B.Sc. Botany – 3rd SEM

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Thallus Organisation of Fungi

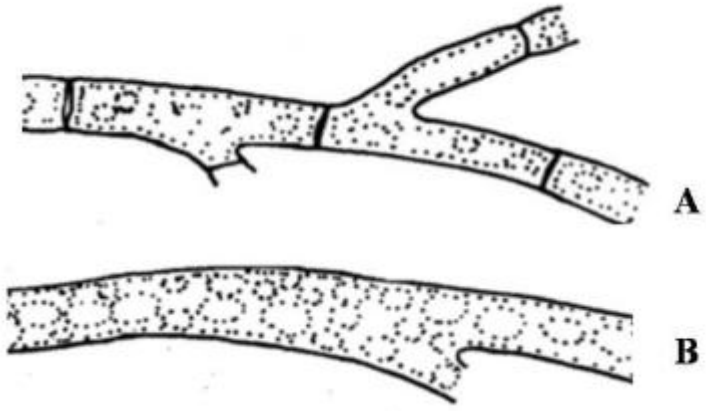
Fungi show great diversity in thallus organization. Their thallus ranges from single celled structures to massive multinucleate structures. Except the unicellular forms, most of the fungi are made up of threadlike filamentous structures called **hyphae** (sing. **hypha**). These hyphae branch profusely and form a network called **mycelium** (pl. **mycelia**). Unicellular thalli often give rise to **pseudomycelium**, which is formed when cells produce buds in succession fail to separate from the parent cell and remain attached to each other in an easily detachable chain. However, in some fungi pseudomycelium is formed in response to high sugar concentration such as Mucorales. Some fungi may show **dimorphism** in their thallus organization as they may either exist in unicellular or filamentous forms. The change in thallus organization from filamentous to unicellular form is brought about by the alteration in environmental conditions. Some of the **zoopathogenic fungi** are mycelial in culture but become unicellular and yeast like in the host. On the other hand, certain **phytopathogenic fungi** (smut fungus and leaf curl fungus) become yeast like in thallus culture and are mycelial in host cells. Fungal thallus grows centrifugally as the younger and more active parts are present towards the periphery and older thallus is found towards the center. At the end all thalli form reproductive structures. In unicellular fungi whole thallus may get converted to reproductive structures; such thalli are known as **holocarpic**. However, in most of the fungi thallus is differentiated into vegetative and reproductive part. This type of thallus is known as **eucarpic** thallus.

Hypha: Fungal hypha is microscopic structures which are bound by a rigid cell wall, contains protoplasm, and may be hyaline (uncoloured) or dark with brown and yellow pigment. It grows indeterminately only at its tip and has a fairly constant diameter of approximately 2-20 μm (depending upon the species). Thallus of higher fungi has the capability to **anastomose**. During this process, neighbouring hyphae in the thallus put out short branches which make contact at the tip and with time may establish contact with each other. With time wall of the hyphae get dissolved at the point of contact and form a continuous tube by joining the two. This process helps in induces efficient cytoplasmic growth, exchange of nuclei, creates a strong mycelial network and coordinated growth of tissues.

Branching is **monopodial** as the apex of the leading hyphae is not suppressed and it grows along with the most active leading branch. **Lateral** branches are usually singly formed but may

be formed in pair or opposite also. Sometimes these lateral branches may arise in whorls of three or more and are known as **verticillate**.

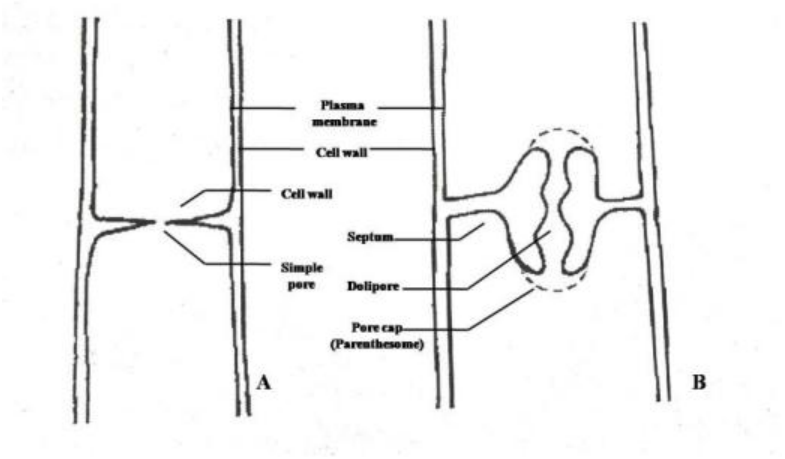
In the members of Zygomycetes and Oomycetes (lower fungi), hyphae are long, multinucleate and comprises of continuous cells called as **coenocytes**. These hyphae are **non-septate** or **aseptate**. Even in these cases septa are formed to delimit aged hyphae or when there is formation of reproductive structures. In Ascomycetes, Deuteromycetes and Basidiomycetes or the higher fungi, hyphal protoplasm is interrupted at regular intervals by cross walls or **septa** (sing. **septum**). Hypha in this case is known as **septate** hypha. But the protoplasm is still continuous throughout the fungal hyphae because of the perforations which are present in the cross walls.



