Introduction to true Fungi

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Fungi (singular fungus- mushroom)are **chlorophyll less thallophytic** plant. Due to absence of chlorophyll, they are heterophytes. Mycology(Mykes-mushroom,logos-study) is the study of fungi and the concerned scientists are called mycologists.

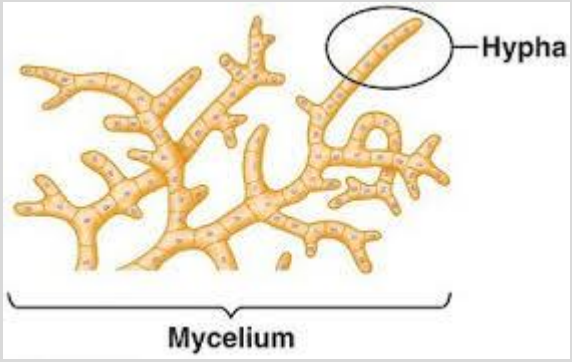
Alexopoulos and Mims(1979) defined fungi as “eukaryotic spore bearing **achlorophyllous organisms** that generally reproduce **sexually** and **asexually,** and whose usually filamentous, branched somatic structures are typically sorrounded by cell walls containing **chitin** or **cellulose** or both of these substances, together with many other complex molecules.”

General characteristics-

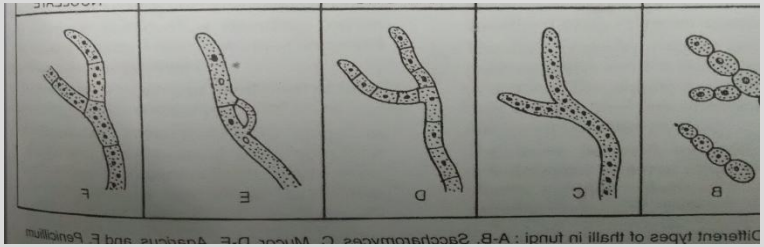
1.Fungi are **cosmopolitan** in distribution i.e, they can grow in any place where life is possible.

2.They are **heteromorphic** in nature due to the absence of chlorophyll. On the basis of their mode of nutrition, they maybe **parasite,saprophyte or synbionts**.

3.The plant body maybe unicellular(*Synchytrium*) or filamrntous(*Mucor,Aspergillus*). The filament is known as **hypha**(plural hyphae) and it's entangled mass is known as **mycelium**.



4.The hypha maybe aseptate i.e.**coenocytic**(without septa and containing many nuclei or septate. The septate mycelium in its cell may contain only one(**monokaryotic),**two(**dikaryotic**) or **more nuclei**.



5.The septa between the cell may have different types of pores; **micropore**(Geotrichum), **simple pore**(most of the Ascomycotina and Deuteromycotina) or **dolipore**(Basidiomycotina,except rusts and smuts).

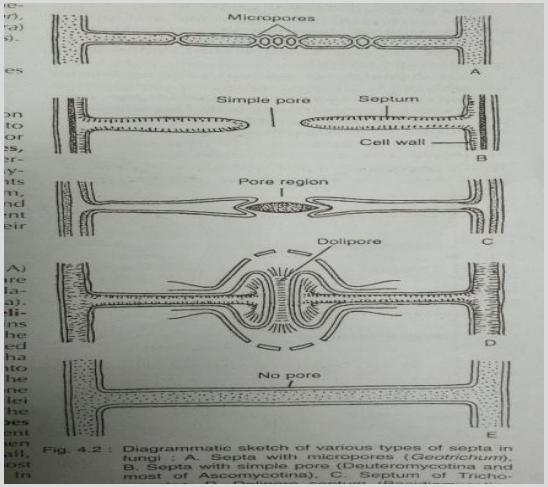


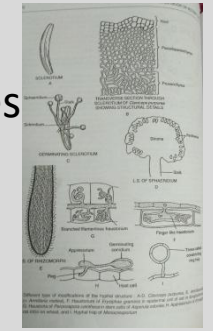
Fig. 4.2 : Diagrammatic sketch of various types of septa in fungi : A. Septa with micropores (*Geotrichum*), B. Septa with simple pore (Deuteromycotina and most of Ascomycotina), C. Septum of Tricho-

6.The cells are sorrounded by distinct cell wall(except slime molds),composed of fungal cellulosei.e**, chitin**, but in some lower fungi(members of oomycetes) the cell wall is composed of cellulose or glucan.

7.The cells generally contain colourless protoplasm due to absence of chlorophyll, containing **nucleus,mitochndria,endoplasmicreticulum,ribosomes,vesicle,microbodies,**etc.

8.The cells are haploid,dikaryotic or diploid. The diploid phase is ephemeral(short lived)

9.In lower fungi like **Mastigomycotina**, the reproductive cells(zoospores and gametes) maybe uni or bifalgellate, having **whiplash and/or tinsel type of flagella**. But in higher fungi **like Zygomycotina,Ascomycotina,Basidiomycotina** and **Deuteromycotina**, motile cells never form at any stage.



10. In response to functional need, the fungal mycelia are modified into different types such as**; plectenchyma,stroma,rhizomorph,sclerotium,hyphal trap,appresorium,haustorium** etc.

