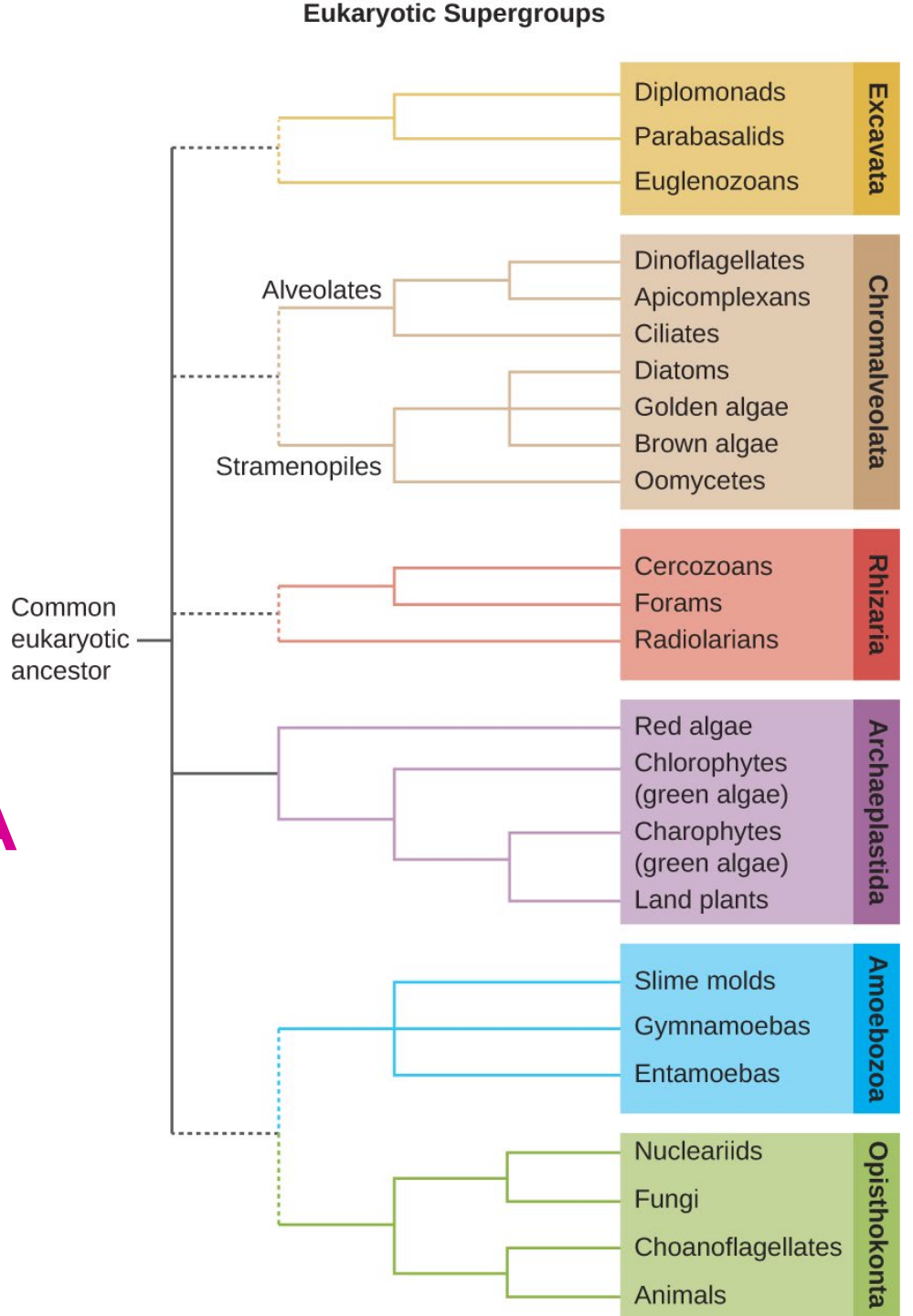
CHROMALVEOLATA

AMOEBOZOA

ARCHAEPLASTIDA

RHIZARIA

OPISTHOKONTA



1. Unicellular Eukaryotic Parasites

Members of the supergroups:

AMOEBOZOA

EXCAVATA

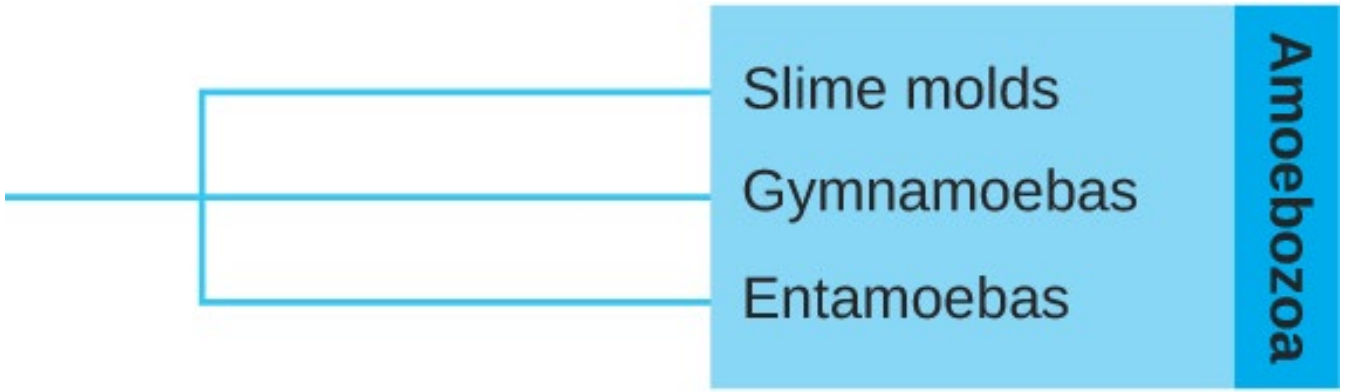
CHROMALVEOLATA

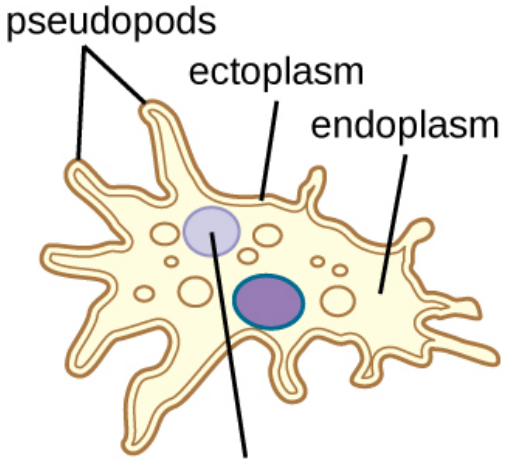
Unicellular Parasites in the Amoebozoa

Members of this supergroup extend pseudopodia and exhibit motility by amoeboid movement, and feed by phagocytosis.

We will look at examples of parasites in the subgroup:

ENTAMOEBAS



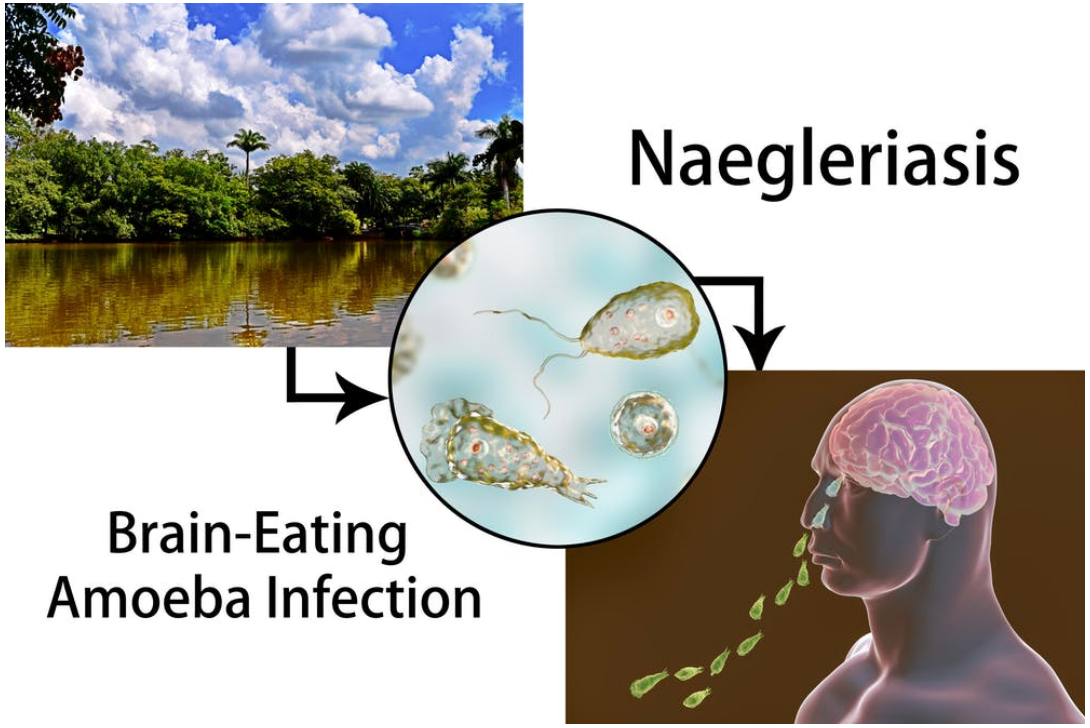


Amoeba

Entamoebas

Entamoeba histolytica

- typically transmitted by contaminated, untreated water
- leads to amoebic dysentery



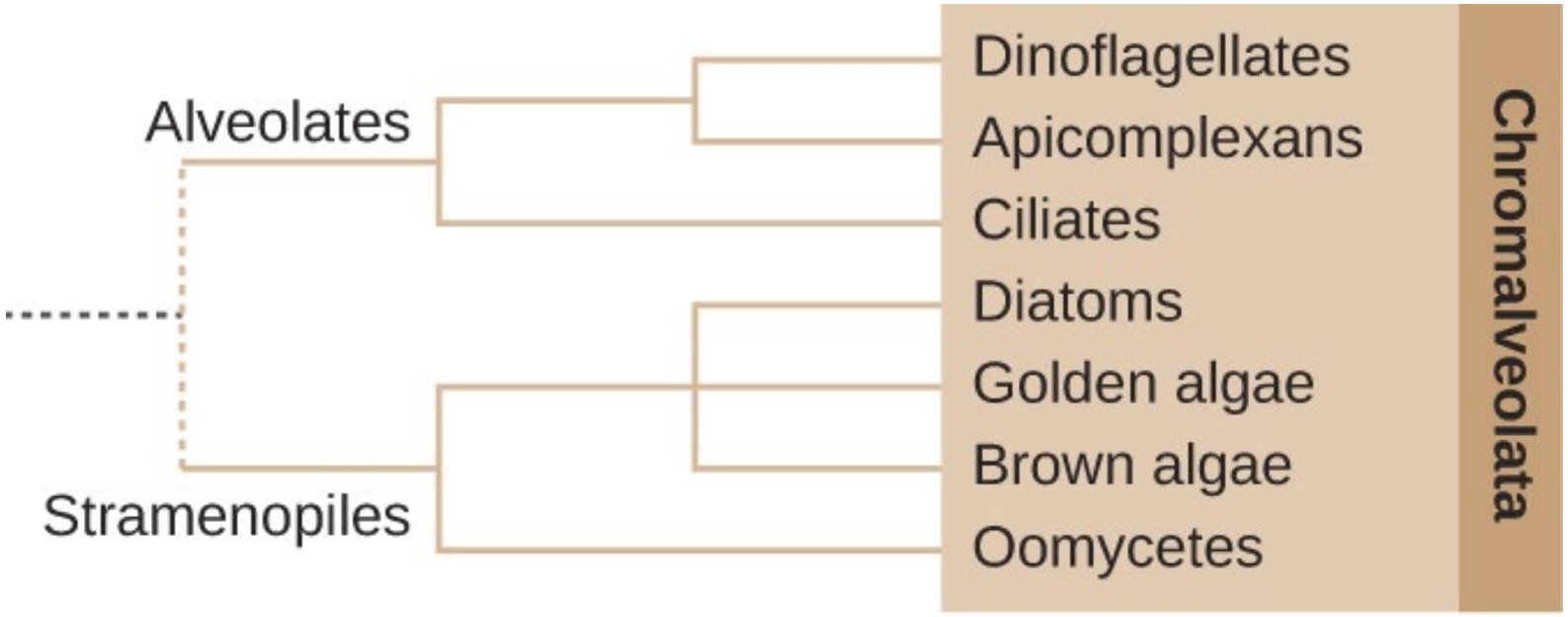
Naegleria fowleri

- typically transmitted by contaminated water via nose
- "brain-eating amoeba, almost always fatal

Unicellular Parasites in the Chromalveolata

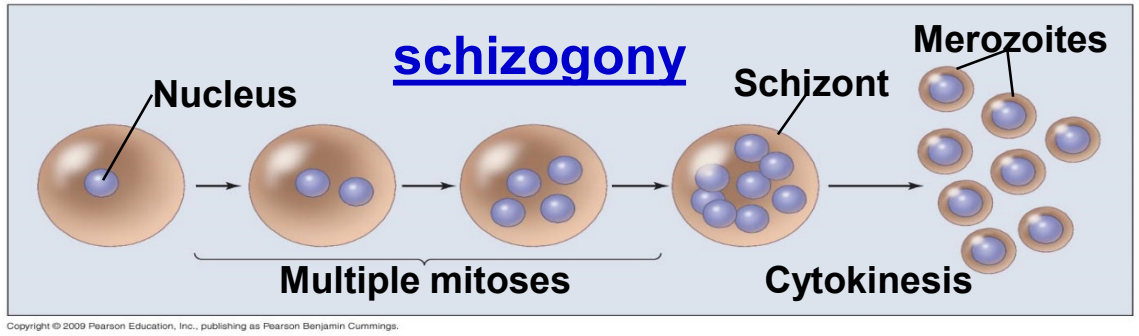
We will look at examples of parasites in the subgroups:

