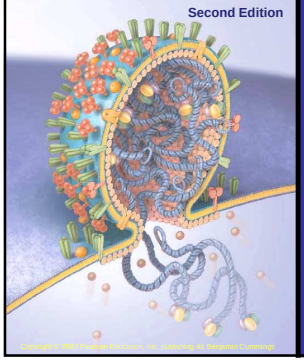
Microbiology

With Diseases by Taxonomy

PowerPoint® Lecture Slides

Second Edition



17

Pathogenic Fungi

Medical Mycology

- Field of medicine concerned with the diagnosis, management, and prevention of fungal diseases or mycoses
- Mycoses are among the most difficult diseases to diagnose and treat
  - Signs of mycoses are often missed or misinterpreted
  - Fungi are often resistant to antifungal agents

Epidemiology of Mycoses

- Fungi and their spores are almost everywhere in the environment
- Because they are widespread, most people will experience a mycosis at some time
- Typically acquired via inhalation, trauma, or ingestion
- Infrequently spread from person-to-person
- Most mycoses are not contagious
  - **Dermatophytes**, fungi found on the skin, are the major exception

Epidemiology of Mycoses

- Epidemics result from mass exposure to some environmental source of fungi
- Mycoses are generally not reportable and thus adequate information on their occurrence and spread is often lacking

Categories of Fungal Agents

- Only four fungi are usually considered true pathogens
  - Have the ability to actively attack and invade tissues
  - Exhibit dimorphism
    - Based on differences in temperature
    - In the environment they have mycelium thalli composed of hyphae and within the body they exist as yeast thalli
    - Yeast forms are invasive due to the production of various enzymes and proteins that allow their survival within the body
  - Endemic to certain regions, primarily in the Americas

Categories of Fungal Agents

- Opportunistic fungi account for the remaining diseases in humans
  - Often commensals that take advantage of a weakness in a host's defenses
  - Distributed throughout the world
  - Dermatophytes are considered in this group because they often occur in individuals susceptible to opportunistic fungi
  - Four factors increase an individual's risk for acquiring an opportunistic mycoses

Factors that Predispose Individuals to Opportunistic Mycoses

Table 22.1 Factors That Predispose Individuals to Opportunistic Mycoses

Factors	Examples
Medical procedures	Surgery; insertion of medical implants (heart valves, artificial joints); catheterization
Medical therapies	Immunosuppressive therapies accompanying transplantation; radiation and other cancer therapies; steroid treatments; long-term use of antibacterial agents
Preexisting conditions	Inherited immune defects; leukemia and lymphomas; AIDS; diabetes and other metabolic disorders; severe burns; preexisting chronic illnesses
Lifestyle factors	Poor diet; poor hygiene; IV drug abuse

Table 22.1

Clinical Manifestations of Fungal Disease

- Fungal diseases are grouped in **three categories** of clinical manifestation
  - **Fungal infections**
    - Most common mycoses
    - Caused by the presence in the body of either true pathogens or opportunists
  - **Toxicoses**
    - Acquired through ingestion
    - Occurs when poisonous mushrooms are eaten
  - **Allergies**
    - Most often result from the inhalation of fungal spores

Diagnosis of Fungal Infections

- A patient's history is critical for diagnosis of most mycoses
- Definitive diagnosis often requires isolation, laboratory culture, and morphological analysis of the fungus involved
  - **Sabouraud dextrose agar** is used to culture fungi collected from patients
    - This medium favors fungal growth over bacterial growth
- Various techniques are used to detect fungal cells in patient specimens

Diagnosis of Fungal Infections

- Immunological tests are not always useful for fungi
  - Due to the prevalence of fungi in the environment it is often hard to distinguish between an infection and simple exposure
- Opportunistic infections are particularly difficult to diagnose
  - Fungi can display abnormal morphology in tissues where infection wouldn't normally occur

Antifungal Therapies

- Mycoses are among the most difficult diseases to heal
  - Fungi can often resist the oxidative damage of T cells during cell-mediated immune responses
  - Fungi are biochemically similar to human cells and antifungal drugs can harm human tissues
- Fungi have ergosterol in their membranes rather than cholesterol and it is often a target for antifungal treatment
  - Side effects can still result, especially with long-term use

