

# FUNGI

It is a group of eukaryotic organisms that are devoid of chlorophyll. Fungi comprise the mold and yeast.

**Molds** are multicellular, filamentous fungi.

**Yeasts** are usually unicellular, non filamentous fungi. Yeasts are typically spherical or oval in shape.



Some fungi are **dimorphic** i.e. they exist in two forms, yeast like form in their host but filamentous mold like growth when growing in soil.

## Habitat and nutrition

All fungi are heterotrophs; that is, they require some preformed organic carbon source for growth. Fungi do not ingest food particles as do organisms such as protozoa, but depend upon transport of soluble nutrients across their cell membranes. To obtain these soluble nutrients, fungi secrete degradative enzymes (for example, cellulases, proteases, nucleases) into their immediate environment. It is this ability that enables fungi to live saprophytically on organic waste. Therefore, the natural habitat of almost all fungi is soil or water containing decaying organic matter. Some fungi can be parasitic on living organisms. However, these parasitic infections usually originate from the individual's contact with fungus-infested soil, an exception being *Candida*, which is part of the normal human mucosal flora.

## IMPORTANCE OF FUNGI

### BENEFICIAL EFFECTS

*Aspergillus niger* for example, has been used to produce citric acid for foods and beverages since 1914. The yeast *Saccharomyces cerevisiae* is used to make bread and wine. It is also genetically

modified to produce a variety of proteins, including hepatitis B vaccine. Trichoderma is used commercially to produce the enzyme cellulase, which is used to remove plant cell walls to produce a clear fruit juice. Fungi are used as a food by humans (mushrooms).

They are involved in production of certain drugs (Alcohol and Antibiotic production). **Example** is penicillin production by *Penicillium notatum*.

Nearly all plants depend on symbiotic fungi known as **Mycorrhizae** which help their roots to absorb mineral and water from soil.

**Saprophytes** (fungi that feed on dead organic matter) decompose complex animal and plant remains, breaking them into simple compounds therefore recycle vital elements. Saprophytic fungi are also important in industrial fermentation e.g. making of wine.

#### **HARMFUL EFFECTS:**

Of more than 1 lack species only about 200 are pathogenic to humans, animals and plants.

#### **MORPHOLOGY OF FUNGI**

The thalus/body of fungus may consist of single cells in yeast, more typically the thalus consist of filaments which are commonly branched. The yeast cell or mold filament is surrounded by a true cell wall exception being slime molds which have a thalus consisting of naked mass of protoplasm. Fungal cell walls are composed largely of chitin, a polymer of N-acetylglucosamine, rather than peptidoglycan "a characteristic component of bacterial cell walls. Fungi are, therefore, unaffected by antibiotics (for example, penicillin) that inhibit peptidoglycan synthesis. The fungal membrane contains ergosterol, rather than the cholesterol found in mammalian membranes. These chemical characteristics are useful in targeting chemotherapeutic agents against fungal infections. Many such agents interfere with fungal membrane synthesis or function. For example, amphotericin B and nystatin bind to ergosterol present in cell membranes of fungal cells. There they form pores that disrupt membrane function, resulting in cell death. Imidazole antifungal drugs (clotrimazole, ketoconazole, miconazole) and triazole antifungal agents (fluconazole and itraconazole) interact with C-14  $\hat{\pm}$ -demethylase to block demethylation of lanosterol to ergosterol. Ergosterol is a vital component of the cell membrane of fungi, and disruption of its biosynthesis results in cell death.

In general yeast cells are larger than most bacteria ranging from 1-5µm in width and 5-30µm or more in length. They are commonly egg shaped but some are elongated and some are spherical. Yeast have no flagella or other organ of locomotion.

