Fungi

Fungus (pl. fungi) is a Latin word which means mushrooms. Fungi are eukaryotic, spore-bearing, achlorophyllous, nonvascular, heterotrophic thallophytic organisms that generally reproduce sexually and asexually and whose usually filamentous branched somatic structures are typically surrounded by cell walls containing chitin, cellulose or both.

The branch of biological science that deals with the study of fungi is called **Mycology** (*Mykes*: mushroom; *Logos*: knowledge).

General Characteristics of fungi

Fungi are characterized by following features:

1. Fungi do not possess stem, roots, leaves and vascular system.
2. Fungi are usually filamentous, uni-or multicellular or plasmodial.
3. Presence of a true nucleus with a nuclear membrane and nucleoli in the cell.
4. The cell wall contains chitin or cellulose or both and other complex polysaccharides.
5. Reserve food accumulates in the form of glycogen and oil drops.
6. Reproduction typically by both asexual and sexual or only by asexual spores.
7. Mode of nutrition is heterotrophic and absorptive. They obtain nutrition either by living as saprophytes or as parasites.
8. They are found in almost every available habitat on the earth where organic material (living or dead) is present. They are thus, universal in their distribution.

Kingdom Fungi comprises the fungi, such as mushrooms, molds, and yeasts, eukaryotic heterotrophs that digest food outside of their bodies. Most fungi are multicellular, but some, the yeasts, are simple unicellular organisms probably evolved from multicellular ancestors. Fungi are present all over the world, in marine as well as terrestrial environments. Many fungi have symbiotic relationships with plants known as mycorrhizae; in fact, it was as mycorrhizal partners of plants that fungi probably first moved onto land. Most fungi are decomposers, breaking dead organisms down into detritus and returning inorganic nutrients to the ecosystem. As such, fungi are also extremely adaptable, and can break down many substances, including some toxic pollutants. This adaptability also accounts for the presence of fungi in many very different environments around the world.

A fungal organism consists of a mass of threadlike filaments called hyphae, which combine to make up the fungal mycelium. Each hypha is composed of a chain of fungal cells, or, in some organisms, a continuous cytoplasm with many nuclei. The hypha is surrounded by a plasma membrane and a cell wall, which is made of the polysaccharide chitin, in contrast to plant cell walls made of cellulose. The hyphae in a fungus branch off of one another to form the mycelium, and are all ultimately connected to the original hypha. Though fungal cells and hyphae are nonmotile, and never have flagellated cells of any kind, a fungal mycelium can expand quickly through very rapid mitotic growth, adding up to a kilometer of new hyphae per day. For large underground mycelia, fruiting bodies grow above ground, such as the mushroom, which is only an extension of an underground mycelium. These fruiting bodies are the reproductive structures of the mycelium.

Due to the structure of the hyphae, the mycelium has a very high surface area to mass ratio, despite its large size. This allows the fungus to absorb large quantities of nutrients from its surroundings, after secreting digestive enzymes and digesting its food outside of its body. This ability to intake large quantities of nutrients despite a growing size is one of the prime reasons for the rapidity of mycelial growth.

Different types of fungus have different methods of reproduction. The unicellular yeasts reproduce only mitotically, while other fungi, such as mushrooms, have much more complex life cycles involving three distinct phases. These include diploid and haploid phases, like plants, but also a completely different phase: the dikaryotic phase, where two haploid nuclei of different types are present in each cell. A mature mycelium, including the fruiting bodies, is in the dikaryotic phase. Mushrooms, the reproductive structures of an underground mycelium, contain specialized cells on the underside of the cap that produce diploid zygotes through fusion of the two haploid nuclei in each cell; these zygotes are the only diploid phase of the life cycle. Immediately, each zygote undergoes meiosis to produce four haploid spores which are then released from the mushroom. Each of the spores in a mushroom will have one of two mating types, because in the original mycelium, each cell contained a nucleus of each type. The spores are carried, by wind, water, or animals, away from the original mycelium, and some will land on moist food sources, where they can germinate and begin to divide mitotically into haploid mycelia of a discrete mating type. Eventually, two nearby mycelia of different mating types will meet each other and join together, with their cells fusing but the nuclei remaining discrete. This is the beginning of the dikaryotic stage; the mycelium will soon grow reproductive structures and the life cycle begins again.