Antifungal Therapies

- **Amphoterecin B** is the "gold standard" of antifungal agents but also the most toxic
- Other antifungal agents include various **azole** drugs, fluorocytosine, and griseofulvin
- Opportunistic infections treatment requires **two steps**
  - High-dose treatment to eliminate or reduce the fungal pathogens
  - Long-term maintenance therapy to control and prevent reinfection

Systemic Mycoses Caused by Pathogenic Fungi

- Infections spread throughout the body
- Caused by one of the four pathogenic, dimorphic fungi of the division **Ascomycota**
  - ***Blastomyces***, *Coccidioides*, *Histoplasma*, and *Paracoccidioides*
- Acquired through inhalation
- Begin as a generalized pulmonary infection that disseminates via the blood to the rest of the body
- Individuals working with dimorphic fungi in the laboratory must take multiple precautions to avoid exposure to spores

Blastomycosis

- ***Blastomyces dermatitidis*** is the causative agent
- Endemic in the southeastern United States north to Canada
- Fungi found in soils rich in organic matter
- Inhalation of dust can carry fungal spores or hyphal pieces into the lungs
- Pulmonary blastomycosis is the most common manifestation in humans
  - Initial pulmonary lesions are mostly asymptomatic and symptoms, when they develop, are often vague
  - The disease resolves in most people but in others it may be chronic
- Treatment is with amphotericin B

Blastomycosis

Figure 22.3

Systemic Mycoses Caused by Opportunistic Fungi

- Opportunistic mycoses don't typically affect healthy humans
- Infections usually limited to people with poor immunity
- Becoming more important as the number of immunocompromised individuals rises
- Can be difficult to identify because their symptoms are often atypical
- Five genera routinely encountered
  - ***Aspergillus***, ***Candida***, *Cryptococcus*, *Pneumosystis*, and *Mucor*

Aspergillosis

- Includes several diseases caused by fungi in the genus ***Aspergillus***
- Can be found throughout the environment
- Disease occurs from the inhalation of the fungal spores
- Most commonly causes three pulmonary diseases
  - Hypersensitivity aspergillosis
    - Manifests as asthma or other allergic symptoms
  - Noninvasive aspergillomas
    - Masses of fungal hyphae form in the cavities after a case of pulmonary tuberculosis

Aspergillosis

  - Acute invasive pulmonary aspergillosis
    - May present as mild pneumonia
    - Necrosis of lung tissue can lead to significant respiratory impairment
- Nonpulmonary diseases can also result
  - Includes cutaneous and systemic aspergillosis
- Treatment can include allergy medications for hypersensitivity reactions and amphotericin B for other diseases

Candidiasis

- Includes various opportunistic infections and diseases
- *Candida albicans* is the most common causative agent
- Common members of the microbiota of the skin and mucous membranes
- *Candida* is one of the few fungi that can be transmitted between individuals
- All cases of disease result from an opportunist infection
- Can produce a wide range of diseases
  - Thrush
  - Diaper Rash
  - Onochymycosis
  - Ocular Candidiasis

Thrush

(a)

Figure 22.10a

Systemic Mycoses

Valley Fever or **Coccidioidomycosis**

- Caused by coccidoides immitis, a dimorphic fungus
- Found in soil in southwest, spores carried by wind
- In soil it is a mold, in human tissue it is a yeast
- Causes a respiratory infection with fever, chills, and cough
- Most cases mild, no treatment needed
- If severe, lung lesions, can result in death
- If skin test is positive, must isolate organisms
- Treatment is Amphotericin B (toxic)

Emergence of Fungal Opportunists in Immunosuppressed Individuals

- AIDS patients have permanent immune dysfunction making a full cure of opportunistic infections unlikely
- Mycoses account for most deaths associated with AIDS
- *Candida albicans*, *Aspergillus fumigatus*, and *Cryptococcus neoformans* are so common in HIV-positive individuals their mycoses partly define end-stage AIDS

Superficial, Cutaneous, and Subcutaneous Mycoses

- Are the most commonly reported fungal disease
- Mycoses are localized at the sites at or near the surface of the body
- Can be acquired by healthy individuals via person-to-person contact or through environmental exposure
- Diseases are usually not life threatening but can be chronic or recurring infections

Superficial Mycoses

- Are the most common fungal infections
- Usually acquired by direct contact with the fungus
- Confined to the outer, dead layers of the skin, nails or hair

