21-1 The Kingdom Fungi

Fungi are **multicellular** eukaryotic heterotrophs that have cell **walls**. Their cell walls contain **chitin**, a complex carbohydrate. Fungi depend on other organisms for food. They digest food **outside** of their bodies and then absorb it. Some fungi absorb nutrients from **organic** matter in the soil. Other fungi are **parasites**, absorbing nutrients from their hosts.
Except for **yeast**, all fungi are multicellular.

Fungi are made up of thin filaments called **hyphae**. Each hypha is only one cell thick.

In some fungi, cross walls (**septa**) divide hyphae into cells with 1 or 2 **nuclei**. In the cross walls, there are openings through which the cytoplasm and nuclei can move.

Some hyphae lack cross walls and contain many nuclei (**multinucleated**). (Acellular slime mold-like)
The bodies of multicellular fungi are composed of many hyphae tangled together into a thick mass called a **mycelium**. The mycelium permits a large **surface area** to come in contact with the food source through which it grows. A mushroom is the **fruiting body** of a fungus. A fruiting body is a **reproductive** structure growing from the mycelium in the soil beneath it.
Reproduction in Fungi

Asexual reproduction occurs when hyphae break off and begin to grow (fragmentation). In some fungi, **spores** are produced in structures called **sporangia** at tips of specialized hyphae called **sporangiophores**. Sexual reproduction involves two mating types: "+" and "-". Hyphae of opposite mating types meet and **fuse**, bringing their nuclei together in one cell. The nuclei form a diploid **zygote** nucleus. The zygote enters **meiosis** and produces **haploid** spores capable of growing into new organisms.
How Fungi Spread (Dispersal)

Giant puffball (Calvatia gigantea)

Cup Fungi (Aurinia aurantia)

Starfish Fungus (Aspergillus rubra)

Many fungi produce dry spores that scatter easily in the wind. If these spores are to germinate, they must land in an environment with the proper combination of temperature, moisture, and food so they can grow. Other fungi are specialized to lure animals, which disperse spores over long distances.
21-2 Classification of Fungi

Fungi are classified according to their structure and method of reproduction. The four main groups of fungi are:

1. Common molds (Zygomycota)
2. Sac fungi (Ascomycota)
3. Club fungi (Basidiomycota)
4. Imperfect fungi (Deuteromycota)
Familiar molds that grow on meat, cheese, and bread are called **Zygomycetes**. Zygomycetes have life cycles that include a **zygosporangium**. A zygospore is a resting spore that contains zygotes formed during the **sexual** phase of the mold's life cycle.
Black bread mold, *Rhizopus stolonifer*, is a zygomycete with two types of hyphae:

- **Rhizoids** are rootlike hyphae that penetrate the bread's surface.
- **Stolons** are stemlike hyphae that run along the surface of the bread.

The sporangium reproduces asexually by releasing haploid spores produced by mitosis.
Black bread molds reproduce both sexually and asexually. **Haploes** from different mating types fuse and produce gamete-forming structures called **gametangia**. Haploid (N) gametes produced in the gametangia fuse with gametes of the opposite mating type to form diploid (2N) **zygotes**, which develop into thick-walled **zygospore**.
In favorable conditions, the zygospore **germinates**, undergoes **meiosis**, and releases new haploid **spores**.
The phylum Ascomycota is named for the **ascus**, a reproductive structure that contains **ascospores**.
The life cycle of an ascomycete usually includes both asexual and sexual reproduction. In **asexual** reproduction, spores called **conidia** form at tips of **conidiophores**, specialized hyphae.
During sexual reproduction, haploid hyphae of two different mating types (+ and -) grow close together. The (N) + (N) hyphae then produce a fruiting body in which sexual reproduction continues. The ascus forms within the fruiting body where two nuclei of different mating types fuse to form a diploid zygote (2N).
The zygote divides by **meiosis**, producing **four** haploid cells. In most ascomycetes, meiosis is followed by **mitosis**, so that **eight** cells called **ascospores** are produced. An ascospore can germinate and grow into a haploid **mycelium**.
**Yeast** are unicellular fungi that reproduce **asexually** by **budding**. Dry granules of yeast contain **ascospores** which become active in a moist environment.
The phylum Basidiomycota, or **club** fungi, gets its name from a specialized reproductive structure that resembles a club. The **spore**-bearing structure is called the **basidium**.
When the right combination of moisture and nutrients occurs, spore-producing fruiting bodies push above the ground.

The mycelia of different mating types fuse to produce a secondary mycelium that contains haploid nuclei (N + N).

Basidiospores germinate to produce haploid (N) primary mycelia (+ & -).

The mushroom cap opens exposing hundreds of tiny gills, each lined with basidia.

Basidia (N+N)

FERTILIZATION

Zygotes (2N)

Nuclei in each basidium fuse, forming a diploid zygote, which undergoes meiosis, forming clusters of haploid basidiospores ready for dispersal.
The Club Fungi (Basidiomycota)

Basidiomycetes include shelf fungi, puffballs, earthstars, jelly fungi, and rusts.
Imperfect fungi, or Deuteromycota, are fungi that cannot be placed in other phyla because researchers have never been able to observe a sexual phase in their life cycles. A well-known genera of the imperfect fungi is *Penicillium notatum*, a mold that is the source of the antibiotic penicillin.
The oldest known fungi fossils are about 230 million years old. Fungi called **lichens** are **pioneer** species helping break down rock to form **soil**. Fungi help plants obtain nutrients and may have been essential to colonization of land (**mycorrhiza**).
Fungi maintain equilibrium in nearly every ecosystem. They recycle nutrients by breaking down the bodies and wastes of other organisms. All fungi are heterotrophs and rely on other organisms for energy. Many fungi are **saprophytes** that obtain food from decaying organic matter. Other fungi are **parasites**, harming other organisms while living directly on or within them. Other fungi are **symbionts** that live in close and mutually beneficial association with other species. (see video clip)
Some fungi form symbiotic relationships in which both partners benefit. Two such mutualistic associations, lichens and mycorrhizae, are essential to many ecosystems. **Lichens** are symbiotic associations between a fungus and a photosynthetic organism, either a green **algae** or a **cyanobacteria**, or both. The algae or cyanobacteria provide the fungus with a source of **carbohydrates**. The fungus provides the algae or bacteria with **moisture** and minerals and protects the green cells from intense sunlight.
Fungi also form **symbiotic** relationships with plants. The associations of plant roots and fungi are called **mycorrhizae** and are essential for the growth of many plants.
Parasitic fungi cause serious plant and animal diseases. A few fungi cause diseases in humans. Fungal diseases are responsible for the loss of approximately 15% of the crops grown in temperate regions of the world. In tropical areas, where high humidity favors fungal growth, the loss of crops is sometimes as high as 50%.