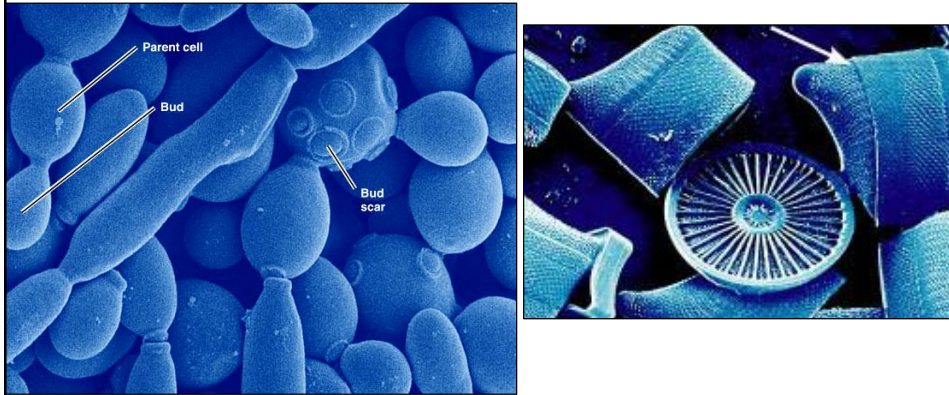


# Chapter 12

## The Eukaryotes:

### Fungi, Algae, Protozoa, & Helminths



## Ch. 12 Objectives:

1. Using specific examples, distinguish between the **life cycles and reproductive structures** of the 3 major fungal divisions: **basidiomycetes**, **ascomycetes**, and **zygomycetes**. ... ..
2. Distinguish between **structural, cellular, metabolic, and human interaction** characteristics between **fungi, algae, protozoans, & helminths**.

# 12.1) The Fungi

1. Eukaryotic
2. Aerobic or facultatively anaerobic
3. Chemoheterotrophic
4. Most are decomposers
5. **Mycology** is the study of fungi

## Mycology: The Study of Fungi

**Table 12.1** Major Differences among Eukaryotic Microorganisms:  
Fungi, Algae, Protozoa, and Helminths

	Fungi	Algae	Protozoa	Helminths
<b>Kingdom</b>	Fungi	"Protists"	"Protists"	Animalia
<b>Nutritional Type</b>	Chemoheterotroph	Photoautotroph	Chemoheterotroph	Chemoheterotroph
<b>Multicellularity</b>	All, except yeasts	Some	None	All
<b>Cellular Arrangement</b>	Unicellular, filamentous, fleshy (such as mushrooms)	Unicellular, colonial, filamentous; tissues	Unicellular	Tissues and organs
<b>Food Acquisition Method</b>	Absorptive	Diffusion	Absorptive; ingestive (cytostome)	Ingestive (mouth); absorptive
<b>Characteristic Features</b>	Sexual and asexual spores	Pigments	Motility; some form cysts	Many have elaborate life cycles, including egg, larva, and adult
<b>Embryo Formation</b>	None	None	None	All

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**Table 12.2** Selected Features of Fungi and Bacteria Compared

	Fungi	Bacteria
<b>Cell Type</b>	Eukaryotic	Prokaryotic
<b>Cell Membrane</b>	Sterols present	<u>Sterols absent, except in <i>Mycoplasma</i></u>
<b>Cell Wall</b>	Glucans; mannans; chitin (no peptidoglycan)	Peptidoglycan
<b>Spores</b>	<u>Sexual and asexual reproductive spores</u>	Endospores (not for reproduction); some asexual reproductive spores
<b>Metabolism</b>	Limited to heterotrophic; aerobic, facultatively anaerobic	Heterotrophic, autotrophic; aerobic, facultatively anaerobic, anaerobic

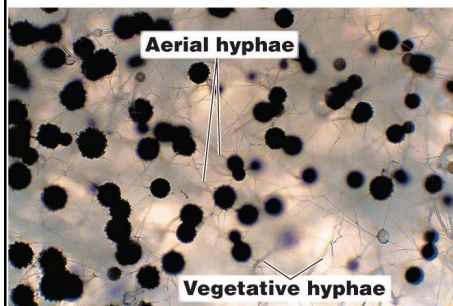
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## Fungal Diseases (mycoses)

1. **Systemic** mycoses = Deep within body
2. **Subcutaneous** mycoses = Beneath the skin
3. **Cutaneous** mycoses = Affect hair, skin, nails
4. **Superficial** mycoses = Localized, e.g., hair shafts
5. **Opportunistic** mycoses = Caused by normal microbiota or fungi that are usually harmless

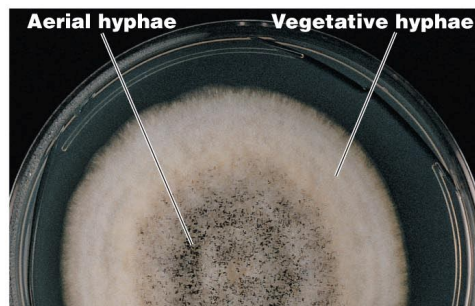
## A. Molds

- The fungal body consists of **hyphae**;
- a mass of hyphae is a **mycelium**.