**Thalus of mold consist of two parts:**

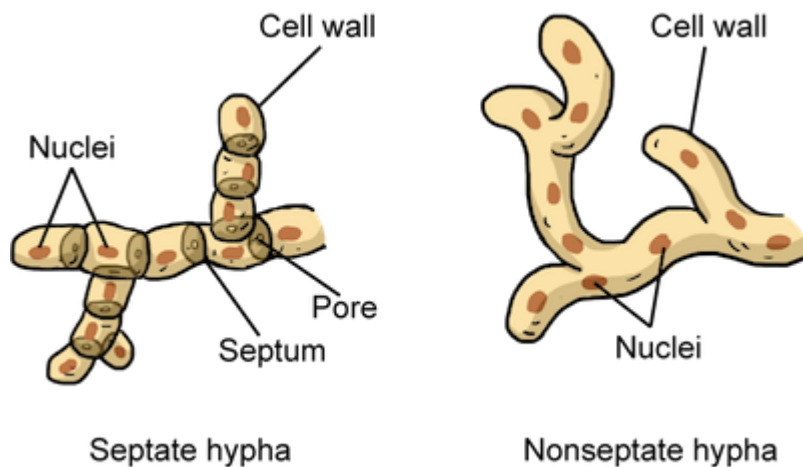
1. Mycellium
2. spore

**MYCELLIUM:**

It is complex of several filaments called **Hyphae**. Each hypha is 5-10µm in width.

**Hyphae** occur in three basic forms:

- a. Non septate hyphae.
- b. septate hyphae with uninucleate cell.
- c. septate hyphae with multinucleate cells.



**SPORE:**

These are formed from Aerial hyphae and are basically of two types.

- a. ASEXUAL SPORES
- b. SEXUAL SPORES

**a. ASEXUAL SPORES:**

These are formed from hyphae of one organism.

**b. SEXUAL SPORES:**

They result from fusion of nuclei from two opposite strains of same species.

## **FUNGAL DISEASES**

Any fungal infection is called as **MYCOSIS**. Mycosis are generally chronic (long lasting) infections because fungi grow slowly.

### **CLASSIFICATION**

Mycosis are classified into five following groups according to degree of tissue damage involvement and mode of entry into host.

**A. SYSTEMIC MYCOSIS:**

Systemic mycosis is fungal diseases or infection that often serious or fatal usually caused by fungi that live in soil.

**ROUTE OF TRANSMISSION:**

Inhalation of spore is route of transmission. These infections typically begins in the lungs then spread to other body tissue. They are not contagious from animal to human or from human to human.

**Examples:** Histoplasmosis, coccidioidomycosis

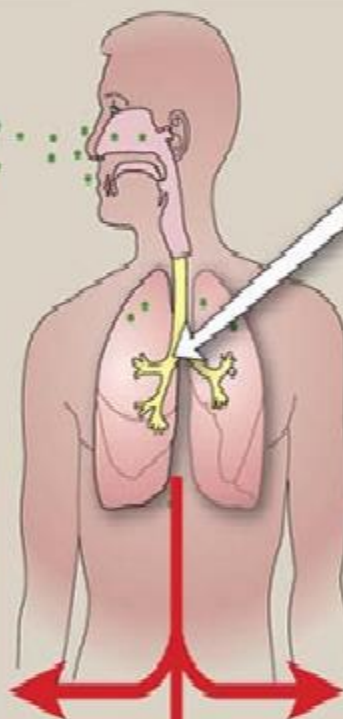
**Treatment**

Systemic mycoses are usually treated with amphotericin B, sometimes in combination with flucytosine. Ketoconazole, fluconazole, and itraconazole are also used, depending on the stage and site of the disease

**1 Spore production**  
Fungi are found in soil and the feces of birds and bats. The fungi produce spores that become airborne.



