



# FUNGI

**General Microbiology Course**

**B 104**

**Level 1**

# Characteristics of Fungi

- Fungi are more closely related to animals than plants
- Fungi are heterotrophic:
  - they use complex organic compounds as sources of energy and carbon, not photosynthesis
- Fungi multiply either asexually, sexually, or both
- Fungi interact with other organisms by either forming beneficial or mutualistic associations (mycorrhizae and lichens ) or by causing serious infections.
- **mycorrhiza**: a symbiotic association between a fungus and the roots of a vascular plant
- **lichen**: any of many symbiotic organisms, being associations of fungi and algae; often found as white or yellow patches on old walls, etc.

# FUNGI (Mycology)

- ◆ Diverse group of heterotrophs.
  - Many are ecologically important saprophytes (consume dead and decaying matter)
  - Others are parasites.
- ◆ Most are multicellular, but yeasts are unicellular.
- ◆ Most are aerobes or facultative anaerobes.
- ◆ Cell walls are made up of **chitin** (polysaccharide).
- ◆ Over 100,000 fungal species identified. Only about 100 are human or animal pathogens.
  - Most human fungal infections are nosocomial and/or occur in immunocompromised individuals (opportunistic infections).
- ◆ Fungal diseases in plants cause over 1 billion dollars/year in losses.



# Fungi

**Unicellular**

**Yeasts**

**Multicellular**

**Molds and Fleshy Fungi**

**Dimorphic**

**Both**



# Characteristics of Fungi

## 1. Yeasts

- ◆ Unicellular fungi, nonfilamentous, typically oval or spherical cells. Reproduce by **mitosis**:
  - Fission yeasts: Divide evenly to produce two new cells (*Schizosaccharomyces*).
  - Budding yeasts: Divide unevenly by budding (*Saccharomyces*).

Budding yeasts can form pseudohypha, a short chain of undetached cells.

*Candida albicans* invade tissues through pseudohyphae.
- ◆ Yeasts are **facultative anaerobes**, which allows them to grow in a variety of environments.
  - When oxygen is available, they carry out aerobic respiration.
  - When oxygen is not available, they ferment carbohydrates to produce ethanol and carbon dioxide.



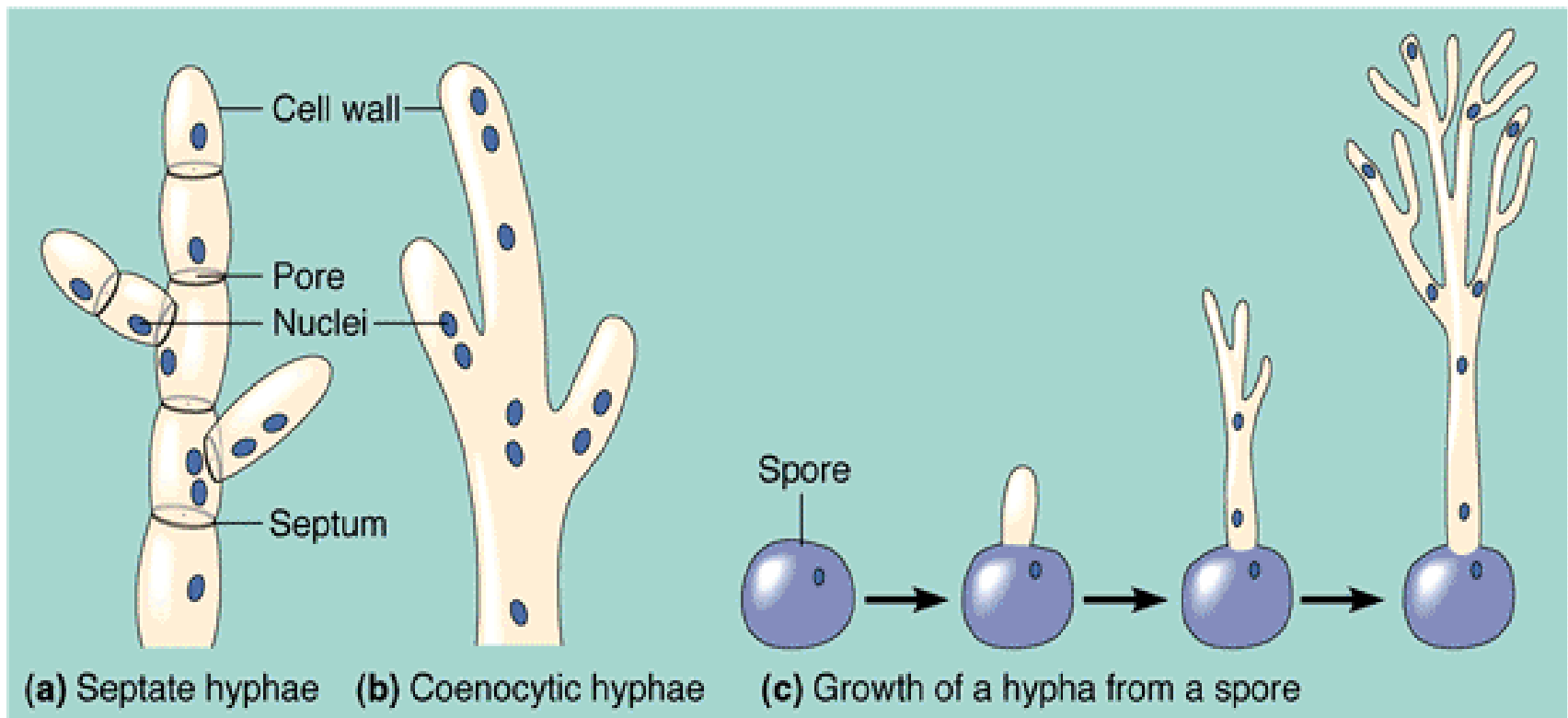
# Characteristics of Fungi (Continued)