APICOMPLEXANS **CILIATES**



Apicomplexans

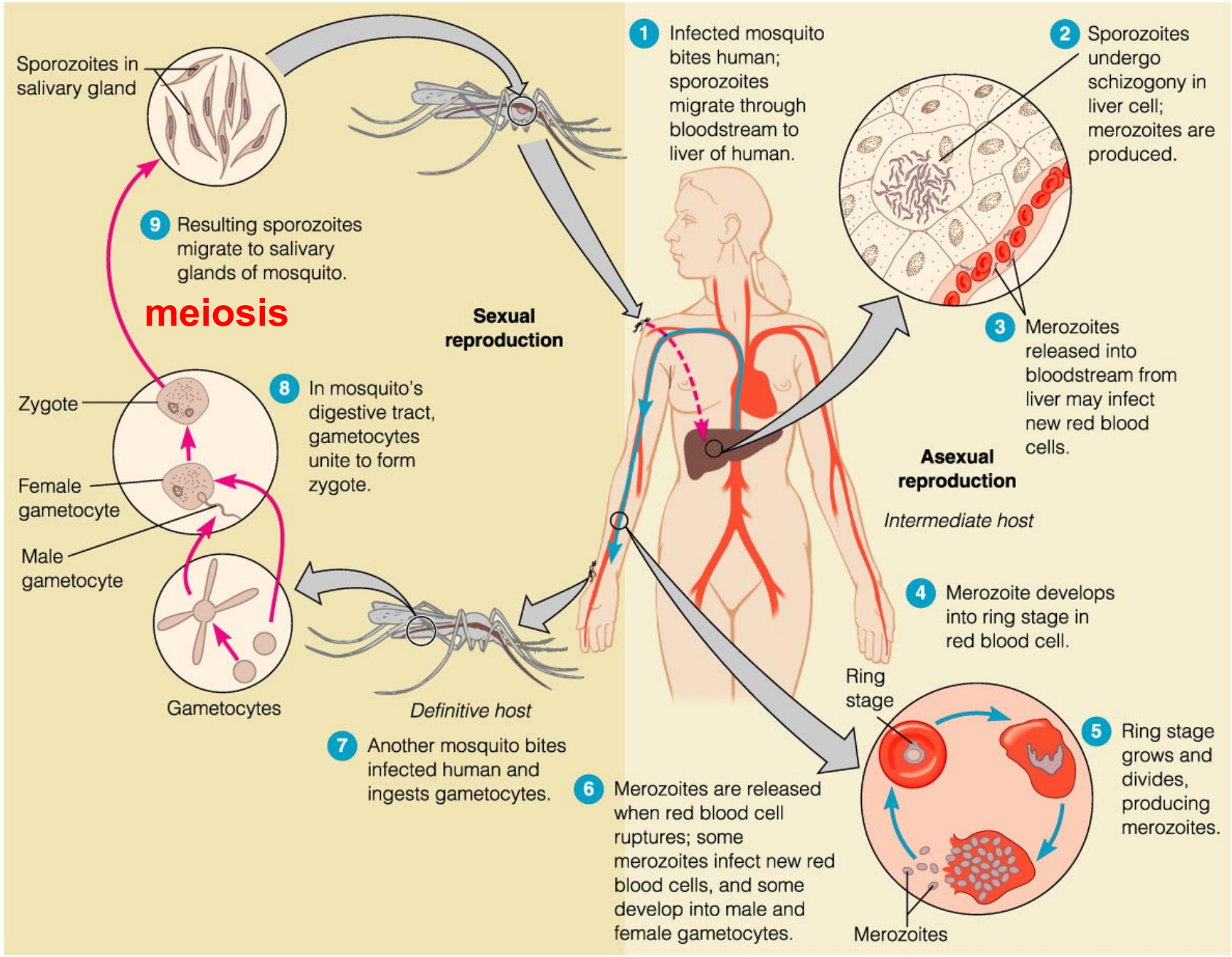
- non-motile obligate intracellular parasites
- have a unique "apical complex" of fibers and vacuoles that release digestive enzymes that aid penetration of animal tissues
- includes species of *Plasmodium* responsible for the disease malaria
  - reproduce asexually by schizogany



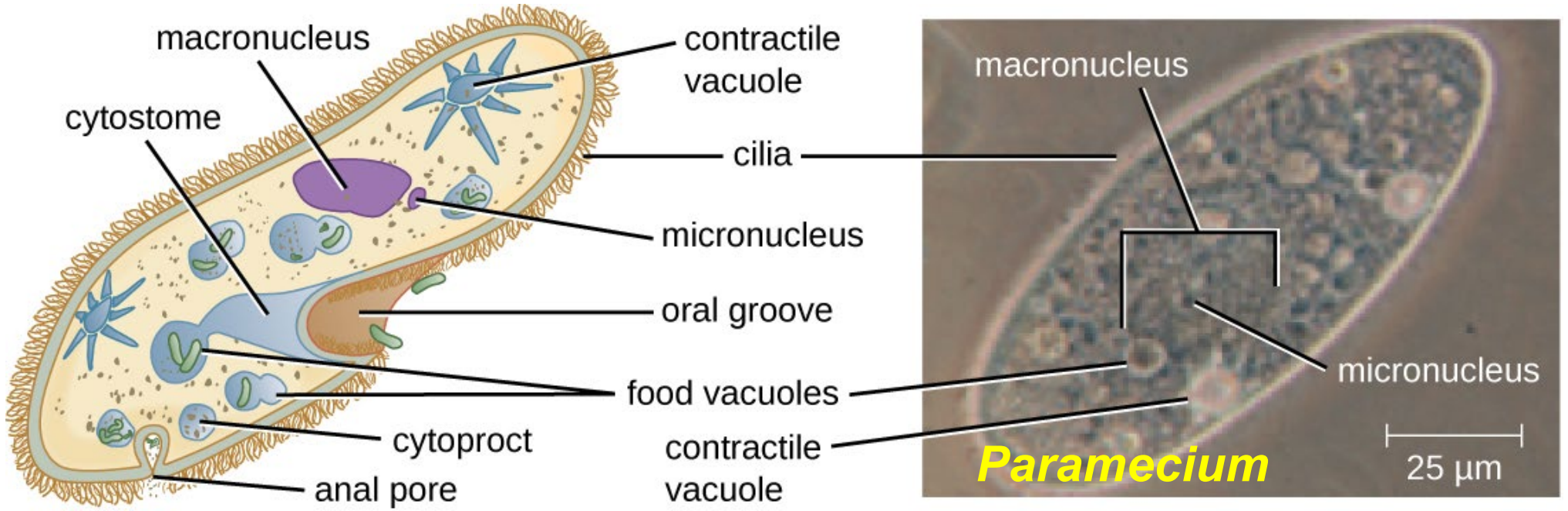
Plasmodium Life Cycle (malaria)

- **<u>definitive</u> host (sexual reproduction) is the mosquito**

- **<u>intermediate</u> host (asexual reproduction) is *Homo sapiens***



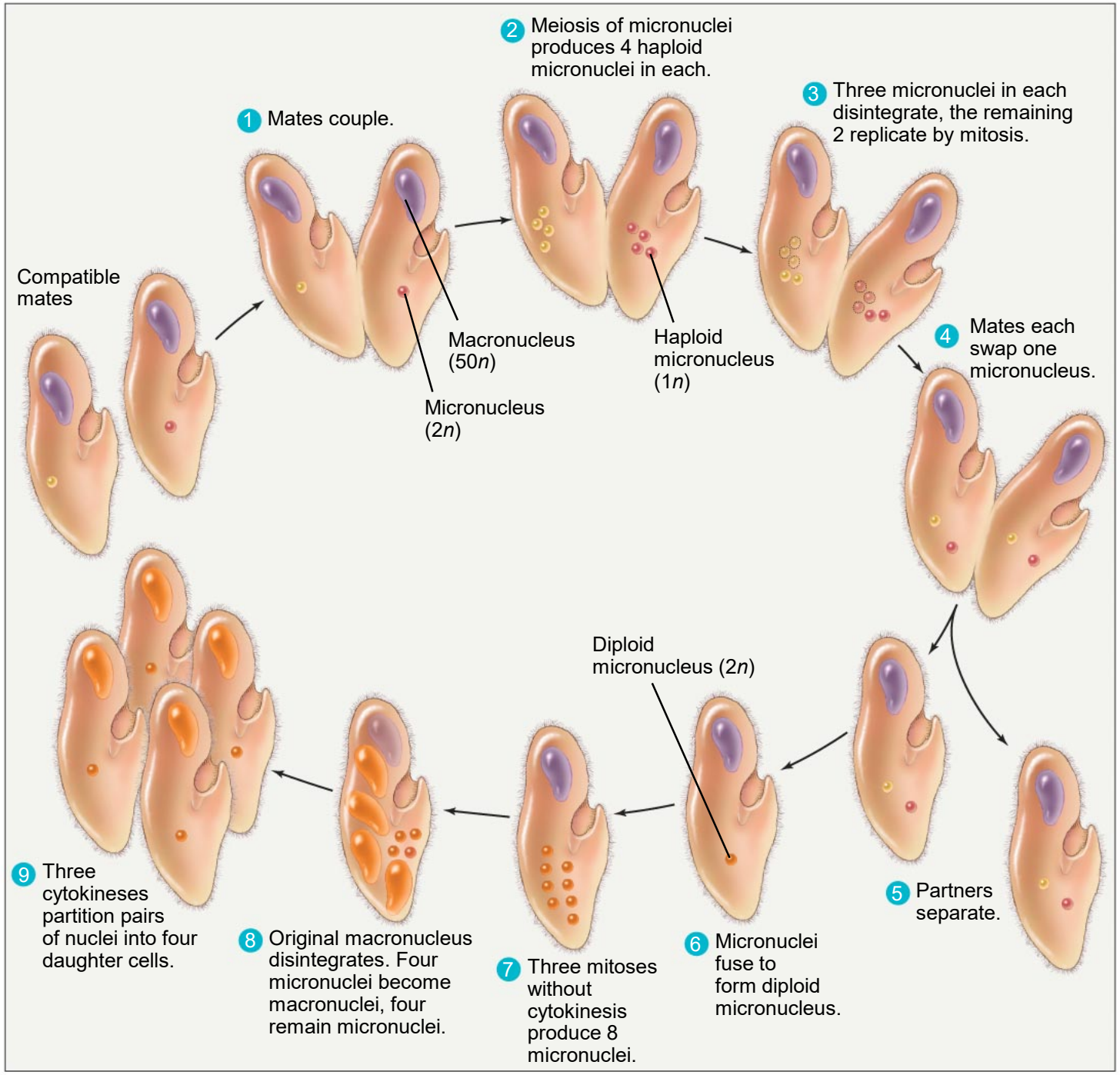
Ciliates



All have many small projections called cilia used for locomotion & to direct food into the cytostome ("mouth")

- **have contractile vacuole to expel excess water taken in by osmosis (expelled by exocytosis)**
- **some have multiple nuclei**

Conjugation in Ciliates



Unicellular Parasites in the Excavata

We will look at examples of parasites in the subgroups:

DIPLOMONADS

PARABASALIDS

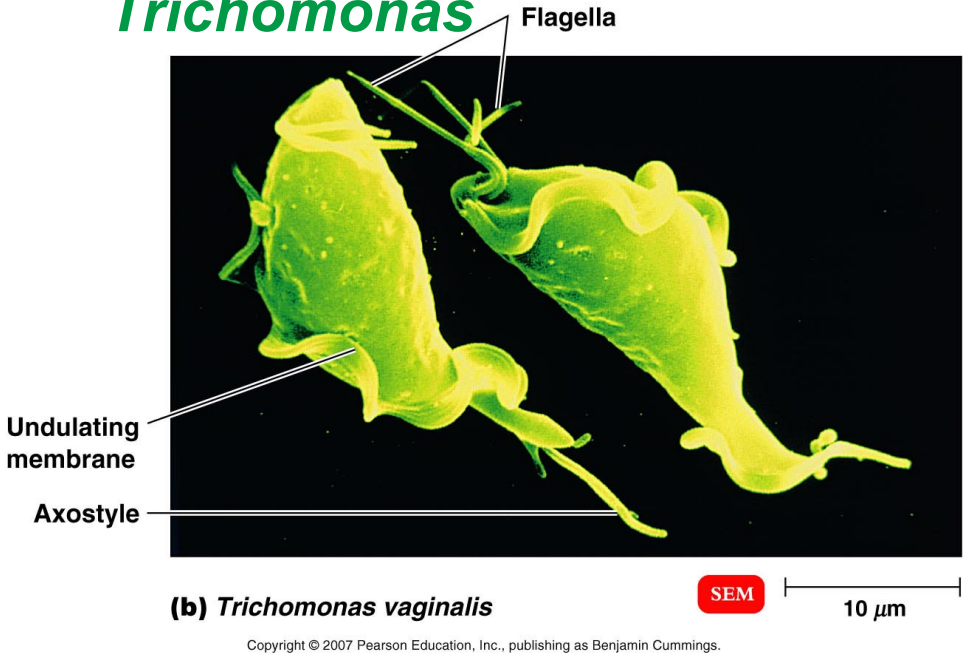
EUGLENOZOA

Parabasalids & Diplomonads

Do NOT have mitochondria, have an analogous mitosome

- **most have multiple flagella, Diplomonads have 2 nuclei**
- **several parasitic genera can cause human disease:**

