Chapter 12

The Eukaryotes: Fungi, Protozoa & Helminths
Fungi

- Mycology - the study of fungi
- Fungi important in food chain
  - Decompose dead matter
  - Recycle vital elements
- Used for food, produce food, drugs
- Chemoheterotrophic
  - Most are aerobic or facultative anaerobes
  - Few anaerobes known
Characteristics of Fungi

- Multicellular fungi ID based on physical appearance
  - Colony characteristics, reproductive spores
  - Classified into 3 groups:
    - Molds and fleshy fungi
    - Yeasts
    - Dimorphic fungi
Characteristics of Fungi

Molds and fleshy fungi

- Thallus – body of fungus
  - Consist of long filaments of cells joined together
    - Called “Hyphae” or “Hypha” (singular)
  - Or consist of individual cells (yeasts)
Characteristics of Fungi

- **Mycelium** – filamentous mass of fungi

![Images of Aerial and Vegetative hyphae](image-url)
Characteristics of Fungi

- Hyphae grow by elongating at the tips
  - Each tip of hypha is capable of growth
  - Fragments that break off can form new hypha
- Vegetative hypha – portion of thallus that obtains nutrients → actively growing portion
Characteristics of Fungi

Two kinds of vegetative hyphae

- Most hyphae have septums
- Septum separates hyphae into “cell-like” units
- Few have no septums
- Appear as long continuous cells with many nuclei
Characteristics of Fungi

- Reproductive hyphae concerned with reproduction
  - Aka “Aerial hyphae”
  - Project above the surface

Reproductive hypha projecting off the surface

(c) Growth of a hypha from a spore
Characteristics of Fungi

Yeast
- Nonfilamentous, unicellular fungi
  - Typically spherical or oval
- Budding yeasts divide unevenly
- Daughter cell (bud) is smaller than parent cell

Saccharomyces cerevisiae, a common budding yeast
Characteristics of Fungi

- Yeasts capable of facultative anaerobic growth
  - Can use oxygen as final electron acceptor
    - Forms CO₂ and water - what type of metabolism?
  - Can use organic compound as final electron acceptor
    - Forms ethanol, CO₂ - what type of metabolism?
- Important in food industry
Characteristics of Fungi

Dimorphic fungi

- Can grow as yeast or mold
- In pathogens, dimorphism is temperature dependent
  - 37°C – yeast-like
  - 25°C – mold-like

*Mucor indicus*
Characteristics of Fungi

Life cycle

- Reproduction accomplished by forming spores
  - Both sexual and asexual
  - Spores detach from parent
  - Germinate into new mold
- Spores can survive for extended periods in dry, heat
  - But not to the extreme like bacterial endospores
Characteristics of Fungi

- Asexual spores formed by fragmenting hyphae
- Spores are genetically identical
- Two types of asexual spores
  - Conodiospore
  - Sporangiospore

Aspergillus flavus produces spores at end of “conidiophore”
Characteristics of Fungi

Conidiospore, conidium
(pl, conidia)

- Spore not enclosed in sac
- Spores produced in chain at end of "conidiophore"
Characteristics of Fungi

Sporangiospores

- Formed within “Sporangium” or sac at end of aerial hyphae called “sporangiophore”
- Can contain hundreds of sporangiospores

Sporangiospore
Characteristics of Fungi

- Sexual spores result of fusion of two nuclei ("+" and "-"")
- Requires opposite mating types
- Spores have characteristics of both parents
- Teleomorphic fungi
  - Produce sexual and asexual spores
- Anamorphic
  - Produce only asexual spores

Sexual structure in *Rhizopus*
Characteristics of Fungi

- Fungi are chemoheterotrophs
  - Compete with bacteria for food
- Nutritional characteristics provide some advantages
  - Fungi can grow at pH 5
  - Resistant to osmotic pressure
  - Can grow in low moisture, low nitrogen environment
  - Capable of degrading complex carbs; lignin in wood
Fungal diseases

- Mycosis – a fungal infection
- Generally chronic (long-lasting) because fungi grow slowly
- Classified into 5 groups according to:
  - Degree of tissue involvement (How much of host is invaded?)
  - Mode of entry into host (How does it get into host?)
Fungal diseases

1. Systemic mycoses
   - Infections deep within the body, many tissues
   - Route of entry is inhalation
     - Begin in lungs, spread to other tissues
   - *Cryptococcus neoformans*