## 2. Molds and Fleshy Fungi

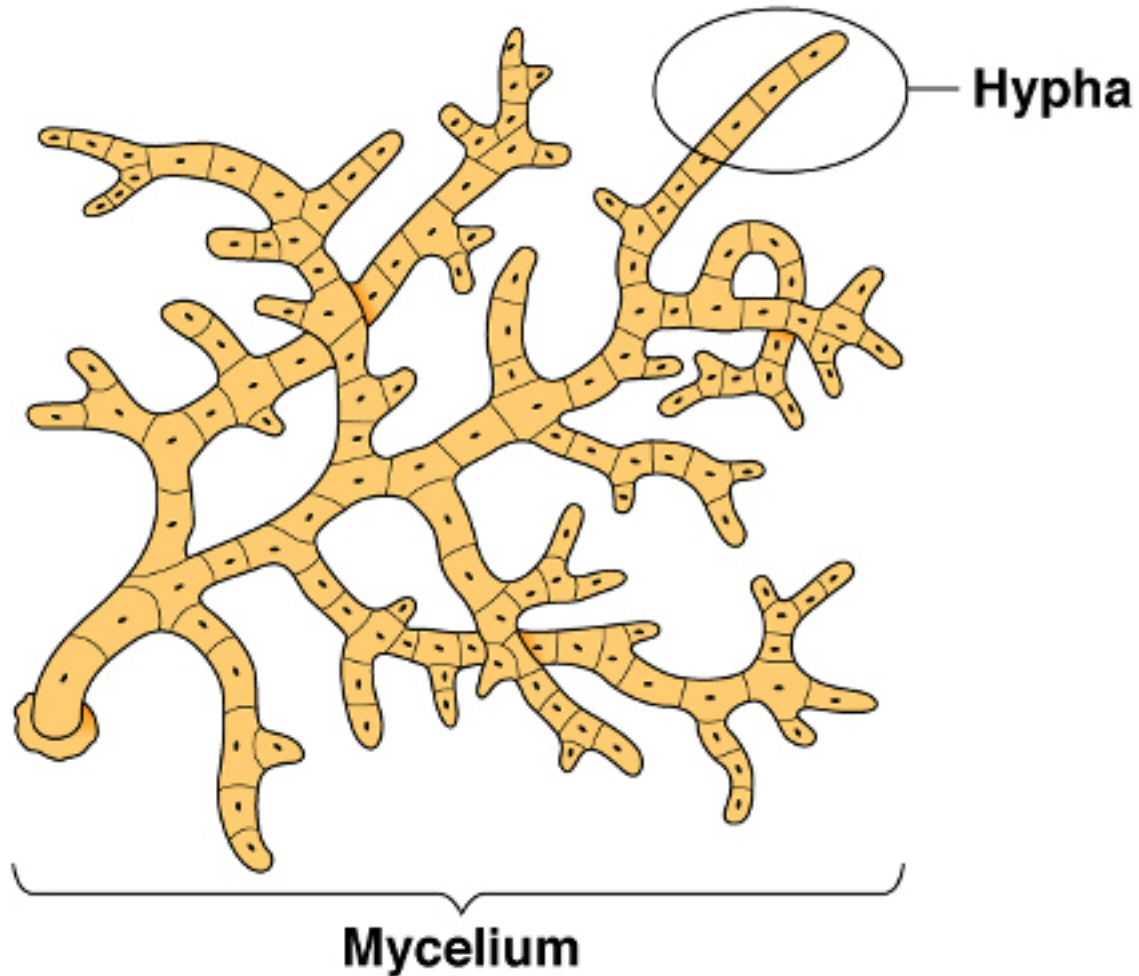
- ◆ Multicellular, filamentous fungi.
- ◆ Identified by **physical appearance, colony characteristics, and reproductive spores.**
  - **Thallus:** Body of a mold or fleshy fungus. Consists of many hyphae.
  - **Hyphae (Sing: Hypha):** Long filaments of cells joined together.
    - ◆ **Septate hyphae:** Cells are divided by cross-walls (septa).
    - ◆ **Coenocytic (Aseptate) hyphae:** Long, continuous cells that are not divided by septa.