(a) *Aspergillus niger*

LM 20 μm



(b) *A. niger* on agar

Figure 12.2

## B. Yeasts

- Unicellular fungi
- **Fission yeasts** divide symmetrically
- **Budding yeasts** divide asymmetrically



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Figure 12.3

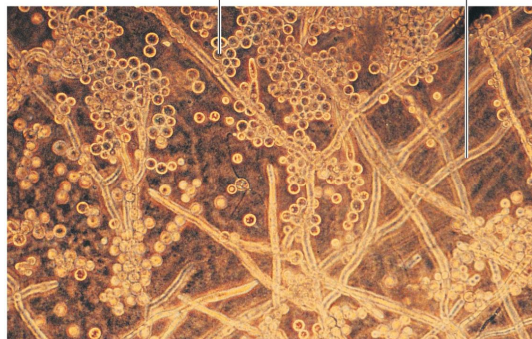
## Fungal Dimorphism (2 forms)

- Pathogenic **dimorphic fungi** are:

– Yeast-like at 37°C

– and mold-like at 25°C

Yeastlike growth      Moldlike growth

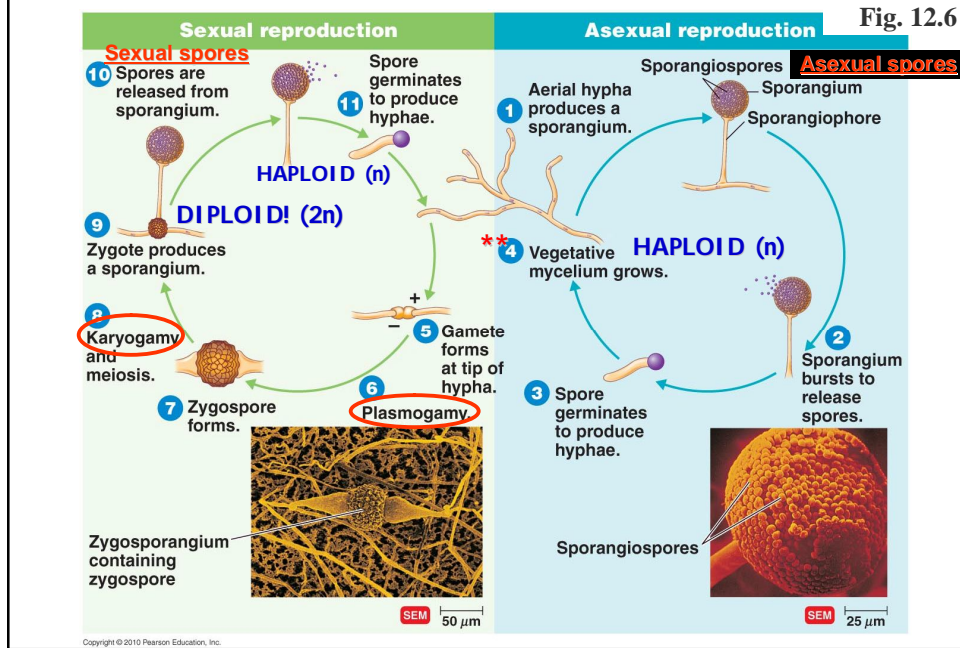


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Figure 12.4

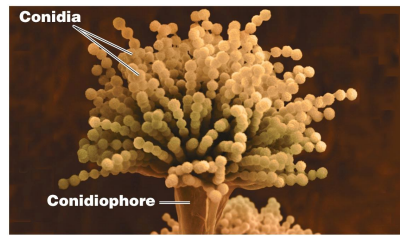


# Fungal (Zygomycete) Life Cycle



## 1. Asexual spores

- **Sporangiospore** – encased.
- **Conidiospore** – naked.
- Chlamydospore – thick walled hypha; *Candida*



(a) Conidia are arranged in chains at the end of *Aspergillus flavus* conidiophore. SEM 5 μm