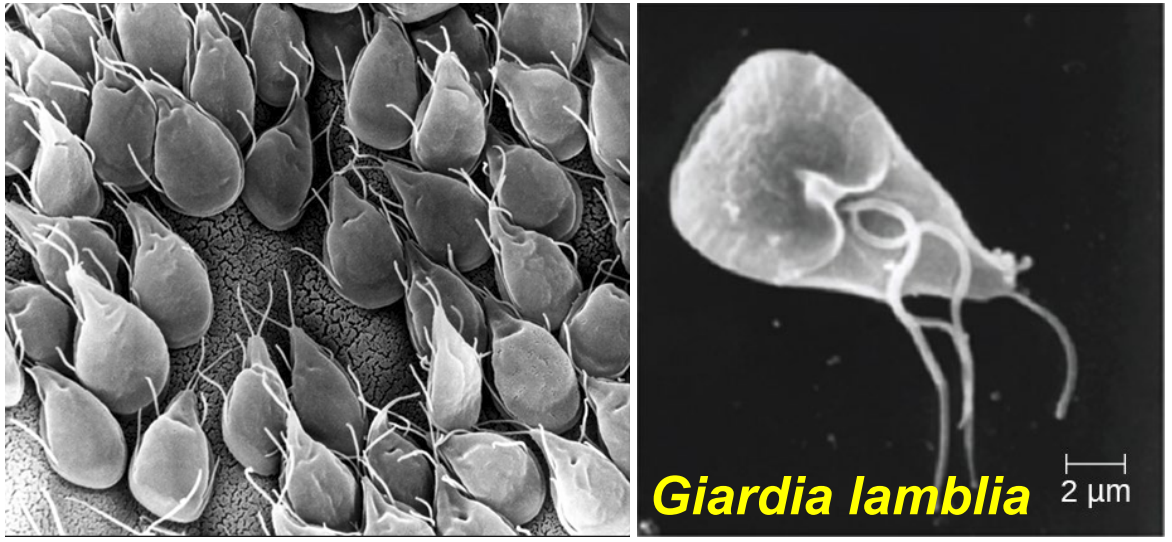
Trichomonas



(b) *Trichomonas vaginalis*

a "Parabasalid"

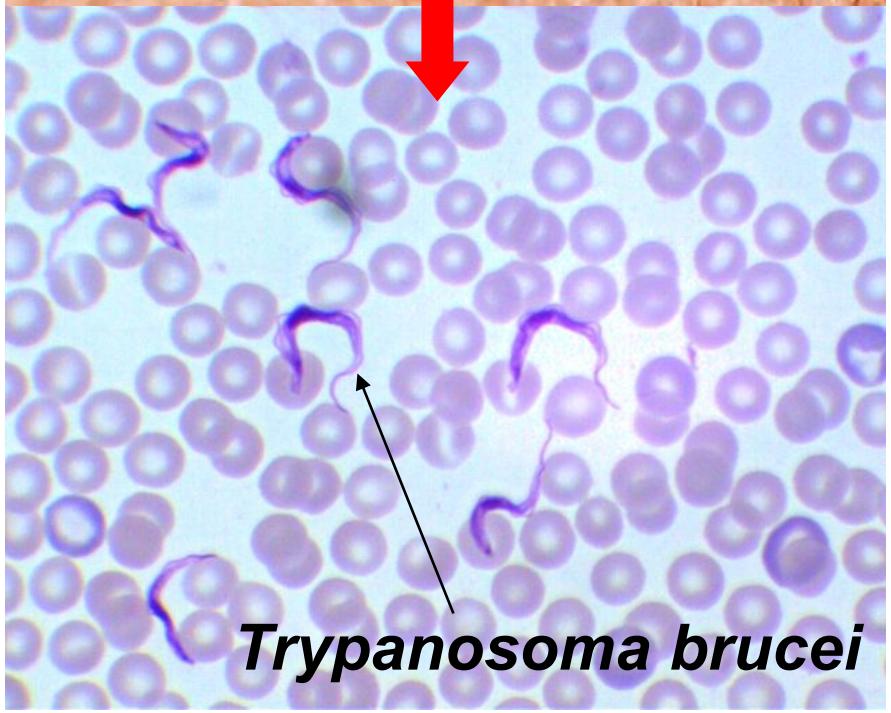
Giardia



a "Diplomonad"

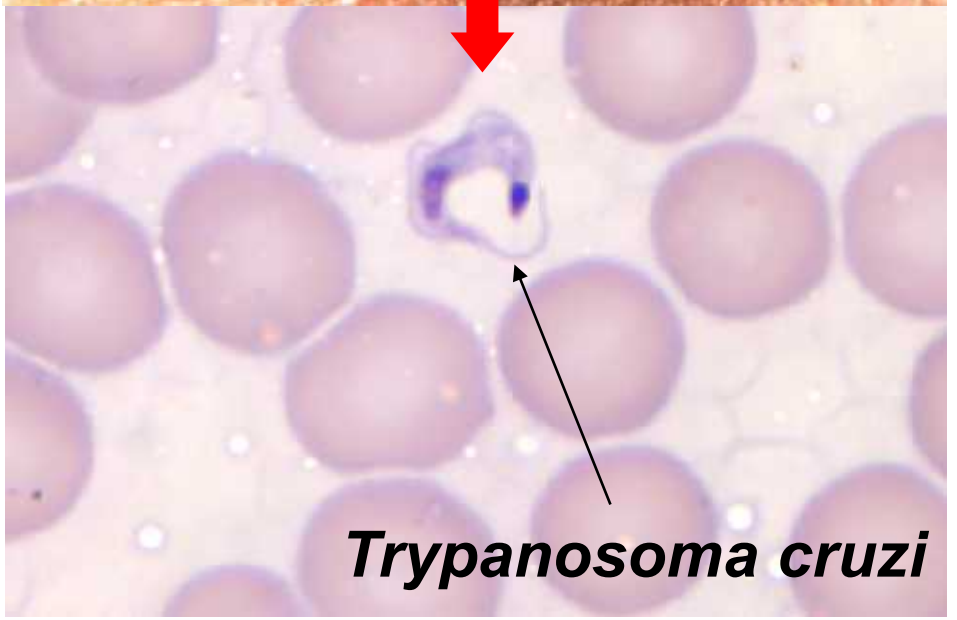
Euglenozoa

Sleeping Sickness



Includes the hemoflagellates (*Trypanosoma*) such as those that cause "sleeping sickness" and "Chagas Disease"

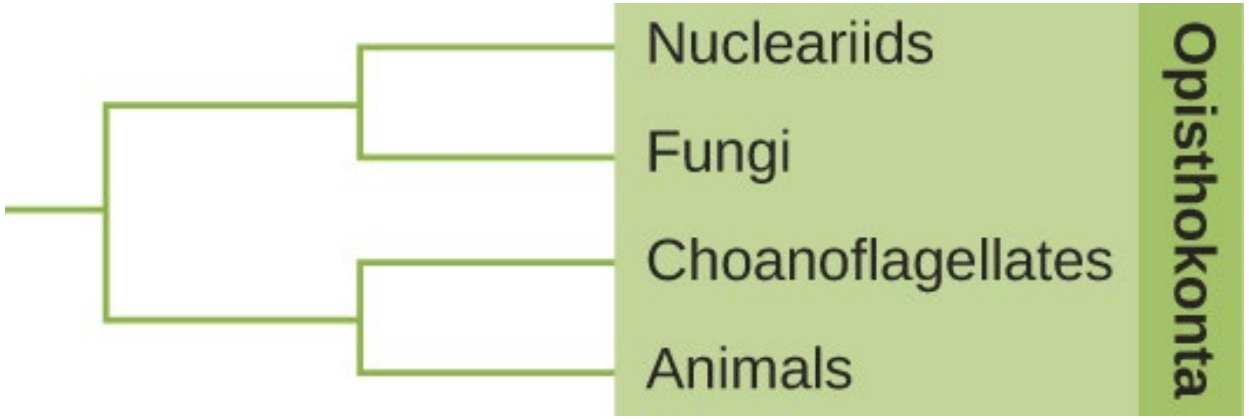
Chagas Disease



2. Parasitic Helminths

From of the supergroup:

OPISTHOKONTA
(animals)



Overview of the Helminths

Helminths are parasitic worms found in 2 animal phyla, the Platyhelminthes (flatworms) and the Nematodes (roundworms).

- **multicellular eukaryotic heterotrophs**
- **have complex life cycles frequently involving multiple hosts**
- **contain distinct organ systems**
  - **some may be reduced or absent due to dependence on host (e.g., no digestive system, no locomotion)**

Platyhelminthes (flatworms):

- typically hermaphroditic (monoecious)
- have a proctostome (single opening, no anus)
- we will look at 2 classes:

  Trematodes (flukes) & Cestodes (tapeworms)

Nematodes (roundworms):

- typically dioecious (2 sexes)
- have complete digestive system (mouth & anus)
- we will look at 1 example: pinworms

Trematodes (flukes)

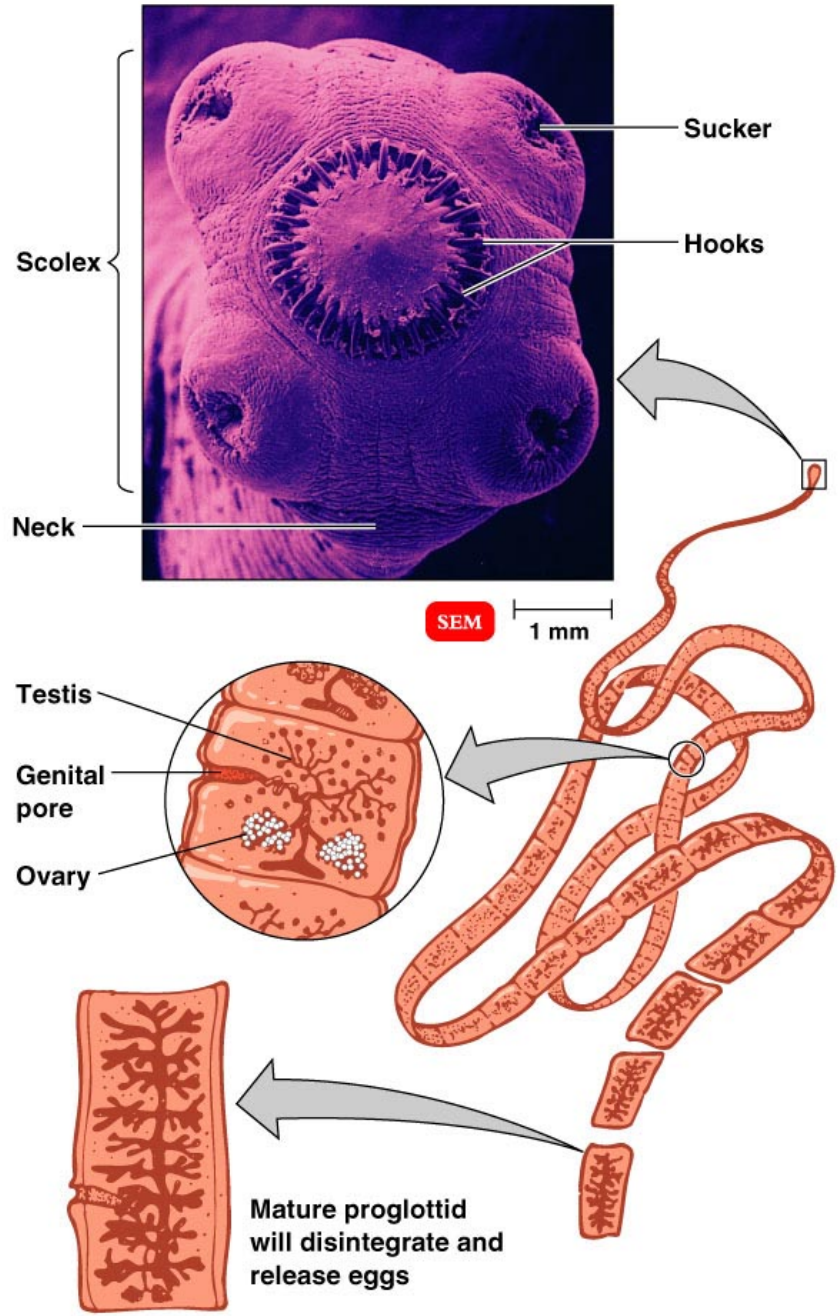
Members of this class of flatworms are all parasites associated w/particular host tissues (liver, blood, lung)

- can have multiple larval stages and hosts
- hermaphroditic (monoecious)
- attach to host tissue via oral and ventral suckers
- absorb nutrients through outer cuticle

(liver fluke)

