

# Introduction to Mycology

By

Ahmed Nasser Alareeq

MSc of microbiology

# Introduction to Mycology

**Mycology:** is the study of fungi (molds, yeasts, and mushrooms).

**Mycoses:** fungal infections

**Mycotoxicosis:** intoxication

The name “**fungi**” is derived from “mykos” meaning mushroom.

# All Fungi are:

1. **Eukaryotic** (e.g., true nucleus, 80S ribosomes, mitochondria, as are humans).

2. **Complex carbohydrate cell walls:** chitin, glucan, and mannan.

3. **Ergosterol** = Major membrane sterol

4. **Heterotrophic** (require organic carbon):

- **Saprophytic or saprobic:**

(fungus living on dead organic material)

- **Parasitic:**

(fungus living on another living organism)

# Comparison of fungi and bacteria

TABLE 71-1

Comparison of fungi and bacteria

Feature	Fungi	Bacteria
Diameter	Approximately 4 $\mu\text{m}$	Approximately 1 $\mu\text{m}$
Morphology	Yeast and mold	Cocci, bacilli, spirochete, branching filamentous
Staining property	Gram-positive, nonacid fast, stained with PAS and GMS	Gram-positive, Gram-negative, acid fast
Cell wall content	Chitin	Peptidoglycan
Cell membrane	Sterols present	Sterols absent except mycoplasma
Cytoplasm	Mitochondria and endoplasmic reticulum present	Mitochondria and endoplasmic reticulum absent
Nucleus	Eukaryotic	Prokaryotic
Spores	Sexual and asexual spores for reproduction	Endospores for survival, not for reproduction
Thermal dimorphism	Yes (seen in some fungi)	No

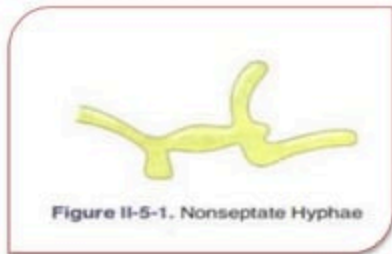
PAS, periodic acid-Schiff; GMS, Gomori's methenamine silver.

# Fungal Morphology

- **Hyphae** = filamentous cellular units of molds and mushrooms

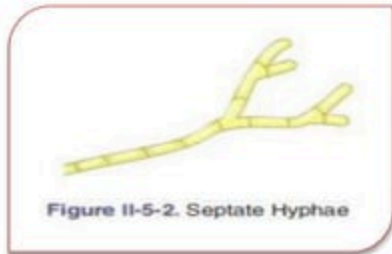
## ➤ **Nonseptate Hyphae**

- No cross walls
- Broad hyphae with irregular width
- Broad angle of branching



## ➤ **Septate Hyphae**

- With cross walls
- Width is fairly regular (tube-like).



# Fungal Morphology

- **Hyphal Coloration**
  - Dematiaceous: dark colored (gray, olive)
  - Hyaline: clear
- **Mat of hyphae:** mycelium
- **Yeasts:** single celled (round to oval) fungi



# Fungal Morphology

- **Dimorphic Fungi**

- Fungi able to convert from hyphal to yeast or yeast-like forms.
- Thermally dimorphic: in the "cold" are the mold form.



Figure II-5-4. Dimorphic Fungi

# Fungal Morphology

- Pseudohyphae (*Candida albicans*):  
Hyphae with constrictions at each septum



Figure II-5-5.  
Candida Pseudohyphae



# Fungal Morphology

- **Spore types:**

1. **Conidia:** • Asexual spores. • born externally on side of hyphae also called conidiospores , Microconidia ,Macroconidia
  - Common.
  - Airborne



Figure II-5-6. Conidia

2. **Blastoconidia:** "Buds" on yeasts (asexual budding daughter yeast cells)



Figure II-5-7. Blastoconidia

3. **Arthroconidia:** Asexual spores formed by segmentation and condensation of hyphae.