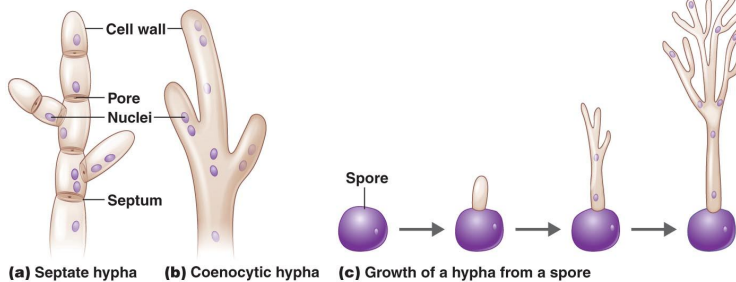


Figure 12.1

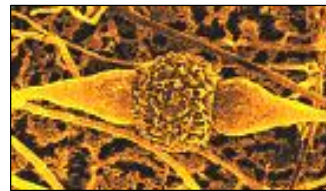
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## 2. Sexual reproduction

1. **Plasmogamy** = Haploid donor cell nucleus (+) penetrates cytoplasm of recipient cell (-)
2. **Karyogamy** = + and - nuclei fuse
3. **Meiosis** = Diploid nucleus produces haploid nuclei (sexual spores)

### Sexual spores → name of phylum

1. **Zygospor** = Fusion of haploid cells produces one zygospore



2. **Ascospore** = Formed in a sac (ascus)



3. **Basidiospor** = Formed externally on a pedestal

- Eg: within mushroom cap



Figures 12.6-8

### 3. Fungal Phyla

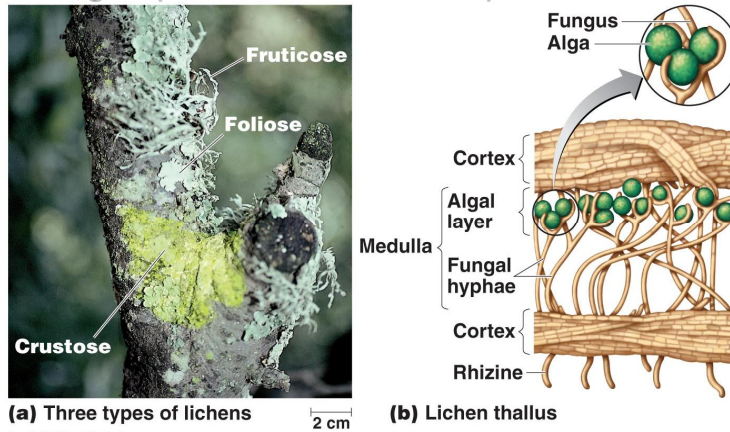
1. **Zygomycota** = Conjugation fungi; **Coenocytic**.
  - *Rhizopus*, *Mucor* (Opportunistic, systemic mycoses)
2. **Ascomycota** = Sac fungi. **Septate** hyphae.
  - *Aspergillus* (opportunistic, systemic mycosis)
  - *Microsporum*, *Trichophyton* (cutaneous mycoses)
3. **Basidiomycota** = Club fungi. **Septate**.
  - *Cryptococcus neoformans* (systemic mycosis)
4. **Anamorphs** = no defined forms; rRNA in Asco, basidio
  - [**Teleomorphic** fungi: Produce sexual and asexual spores.]
  - **Anamorphic** fungi: **Produce asexual spores only.**
    - **Penicillium**: *Pneumocystis* (systemic mycoses);
    - **Candida albicans** (Cutaneous mycoses)

### 4. Economic Effects of Fungi

<u>Fungi</u>	<u>Positive Effects</u>	<u>Negative Effects</u>
<b>Saccharomyces</b>	Bread, wine, beer	Food spoilage
<b>Trichoderma</b>	Cellulase used for juices and fabric	<b>Cryphonectria parasitica</b> (chestnut blight)
<b>Taxomyces</b>	Taxol production	<b>Ceratocystis ulm</b> (Dutch elm disease)
<b>Entomorphaga</b>	Gypsy moth control; saved trees in eastern U.S	

## C. Lichens

- **Mutualistic** combination of an alga (or cyanobacterium) & fungus.
  - Alga produces and secretes carbohydrates,
  - Fungus provides holdfast & protection.