      - Hyphae grow by elongating at the tips.
      - Each part of a hypha is capable of growth.
    - ◆ **Vegetative Hypha:** Portion that obtains nutrients.
    - ◆ **Reproductive or Aerial Hypha:** Portion connected with reproduction.
  - **Mycelium:** Large, visible, filamentous mass made up of many hyphae.



# CHARACTERISTICS OF FUNGAL HYPHAE: SEPTATE VERSUS COENOCYTTIC

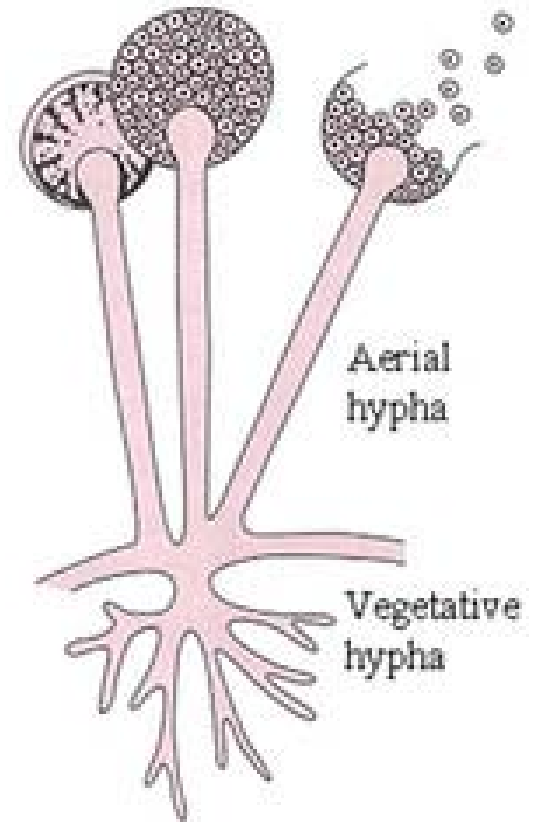
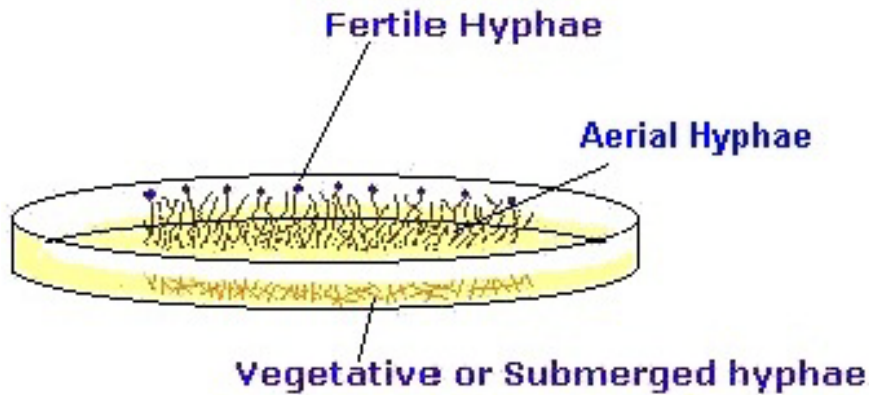


