Fungi

Eukaryotic, yeast and mold forms
Hyphae, mycelium, reproductive structures
Spores and Conidia, sexual and asexual reproductive products

Dimorphism

Fungal cell wall
Chitin, beta-1,3-glucan, ergosterol in plasma membrane

Fungal diseases
mycotoxicosis, allergies, mycoses

Fungal diagnosis
Microscopy: 10% KOH, calcofluor-white
Antigen detection, serology, nucleic acid amplification

Cutaneous and subcutaneous mycoses
Example: Dermatophyte infections – molds

Systemic mycoses
Examples
Coccidioides (dimorphic) : Southwest US
Histoplasma (dimorphic): Missouri and Mississippi river valleys
Cryptococcus (yeast with capsule): soil with bird droppings, meningitis
  C. neoformans, C. gattii (endemic in Pacific Northwest, more likely to
  cause serious disease in healthy hosts)
All cause mild lung infections, immunocompromised at greater risk for invasive disease

Opportunistic fungi
Examples: Candida (yeast): human microbiota, vaginitis, thrush,
Aspergillus (mold): environmental, allergy, aspergilloma, invasive disease in
immunocompromised
Medical Mycology

- Fungi
  - Eukaryotic, heterotrophic
  - Single cell form: yeast
  - Multicellular form: mold (also spelled mould)
    - Multicellular filaments called hyphae
    - Mass of hyphae form mycelium
    - Specialized reproductive structures
  - Asexual and sexual reproduction
    - Spores are the product of sexual reproduction
    - Conidia are the product of asexual reproduction (asexual spores)

Yeasts and Hyphae

- Dimorphism
  - Dimorphic fungi can alternate between yeast or hyphal forms depending on conditions
  - Several important human pathogens are dimorphic, forming hyphae in the environment and yeasts in human tissue

Biological Significance of Fungi

- Aerobic degradation of organic material
- Symbiotic relationships with most vascular plants
  - Mycorrhizas: fungal colonization of plant roots enhances uptake of phosphorus and other nutrients
- Pathogenic relationships with plants and animals

Importance of Fungi to Humans

- Foods
  - Production
    - Cheese, bread, beer and wine, mushrooms
  - Spoilage
- Pharmaceuticals
  - Producers of antimicrobial drugs
- Diseases
  - Mycotoxicosis (fungal toxins)
    - Mushroom poisoning (Amanita phalloides)
    - Liver and kidney failure
  - Aflatoxin (Aspergillus flavus)
    - Found in stored grains, corn, peanuts
    - Implicated in liver cancer
  - Ergotism (Claviceps purpurea)
    - alkaloid toxins of fungus that infects rye and other cereals
    - vomiting, diarrhea, hallucinations, gangrene

Allergies

- Asthmatic reaction to fungal spores
  - e.g. allergic bronchopulmonary aspergillosis
- Mycoses: fungal infections
  - Most fungal infections in healthy individuals are usually mild
  - Severe, life threatening fungal infections are usually seen in persons with impaired host defences
  - Defects in neutrophil function or cellular immunity

Mycoses can be classified as

- Cutaneous and subcutaneous
- Systemic
- Opportunistic

Diagnosis of mycoses

- Microscopy
  - 10% KOH treatment of skin scrapings denatures skin and hair, fungi are resistant due to chitin
  - addition of calcofluor-white to KOH enhances visualization of fungi under fluorescent microscopy, binds to chitin

- Fungal Cell Wall
  - Chitin
  - Glucan
    - β-1,3-glucan
- Fungal Cytoplasmic Membrane
  - Ergosterol
- Glucan and ergosterol are targets of antifungal drugs
- Systemic fungi
  - *Coccidioides immitis* and *C. posadasii*
  - Dimorphic fungi
    - Hyphal growth in environment, endospore-filled spherules in tissue
  - Disease acquired by inhalation of spores
    - Most infections are asymptomatic or mild lung infections (valley fever)
    - Dissemination to other organs (especially bones and CNS) can occur in people with defective cellular immunity
    - Endemic to California Central Valley (*C. immitis*) and Southwestern US, Mexico, and South America (*C. posadasii*)

- Opportunistic fungi
  - *Candida albicans*
    - Yeast
    - Part of the normal human microbiota of the oropharynx, colon and vagina
    - Grow as yeast under most conditions, but can form hyphae in culture and in infection
    - Disease usually from an individual's own microbiota
    - Thrush – superficial oral infection
    - Associated with immunosuppression
    - Vaginitis
      - Associated with antibiotic use, diabetes, pregnancy
      - Diaper rash
      - Urinary tract infections
      - Blood and disseminated infections associated with immunosuppression and other compromising conditions

- Systemic fungi
  - *Histoplasma capsulatum*
  - Dimorphic fungi
    - Hyphal growth in environment, budding yeast in cytoplasm of macrophages in tissue
  - Disease acquired by inhalation of spores
    - Most infections are asymptomatic or mild lung infections
    - Dissemination to other organs (especially liver and spleen) can occur in people with defective cellular immunity (e.g. AIDS patients)
    - Endemic to Mississippi and Missouri River valleys.

- Cutaneous and subcutaneous mycoses
  - Cutaneous mycoses
    - Dermatophytosis (tinea, ringworm)
      - tinea capitis (head)
      - tinea corporis (body)
      - tinea cruris (jock itch)
      - tinea pedis (athletes foot)
      - tinea unguium, onycomycosis (nails)
    - Dermatophytes are molds (*Trychophyton, Epidermophyton, Microsporum*)
      - include species:
        - limited to humans (anthropophilic)
        - found in animals (zoophilic)
        - found in soil (geophilic)

- Systemic fungi
  - *Cryptococcus neoformans*
    - Yeast
    - Budding yeast
    - Found in soil with bird droppings and decaying organic matter
    - Yeasts in tissue surrounded by thick polysaccharide capsule
    - Disease acquired by inhalation
      - Asymptomatic or mild lung infections
      - Meningitis is most commonly recognized disease
      - Dissemination to skin and bones in persons with defective T cell-mediated immunity
      - Most common fungal infection in AIDS patients
    - *C. gattii*
      - Related species considered to be more virulent, more likely to disseminate in immunocompetent individuals
      - Increasing in incidence
      - Endemic focus in Pacific Northwest

- Cutaneous of mycoses
  - Direct observation by microscopy
    - 10% KOH treatment of skin and other specimens denatures host cells and hair, fungi are resistant due to chitin
    - addition of calcofluor-white to KOH enhances visualization of fungi under fluorescent microscopy, binds to chitin
    - histology and tissue stains, specialized fungal stains
  - Culture – specialized media, e.g. Sabaroud’s dextrose agar
    - Antigen detection
    - Serology – detection of antibodies produced during infection
    - Nucleic acid amplification

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Opportunistic fungi
  - *Aspergillus fumigatus*, other *Aspergillus* species
  - Mold, widespread in the environment
  - Disease acquired by inhalation of spores
    - Allergic aspergillosis — exacerbation of asthma
    - Aspergilloma — mycelial mass in lung cavity in patients with pre-existing chronic pulmonary disease
    - Serious invasive disease in immunosuppressed persons
      - Pneumonia
      - Sinusitis
      - Dissemination to skin and other organs via blood circulation
      - Poor prognosis, difficult to treat