2. Subcutaneous mycoses
   - Fungal infections beneath skin
   - Infections occurs by implantation of spores into skin
   - *Sporothrix schenckii* → sporotrichosis in gardeners
Fungal Diseases

3. Dermatomycoses, cutaneous mycoses
   - Infect epidermis, hair, nails
     - Secrete keratinase, degrades keratin in hair, skin
   - Transmitted by contact
   - *Candida albicans*

4. Superficial mycoses
   - Localized along hair shafts, surface of skin cells
     - No tissue is invaded, often unaware of infection
   - *Malassezia furfur* → dandruff
Fungal Diseases

5. Opportunistic pathogen
   - Generally harmless in normal habitat
   - Becomes pathogenic in compromised host
     - Under treatments with antibiotics, suppressed immune system
   - *Pneumocystis* most common life threatening infection among AIDS patients
   - *Stachybotrys* can grow in water damaged homes, cause pulmonary hemorrhage in infants
Name that asexual spore

Sporangiospores Conidiospores
# Name that mycosis

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<th>Genus</th>
<th>Method of entry</th>
<th>Site of infection</th>
<th>Mycosis</th>
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<td><em>Blastomyces</em></td>
<td>Inhalation</td>
<td>Lungs</td>
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<td><em>Sporothrix</em></td>
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<td><em>Microsporum</em></td>
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<tr>
<td><em>Trichosporon</em></td>
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<td><em>Aspergillus</em></td>
<td>Inhalation</td>
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Characteristics of Protozoa

- Unicellular eukaryotes
- Inhabit water and soil
- Trophozoite – feeding and growing stage
- Relatively few cause disease
  - But diseases are significant
  - *Involve complex life cycles*
  - *Often with multiple hosts*
Characteristics of Protozoa

Life cycle

- Reproduce asexually by fission, budding, or schizogeny
- Schizogeny – multiple fission, nucleus divides many times before cell division
- Some protozoa reproduce sexually by “conjugation”
  - Fusion of cells, nuclei fuse
  - Cells separate
Characteristics of Protozoa

- Encystment – formation of a protective capsule called a cyst
  - Occurs when food, moisture, oxygen lacking
  - Parasites can survive outside of host
Characteristics of Protozoa

- Mostly aerobic heterotrophs
  - Some capable of anaerobic growth
- All live in areas with large supply of water
Malaria

**Plasmodium**
Causative agent of malaria

Anopheles mosquito is “definitive” host – sexual reproduction

Human is “intermediate” host – asexual reproduction
Toxoplasmosis

**Felines are “definitive” hosts**

**Humans can eat cysts directly or indirectly**

**Especially harmful to pregnant women** → can cause miscarriage

**Toxoplasma gondii**
Causative agent of toxoplasmosis

Humans, other mammals are “intermediate” hosts → humans are “accidental” or “incidental” hosts
Characteristics of Helminths

- Multicellular eukaryotic animals
- Parasitic helminths have characteristics that differ from free-living helminths
  - Lack digestive system
  - Reduced nervous system
  - Reduced or absent mobility
  - Complex reproductive system
- Two groups of helminths
  - Platyhelminths and Nematodes
Types of Helminths

- Platyhelminths
  - The Flatworms → flukes and tapeworms
- Nematodes
  - The Roundworms
- Two modes of transmission
  - Eating of eggs, cysts
    - Secreted in feces
  - Eating of larvae
    - From undercooked meat
**Paragonimus westermani**  
Paragonimiasis

- Lives in lungs, excreted in feces
- Humans are “definitive” hosts
- Uses mollusks as intermediate host

**Lung Fluke**
Rat Lungworm disease

**Angiostrongylus cantonensis**
Angiostrongyliasis

- Rats are "definitive" hosts
  - Lives in lungs, excreted in feces
- Humans are "accidental" or "incidental" can be infected, but not part of life cycle
- Snails are "intermediate" hosts
  - First-stage larvae infect snails and slugs
  - Third-stage larvae are ingested by rats
  - Humans eat larvae from raw or undercooked snails, or snail eat contaminated water, vegetables

Humans eat larvae from raw or undercooked snails, or snail eat contaminated water, vegetables

Snails are "intermediate" hosts
Three cases on Big Island in December 2008
Two in coma
Both recovered
What’s the lesson?