Microbiology

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Introduction to Mycology

- **Medical Mycology** is the study of mycoses (fungal infections) in humans and their causative agents. While there are thousands of fungal species, fewer than 300 are pathogenic to humans.
  - The concept of fungal invasion was recognized as early as the 1800s, even before the science of bacteriology emerged.

- **What is a Fungus?**
  - ***Kingdom Fungi:*** Eukaryotic, meaning they have a true nucleus.
  - ***Characteristics:***
    - ✓ Heterotrophic (do not produce their own food).
    - ✓ Do not contain chlorophyll.
    - ✓ Include yeasts and filamentous structures (hyphae).
    - ✓ Reproduce via spores (sexual and asexual).
    - ✓ Saprophytic (feed on dead tissue) or parasitic (feed on living organisms).
    - ✓ Require an organic source of carbon associated with decaying matter.
  - ***Cell Wall***: Composed of chitin and β-glucan, both polysaccharides, which are the targets of some antifungal drugs.
  - ***Cell Membrane***: Contains ergosterol, which is also the target of certain antifungal drugs.
  - ***Oxygen Requirements:*** Most fungi are obligatory aerobes.

- **Importance of Fungi**
  1. ***Agricultural Impact:*** Fungi cause damage to crops and the food chain.
  2. ***Human Disease***: Fungal infections are increasing, especially in immunocompromised individuals (e.g., AIDS, other immunosuppressive conditions).
  3. ***Antibiotic Production***: Some fungi produce antibiotics, such as penicillin.

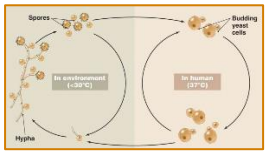
- **General Mycology**

Fungi can be classified by morphology and growth forms into:

1. ***Yeast:***
   - ✓ Oval or round cells that reproduce by budding.
   - ✓ Can form *pseudohyphae* (chains of elongated budding cells).
   - ✓ Examples: *Candida albicans*, *Cryptococcus neoformans*.

- ✓ Common in immunocompromised patients, causing infections like meningitis, arthritis, and respiratory infections.
- ✓ *C. neoformans* is found in soil and pigeon feces, commonly infecting the lungs first.

2. ***Filamentous Fungi (Molds)**:*
   - ✓ Have branching tubular filaments called *hyphae* (may be septate or non-septate).
   - ✓ *Mycelium*: Mass of interlinking hyphae.
   - ✓ May produce asexual spores called *sporangiospores* at the tip or side of hyphae.
   - ✓ Examples: *Zygomycetes*, *Aspergillus*, *Dermatophytes*.
3. ***Dimorphic Fungi**:*
   - ✓ Present in two forms: yeast form at 37°C (in tissues) and filamentous form at 22°C.
   - ✓ Examples: *Blastomyces dermatitidis*, *Coccidioides immitis*, *Histoplasma capsulatum*.



- **Fungal Diseases**
  - ➢ Fungal infections are a growing threat, particularly in immunocompromised individuals.
  - ➢ The types of fungal diseases include:

1. ***Fungal Allergies**:*
   - ✓ Molds grow on damp organic surfaces, and spores are airborne.
   - ✓ Inhalation of spores or fungal toxins can cause allergic reactions such as asthma and eosinophilia.
   - ✓ *Aspergillus fumigatus* is notable for causing these reactions.
2. Fungal Toxins **(*Mycotoxicosis*)**:
   - ✓ *Aflatoxicosis*: Poisoning caused by ingesting aflatoxins produced by *Aspergillus flavus* and *A. parasiticus*. This occurs when these fungi contaminate food, especially tree nuts, peanuts, oilseeds, and corn.
   - ✓ Aflatoxins are metabolized in the liver to a potent carcinogen (epoxide), leading to liver cancer. They induce mutations in the *p53* tumor suppressor gene.
3. Fungal Infections **(*Mycoses*)**:
   - ✓ *Superficial & Cutaneous Infections*: Affect the skin, mucous membranes, nails, or hair. Examples include *Pityriasis versicolor*, *Tinea nigra*, *Cutaneous candidiasis*, and dermatophytes.
   - ✓ *Subcutaneous Infections*: Confined to subcutaneous tissue without spreading to distant organs. Example: *Chromoblastomycosis*.
   - ✓ *Systemic Mycoses*: Primarily affect the lungs and may spread to other organs. Examples: *Coccidioidomycosis*, *Histoplasmosis*.

- ✓ *Opportunistic Mycoses:* Occur in immunocompromised individuals. Examples: *Candida spp.*, *Cryptococcus*.

- **Diagnosis of Fungal Infections**
  - ➢ *Clinical Diagnosis:*
    - ✓ Failure to respond to antibacterial treatments may suggest a fungal infection.
  - ➢ *Laboratory Diagnosis*:
    - ✓ ***Microscopy***: Pathogen recognition in tissue.
    - ✓ ***Culture***: Isolation of the fungus in culture.
    - ✓ ***Serological Tests***: For detecting fungal antigens or antibodies.
    - ✓ ***PCR***: Detection of fungal DNA.

- **Types of Specimens**
  - ➢ ***Superficial Infections***: Skin scales, nail clippings, scalp scrapings, hair stubs.
  - ➢ ***Mucosal Infections***: Swabs from suspected *Candida* infections.
  - ➢ ***Subcutaneous Infections:*** Scrapings, crusts, aspirated pus, biopsies.
  - ➢ ***Systemic Infections***: Specimens from the relevant organs.
- **Stains and Direct Microscopic Examination**
  - ➢ ***Wet Mounts***: Most specimens are examined with wet mounts after partial tissue digestion with 10–20% potassium hydroxide (KOH).
  - ➢ ***Calcofluor White***: Enhances fungal detection through fluorescence microscopy.
  - ➢ ***Special Stains***: Methylene blue, lactophenol blue, PAS, and ink.
- **Culture**
  - ➢ ***Sabouraud Dextrose Medium*** is commonly used for culturing pathogenic fungi.
  - ➢ May be supplemented with ***chloramphenicol*** (to prevent bacterial contamination) and ***cycloheximide*** (to reduce contamination with saprophytic fungi).
- **Antifungal Therapy**
  - ➢ Antifungal treatment is based on the presence of ***ergosterol*** in fungal cell membranes.
  - ➢ ***Polyenes*** (e.g., Amphotericin B, Nystatin) are fungicidal.
  - ➢ ***Azoles*** (e.g., Ketoconazole, Fluconazole, Itraconazole, Voriconazole, Posaconazole) are fungistatic.
  - ➢ Other antifungal drugs include ***Griseofulvin***, ***5-fluorocytosine (5-FC)***, ***Allylamines*** (e.g., Terbinafine), and ***Echinocandins***.

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