# MYCELIUM: LARGE, VISIBLE MASS OF HYPHAE





# Vegetative and Reproductive or Aerial Hypha




# Characteristics of Fungi (Continued)

## Dimorphic Fungi

- ◆ Dimorphic fungi are those fungi that exist either in **yeast form** or as **mold (mycelial form)** depending on environmental conditions, physiological conditions of the fungus or the genetic characteristics
- ◆ Many pathogenic species.
  - Mold form produces aerial and vegetative hyphae.
  - Yeast form reproduces by budding.
- ◆ Dimorphism in pathogenic fungi typically depends on temperature:
  - At 37°C: Yeast form.
  - At 25°C: Mold form.
- ◆ Dimorphism in nonpathogenic fungi may depend on other factors: Carbon dioxide concentration.



# LIFE CYCLE OF FUNGI

- ◆ Filamentous fungi can reproduce asexually by fragmentation of their hyphae.
  - ◆ Fungal spores are formed from aerial hyphae and are used for both sexual and asexual reproduction.
    1. **Asexual spores:** Formed by the aerial hyphae of one organism. New organisms are identical to parent.
      - ◆ **Conidiospore:** Unicellular or multicellular spore that is not enclosed in a sac.
      - ◆ **Chlamydospore:** Thick-walled spore formed within a hyphal segment.
      - ◆ **Sporangiospore:** Asexual spore formed within a sac (sporangium).
    2. **Sexual spores:** Formed by the fusion of nuclei from two opposite mating strains of the same species. New organisms are different from both parents.
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**Ascospores enclosed in a sac-like structure (**ascus**).**

**Basidiospores: Spores formed externally on a club shaped sexual structure or base called **basidium**.**



# NUTRITIONAL ADAPTATIONS OF FUNGI

- ◆ Fungi **absorb** their food, rather than **ingesting** it.
- ◆ Fungi grow better at a **pH of 5**, which is too acidic for most bacteria.
- ◆ Almost all molds are **aerobic**. Most yeasts are **facultative anaerobes**.
- ◆ Fungi are **more resistant to high osmotic pressure** than bacteria.
- ◆ Fungi can grow on substances with very **low moisture**.
- ◆ Fungi require **less nitrogen** than bacteria to grow.
- ◆ Fungi can **break down complex carbohydrates** (wood, paper), that most bacteria cannot.



# FUNGAL DISEASES

## Mycosis:

Any fungal disease. Tend to be **chronic** because fungi **grow slowly**.

Mycoses are classified into the following categories:

- I. **Systemic mycoses:** Fungal infections deep within the body. **Can affect a number of tissues and organs.**
  - ◆ Usually caused by fungi that live in the soil and are inhaled.
  - ◆ **Not contagious.**
  - ◆ **Examples:**
    - **Histoplasmosis** (*Histoplasma capsulatum*): Initial infection in lungs. Later spreads through blood to most organs.
    - **Coccidiomycosis** (*Coccidioides immitis*): Resembles tuberculosis.