Diagrammatic representation of fungal hypha. A: Septate. B: Non-septate or aseptate

Septa are of two types: primary and adventitious. All types of septa are formed by centripetal growth from the hyphal wall towards inward. Primary septa is formed as result of nuclear division between daughter nuclei; however the formation of adventitious septa is independent of nuclear division and is formed because of the changes in cytoplasm concentration as it moves from one part of the hyphae to another. In Ascomycetes, cytoplasmic continuity is maintained by a small simple pore in the center of the septa. Perforated septa are also found in Basidiomycetes (except rusts and smuts); however with a slight modification which involves the presence of a barrel shaped inflation with a hemispherical perforated membrane on each side of the opening. This is known as **dolipore septum**. Fungal mycelium is called as **homokaryotic** when individual cells of the septate hyphae have genetically identical nuclei. On the other hand, some fungal mycelium contains nuclei of different genotype which arises as result of mutation or anastomosis of hyphae; these hyphae are known as **heterokaryotic**.

Members of Basidiomycetes may have two genetically different nuclei (**dikaryotic**) or may have single, haploid, genetically identical nuclei in each segment (**monokaryotic**).



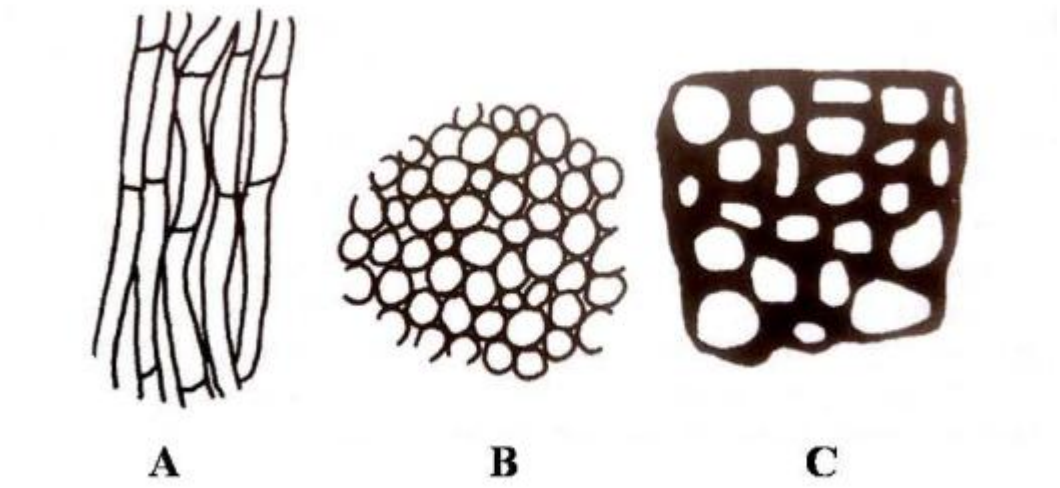
Types of primary septa. A: Simple septa, B: Dolipore septum with a parenthesome

Aggregations of fungal hyphae: At certain stages in life history of all fungi they show various degrees of hyphal aggregation ranging from loosely to compactly woven tissues. All such organized fungal tissues are known as **plectenchyma**. The three general types of plectenchyma are:

Prosenchyma – it is a loosely interwoven tissue in which component hyphae lie more or less parallel to one another and their elongated cells are generally distinguishable from each other.

Pseudoparenchyma – it consists of closely packed, isodiametric or oval, thin-walled cells and has a close resemblance with the parenchyma of vascular plants.

Pseudosclerenchyma – it consists of closely packed, thick-walled and dark cells.



Types of plectenchyma. A: Prosenchyma, B: Pseudoparenchyma, C: Pseudosclerenchyma

Plectenchyma forms various types of vegetative and reproductive structures such as mycelial strands, mycorrhiza, rhizomorph, stroma, sclerotia and sporophore.

i) Mycelial strands are found in Basidiomycetes and some members of Deuteromycetes. These are the aggregates of parallel and comparatively undifferentiated hyphae. Mycelial strand is formed around one or more leader hyphae; these leader hypha grow out of the thallus margin, become surrounded by their own interweaving and anastomosing branches to form a cord (1-2 mm thick and a few centimeters long). Mycelial strands are involved in translocation of material and these are the means of by which fungus is capable of extending itself to a new substratum form an established food base.

ii) Mycorrhiza is the symbiotic association between fungal hyphae (mainly Agaricales) and plant roots. Root tips of coniferous and deciduous plants are often made up of several layers of fungal cells. Fungal mycelium extends into the layer of the soil and then inwards in the cortical cells of the root to form 'Hartig network'. The extended fungal mycelium replaces the function of the roots and is thus involved in better absorption of minerals from the soil. The roots with mycorrhizal network outperform roots without mycorrhizal associations.