## 12.2) The Algae

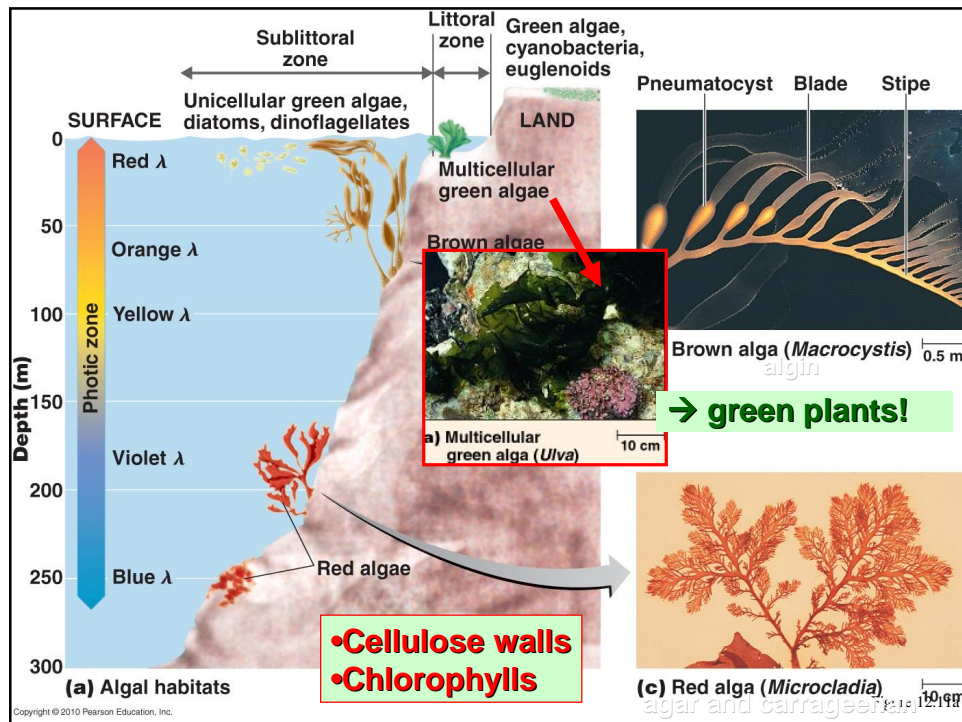
1. Eukaryotic
2. Unicellular, filamentous, or multicellular (thallic)
3. Most are ***photoautotrophs***

**A. Green Algae (Chlorophyta)**

**B. Red Algae (Rhodophyta)**

**C. Brown Algae (Phaeophyta)**





## D. Bacillariophyta

- **Diatoms**; Pectin and silica cell walls
- Unicellular; Store oil photosynthate
  - (not sucrose, glucose, or starch)
- Fossilized diatoms formed oil
- Produce **domoic acid** neurotoxin

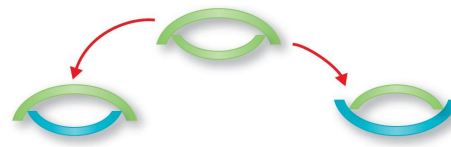
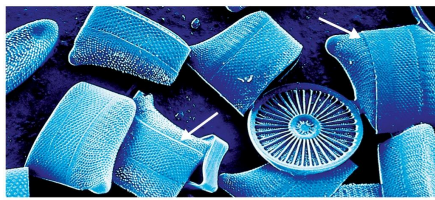


Figure 12.12

## E. Dinoflagellata

- **Dinoflagellates**
  - **Cellulose** in PM; Unicellular;
  - Chlorophylls; **starch**
  - **30% of earth's oxygen!** (> rainforests)
- **Neurotoxins**

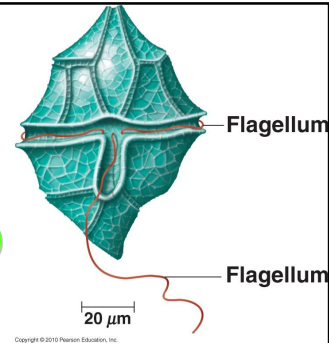


Figure 12.13

## F. Oomycota (fungus-like!)

- Water molds; **Cellulose**;  
**Chemoheterotrophic**
- Decomposers and plant parasites
  - **Phytophthora infestans** responsible for Irish potato blight
  - *P. ramorum* causes sudden oak death

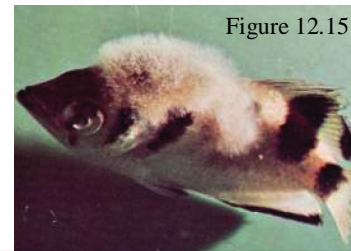
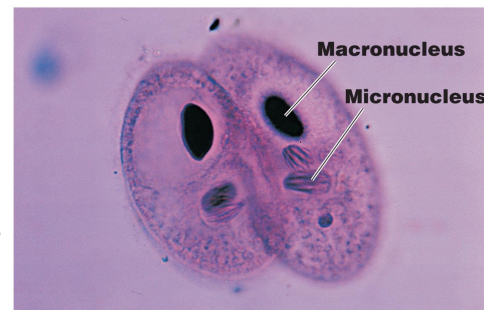