# SYSTEMIC MYCOSIS: HISTOPLASMOSIS



**Disseminated *Histoplasma capsulatum*, lung infection.**  
**Source: Microbiology Perspectives, 1999.**



# FUNGAL DISEASES (Continued)

## II. Cutaneous mycoses: Fungal infections of the skin, hair, and nails.

- ◆ Secrete **keratinase**, an enzyme that degrades keratin.
- ◆ Infection is transmitted by direct contact or contact with infected hair (hair salon) or cells (nail files, shower floors).
- ◆ Examples:
  - **Ringworm** (*Tinea capitis* and *T. corporis*)
  - **Athlete's foot** (*Tinea pedis*)
  - **Jock itch** (*Tinea cruris*)





# CUTANEOUS MYCOSIS



**Ringworm skin infection:** *Tinea corporis*  
**Source:** Microbiology Perspectives, 1999



# CUTANEOUS MYCOSIS



***Candida albicans* infection of the nails.**

**Source: Microbiology Perspectives, 1999.**





Athlete's foot





Athlete's foot



# FUNGAL DISEASES (Continued)

**III. Subcutaneous mycoses:** Fungal infections beneath the skin.

- ◆ Caused by saprophytic fungi that live in soil or on vegetation.
- ◆ Infection occurs by implantation of spores or mycelial fragments into a skin wound.
- ◆ Can spread to lymph vessels.

**IV. Superficial mycoses:** Infections of hair shafts and superficial epidermal cells. Prevalent in tropical climates.



# FUNGAL DISEASES (Continued)

**Opportunistic mycoses:** Caused by organisms that are generally harmless unless individual has weakened defenses:

- AIDS and cancer patients
- Individuals treated with broad spectrum antibiotics
- Very old or very young individuals (newborns).

## ◆ **Examples:**

- **Aspergillosis:** Inhalation of *Aspergillus* spores.
- **Yeast Infections or Candidiasis:** Caused mainly by *Candida albicans*. Part of normal mouth, esophagus, and vaginal flora.



# ECONOMIC IMPORTANCE OF FUNGI

- ◆ 25-50% of harvested fruits and vegetables are damaged by fungi.
- ◆ Fungal infections of plants are commonly called rots, rusts, blights, wilts, and smuts.
  - *Phytophthora infestans*: Caused great potato famine in mid-1800s. Over 1 million people died from starvation in Ireland. Many immigrated to the U.S.
- ◆ **Beneficial fungi:**
- ◆ Fungi have several positive economic effects, such as consuming biodegradable waste, improving soil, acting as symbiotic organisms for various crops, generating antibiotics and other medicines, and being a food source



## **Fungi used as food:**

**Mushrooms and morels:-** These are edible fungi used as delicious vegetables all over the world.

**Yeast:-** It mainly consists of carbohydrates, proteins and fats. Yeast food is a rich source of vitamins such a **thiamin, riboflavin, nicotinic acid, pantothenic acid, biotin, pyridoxin and amino benzoic acid.**

## **Fungi used in food processing:**

Fungi such as species of *Aspergillus* and *Penicillium* are employed in the processing of certain food products, baking and cheese industry.

### **Bread Making:**

*Saccharomyces cerevisiae* is used in bread making.

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## Fungi in medicine:

Fungi were extensively used for their supposed curative properties.

### (a) Antibiotics:

Notatin

Penicillin

*Penicillium notatum*,

*Penicillium chrysogenum*

(b) **Steroids:** Except Myxomycetes wide variety of fungi synthesized steroids.

(c) **Vitamins:** These include thiamin, Riboflavin, Pantothenic acid, Pyridoxin, Biotin, Choline Ergosterol and Vitamin B and D.

(d) Therapeutic uses of – Extracts of *Saccharomyces cerevisiae* and *Aspergillus niger* have proved specific in extreme cases of malignancy



## Other examples

***Candida oleophila***: Prevents fungal growth on harvested fruits.

Genetically engineered yeast strains are used to make proteins (Hepatitis B vaccine).

***Taxomyces***: Produces anticancer drug taxol.

***Trichoderma***: Produces cellulose. Used to make fruit juice.