iii) Rhizomorph (Gr. *rhiza* = root + *morphe* = shape**)** are highly differentiated root like hyphal aggregations which have a well-developed apical meristem, a central core (thin-walled, elongated cells) and a rind (smaller, thick-walled highly pigmented

cells). These are produced by *Armillaria mellea*, a tree and shrub parasite. Rhizomorphs helps the fungus in spreading from one root system to another.

iv) Stroma is a compact hyphal aggregation like a cushion or mattress in which fructifications are formed. These are reported in members of Deuteromycetes, Basidiomycetes and Ascomycetes in the form of various types of ascocarp, pycnidia, basidiocarp, acervuli, synnemata, pycnidia and sporodochia.

v) Sclerotium (pl. **Sclerotia)** is a hard resting body formed by aggregation of somatic hyphae. They may be round, elongated or flattened mass and are the characteristic feature of a particular species in size, shape and colour. **Microsclerotia** (*Macrophomina phaseoli*) may be less than 100 micrometer in diameter and majority of sclerotia do not exceed beyond a diameter of 2 cm. In *Polyporus myllittae* sclerotia are more than 25 cm in diameter and weigh around several kilograms. These are meant for storage and help the fungus in survival during unfavourable environmental conditions by acting as a propagule.

vi) Sporophores are the spore bearing structures which are usually erect and aerial, branched (*Peronospora*) or unbranched (*Albugo*) and bear sporangia (*Albugo*) or conidia (*Peronospora*) on them. The sporophore bearing sporangia are called sporangiophore and those bear conidia are known as conidiophores. Sporophores may often be present in groups and form pycnia, hymenia, sporodochia and acervuli.

Fungi exists in different forms:

a) Unicellular forms

Yeast

The fungi are eukaryotic organism which are unicellular and can be multicellular or acellular also. Yeast is of wide occurrence; is found on sugary surface of ripened fruits and can be easily grown in any sugar solution. Individual cells remain attached to each other forming a chain. Fine structure of a yeast cell resembles with that of a eukaryotic cell. The cell has a well-defined nucleus, endoplasmic reticulum, mitochondria and other organelles along with a large area of the cell occupied with a vacuole. Cell wall is of 2-3 layers thickness comprising of glucans and mannans. Variable amount of proteins and lipids are accumulated in the cell depending upon the stage of development. They have a particular ability of utilizing carbohydrate and hence the same *Saccharomyces* is applied to this group.

Slime molds: During a certain stage of the life cycle of slime moulds unicellular (multinucleate) forms are also seen. However, these are not considered true fungi since their characters resembles to both protozoa and fungi and it becomes very difficult to characterize them easily. During the course of their life cycle these organisms show protozoan-like (unicellular and multinucleate) or fungus-like stages (multicellular)

Slime moulds are of two types:

(i) **Cellular type** – during the vegetative phase *Dictyostelium discoideum*, a small independent uninucleate cell known as myxamoeba. It feeds on bacteria by phagocytosis and cell multiplication occurs by binary fission. During the later stages of development, large number of myxamoeba comes together to form a single multinucleate slug, but the individual cell retain their cell membranes intact. The resulting structure is known as **pseudoplasmodium**. Like a true fungi, during reproductive phase spores are produced in sporangia. Each spore upon germination gives rise to an amoeba like structure.

(ii) **Plasmodial type** – During vegetative phase in *Echinostelium minutum*, there is formation of a large mass of multinucleate amoeboid cytoplasm with diploid nuclei. The individual cells are however not delimited by cell membrane. It feeds on bacteria and encysted myxamoeba. They do not have a definite size or shape and thus may be globose or spreading like a sheet over a large area in form of a thin network. It alters its shape depending upon the substratum and engulfs food on its way. During reproductive phase entire plasmodium takes part in formation of frutification which bears spores. Spores germinate to form flagellated cells which later on develop into plasmodium.

Slime mould plasmodium is brilliantly coloured. Protoplasm of the plasmodium, such as *Physarum polycephalum*, is structure-less and has granules, vacuoles and other bodies embedded in it. Additionally, one of the most fascinating processes about plasmodium is their protoplasm streaming under microscope. This streaming is related to the presence of a contractile protein known as **myxomyosin**.

b) Filamentous forms: Most of the fungi are filamentous and each filament is known as **hypha** (basic unit of fungal body). Mass of interwoven hyphae is known as **mycelium** which has a large surface-to-volume ratio close to food source (adaptation for absorptive mode of nutrition).

c) Pseudoparenchymatous forms: As it has been already mentioned above that fungus mycelium forms a network of loosely interwoven hyphae. In some specific groups of fungi, the

entire mycelium or some part of the fungal mycelium undergoes various modifications. The hyphal mass in cross section appears to be a continuous structure as the walls of hyphae fuses and they lose their individuality. This structure looks like the parenchymatous tissue of higher plants but it is not a true parenchyma. Such a tissue is known as **plectenchyma**