One-third of all species of fungi are mutualists, either as mycorrhizae or lichens. Mycorrhizal fungi live on the roots of plants and provide inorganic nutrients, and often resistance to some pathogens, to the plants in exchange for organic sugars. The first colonization of land by plants was facilitated, if not made possible by, the ability of mycorrhizal fungi to uptake nutrients from hostile soil. The lichens are fungi living in symbiotic relationships with algae or cyanobacteria. They consist of algae or bacteria trapped in the fungal hyphae. Though the details of this relationship are not completely understood, the fungus typically provides water and minerals for the algae or bacteria, in exchange for organic food from photosynthesis. The photosynthetic species in lichens are actually capable of living by themselves, but the fungal species depend on their counterparts for survival. Lichens can reproduce asexually when small reproductive units, consisting of both fungi and algae or bacteria, break of from the lichen and are carried by the wind to other locations; they can also reproduce sexually through independent sexual reproduction of both parts and a reattachment. Due to the effectiveness of the mutualist relationship in lichens, they can grow in the most inhospitable of terrestrial habitats, and often serve as key organisms in the primary succession of a habitat.

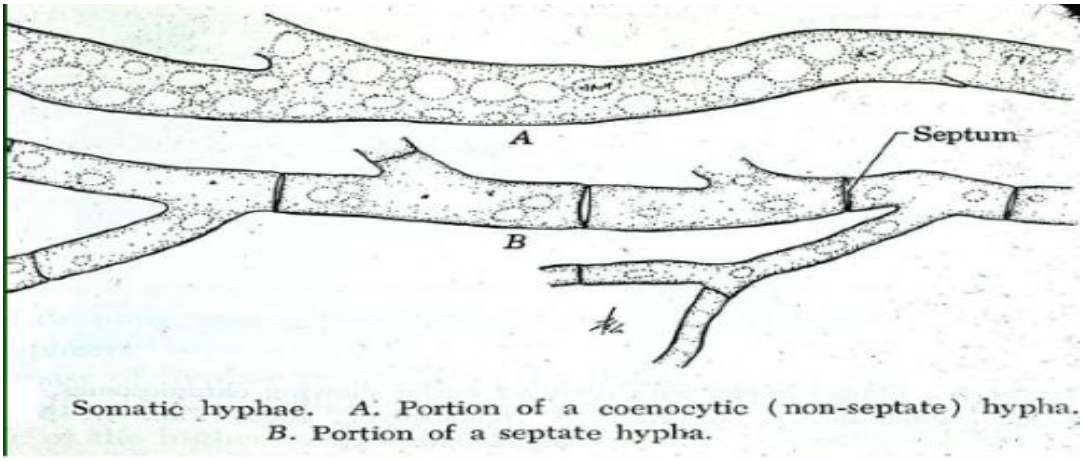
Fungi are often directly involved in our lives. Some fungi are parasitic, and cause devastating plant infections; though only about 50 species are known to harm animals. Serious agricultural pests, parasitic fungi such as the rusts and the smuts can ruin entire crops, especially affecting cereals such as wheat and corn. Fungi are also important in agriculture and food production; mycorrhizal fungi render increased disease resistance to some plants, yeasts are necessary for bread baking, and we eat many fungi, such as the mushrooms. Many medical applications of fungi have recently been discovered, especially antibiotics produced by fungi. The first among these is penicillin, possibly the most important non-genetic medical breakthrough of the century.

MORPHOLOGY OF FUNGI

Fungi have their somatic structures in the form of a thallus (pl. thalli). A Thallus is a plant body devoid of stem, roots and leaves. The fungal thallus is of three kinds:

1. Unicellular thallus, in which a single cell is a complete individual.
2. Plasmodial thallus, in which the thallus is in the form of a plasmodium. The cell lacks a rigid cell wall and cytoplasm is surrounded with only plasma membrane.
3. Filamentous thallus, which is composed of fine, microscopic filaments or threads called **Hypha**.

Filamentous thallus is composed of hyphae which are branched in all the directions spreading over or within the substratum utilized for food. The fungus absorbs food throughout the entire surface of its thallus (absorptive nutrition). Each of these filaments is known as **HYPHA (pl. hyphae)**. A hypha is made of a thin, transparent, tubular wall filled with a layer of protoplasm. The mass of hyphae constituting the vegetative body (thallus) of a fungus is called **MYCELIUM (pl. mycelia)**. **Thus, the hypha is the structural unit of mycelium and the mycelium is the network of hyphae constituting the somatic (vegetative) body of a fungus.**



Somatic hyphae. *A*. Portion of a coenocytic (non-septate) hypha. *B*. Portion of a septate hypha.