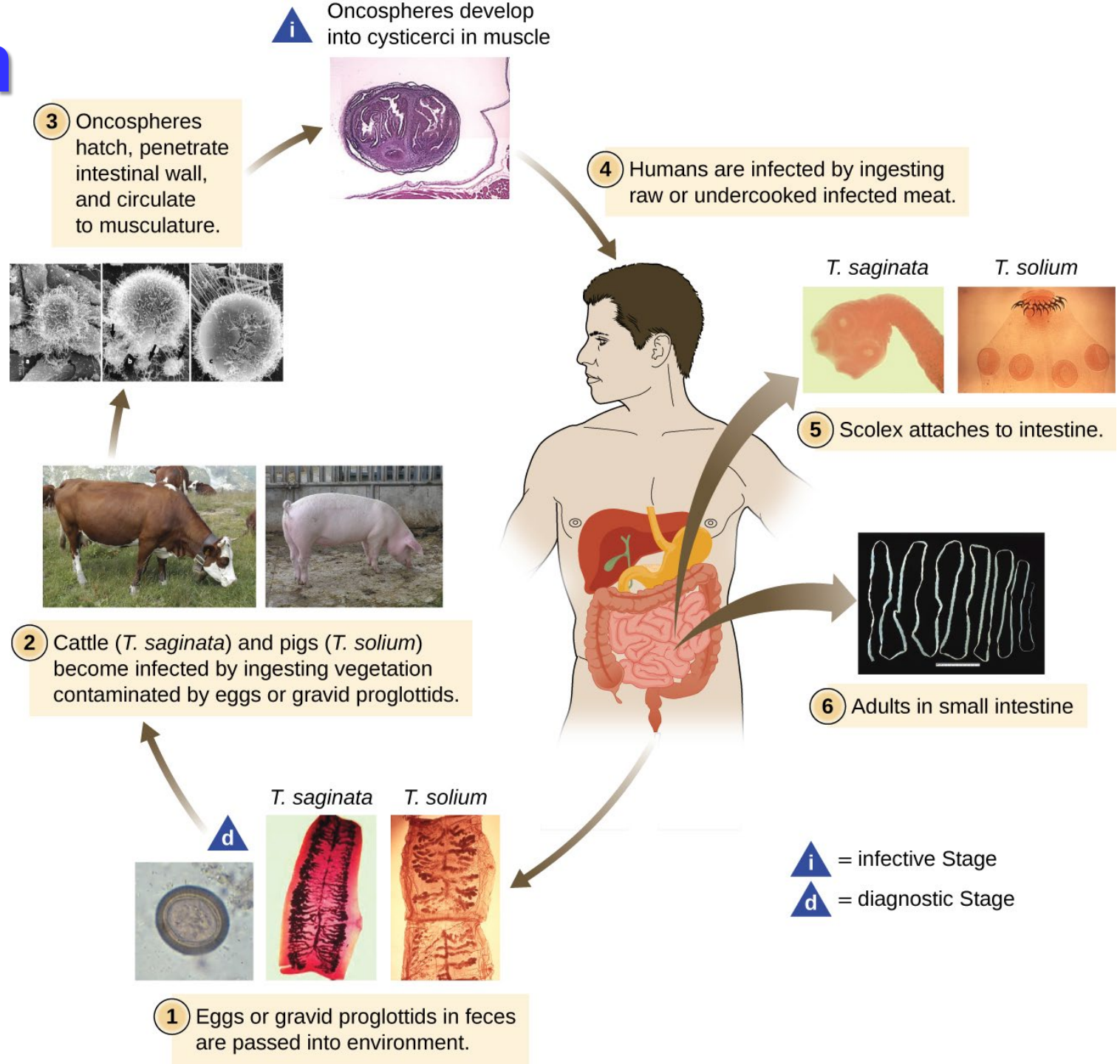
Tapeworms (cestodes)

- intestinal parasites
- <u>scolex</u> (head) has hooks & suckers for attachment
- no digestive system, absorb nutrients
- repeating <u>proglottids</u> have male & female reproductive organs (monoecious)
- mature proglottids detach & pass w/feces allowing transmission to other hosts



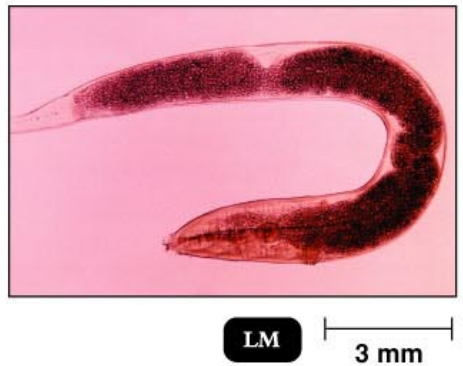
Typical Tapeworm Life Cycle

- humans are the <u>definitive</u> or <u>primary</u> host
- cows or other grazing animals are a <u>secondary</u> or <u>intermediate</u> host

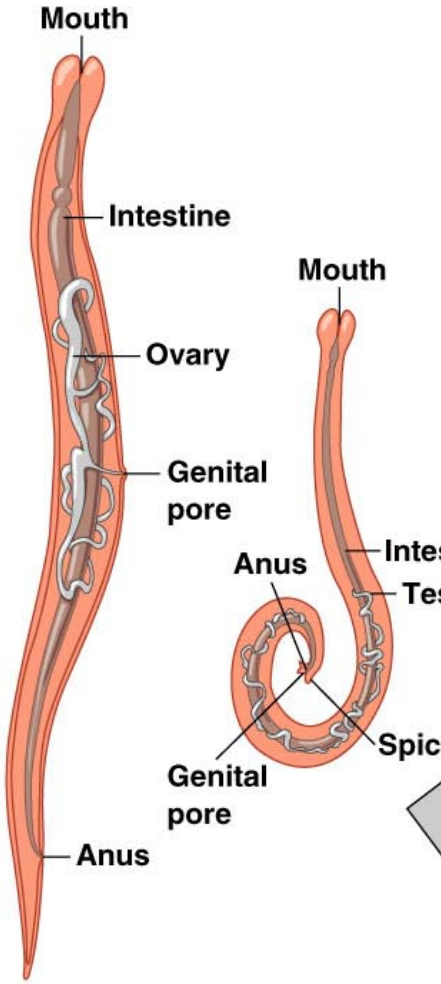


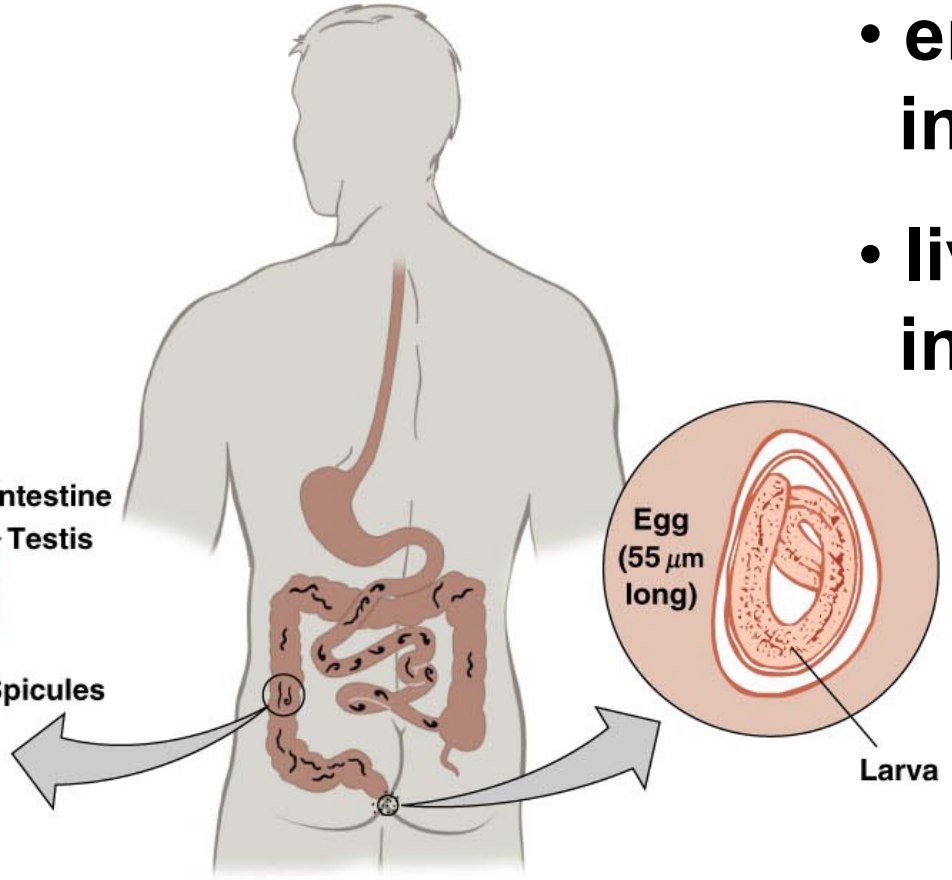
Pinworms

Dioecious parasitic roundworm (nematode)



(a) Adult pinworm





Enterobius vermicularis

(b) Pinworm egg

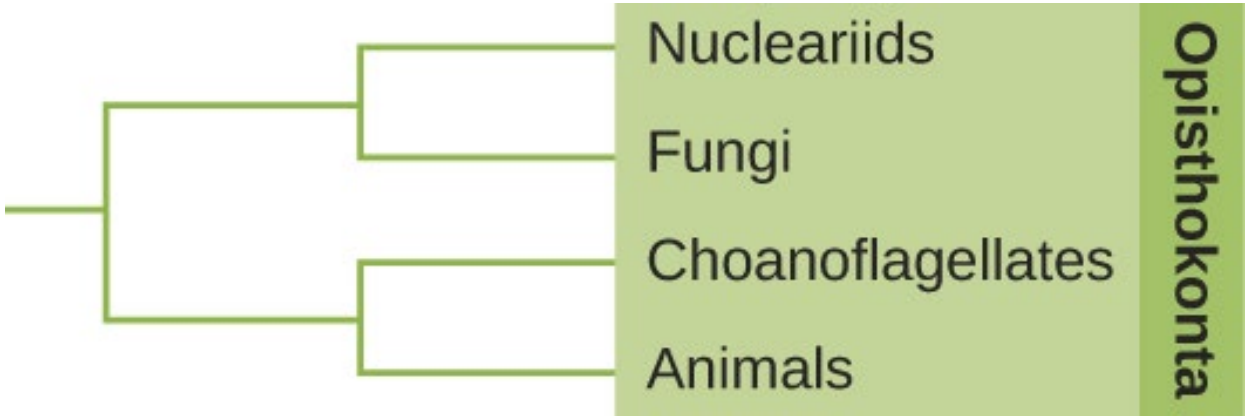
- entire life cycle in human hosts
- live in large intestine
- females lay eggs on anus
- leads to itching & scratching

transmitted to new hosts via eggs

3. Fungi

From of the supergroup:

OPISTHOKONTA



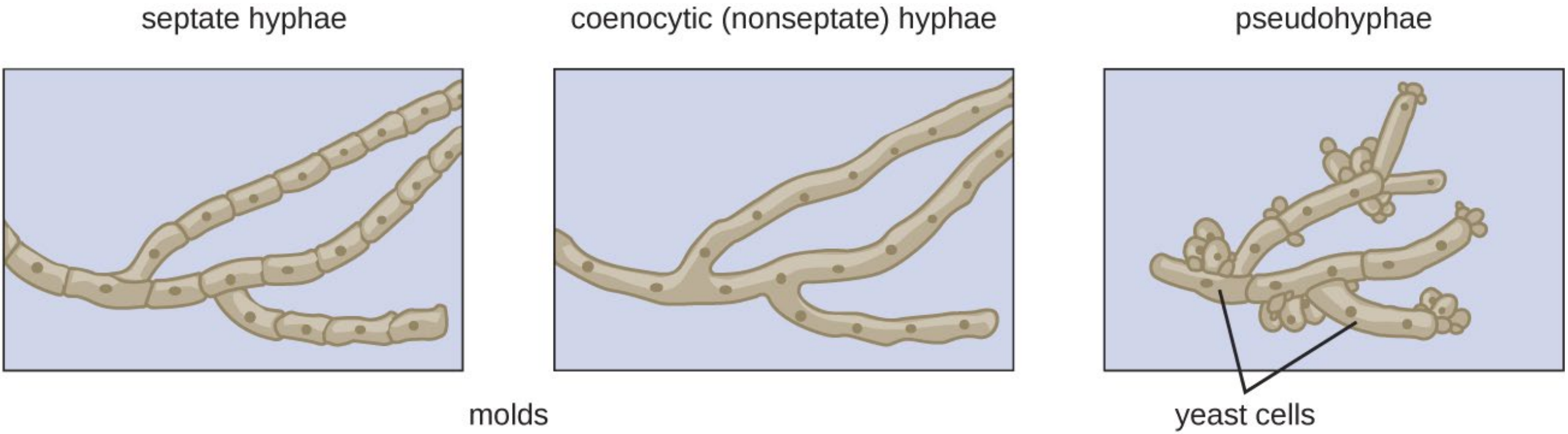
Overview of the Fungi

General characteristics:

- terrestrial eukaryotic absorptive heterotrophs
- ecologically important decomposers
- unicellular (yeasts) or multicellular (molds, club fungi)
- cells are haploid and have cell walls made of chitin
- all fungi develop from haploid spores (no embryos)
- do NOT have flagella (spores are immotile)

**study of fungi is known as mycology **

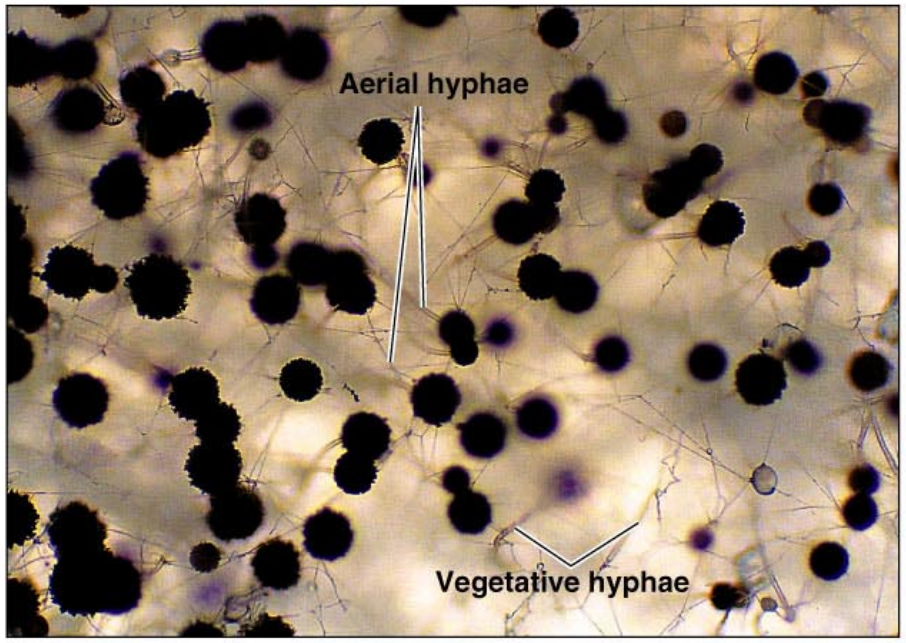
Structure of Multicellular Fungi



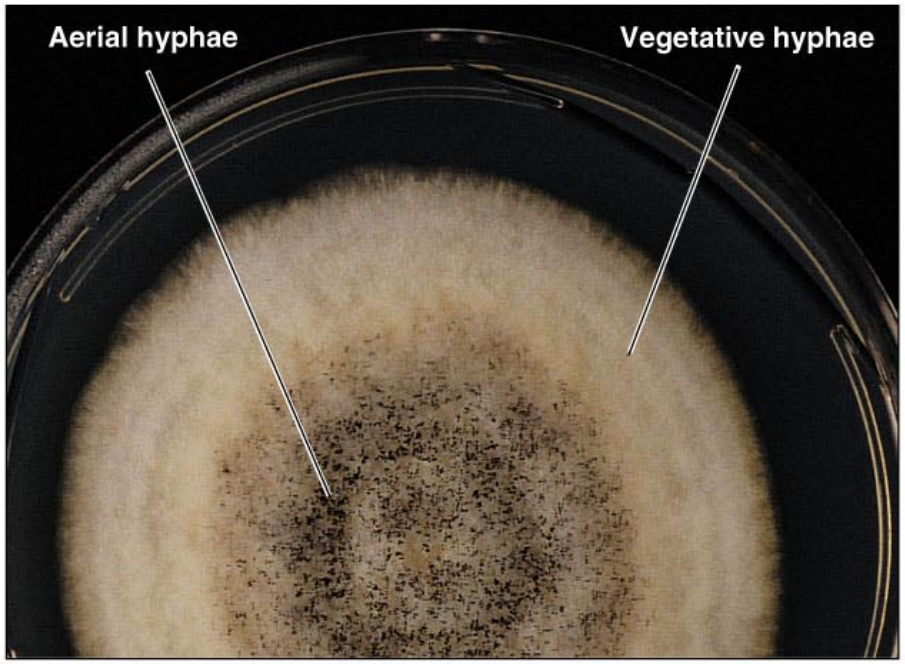
The thallus ("body") of a fungus consists largely of filamentous chains of cells called hyphae:

- **vegetative (non-reproductive) or aerial (reproductive)**
- **some have septa (septate), some don't (coenocytic)**

Hyphae form a Mycelium



(a) *Aspergillus niger*



(b) *A. niger* on agar

On a rich source of nutrients, many hyphae can be produced to form a continuous mass called a mycelium.

