

Introduction to Fungi

The **fungi** (singular, **fungus**) include several thousand species of eukaryotic, spore-bearing organisms that obtain simple organic compounds by absorption. The organisms have no chlorophyll and reproduce by both sexual and asexual means. The fungi are usually filamentous, and their cell walls have **chitin**. The study of fungi is called **mycology**, and fungal diseases are called **mycoses**.

Together with bacteria, fungi are the major decomposers of organic materials in the soil. They degrade complex organic matter into simple organic and inorganic compounds. In doing so, they help recycle carbon, nitrogen, phosphorous, and other elements for reuse by other organisms. Fungi also cause many plant diseases and several human diseases. Two major groups of organisms make up the fungi. The filamentous fungi are called molds, while the unicellular fungi are called yeasts. The fungi are classified in the kingdom Fungi in the Whittaker five-kingdom system of classification.

Structure and Physiology of Fungi

There is considerable variation in the structure, size, and complexity of various fungal species. For example, fungi include the microscopic yeasts, the molds seen on contaminated bread, and the common mushrooms. **Molds** consist of long, branching filaments of cells called **hyphae** (singular, **hypha**). A tangled mass of hyphae visible to the unaided eye is a **mycelium** (plural, **mycelia**). In some molds, the cytoplasm passes through and among cells of the hypha uninterrupted by cross walls. These fungi are said to be **coenocytic fungi**. Those fungi that have cross walls are called **septate fungi**, since the cross walls are called septa. **Yeasts** are microscopic, unicellular fungi with a single nucleus and eukaryotic organelles. They reproduce asexually by a process of **budding**. In this process, a new cell forms at the surface of the original cell, enlarges, and then breaks free to assume an independent existence.

Some species of fungi have the ability to shift from the yeast form to the mold form and vice versa. These fungi are **dimorphic**. Many fungal pathogens exist in the body in the yeast form but revert to the mold form in the laboratory when cultivated. Reproduction in yeasts usually involves **spores**. Spores are produced by either sexual or asexual means. Asexual spores may be free and unprotected at the tips of hyphae, where they are called **conidia** (Figure 1). Asexual spores may also be formed within a sac, in which case they are called **sporangiospores**.

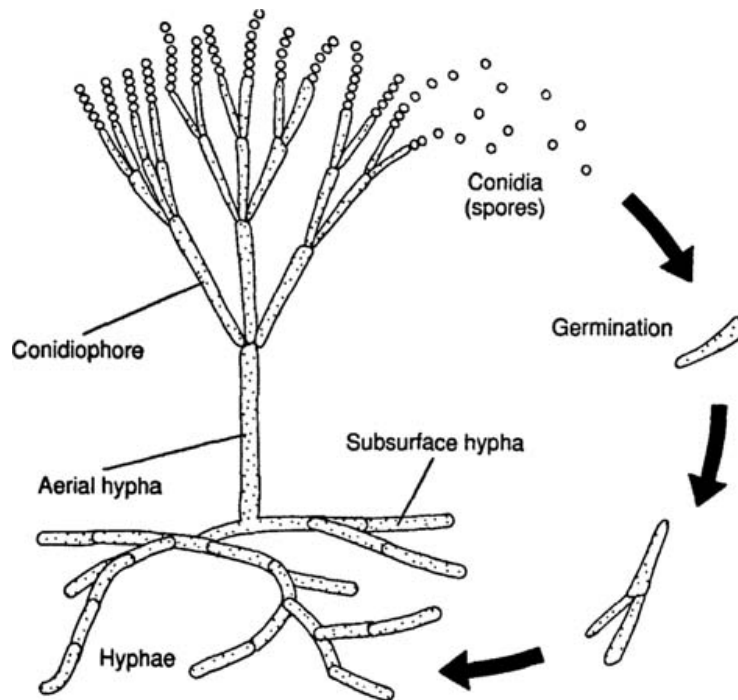


Figure 1

The microscopic structures of a septate fungus showing asexually produced conidia that leave the fungus and germinate to produce a new mycelium.

Nutrition. Fungi grow best where there is a rich supply of organic matter. Most fungi are saprobic (obtaining nutrients from dead organic matter). Since they lack photosynthetic pigments, fungi cannot perform photosynthesis and must obtain their nutrients from preformed organic matter. They are therefore **chemoheterotrophic organisms**. Most fungi grow at an acidic pH of about 5.0, although some species grow at lower and higher pH levels. Most fungi grow at about 25°C (room temperature) except for pathogens, which grow at 37°C (body temperature). Fungi store glycogen for their energy needs and use glucose and maltose for immediate energy metabolism. Most species are aerobic, except for the fermentation yeasts that grow in both aerobic and anaerobic environments.

Reproduction. Asexual reproduction occurs in the fungi when spores form by mitosis. These spores can be conidia, sporangiospores, arthrospores (fragments of hyphae), or chlamydospores (spores with thick walls).

During **sexual reproduction**, compatible nuclei unite within the mycelium and form sexual spores. Sexually opposite cells may unite within a single mycelium, or different mycelia may be required. When the cells unite, the nuclei fuse and form a diploid nucleus. Several divisions follow, and the haploid state is reestablished. Fungal spores are important in the identification of the fungus, since the spores are unique in shape, color, and size. A single spore is capable of germinating and reestablishing the entire mycelium. Spores are also the method for spreading fungi in the environment. Finally, the nature of the sexual spores is used for classifying fungi into numerous divisions.

Classification of Fungi

Division Zygomycota: Members of the division **Zygomycota** are known as **zygomycetes**. Zygomycetes produce sexual spores known as **zygospores** (Figure 1), as well as asexual sporangiospores.