Figure 12.15

# 12.3) The Protozoa

- **Eukaryotic**
- **Unicellular**
- **Chemoheterotrophs**
- Asexual reproduction by fission, budding, or **schizogony.**
- Sexual reproduction by **conjugation**
- Some produce **cysts.**



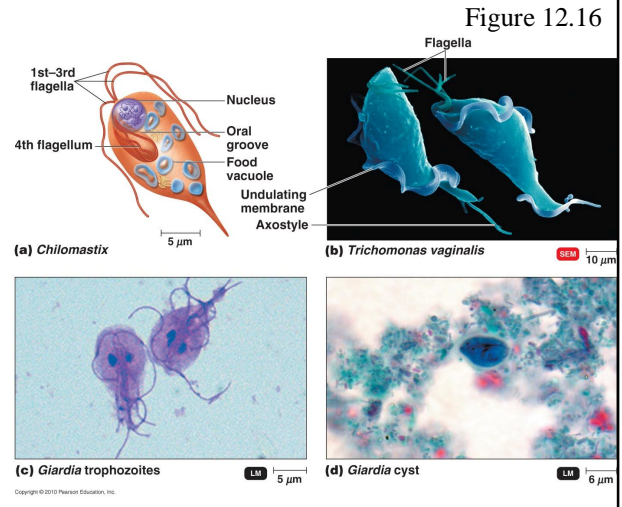
LM 35 μm

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Figure 12.15

# A. Archaezoa

- **No mitochondria**
- **Multiple flagella**
  - *Giardia lamblia*
    - No mitochondria!!
  - *Trichomonas vaginalis*
    - (no cyst stage)



# B. Rhizopoda (amoebas)

- Move by **pseudopods**
  - *Entamoeba*
  - *Acanthamoeba*

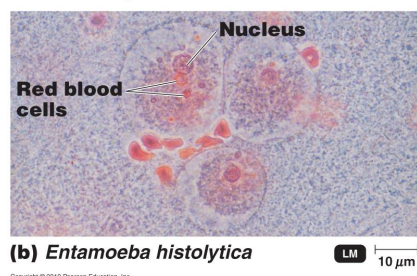
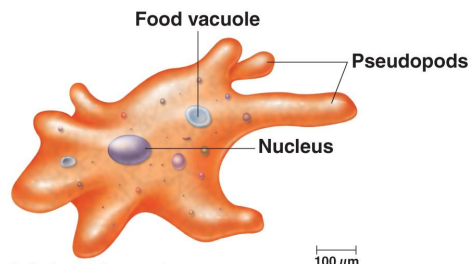
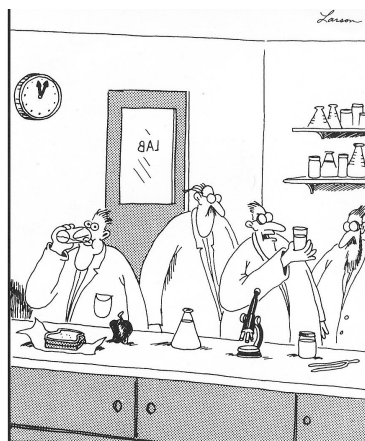
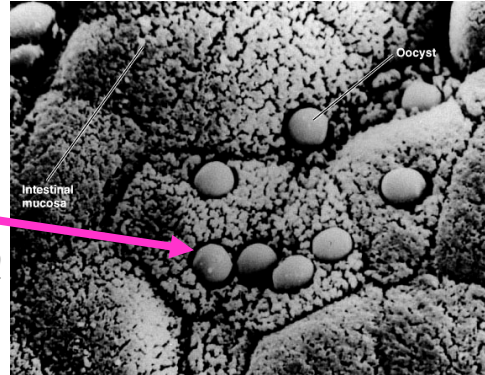


