Eukaryotes: Protists and Helminths

Lecture 15

Learning Outcomes

• Protists
  - Alveolates
    - Plasmodium
  - Ciliates
  - Excavates
    - Euglenoids
  - Parabasalids and Diplomonads
    - Giardia and Trichomonas
    - Kinetoplastids
  - Trypanosoma
  - Amoebas
• Helminths
  - Flukes and Tapeworms
Protozoa

- Unicellular eukaryotes
- Feeding stage trophozoite
- heterotrophic or mixotrophic
- 20,000 identified species
- Very few pathogens
- Paraphyletic
- May represent several groups with little evolutionary kinship
- Classification confusing and ever-changing

Life Cycle

- Asexual reproduction by
  - Fission
  - budding, or
  - Schizogony
  - Nucleus divides several times BEFORE cell divides into several daughter cells
- Sexual reproduction by conjugation
  - Paramecium exchange haploid nuclei
- Some produce cysts
• (Archaezoa)
• Two nuclei
• Two sets of flagella
• No functional mitochondria
  - Obligate Fermenters
• Giardia lamblia
• Inhabit small intestines
• Forms Cysts
• Permits survival in inhospitable conditions
• Aid in transmission
• Fecal-Oral from contaminated freshwater

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• Diplomonads

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• Parabasalids
• Lack mitochondria
• Fermenters
• Trichomonas vaginalis
• Motility due to undulating membrane
• no cyst stage
• Trophozoite transmitted via direct contact
• Incidence 5 million cases per year USA
• 50% cases asymptomatic
• Prefer conditions of lower vaginal acidity

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Figure 12.17b-d

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**Excavates**

- Possess long Zooflagella
- (formerly known as flagellates)
- Mitochondria atypical or absent
- Deep (excavated) oral grooves
- Euglenids
- Some genera heterotrophic lacking chloroplasts

**Euglena**
- Mixotrophic
- Some photosynthetic
- Chloroplast triple membrane
- Secondary endosymbiosis of green algae Red eyespot senses light and directs positive phototaxis

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**Hemoflagellates**

- Transmitted via bites of blood feeding insects
- Sexual reproduction absent
- Chemoheterotrophs
- Hemoflagellates (blood parasites)
- Reproduce in vector via schizogony
  - *Trypanosoma brucei gambiense*
  - African Sleeping Sickness
  - transmitted by tsetse fly
  - *T. cruzi*
  - Chagas' disease
  - South America
  - Transmitted via kissing bug
**Amoebozoans**

- Move by pseudopods
- Aquatic
- *Amoeba proteus*
  - Predator of bacteria
  - Common in soil, ponds
- *Entamoeba histolytica*
  - Amoebic dysentry
  - Fecal-oral route via cysts
- *Acanthamoeba*
  - Grow in water
  - Infect cornea
  - Keratitis
  - Associated with unsanitary contact lens use

**Apicomplexa**

- Within Alveolate Supergroup
- Nonmotile
- Possess relict plastid (chloroplast)
- Intracellular parasites
- Apical complex punctures host cells
- Complex life cycles
- *Toxoplasma gondii*
- *Babesia*
- *Cryptosporidium*
- *Cyclospora*
Malaria

- Affects 10% of the world's population
- 300 to 500 million cases per year worldwide
- 2 to 4 million deaths
- 4 forms
  - *Plasmodium vivax*
  - *P. ovale*
  - *P. malariae*
  - *P. falciparum* - 50% mortality
• Within Alveolate Supergroup
• Move by cilia
• Large complex cells
• Outer pellicle
• Cytostome or gullet
• Anal pore
• Contractile vacuole
  - Export water the enters via osmosis
• Micronucleus
  - Copied and transferred during conjugation
• Paramecium
• Ubiquitous in pond water
Helminths

- Parasitic worms and flukes
- Multicellular animals
- Compared to free-living helminths, parasitic helminths:
  1. May lack a digestive system
  2. Reduced nervous system
  3. Motility reduced or lacking
  4. Reproductive system is often complex
     - Multiple larval stages requiring intermediate hosts
     - Hermaphrodites or separate males and females

Helminth Taxonomy

- Phylum: Platyhelminthes (flatworms)
  - Class: Trematodes (flukes)
  - Class: Cestodes (tapeworms)
- Phylum: Nematoda (roundworms)
- **Flukes**
- **Protective cuticle** resistant to host digestive juices
- **Two suckers used for attachment**
- **Absorb nutrients from host bodily fluids across cuticle**
- **Incomplete digestive system**
- **Hermaphrodites**
- Clonorchis sinensis
- Eggs shed in feces
- Eggs ingested by intermediate host 1 (aquatic snail)
- Larval stages:  
  - miracidium, sporocyst, Rediae in snail
- Free swimming cercaria burrow into fish (intermediate host 2)
- Metacercariae ingested by human in undercooked fish
- Asian Liver fluke cannot spread in US because intermediate host (snail) is absent

- Schistosoma sp.
- Blood flukes
- Adults 15-20 mm
- Female inhabits groove in male
- Symptoms result from continually shed eggs lodging in host tissue
- Granulomas  
  - Local damage to tissue caused by immune response
- 20 million severe infections
- 200,000 deaths annually
- Second only to malaria in socio-economic and public health importance
Transmission of Schistosoma

- Adult flukes lay eggs in human host
- Eggs in feces contaminate water
- Free swimming larvae hatch
- Larvae penetrate snail (intermediate host)
- Cercariae leave snail and penetrate human (definitive host) foot
- Adults mature in human intestinal blood vessels

Cestodes

- Tapeworms
- Few mm to 6m
- Scolex hooks and suckers - attaches to intestinal musoca
- Lack digestive system - absorb nutrients digested by host
- Proglottids contain reproductive organs
- Egg cases shed in feces
Tapeworm Infections

- *Taenia solium* Pork Tapeworm
- Humans as Definitive host
- Pigs ingest eggs shed in human feces
- Transmitted as larvae cysticerci in undercooked meat
- Larvae mature in human intestine
- Humans as intermediate hosts
- Cysticerci may develop in humans if eggs are consumed
- Diagnosed by observing proglottids and eggs in feces
- Treatment with praziquantel
- Neurocysticercosis may require surgery

Nematodes

- Cylindrical and tapered at each end
- Complete digestive system
- Dioecious (two houses) males and females
- Intestinal roundworms infect 2 billion people worldwide
- Whipworm (*Trichuris trichiura*)
- Pinworm (*Enterobius vermicularis*)
Ascariasis

- *Ascaris lumbricoides*
- One of the most common intestinal parasites of humans
- Males 15-30cm
- Females 20-50cm
- Capable of producing 200,000 eggs daily
- Fecal-oral transmission
- Eggs hatch in intestines
- Juvenile migrate to heart and lungs via blood vessels
- Larvae travel up trachea before being swallowed

Nematodes: Trichinella

- Adult *Trichinella spiralis* develop, invade intestinal wall of pig, and produce larvae that infest muscles.
- Larvae encyst in muscle, with permissive host that has been infected.
- Undescended testis
- Adult *T. spiralis* encysted in pig's muscle. Capsule.
- Differentiation of *T. spiralis* larva. Figure 25.26

- In human intestines, muscle wall is necrotic, and *T. spiralis* nematode penetrates muscle wall, releasing larvae that enter the muscles.
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<th>Egg Type</th>
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**Table 12.6** Representative Parasitic Heteroptera

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**Table 12.7** Representative Parasitic Diptera

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