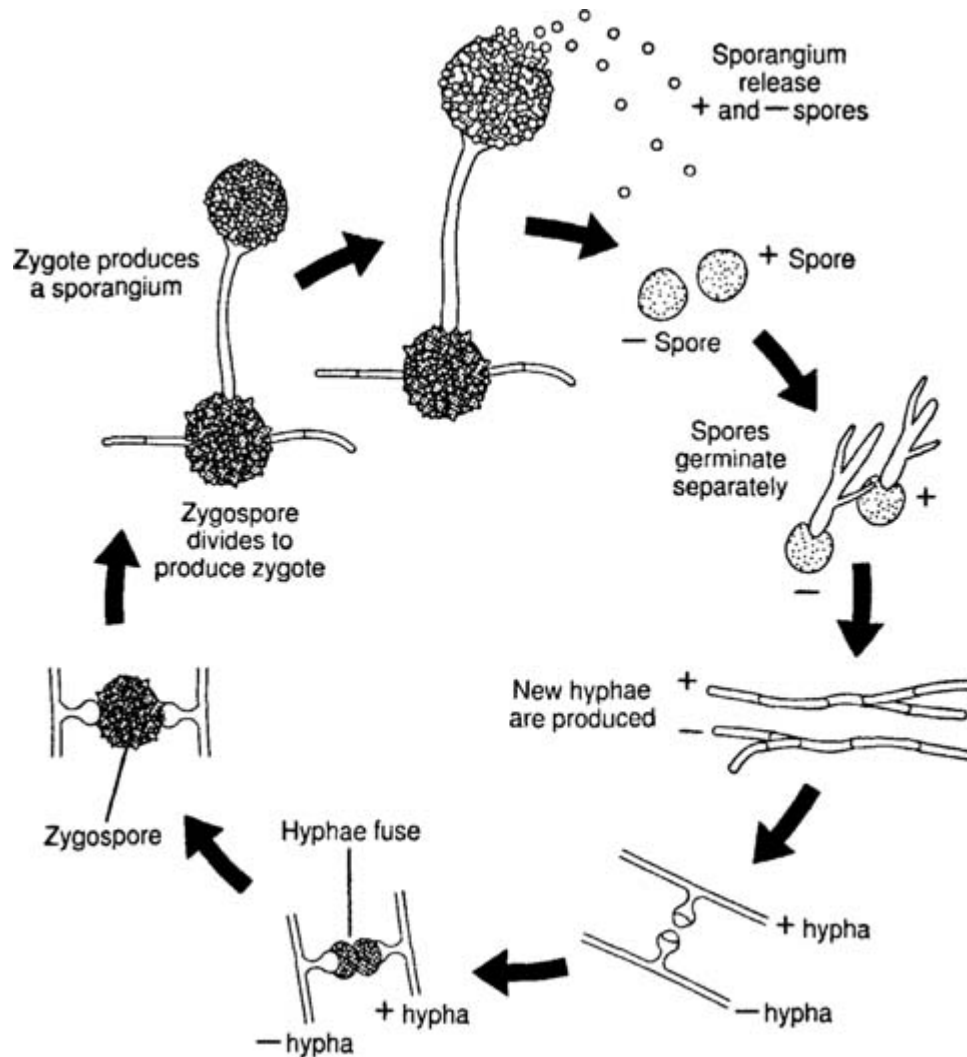


Figure 2

Sexual reproduction in the mold Rhizopus stolonifer. Plus and minus mycelia produce sexually opposite hyphae that fuse and give rise to zygospores, which germinate to form new mycelia.

A familiar member of the division is *Rhizopus stolonifer*, a fungus found on fruits, vegetables, and breads. It is the familiar bread mold. It anchors itself to the substratum with special hyphae known as **rhizoids**. *Rhizopus* is used in the industrial production of steroids, meat tenderizers, industrial chemicals, and certain coloring agents.

Division Ascomycota: Members of the division **Ascomycota** are referred to as **ascomycetes**. After sexual fusion of cells has taken place, these organisms form their sexual spores within a sac called an **ascus**. Therefore, they are called **sac fungi**.

Ascomycetes include the powdery mildews and the fungi that cause Dutch elm disease and chestnut blight disease. The research organism *Neurospora crassa* is found within this group. Asexual reproduction in the ascomycetes involves conidia. Many yeasts are classified in the division Ascomycota. Of particular interest is the **fermentation yeast** *Saccharomyces*. This yeast is used in the production of alcoholic drinks, in bread making, and as a source of growth factors in yeast tablets. It is an extremely important research organism as well.

Division Basidiomycota: Members of the division **Basidiomycota** are referred to as **basidiomycetes** and are called **club fungi**. After the sexual cells have united, they undergo division and produce a clubshaped structure called a **basidium**. Sexually produced **basidiospores** form at the tips of the basidia. Basidia are often found on huge, visible, fruiting bodies called **basidiocarps**. The typical **mushroom** is a basidiocarp. Basidiomycetes are used as food (for example, mushrooms), but some basidiomycetes are pathogens. One of the organisms of meningitis is the basidiomycete *Cryptococcus neoformans*. The mushroom *Amanita* is poisonous to humans.

Division Deuteromycota: Members of the **Deuteromycota** division are called **deuteromycetes**. These fungi lack a known sexual cycle of reproduction and are said to be “imperfect.” When its sexual cycle is discovered, a fungus from this division is usually reclassified in one of the other divisions. Among the imperfect fungi are the organisms of athlete's foot and ringworm.