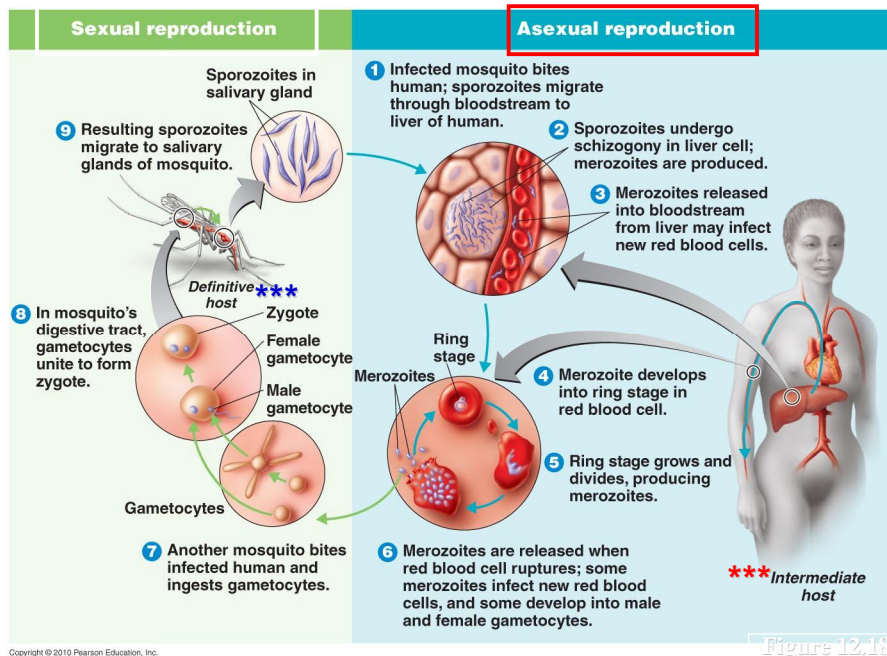
Figure 12.17

# C. Apicomplexa

- Nonmotile
- Intracellular parasites
- Complex life cycles
  - *Cryptosporidium*
  - *Plasmodium - malaria*



## Plasmodium



## D. Ciliophora (ciliates)

- Move by cilia:
  - *Paramecium*,  
*Tetrahymena*, *Vorticella*
- Complex cells
- *Balantidium coli* is the only human parasite

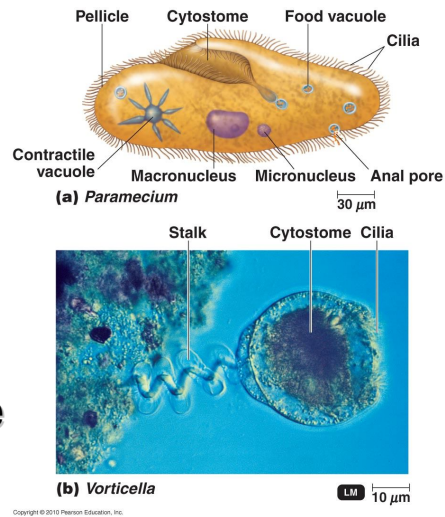


Figure 12.19

## E. Euglenozoa

- Move by flagella.
  - Photoautotrophs: **Euglenoids (“algae”)**
  - Chemoheterotrophs:
    - ***Trypanosoma*** = **sleeping sickness**
      - Undulating membrane, transmitted by vectors.

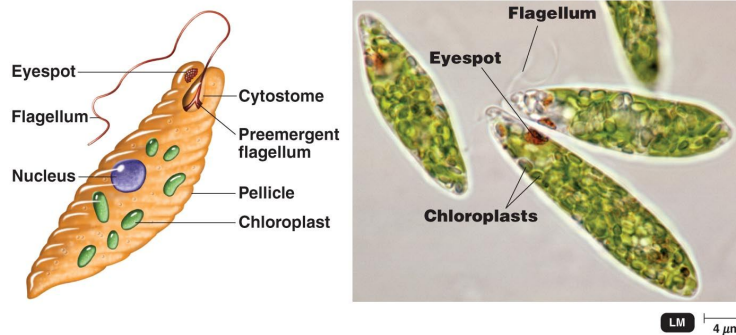


Figure 12.20

## 12.4) Slime Molds

### • Cellular slime molds

- Resemble amoebas, ingest bacteria by **phagocytosis**
- Cells aggregate into **stalked fruiting body**.
- Some cells become **spores**

### • Plasmodial slime molds

- **Multinucleated** large cells
- Cytoplasm separates into **stalked sporangia**
- Nuclei undergo meiosis and form **uninucleate haploid spores**

