"Basic Fungi" 🍄

Definition

- Fungus: A eukaryotic, heterotrophic organism devoid of chlorophyll, obtaining nutrients by absorption and reproducing via spores.
- Key Point: Unlike plants, fungi do not photosynthesize. 🌱

General Characteristics of Fungi

- Non-motile heterotrophs: Depend on other organisms for nutrients.
- Aerobic to facultatively anaerobic: Grow best in sugar-rich, acidic media (e.g., Sabouraud Dextrose Agar – SDA).
- Saprophytic: Many live on dead or decaying matter.

- Parasitic: Some extract nutrients from living organisms.
- Medically important fungi: ~100–150 species out of ~50,000.

Fungal Cellular Features

- Life cycle: Mostly haploid; diploid occurs only during meiosis.
- Non-vascular: No internal nutrient transport system.
- Cell wall: Composed of chitin (bacteria have peptidoglycan).
- Cell membrane: Contains ergosterol (absent in bacteria).
- DNA analysis: Fungi are closer to animals than plants. 🧬

Fungi vs Bacteria 🫓

Feature	Fungi	Bacteria
Diameter	~4 µm (Candida)	~1 µm (Staphylococcus)
Nucleus	Eukaryotic	Prokaryotic
Cytoplasm	Mitochondria & ER present	Mitochondria & ER absent
Cell membrane	Sterols present	Sterols absent (except Mycoplasma)
Cell wall content	Chitin	Peptidoglycan
Spores (reproduction)	Sexual & asexual	Endospores (survival only)
Thermal dimorphism	Yes (some species)	No
Metabolism	Requires organic carbon	Many can survive without organic carbon
Examples of importance	Bread, cheese, wine, antibiotics, soil	Food spoilage, disease

---

Importance of Fungi 🌱

- Food & beverage: Yeast → bread, cheese, wine, beer.

- Ecological: Decomposers, soil formation, nutrient cycling.
- Mutualistic: Mycorrhizae enhance plant nutrient absorption.
- Medical & industrial: Antibiotic production (e.g., penicillin).
- Pest control: Some fungi attack insects.
- Food spoilage: Dry, acidic, high-osmotic conditions.

Nutrition: Heterotrophic by Absorption 🍽️

Process Flowchart:

Substrate (organic matter)

↓

Hyphal tips release enzymes

↓

Enzymatic breakdown of substrate

↓

Products diffuse back into hyphae → used as nutrients

↓

Nucleus "directs" growth & metabolism

> Note: Fungi absorb nutrients externally, unlike animals which ingest internally.

Reproduction & Spores 🧬

1. Sexual Spores

- Zygospores: Thick-walled, single spores.
- Ascospores: Formed in a sac called ascus.
- Basidiospores: Formed externally on basidium.
- Imperfect fungi (Fungi Imperfecti): Fungi without sexual spores.

2. Asexual Spores

- Conidia: Asexual spores for propagation.
- Important types:
    - Arthrospores: Fragmentation of hyphal ends (e.g., *Coccidioides immitis*)

- Chlamydospores: Rounded, thick-walled, resistant (e.g., *Candida albicans*)
- Blastospores: Budding (yeasts), may form pseudohyphae in chains
- Sporangiospores: Within a sac (sporangium) on stalks (e.g., *Rhizopus, Mucor*)

Generalized Life Cycle of a Fungus

Flowchart:

Spores → Germination → Hyphae → Mycelium → Sporulation → Spores

Mycelium: Root-like structure of branching hyphae.

Pathogenesis & Immunity 🦠

- Host response: Granulomatous or pyogenic inflammation.

- Cell-mediated immunity: Tested by delayed hypersensitivity skin test (antigen injected intradermally → induration).
- Predisposing factors for disseminated disease:
  - ↓ Cell-mediated immunity → *Histoplasma, Coccidioides*
  - ↓ Neutrophils → *Aspergillus, Mucor*

Transmission & Habitat of Medically Important Fungi 🌍

Genus	Habitat	Form	Portal of Entry
Coccidioides	Soil	Arthrospores	Inhalation
Histo plasma	Soil + bird feces	Microconidia	Inhalation
Blasto myces	Soil	Microconidia	Inhalation
Paracocci dioides	Soil	Uncertain	Inhalation

Crypto coccus	Soil + pigeon feces	Yeast	Inhalation
Aspergillus	Soil & vegetation	Conidia	Inhalation
Candida	Human body	Yeast	Normal flora (skin, mouth, GI, vagina)

Fungal Toxins & Allergies ⚠️

- Mycotoxicoses: Caused by ingestion of fungal toxins.
  - *Amanita* mushrooms → liver necrosis (amanitin, phalloidin)
  - *Aspergillus flavus* → aflatoxin → liver cancer
- Allergies: Inhalation of spores
  - *Aspergillus fumigatus* → allergic bronchopulmonary aspergillosis

---

Predisposing Factors for Fungal Infections

- Immunosuppression, chemotherapy

- Atopy, diabetes
- Local trauma, closed communities
- Public baths, swimming pools, spa
- Occlusive footwear
- Warm/moist environments
- Exposure to infected animals or family members
- Old age

Laboratory Diagnosis of Fungal Infections 🔬

---

1. Microscopy & Stains

- Wet mount – for direct observation of fungal elements.
- Fungal stains: e.g., Lactophenol cotton blue, PAS stain for tissue sections.
- Direct fluorescent microscopy – highlights fungal structures.