Figure II-5-8. Arthroconidia

4. **Spherules and Endospores ( Coccidioides):**

Spores inside the spherules in tissues

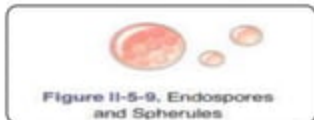


Figure II-5-9. Endospores and Spherules



# Classification of Fungi

**1. Morphological Classification**

**2. Taxonomical Classification of Fungi**

**3. Classification based on Medical Important.**

# Morphological Classification

The fungi can be classified into the following four main groups based upon the morphology:

**A Yeast:** Round or oval unicellular fungi that reproduce by asexual budding.

**B Yeast-like form:** They grow partly as yeasts and partly as long filamentous cells joined end to end forming a pseudomycelium.

**C Molds:** They are filamentous and fungi. They grow as long filaments or hyphae

**D Dimorphic fungi:** They grow in mycelia form at low temperature 22 °C and in soil whereas growth at 37°C and in animal body occurs in yeast form.

# Classification based on spore production:

Here **There are four classes of fungi:**

- Zygomycetes.
- Ascomycetes.
- Basidiomycetes.
- Deuteromycetes or Fungi Imperfecti.

## Classification based on medical important.

**Superficial:** Confined to the outermost layers of the skin and hair.

**Cutaneous:** Have particular affinity for the keratin of the skin, nails, and hair.

**Subcutaneous:** Involve the deeper layers of skin and often muscle tissue.

**Systemic:** Attack the deep tissues and organ systems; often create symptoms that resemble other diseases.

## Two categories of systemic disease.

☐ a. Those caused by **truly pathogenic fungi** with the ability to cause disease in the normal human host when the inoculum is of sufficient size.

- *Histoplasma capsulatum*
- *Blastomyces dermatitidis*
- *Coccidioides immitis*
- *Paracoccidioides brasiliensis*

☐ b. **Opportunistic fungi**, low virulence organisms, require the patient's defenses to be lowered before the infection is established.

*Aspergillus sp.*

*Candida albicans*

*Cryptococcus neoformans*

# Reproduction and sporulation

1. Sexual spores are of four types:

- oospore, ascospore, zygosporangium and basidiospore

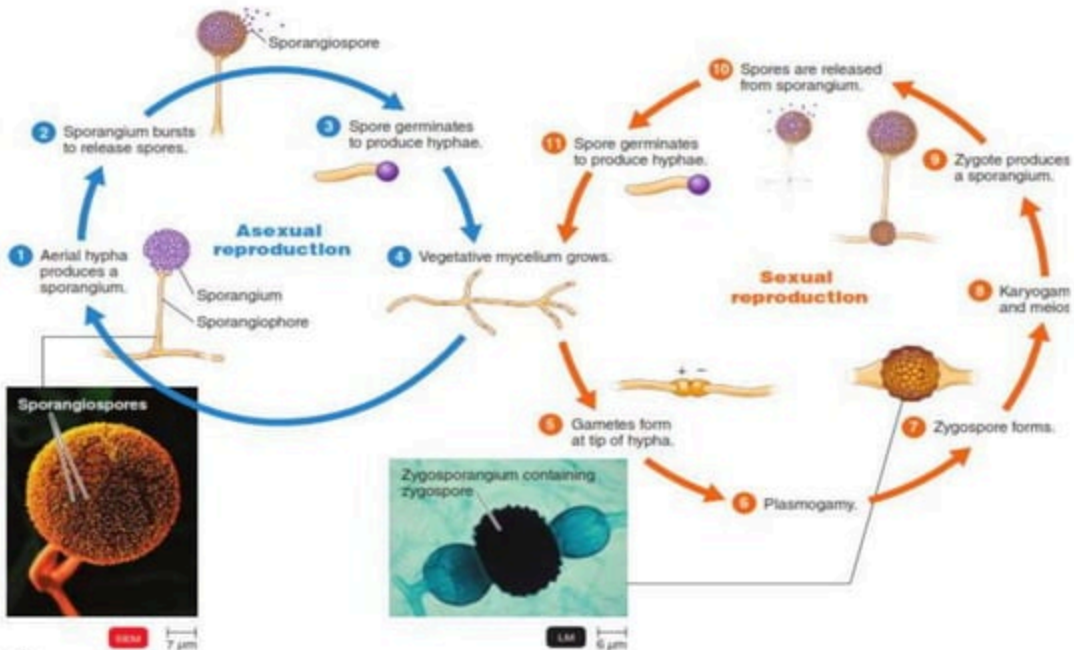
2. Vegetative spores :

**Blastospores:** These are formed by budding from parent cell, as in yeasts.

**Arthrospores:** These are formed by the production of cross-septa into hyphae resulting in rectangular thick-walled spores.