Black Piedra and White Piedra

- Superficial infection that forms nodules on the hair shaft
- Transmission is often mediated by shared hair brushes or combs
- Several members of a family are usually infected at the same time
- Infected areas must often be shaved to remove the fungi

Black Piedra

Figure 22.12a

White Piedra

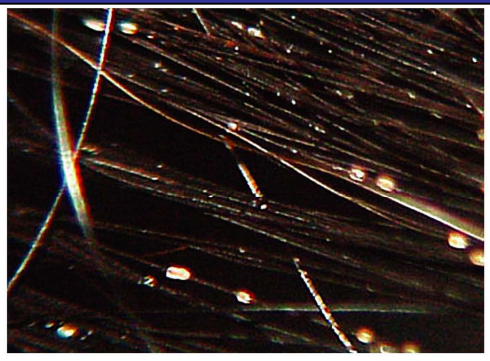


Figure 22.12b

Cutaneous and Subcutaneous Mycoses

- Fungi are commonly found in the soil
- Infections are rare
  - Requires traumatic introduction of the fungal elements beneath the outer, dead layers of skin
- Most lesions remain localized to the subepidermal tissues in the skin

Dermatophytoses

- Fungal infections of the skin or nails caused by dermatophytes
- Infections were previously called ringworms because they resemble a worm lying below the surface of the skin
- Result from fungi that use keratin as a nutrient source and thus colonize only dead tissues
- Can provoke cell-mediated immune response that damages living tissues

Dermatophytoses

- Three genera of **ascomycetes** cause most dermatophytoses
  - ***Trichophyton***, *Microsporum*, and *Epidermophyton fluccosum*
- Dermatophytoses show a variety of clinical manifestations
- Treatment is with topical antifungal agents
  - *Tinea pedis* (“athlete’s foot”)
  - *Tinea cruris* (“jock itch”)
  - *Tinea unguium*
  - *Tinea corporis*
  - *Tinea capitis*

Malassezia furfur

- Normal inhabitant of the skin
- Causes various superficial infections that tend to be chronic
  - Pityriasis
    - Fungi interfere with melanin production
    - Characterized by depigmented or hyperpigmented patches of scaly skin
  - Folliculitis
  - Seborrheic dermatitis and dandruff

Malassezia furfur

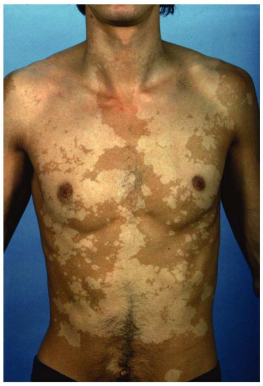


Figure 22.13

Mycetomas

- Tumorlike infections of the skin, fascia, and bones of the hands or feet
- Caused by **mycelial fungi** in the division **Ascomycota**
- Fungi are found in the soil
- Humans are infected when the fungi are introduced via pricks or scrapes from contaminated twigs, thorns, or leaves
- Small, hard, subsurface nodules form at the site of infection that slowly worsen and spread

Mycetomas

Figure 22.17

Fungal Intoxications and Allergies

- Some fungi cause allergies or produce toxins that cause toxicosis
- **Two types of toxicosis**
  - **Mycotoxicosis**
    - Caused by eating foods contaminated with fungal toxins
  - **Mycetismus**
    - Mushroom poisoning from eating a fungus
- **Fungal allergens** can elicit a hypersensitivity response in sensitive individuals
    - Result from inhalation, ingestion, or other contact

Mycotoxicoses

- **Mycotoxins** are produced by fungi during normal metabolic activities but are poisonous to animals and humans
- Mycotoxins are often consumed in contaminated food crops
- Long-term ingestion of mycotoxins can cause liver and kidney damage, gastrointestinal or gynecological disturbances, or cancers

Mycetismus

- Most mushrooms are not toxic
- Mushrooms that produce poisons can cause neurological dysfunction or hallucinations organ damage, or even death
- Poisoning typically occurs when untrained individuals pick and eat wild mushrooms
- The deadliest mushroom toxin is produced by the "death cap" mushroom

Allergies to Fungi

- **Fungal allergens** are common both indoors and out
- Determining the specific cause can be difficult because of their presence in the environment
- Fungal allergens usually cause type I hypersensitivity reactions that can result in asthma, eczema, and hay fever
- Type II and III hypersensitivity reactions can occur but much less frequently