**\*\* Fungus-like Protozoans; something like the Oomycota.**

## A. Cellular Slime Mold

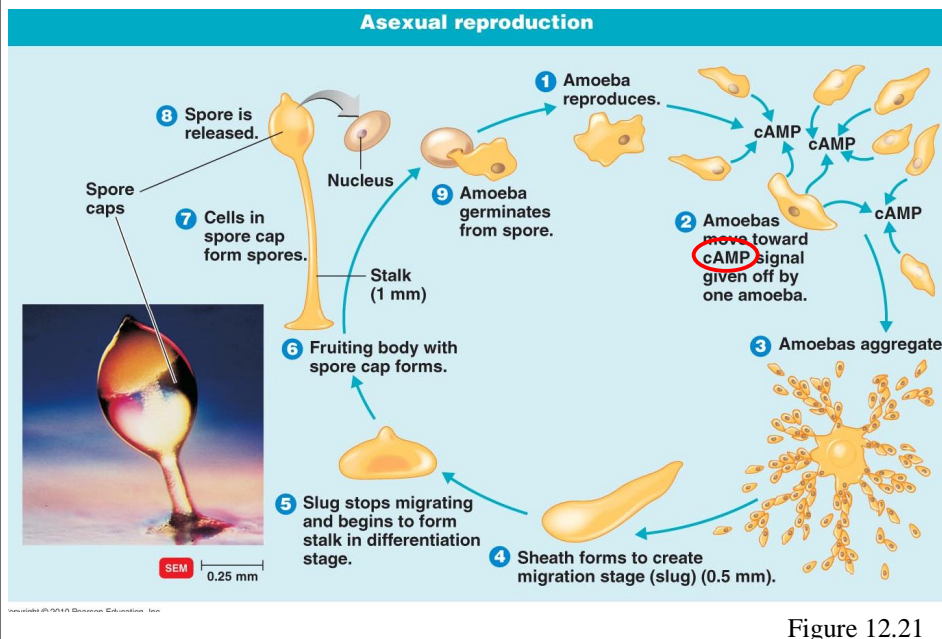
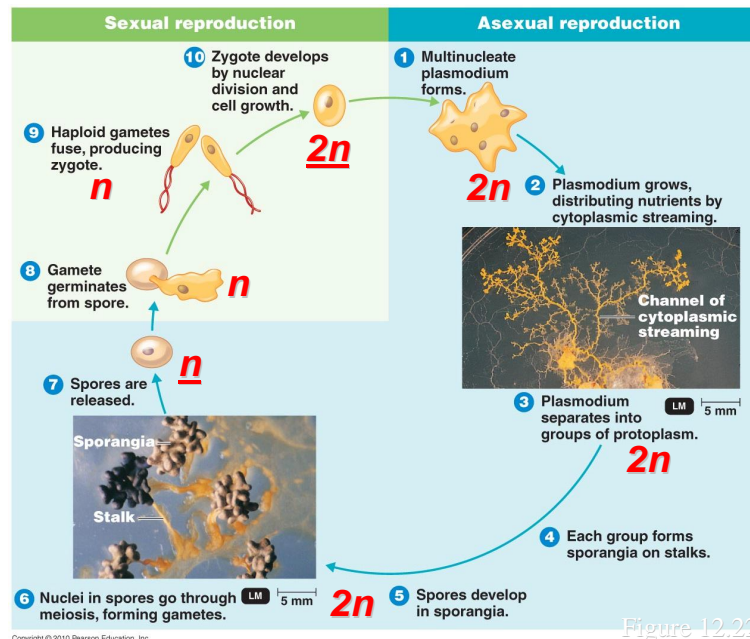


Figure 12.21

## B. Plasmodial Slime Mold



## 12.5) The Helminths

	Fungi	Algae	Protozoa	Helminths
<b>Kingdom</b>	Fungi	"Protists"	"Protists"	Animalia
<b>Nutritional Type</b>	Chemoheterotroph	Photoautotroph	Chemoheterotroph	Chemoheterotroph
<b>Multicellularity</b>	All, except yeasts	Some	None	All
<b>Cellular Arrangement</b>	Unicellular, filamentous, fleshy (such as mushrooms)	Unicellular, colonial, filamentous; tissues	Unicellular	Tissues and organs
<b>Food Acquisition Method</b>	Absorptive	Diffusion	Absorptive; ingestive (cytostome)	Ingestive (mouth); absorptive
<b>Characteristic Features</b>	Sexual and asexual spores	Pigments	Motility; some form cysts	Many have elaborate life cycles, including egg, larva, and adult
<b>Embryo Formation</b>	None	None	None	All

