I. Basic Characteristics of Fungi

A. What are fungi?

- Molds
- Yeasts

B. General Characteristics of fungi:

1. Devoid of chlorophyll
2. Have a definite cell wall
3. Usually non-motile (except in some animals)
4. Reproduce by means of spores
5. Many are filamentous
6. Multicellular, eukaryotic
7. Have a discrete nucleus
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II. Structure and Function

Basic cell structure of molds

1. The hypha: the basic element of a mold. → make up a colony
2. Hyphae: Plural of hypha. (Gr. = web).
4. Thallus: Mycological term for a colony of hyphae
5. Vegetative hyphae: Hyphae growing in the substrate
6. Aerial hyphae: Hyphae growing above the substrate
7. Septate hyphae → has crossed walls (constrictions)
8. Nonseptate hyphae → no crossed walls

A B C D

 HYPHA

E F G

 HYphae → MYCELIum/colony

1) Spore → right medium
2) Grow / elongate
3) Hyphae

Hyphae - Mycelium - colony
are a continuum

※ mold on fruit, etc.
are mycelium.
II. Subcellular structures of fungal cells

**Cell Wall**

Function: Supporting structure of cell and regulates cell size.
Structure: Made up of microfibrils, in a thatched network, usually multi-layered.
Composition: Primarily composed of glucans, mannans, **CHITIN** and glucan- and mannan-protein complexes.

Note: Cell wall composition influences antigenicity of the fungus and immunological host response.

- **B-glucan**: **B1-3** linkage.
- **some** antifungal stock this.
Cytoplasmic Membrane (Plasmalemma)

A two-layered membrane composed primarily of lipoprotein and contains high concentrations of **sterols, primarily ERGOSTEROL.** NOT CHOLESTEROL

Differential permeability

Transport mechanisms and synthesis of cell wall.

Mitochondria

As in other eucaryotic cells.

These are more concentrated in the growing portion (tip) of hyphae.

Ribosomes

80S, with 60 and 40 S subunits. Vary in number with stage of growth.

Vacuoles

Vary greatly in size and function. Often contain lipid and many enzymes involved in cellular metabolism. Associated with lysosomes.

Nucleus

Discrete, with nuclear membrane. Vary in size. Nonseptate hyphae are multinucleated.

Golgi and Endoplamic Reticulum

As in other eukaryotic cells

Capsule

A capsule surrounds some yeast cells

mucopoly sacch. around yeasts
Site of action of antifungal agents

**TARGETS FOR ANTIFUNGAL AGENTS**

- **Echinocandins**
- **Polymers, Azoles**
- **Mannoprotein**
- **β-GLUCAN**
- **β-GLUCAN-CHITIN**
- **Plasma Membrane**

**Ergosterol Synthesis and Antimycotic Action**

- **Acetyl-CoA**
- **Acetoacetyl-CoA**
- **HM7-CoA**
- **Mevalonic Acid**
- **Squalene**
- **Squalene-2,3-Epoxide**
- **Lanosterol**
- **Azoles**
- **Morpholines**
- **Polyenes**
- **Ergosterol**

Morphology of Fungi

**Hyphae**
Tube-like, branching structures formed by molds

**Yeast**
*Single-celled*, daughter cell separates from mother cell

- Unique:
  - No hyphae, no tubes
  - Septae aren't even an option
- Not fuzzy like no hyphae
- Grow kind of like vegetative mold (in/on substrate)
**Pseudohyphae**, daughter cell does not separate from mother cell resulting in a chain of yeast cells.

- Look like hyphae but are really buds → even if they branch; do not break from mother
- No parallel cell walls
- Good to make a tentative dx.

**Dimorphic**
Definition: The ability of a fungus to grow in the mold (mycelial) form or yeast form.

- Caused many dx, even in usa
- Dep. on medium

Environmental Factors in dimorphism
- Increased CO₂
- Elevated temperature to 35-37 C
- Organic nitrogen source
- -SH compounds (cysteine)
- Abundance of simple sugars

**Examples of dimorphism**
- Blastomyces dermatitidis
- Histoplasma capsulatum
- Sporothrix schenckii
- *Boccidiodes immunis*
- *Paracoccidioides brasiliensis*
Fungal Metabolism

Oxygen requirement
- Aerobic
- Facultatively anaerobic
- Yeast for beer, wine

Source of Nutrients
- Extremely resourceful in using nutrients. May utilize anything from simple sugar to plastic to jet fuel.
- Heterotrophic
  - May grow on minimal medium, given an organic carbon source
  - CO₂ can be fixed but not utilized as sole carbon source
  - Can utilize nitrates, nitrites or ammonia as sole nitrogen source

Carbohydrate metabolism
- Extremely variable in carbohydrate utilization.
- Some fungi may utilize all the pathways of carbohydrate catabolism
- Most fungi cannot assimilate complex molecules, but must break them down enzymatically, then transport the simpler molecules across the cell wall and cytoplasmic membrane (plasmalemma).
- Some enzymes and secondary metabolites may be potent virulence factors in human disease, e.g., proteases, toxins, antibiotics.

Chemical and Physical Factors Affecting Fungal Growth

Temperature
- Psychrophilic: 0-20°C
- Mesophilic: 30-40°C
- Thermophilic: 30-50°C
- *Thermotolerant: will grow (not well) in cold & hot
- *Often a cause of allergies (e.g., psychrotrophic or thermophilic)

Optimum temperature for in vitro growth of most fungi of medical importance is 30°C.

pH
- Considerable variation, depending on species.
- Some yeast can grow at pH of 2.0, while some molds can grow at pH of 8.5.
- Optimal pH for in vitro growth of medically important fungi is 6.5-7.0.

Moisture
- Most fungi require 60-95% relative humidity for good growth.

Light
- Most molds are photosensitive; especially the growing tips.
- *Needs light in macroenvironment
- Don't grow well