**2 Primary pulmonary infection**  
When inhaled, spores cause a primary pulmonary infection.



Lung of a patient with acute coccidioidal pneumonia



- Possible sites of infection:
- Central nervous system
  - Bone

Yeast form of *Blastomyces dermatitidis*

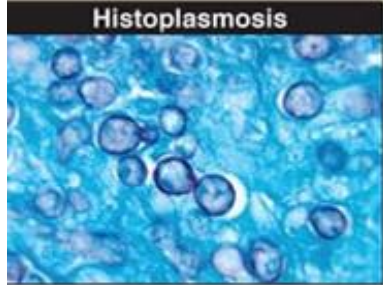


- Possible sites of infection:
- Skin
  - Bone
  - Genitourinary tract

**3 Dissemination of infection**

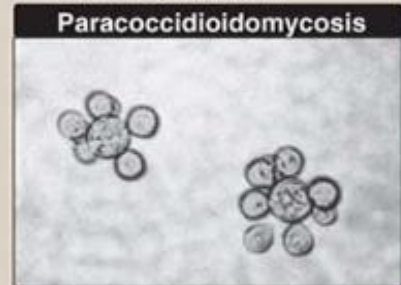
The fungi may travel from the lungs to other sites where infection can occur.

Methenamine silver stain



- Possible sites of infection:
- Liver
  - Spleen
  - Lymph nodes
  - Bone marrow

Central fungal cell with a series of buds that look like spokes of a wheel



- Possible sites of infection:
- Mucosa of the mouth and nose

## B. SUBCUTANEOUS MYCOSIS:

These are fungal infections that occur beneath the skin.

**Causative agents** are saprophytic fungi that live in soil and on vegetation.

### ROUTE OF TRANSMISSION:

Infection occur by direct implantation of spores or mycelial fragments into a puncture wound into the skin.

**EXAMPLE:** Sporotrichosis. A disease that is acquired by gardeners and farmers.



Oral itraconazole is the drug of choice for sporotrichosis



Treatment is difficult. Surgical removal of small lesions is effective. More advanced stages of the disease are treated with itraconazole and terbinafine



There is no effective chemotherapy for fungal mycetoma; the treatment is usually surgical excision

## C.CUTANEOUS/DERMATOMYCOSIS

It is a wide spread and difficult to control disease but is not serious.

**CUASATIVE AGENT:** Fungi that affect only the epidermis, nail and hair are called Dermatophyte

They secrete keratinase. It is an enzyme that degrade keratin. Keratin is a protein that found in hair, skin and nails.

### ROUTE OF TRANSMISSION:

These are contagious infections transmitted from human to human or from animal to human by direct contact or by contact with infected hair and epidermal cells.

### SYMPTOMS:

Usually there is irritation, arrhythmia, edema and inflammation. This pinkish circle gives rise to name of ring worm.



Ring worm (Tinea corporis)

Treatment



Removal of infected skin, followed by topical application of antifungal antibiotics such as miconazole or clotrimazole, is the first course of treatment. Refractory infections usually respond well to oral griseofulvin and itraconazole. Infections of the hair and nails usually require systemic (oral) therapy. Terbinafine is the drug of choice

#### **D. OPPORTUNISTIC MYCOSIS:**

They are generally harmless in its normal habitat but becomes pathogenic in a host who is seriously debilitated or whose immune system is suppressed by drugs or by immune disorder.

#### **EXAMPLES:**

**PNEUMOCYSTIS PNEUMONIA :** It causes life threatening infection in AIDS.



Figure 20.20 *Pneumocystis pneumonia*.



Figure 20.14 Oral candidiasis (thrush).

**MYCOMYCOSIS:** It is an opportunistic mycosis caused by the Rhizopus or Mucor. This infection mostly occurs in patients with Diabetes Mellitus, leukemia or undergoing treatment with immunosuppressant drugs.





### **Laboratory identification**

Most fungi can be propagated on any nutrient agar surface. The standard medium is Sabouraud dextrose agar, which, because of its low pH (5.0), inhibits bacterial growth while allowing fungal colonies to form. Various antibacterial antibiotics can also be added to the medium to further inhibit bacterial colony formation. Cultures can be started from spores or hyphal fragments. Clinical samples may be pus, blood, spinal fluid, sputum, tissue biopsies, or skin scrapings. Identification is usually based on the microscopic morphology of conidial structures. Serologic tests and immunofluorescent techniques are also useful in identification of fungi from clinical isolates.