2. Culture

- SDA (Sabouraud Dextrose Agar) – standard medium for fungal growth.
- Blood agar – supports growth of some pathogenic fungi.

3. Serological & Molecular Tests

- Serology: Detects fungal antigens or antibodies.
- Complement fixation test – evaluates immune response.
- Latex agglutination test – rapid antigen detection.

4. Biopsy & Histopathology

- PAS staining – highlights fungal elements in tissue.

Current Diagnostic Modalities

- CHROMagar: Differentiates *Candida* species by colony color.

- API 20 C Aux: Biochemical identification of yeasts.
- Vitek 2.0 System: Automated identification & susceptibility testing.
- Rapid ID Yeast Plus: Quick yeast ID.
- MicroScan: Automated microbial ID.
- MALDI-TOF: Mass spectrometry for precise species identification.
- DNA probe tests & PCR: Molecular detection of fungi.
- BioFire arrays: Multiplex pathogen detection.
- Sequencing analysis: Confirmatory ID for rare or resistant strains.

Specimen Collection 🧾

Skin

- Scrub with 70% ethyl alcohol.
- Scrape active periphery of lesion with scalpel.

Nails

- Scrub with 70% ethyl alcohol.
- Collect subungual keratin debris + nail clippings.
- Cut clippings into small pieces.

Hair

- Pluck broken or lustreless hairs from lesion periphery.
- Scrape scalp from edge of hair-loss area.
- Do not cut hair.

Laboratory Diagnosis Approach

Flowchart:

Specimen collected

↓

Direct Microscopy → KOH prep (20–30%)

↓

Visualize → hyphae, asexual spores, yeasts

↓

Culture → SDA ± antibiotics

↓

Observe colony morphology

↓

Identification → Scotch tape method / Lactophenol blue staining

↓

Confirm → CHROMagar, API 20C Aux, molecular tests

Notes:

- KOH dissolves human cells → highlights fungal structures.
- SDA + chloramphenicol/actidione → prevents bacterial contamination.
- Incubation at 22°C for up to 3 weeks, examine twice weekly.

Culture & Identification Techniques

- SDA: Standard medium.

- SDA + Chloramphenicol/Actidione: Suppresses bacterial growth.
- Dermatophyte Identification Medium: Specialized for skin/nail fungi.
- CHROMagar: Differentiates *Candida* species by color:

Candida Species	Colony Color on CHROMagar
C. albicans	Green
C. tropicalis	Blue
C. krusei	Pink
C. glabrata	Purple
C. parapsilosis	Cream

Antifungal Therapy 💊

- Targets fungal-specific structures (ergosterol, chitin).
- Does not affect bacteria (peptidoglycan, 70S ribosomes).
- Common classes: Azoles, Polyenes, Echinocandins, Flucytosine.

Fungal Morphological Classification 🧫

1. Molds (Filamentous Fungi)

- Hyphae → network called mycelium.
- Reproductive spores germinate → hyphae.
- Septate hyphae: transverse walls present.
- Non-septate hyphae: lack cross walls.

Examples:

- *Aspergillus fumigatus*
- Zygomycetes: *Mucor, Rhizopus*
- Dermatophytes (skin, hair, nails)

---

2. Yeasts (Single-cell Fungi)

- Shape: spherical, oval, cylindrical.
- Reproduction: binary fission or asexual budding.

Examples:

- *Candida albicans*
- *Cryptococcus neoformans / gattii*
- *Malassezia furfur / globosa*

---

3. Dimorphic Fungi 🌡️

- Existence: Mold at 25°C → Yeast at 37°C
- Pathogenic examples:
  - *Histoplasma capsulatum*
  - *Coccidioides immitis*
  - *Blastomyces dermatitidis*
  - *Sporothrix schenkii*

Flowchart: Dimorphism → Pathogenic Fungi

25°C → Mold form (multicellular)

↓

37°C → Yeast form (unicellular)

---

4. Clinical Classification

Type	Site Affected	Examples
Superficial / Cutaneous	Skin, hair, nails	Dermatophytes (*Tinea*)
Subcutaneous	Connective tissue under dermis	Mycetoma
Systemic / Deep	Blood & organs	*Histoplasma, Blastomyces*
Opportunistic	Immunocompromised hosts	*Candida, Cryptococcus, Aspergillus*