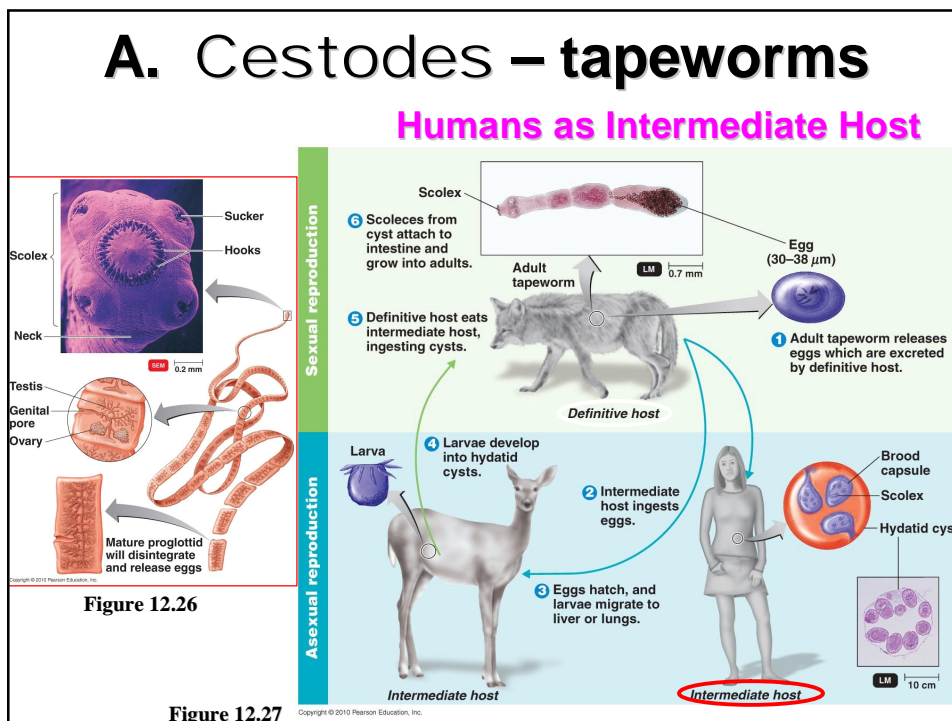
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Table 12.1

# Helminths (parasitic worms)

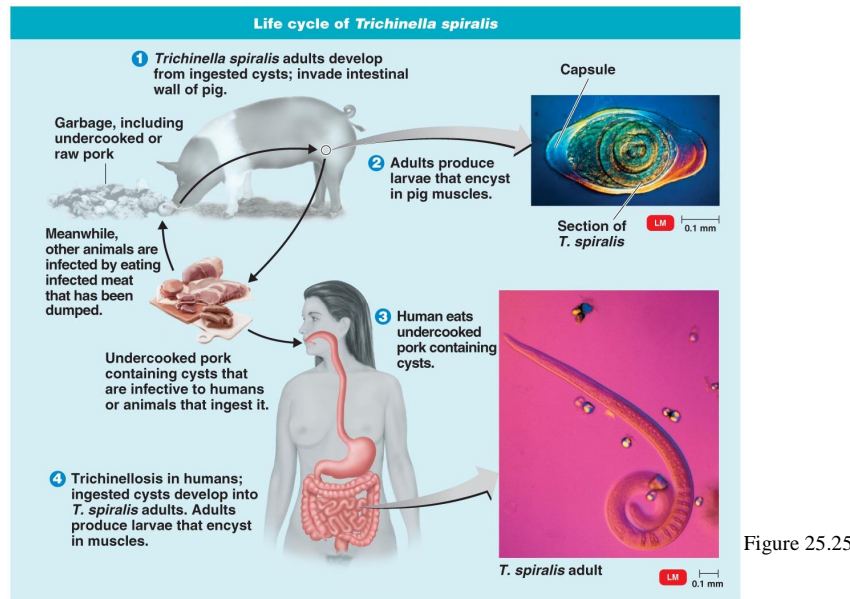
1. Eukaryotic
2. Multicellular animals
3. Chemoheterotrophic

- **Kingdom: Animalia !!!!**
  - Phylum: **Platyhelminthes (flatworms)**
    - Class: Trematodes (flukes)
    - Class: Cestodes (tapeworms)
  - Phylum: **Nematodes (roundworms)**





## B. Nematodes: Larvae Infective in Humans



## Arthropods as Vectors

- Kingdom: Animalia

- Phylum: **Arthropoda**

(exoskeleton, jointed legs)

- Class: **Insecta** (6 legs)

- Lice, fleas, mosquitoes

- Class: **Arachnida** (8 legs)

- Mites and ticks

- May transmit diseases (disease vectors)

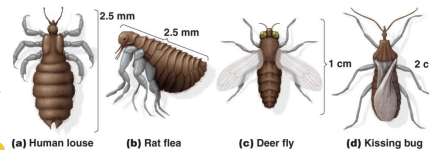


Figure 12.30-32