- **vegetative hyphae spread across food source & "absorb"**
- **aerial hyphae grow vertically & produce spores**

Reproduction in Filamentous Fungi

Can reproduce asexually by fragmentation:

- fragments of hyphae grow by mitosis in to a new thallus

Asexual spore production

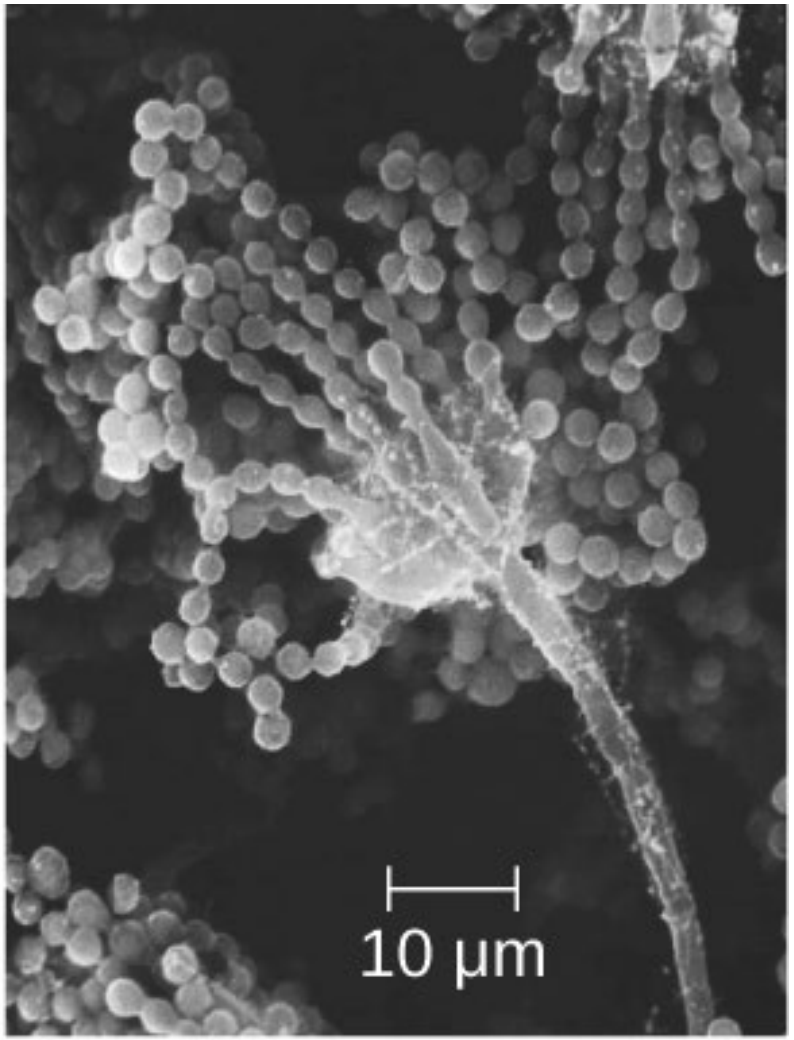
- occurs at the tip of aerial hyphae
- derived from single parent fungus by mitosis

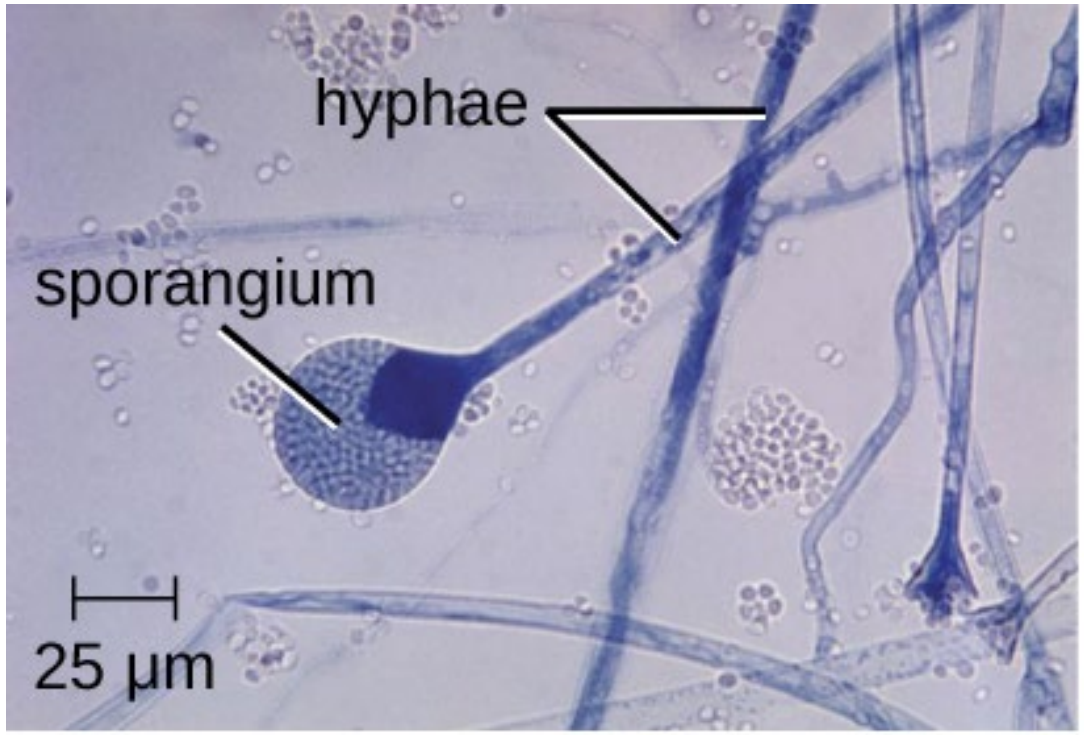
Sexual spore production

- involves a partner of opposite mating type, meiosis

Asexual Spore Production

Some types of fungi produce <u>conidiospores</u> or "conidia" that are not enclosed sac in any type of sac:





Other types of fungi produce <u>sporangiospores</u> are produced within an enclosed sac called a <u>sporangium</u>:

Sexual Spore Production

Sexual spores in fungi require 3 phases not seen in the production of asexual spores:

1) **PLASMOGAMY: transfer of a haploid nucleus to a cell of the opposite mating type producing a dikaryon (cell w/2 nuclei)**

2) **KARYOGAMY: fusion of the haploid nuclei to form a diploid zygote nucleus**

   - **haploid nuclei may reproduce by mitosis before fusing**
   - **this is the ONLY occasion when fungal cells are diploid**

3) **MEIOSIS: produce haploid, genetically unique sexual spores**

Important Subgroups of Fungi

We will look at examples of fungi in the subgroups:

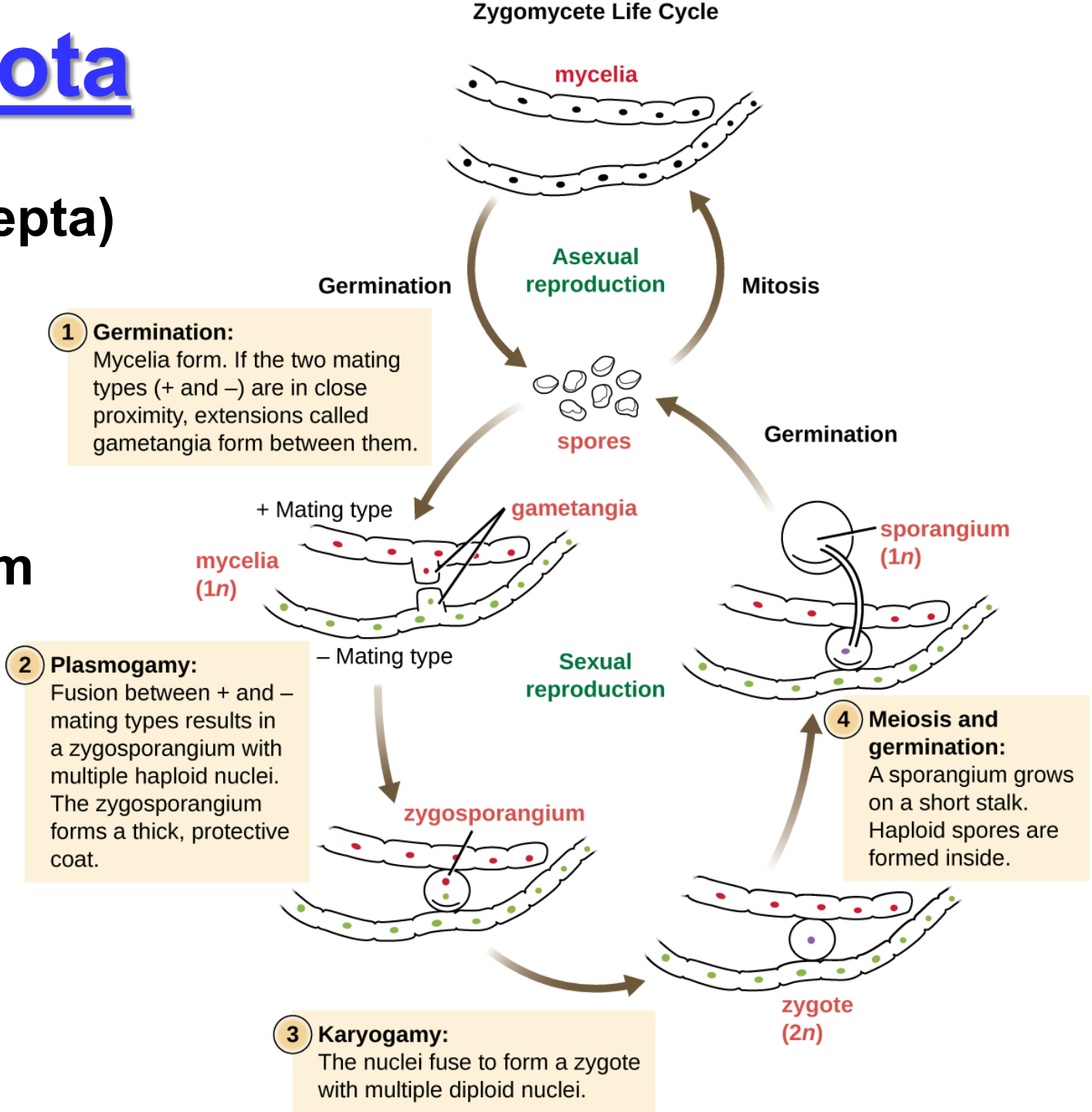
ZYGOMYCOTA

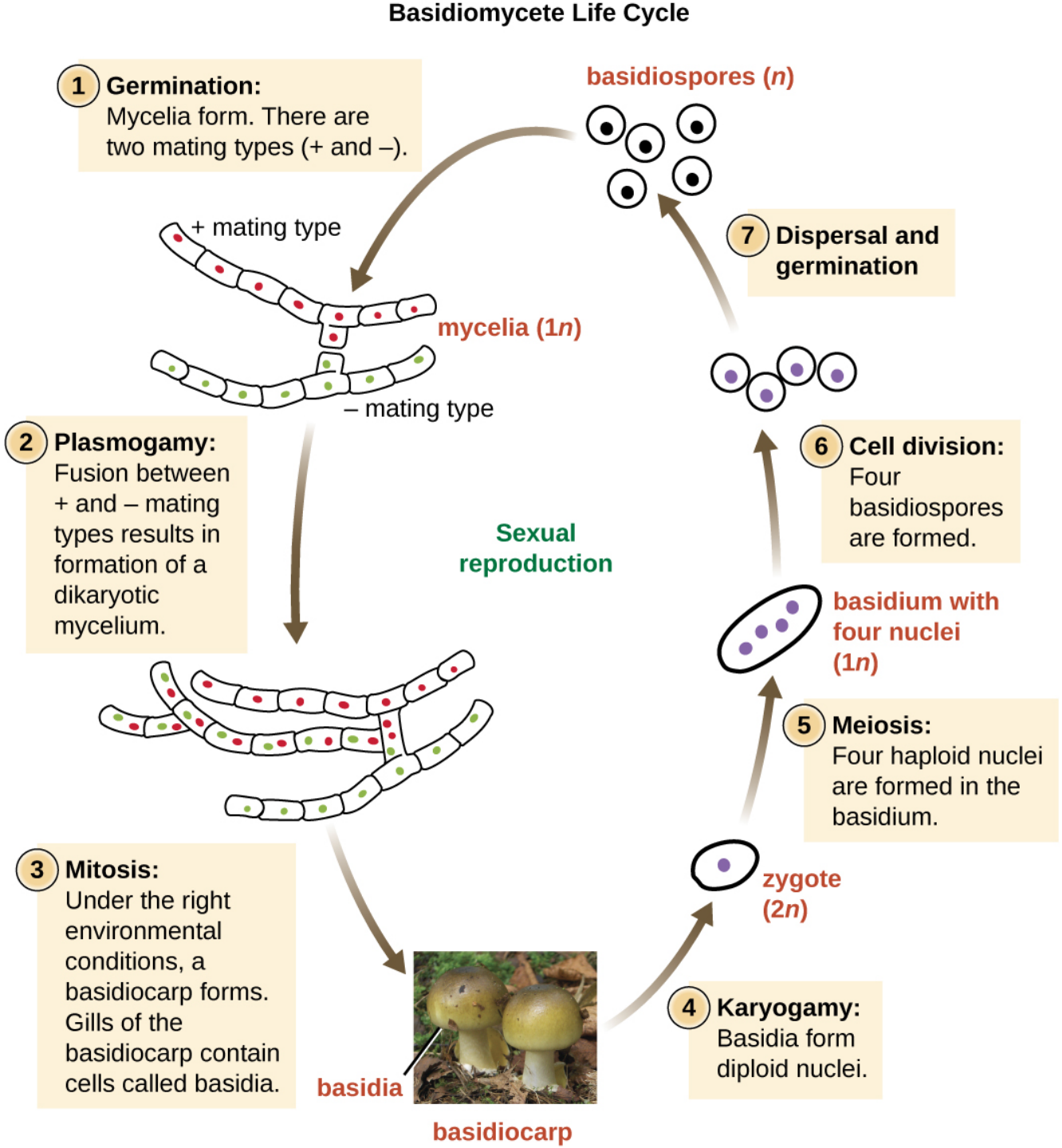
BASIDIOMYCOTA

ASCOMYCOTA

Zygomycota

- have *coenocytic* hyphae (no septa)
- asexually produced spores are in sporangia
- sexually produced spores are derived from a zygosporangium



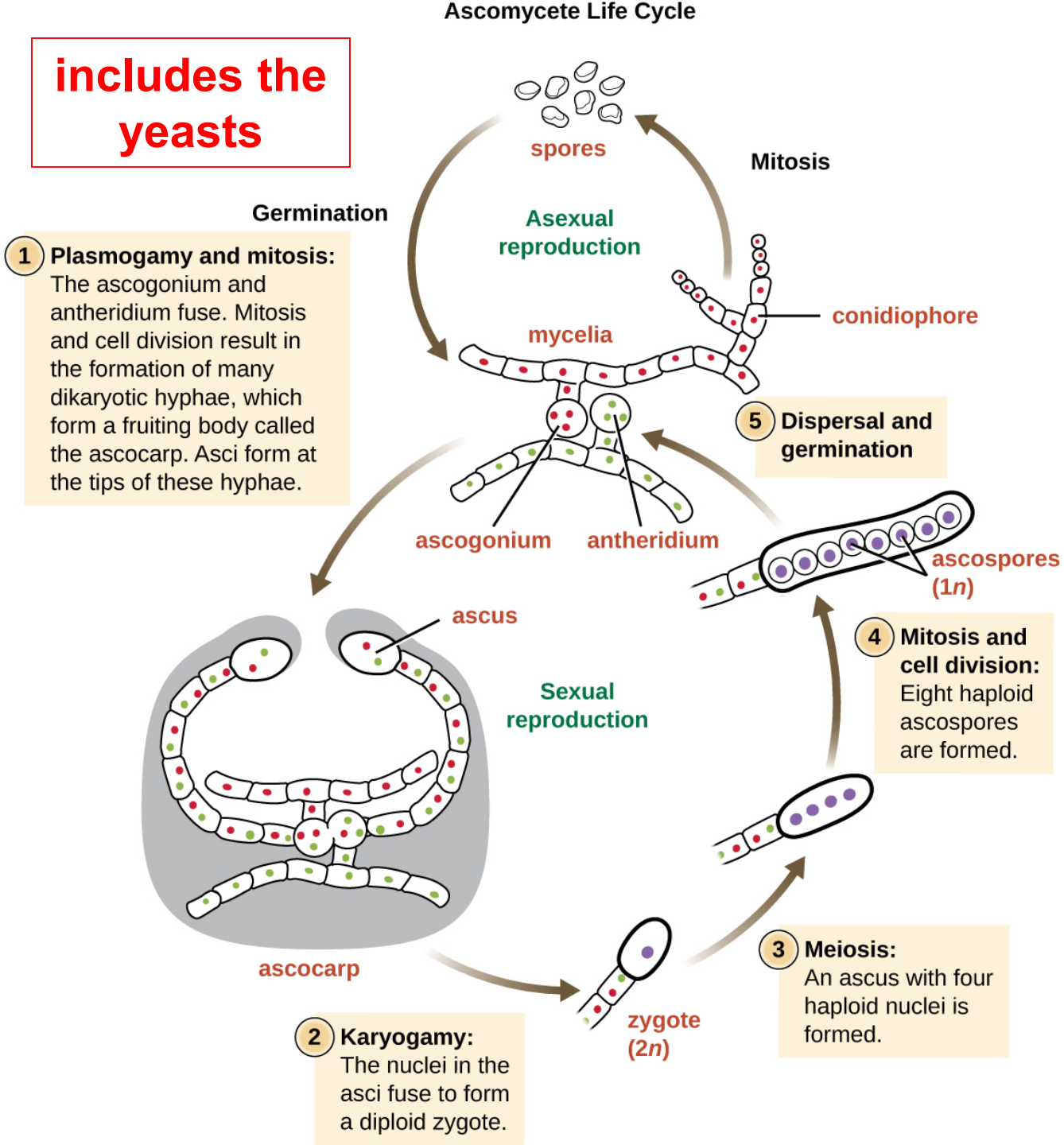


Basidiomycota

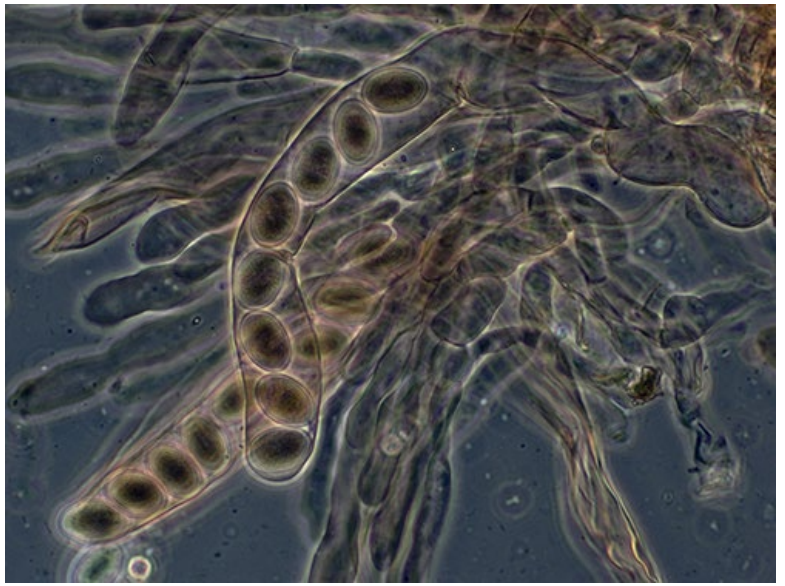
- hyphae are septate
- sexual spores are in a club-shaped basidium (basidiospores), hence the term for this group – "club fungi"
- includes mushrooms, rusts, puffballs, stinkhorns

Ascomycota

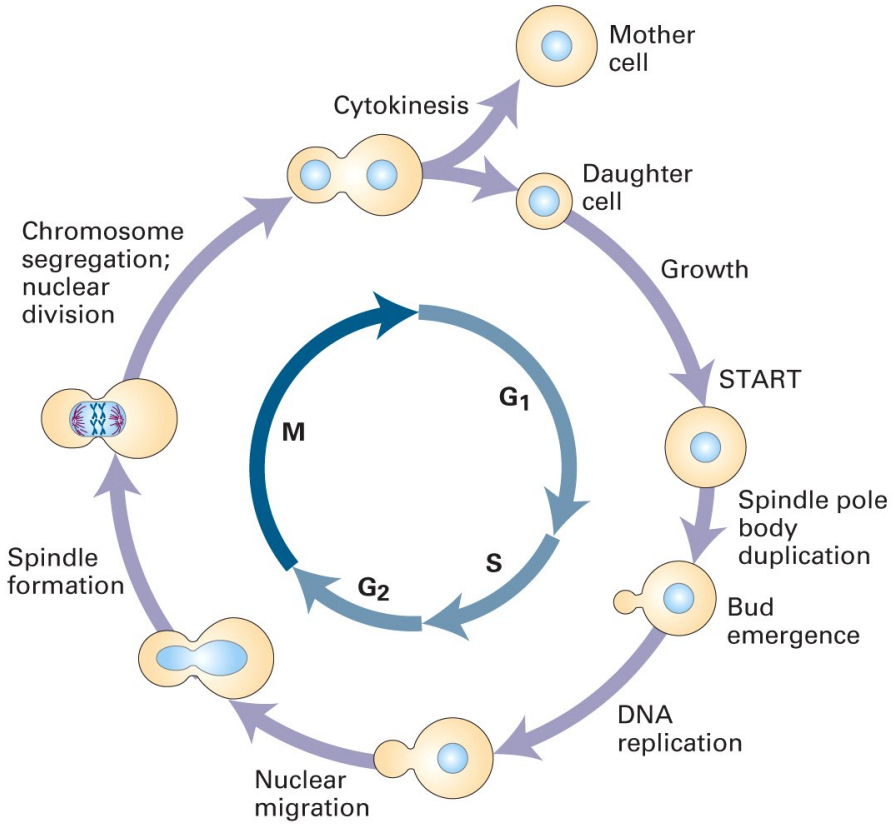
includes the yeasts

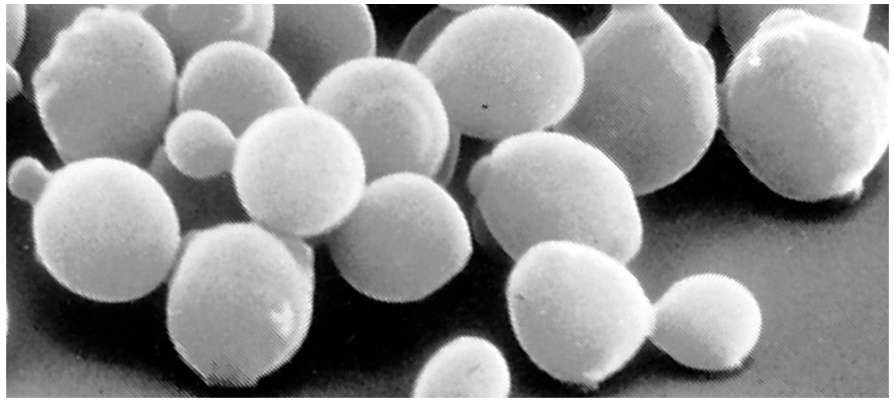


- hyphae are <u>septate</u>
- produce asexual conidiospores
- sexual spores are in an <u>ascus</u> (ascospores)



Budding Yeasts





Saccharomyces cerevisiae

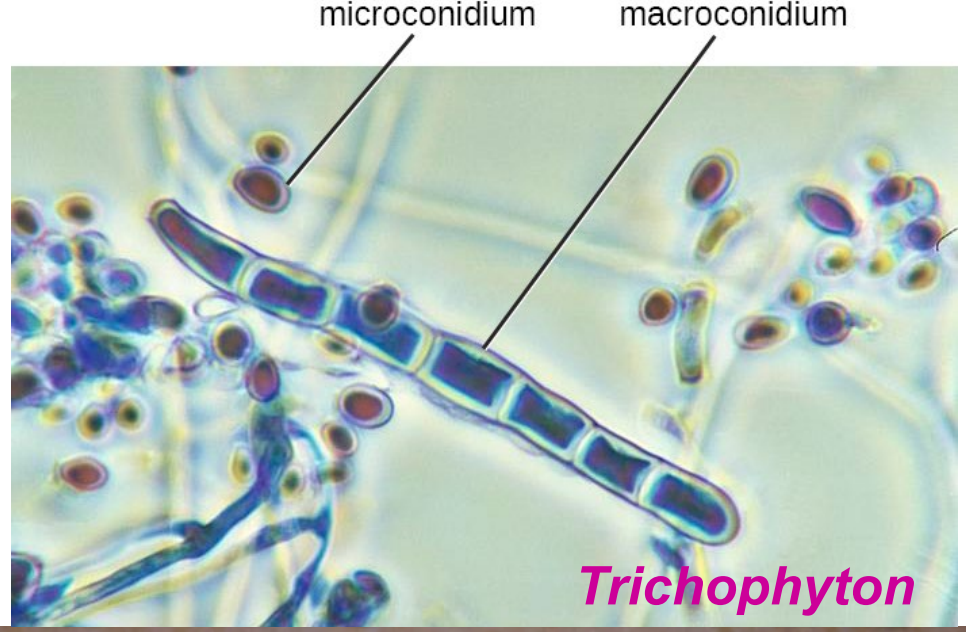
Spherical unicellular fungi:

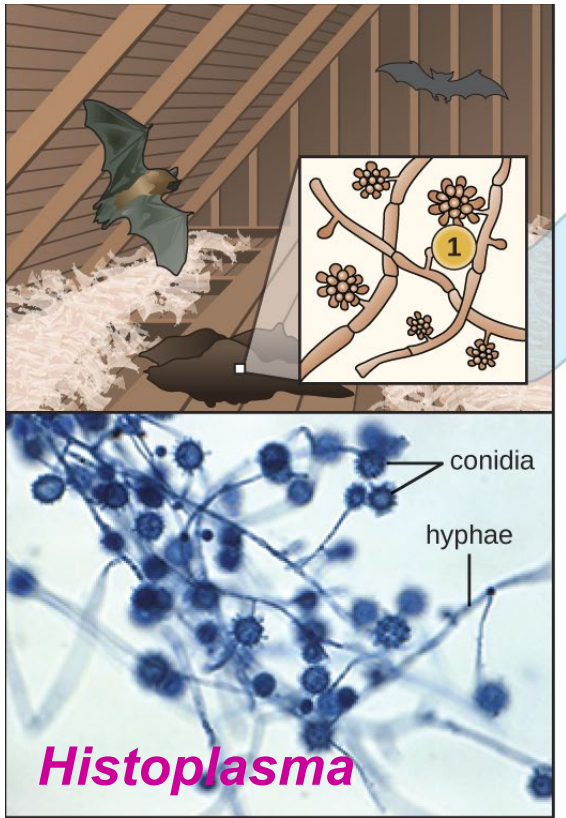
- reproduce asexually by <u>budding</u>
- facultative anaerobes used in producing fermented beverages (beer, wine) and bread
- important in biological research
- production of insulin & other biologics

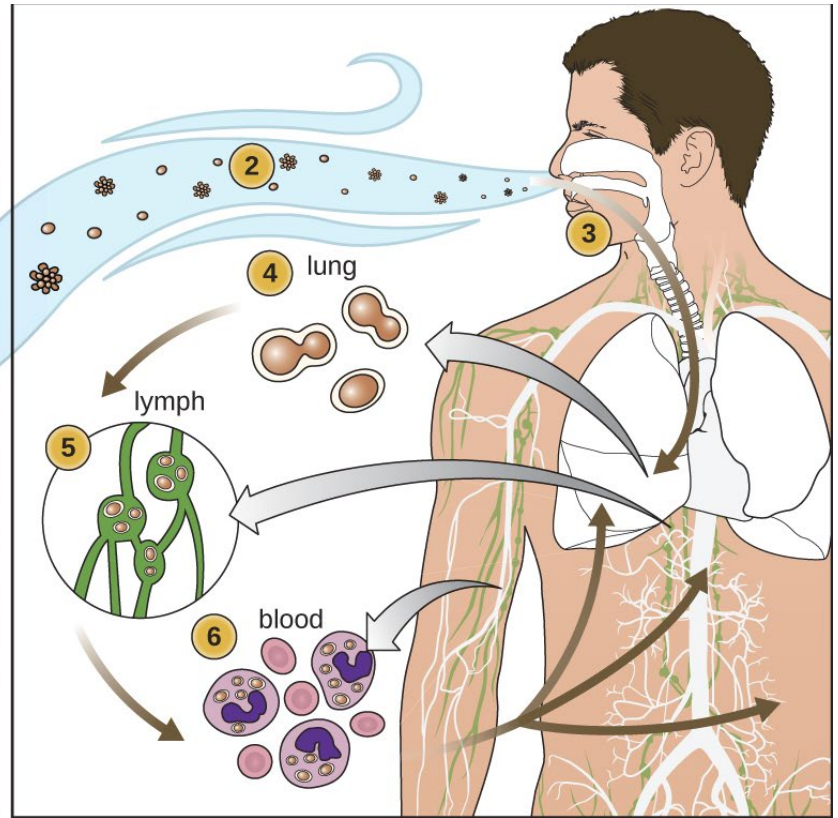
Pathogenic Fungi

Trichophyton **species are the cause of "ringworm", "athlete's foot" and other fungal skin infections.**

Histoplasma capsulatum **is the cause of <u>histoplasmosis</u> – a chronic lung disease.**







4. Algae and Lichens

Members of the supergroups:

ARCHAEPLASTIDA

CHROMALVEOLATA

Overview of the Algae

General characteristics of algae:

- unicellular or multicellular eukaryotes
- photoautotrophs (photosynthetic)
- all are essentially aquatic (live in fresh or saltwater)
- all are capable of asexual reproduction

produce an estimated 80% of O_2 in the atmosphere!

Algal Subgroups of the Chromalveolata

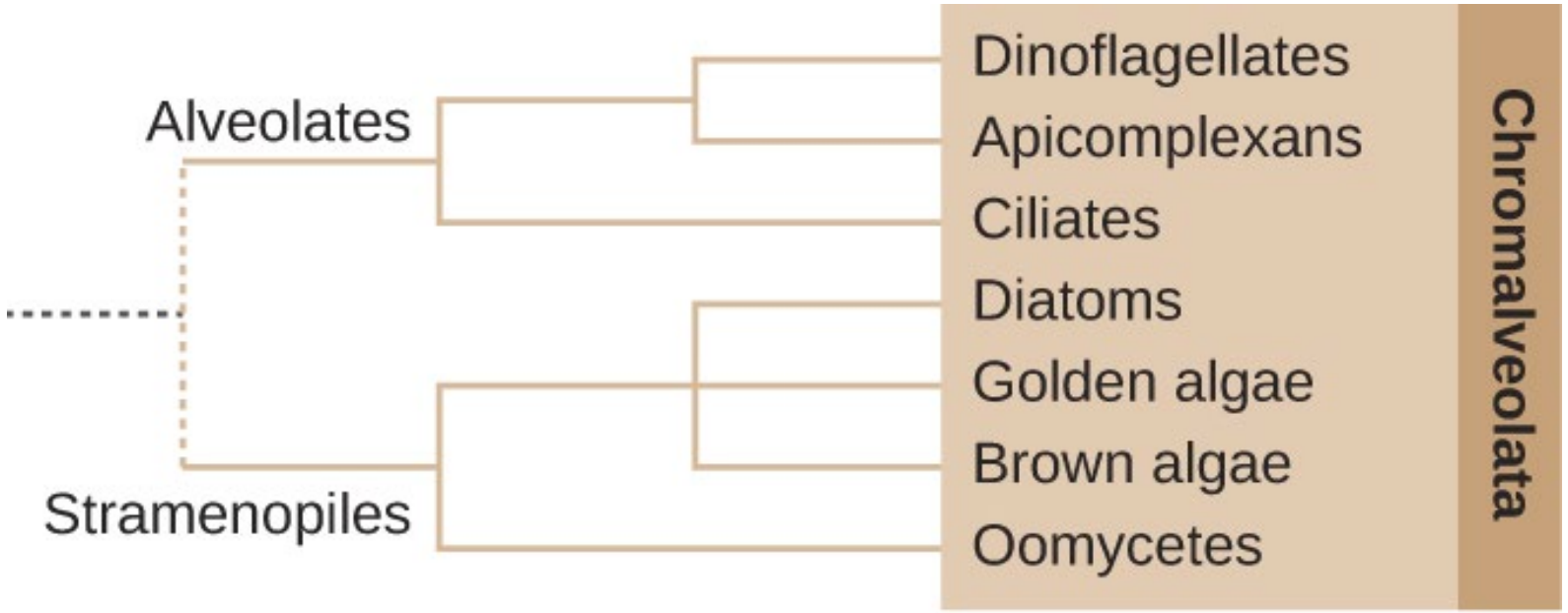
We will be concerned with the following subgroups that contain photosynthetic organisms that qualify as:

DINOFLAGELLATES

DIATOMS

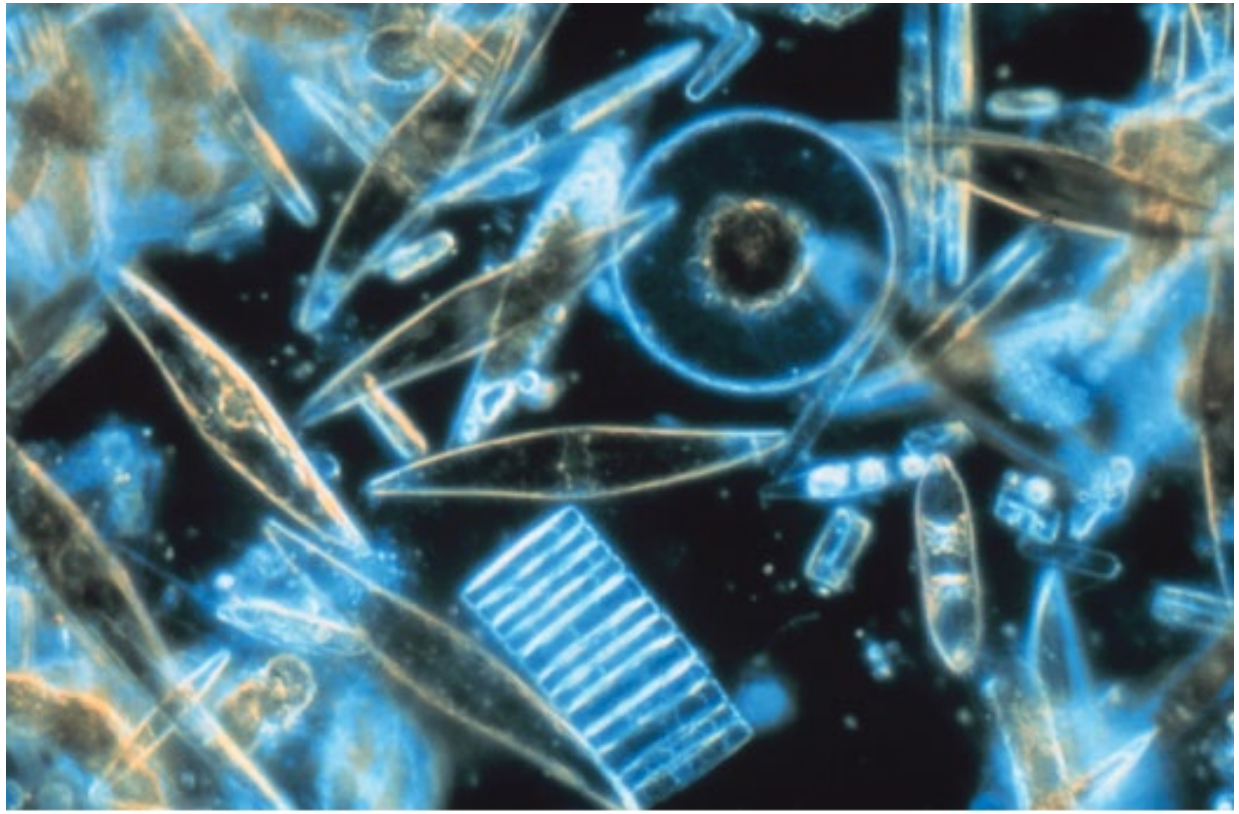
BROWN ALGAE

GOLDEN ALGAE



Diatoms

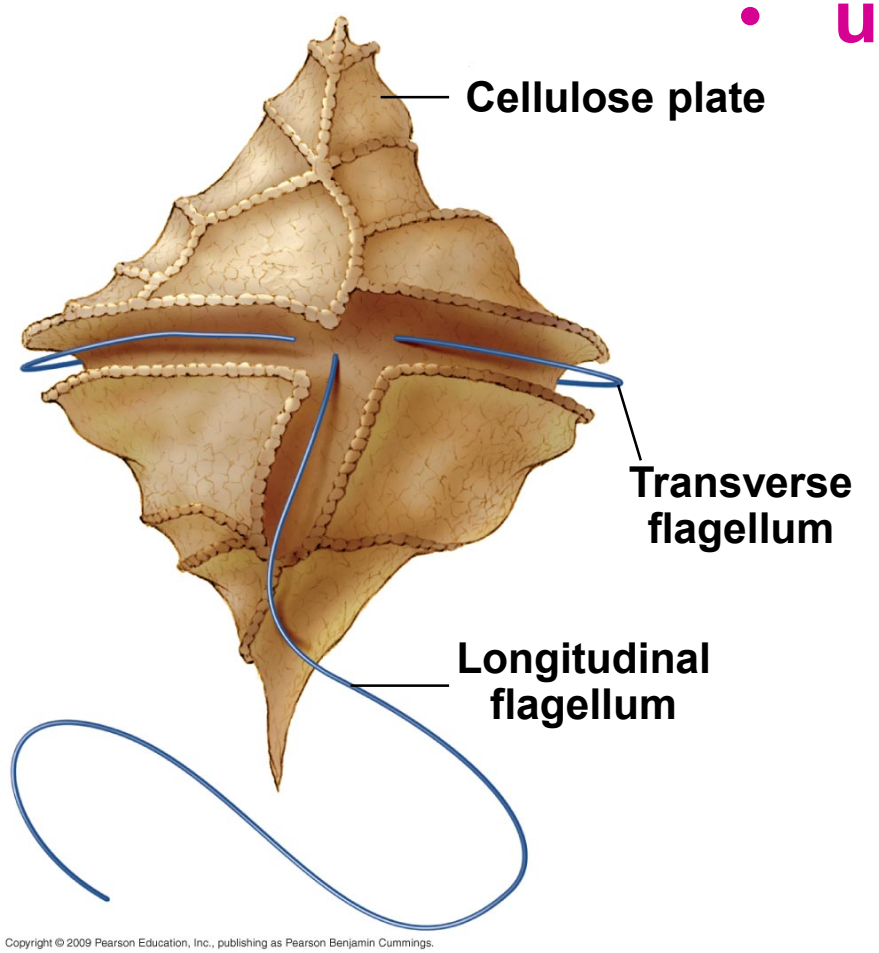
Unicellular or filamentous and have a unique cell wall structure composed of a carbohydrate called pectin & silica which gives them their glass-like geometric appearance.