Hyphae may be coloured (black, orange, red, yellow blue and brown) or transparent (having no colour). **Hyphae with no colour are called HYALINE**.

In soil, hyphae are present in between soil particles in a fluid medium. In plant tissues, they are either **INTERCELLULAR** (between the cells), **INTRACELLULAR** (within the cell) or **SUBCUTICULAR** (between the cuticle and epidermis).

HYPHAL SEPTATION

Hyphae may or may not be segmented into cells or compartments by partition or cross walls. The cross walls are called **SEPTA (sing. septum)**. A segmented hypha/mycelium is called **SEPTATE** whereas hypha/mycelium without septa is known as **COENOCYTIC** (non-septate or aseptate). Septa in fungi, therefore, are the restrictions or boundaries that make a hypha multicellular. These may be of the following kinds:

1. ADVENTITIOUS SEPTA: Septa with no pore (completely closed septa) are called adventitious septa.

2. PRIMARY SEPTA: Septa with one or more perforations (septal pores) are known as primary septa. These septal pores permit continuity of the cytoplasmic streaming between adjacent cells. Septa with so many pores are better called **PSEUDOSEPTA** and there are also septa with modifications of the septal pores called **DOLIPORE SEPTA**.

APPRESSORIA: Fungi also have organs for attachment to their substrate or host. These organs are called **APPRESSORIA (sing. Appressorium)**. An appressorium is a simple or lobed mucilaginous swelling of the germ tube or hypha which helps these structures to attach to the surface of the host or other substrates.

HAUSTORIA: Although, fungi absorb nutrition from the substrate through entire surface of their contact, there are specialized feeding organs also found in these organisms. These are called **HAUSTORIA (sing. Haustorium)**. Haustoria are specialized feeding organs of fungi. These special organs arise from the main hypha present in between the cells or from infection pegs from appressoria or ectophytic hyphae present on the host surface.

FUNGAL TISSUES

The fungal mycelium is normally a mass of hyphae interwoven loosely to form a network. In some fungi, the whole mycelium or its parts undergo various modifications. The hyphae become altered in shape and become closely packed together to form a false tissue. However, these are not real tissues, but as the literature in English uses this term, we also do so, but bear in mind that fungal tissues do not fulfill the definition of real tissues. Such a false tissue is called **PLECTENCHYMA** or **FUNGAL TISSUES**. All fungal tissues come under the general term Plectenchyma.

Plectenchyma is of two types:

1. **PROSENCHYMA:** It is rather a loosely woven fungal tissue. The hyphae composing it do not loose their identity. They run more or less parallel to one another and are composed of elongated cells.
2. **PSEUDOPARENCHYMA:** In the fructifications of higher fungi, the hyphae become woven and intertwined into a compact mass. The walls of the hyphae in the mass get fused and they lose their individuality or identity.

FUNGAL FLAGELLA:

Flagella (sing. flagellum) are the organs of locomotion. The fungal flagella have the typical 9+2 arrangement of fibrils.

In fungi, Flagella are of two kinds:

1. **WHIPLASH TYPE:** These flagella are usually posterior in location and have a blunt tip with smooth surface. Also known as **Acronematic** or **peitchgeisal** flagella.
2. **TINSEL TYPE:** They are usually anterior in location and do not have smooth surface but are covered with fine lateral hairy appendages that are called **flimmer hairs** or **mastigoneme**. These flagella are also called **Pantonematic** or **flimmer** flagella.

When the fungal cell has only one flagellum, it is called **MONOFLAGELLATE** and when two flagella, called **BIFLAGELLATE**. If biflagellate, normally, one flagellum is whiplash type that is posterior and another is tinsel type that is anterior in location. When both flagella are equal in length, the cell is called **ISOKONT** and when unequal in length, the cell is known as **HETEROKONT**.

Monokaryotic mycelium or uninucleate: Mycelium contains single nucleus that usually forms part of haplophase in the life cycle of fungi.

Dikaryotic mycelium (binucleate): Mycelium contains pair of nuclei (dikaryon) which denotes the diplophase in the life cycle of fungi.

Homokaryotic mycelium: The mycelium contains genetically identical nuclei.

Heterokaryotic mycelium: The mycelium contains nuclei of different genetic constituents.

Multinucleate: The fungal cell contains more than 2 nuclei.

STROMA

The compact pseudoparenchymatous somatic tissue into which the sporophores of a parasitic or saprophytic fungus get embedded is known as stroma.