**Chlamydospores:** These are thick-walled resting spores developed by rounding up and thickening of hyphal segments.

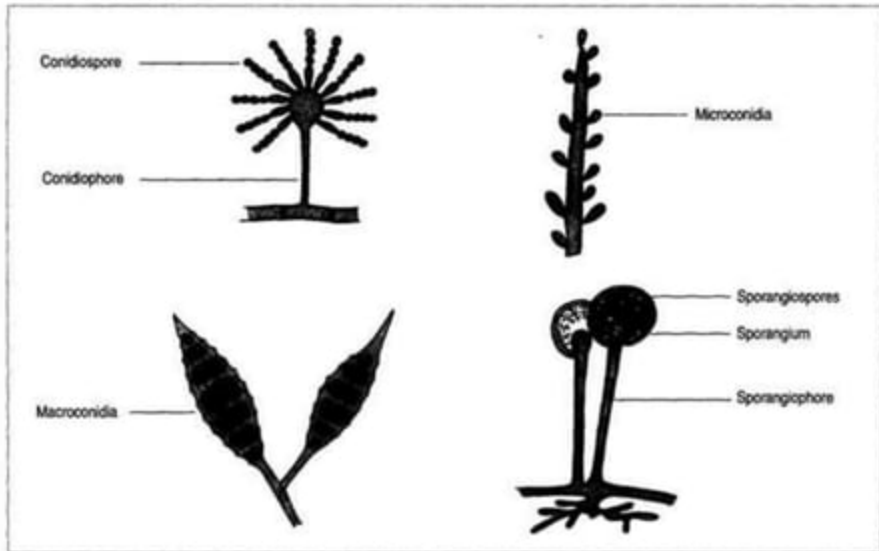




### 3. Aerial spores

- **Conidiospores:** Spores borne externally on sides or tips of hyphae are called conidiospores or simply conidia.
  - **Microconidia:** When conidia are small and single, these are called microconidia.
  - **Macroconidia:** These are large and septate conidia and are often multicellular.
- **Sporangiospores:** These are spores formed within the sporangium. Examples are Mucor and Rhizopus.

# 3. Aerial spores



# Laboratory Diagnosis

- **Direct Microscopy:**

- 1. Potassium Hydroxide (KOH) Preparation**

Specimen is placed in a drop of 10% KOH on a microscopic slide and covered with a coverslip. It is heated gently and examined under microscope.

## 2. KOH with Calcofluor White:

A drop of calcofluor white solution can be added to the KOH preparation before covering it with the coverslip. Fungal elements fluoresce due to binding of calcofluor white to the fungus.

## 3. Gram Staining:

It is done to observe Gram positive yeasts as in case of *Candida* species.

## 4. India Ink Preparation

Indian ink preparation may be used for detection of capsulated yeast such as *Cryptococcus neoformans* in cerebrospinal fluid (CSF).

# Culture

1. a. **Sabouraud's dextrose agar (SDA)** and SDA medium with antibiotics are inoculated and incubated at 25°C and 37°C for three weeks.  
  
b. **Brain heart infusion (BHI) agar** with blood and antibiotics is another medium used for primary isolation of fungi.

## **2. Microscopy is performed from fungal colony:**

(in teased mounts or slide cultures) to study the morphology of hyphae, spores and other structures. Teased mounts are prepared in lactophenol cotton blue (LCB) which contains lactic acid, phenol and cotton blue.

**3. Slide culture** is done for studying the exact morphology of the fungus.

## **Tissue Sections:**

Fungal elements in tissue can be identified by methenamine silver stain and Periodic" Acid Schiff (PAS) stain.