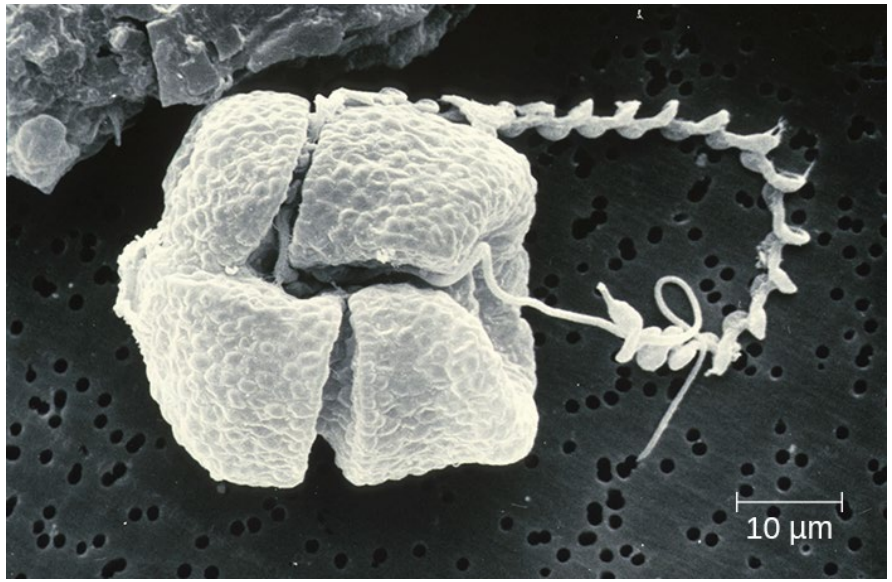
- **major portion of "phytoplankton" and important part of oceanic food webs**

Dinoflagellates

A significant portion of "phytoplankton" and important part of the oceanic food web.



- unicellular algae with 2 perpendicular flagella
- some produce potent neurotoxins and are the basis of toxic "red tide" algal blooms



Golden and Brown Algae

An important example of Brown Algae is the "giant kelp" the basis of a very unique marine ecosystem.

Most types of Golden Algae are unicellular flagellates, though some are colonial.

Dynobryon

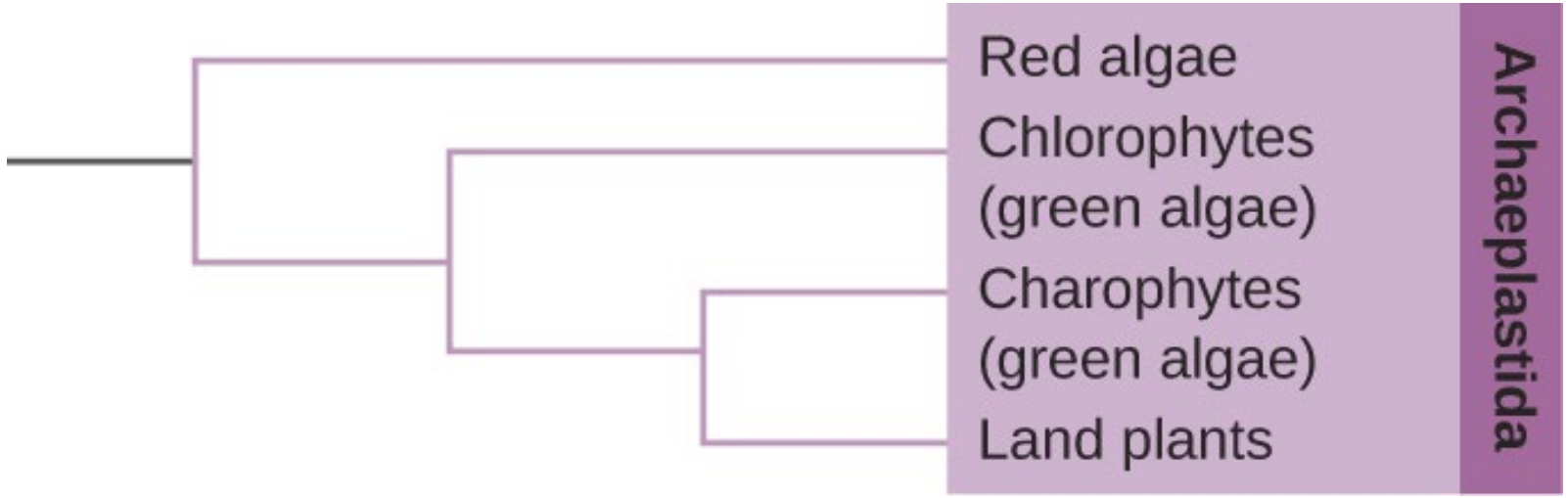
"Giant kelp"

Algal Subgroups in the Archaeplastida

Members of this supergroup are unicellular or multicellular and photosynthetic.

We will look at examples from the following subgroups:

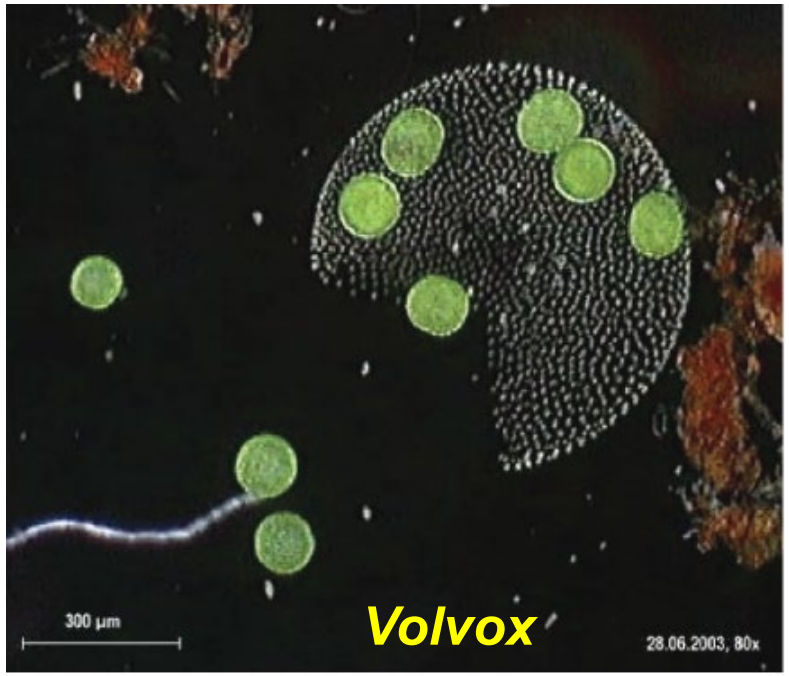
GREEN ALGAE **RED ALGAE**

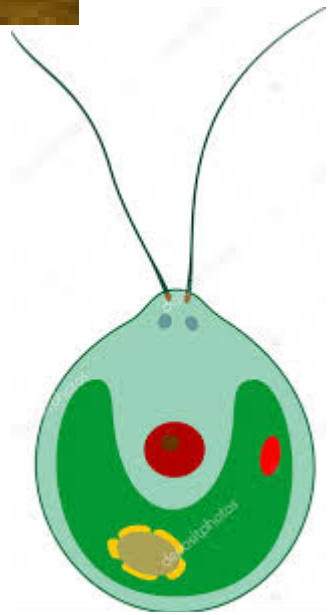


Green & Red Algae

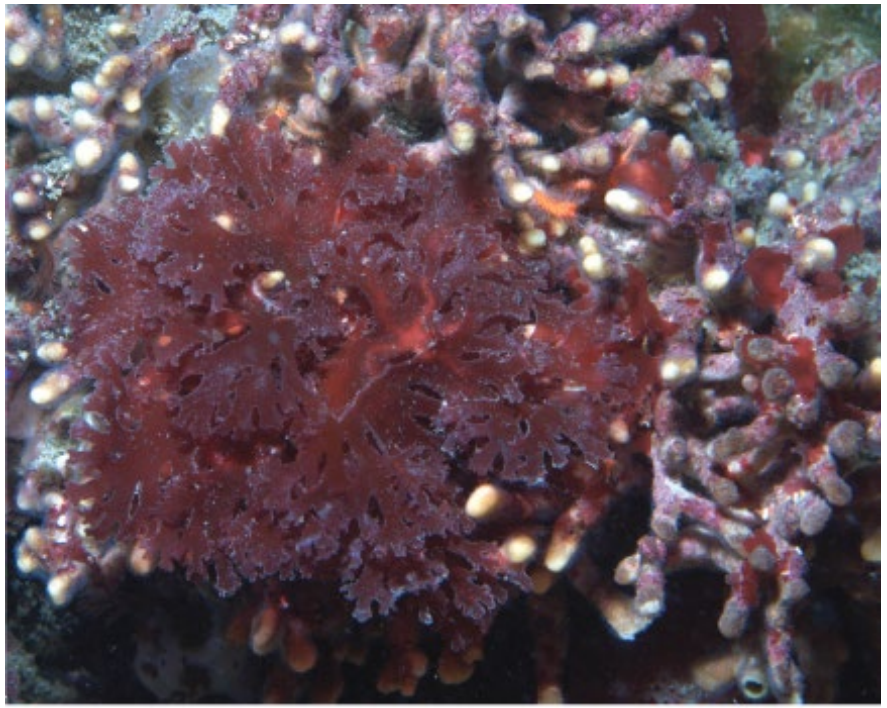
Species of Green Algae are unicellular (*Chlamydomonas*), colonial (*Volvox*) or multicellular (*Ulva*).

Red Algae are multicellular, live in deeper water where red light does not penetrate, and are an important source of food and agar!





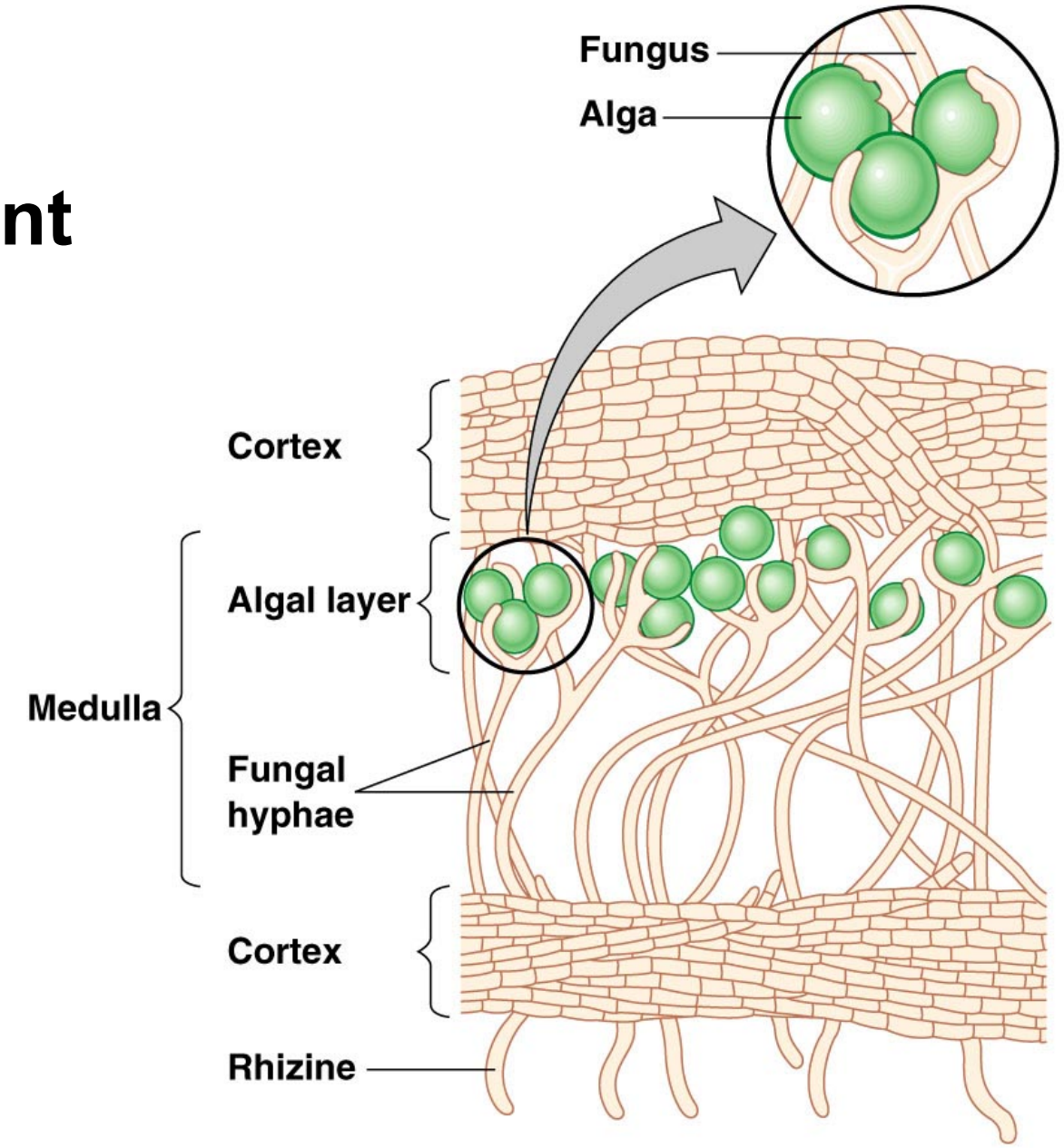
Chlamydomonas



Lichens

Lichens are actually 2 different organisms in a mutualistic symbiosis:

- **cyanobacteria OR green algae living among the hyphae of an ascomycete**



(b) Lichen thallus

Ecological Importance of Lichens

Lichens are important pioneers in nature, being able to grow on inorganic surfaces and thus begin the process of succession after catastrophic events that kill all life in a region (e.g., volcanic eruption).

Key Terms for Chapter 5

- thallus, hyphae, mycelium
- septate, aseptate, coenocytic
- conidia, sporangia
- plasmogamy, karyogamy, dikaryon
- zygospore, basidium, ascus
- proctostome, monoecious, dioecious
- mitosome, cytostome, pseudopods
- scolex, proglottids
- definitive vs intermediate host