11. The **unicellular fungi**, where entire plant body becomes converted into reproductive unit are known as **holocarpic fungi(*Synchytrium*)**. However, in many others**,only a part of the mycelial plant body** is converted into reproductive unit, thus they are called **eucarpic fungi(*Phytopthora*).**

12. They reproduce by three means; **vegetative,asexual and sexual**.

a)Vegetative reproduction takes place by **fragmentation(*Mucor*)**, **budding(*Saccharomyces*)**, and **fission(*Sachharomyces*)**.

b)Asexual reroduction takes place by different types of spores. These are **zoospores(*Synchytrium*), conidia(*Aspergilus*), oidia(*Rhizopus*), chlamydospore(*Fusarium*)**. The spores maybe **unicellular(*Aspergillus*)or multicellular*(Alternaria*)**.

c)Sexual reproduction takes place by the following processes: **Gametic copulation(Synchytrium), gametangial contact(Pythium),Gametangial copulation(Rhizopus),Spermatization(Pucinia), and Somatogamy(Polyporus).**

Composition of cell wall-

The cells are sorrounded by outer rigid structure, the cell wall. It's composition varies in different groups of fungi.

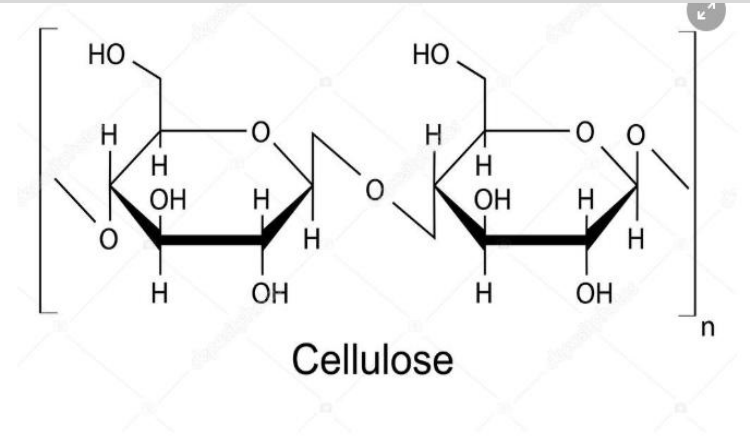
According to Aronson and Bartnicki-garcia the cell wall consists of about **80-90% polysachharides** along with **proteins(1-15%)** and **lipids (2-10%).**

The most common cell wall material is **chitin**.

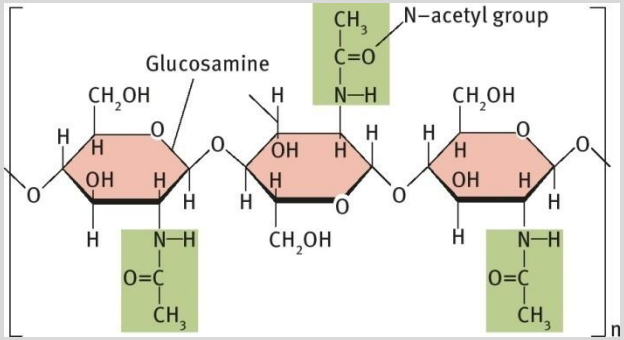
But in some other fungi, cellulose or other glucans are present.

Cellulose is **a disachharide** composed of **two beta d glucose subunits**, whereas, **Chitin** is the polysachharide made up of **N-acetyl glucose amine.**

The composition of cell wall varies in different groups of fungi. These are **cellulose-glycogen(Acrasiomycetes), cellulose-glucan(Oomycets), cellulose-chitin(hyphochytridiomycetes), chitin-chitosan(Zygomycetes), chitin-glucan(Asco,Basidio and Deuteromycotina), mannan-glucan(Sachharomycetaceae).**



Cellulose



Chitin

Classification

Perfect state unknown

Schematic outline of the classification of G. C. Ainsworth (1973) :

Kingdom — MYCOTA

Plasmodium or pseudoplasmodium present

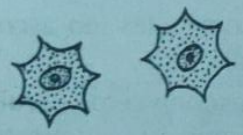
Division. MYXOMYCOTA

Plasmodium or pseudoplasmodium absent. Assimilative phase typically filamentous

Division. EUMYCOTA

Class-Acrasiomycetes

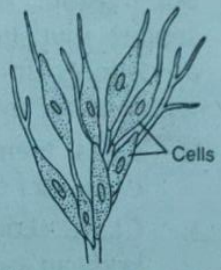
Assimilative phase free-living amoebae which unite as pseudomycelium before reproduction



Ceratiomyxella tahitiensis
Class : Acrasiomycetes
e.g. *Acrasis, Guttulina*

Class-Hydromyxomycetes

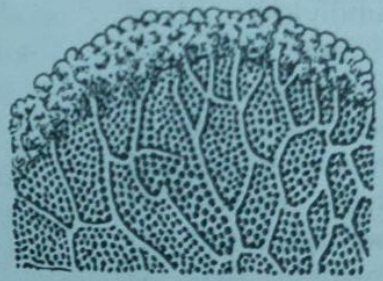
Assimilative phase a net-plasmodium



Net plasmodium of *Labyrinthula* sp.
Class : Hydromyxomycetes
e.g. *Zostera, Labyrinthula*

Class-Myxomycetes

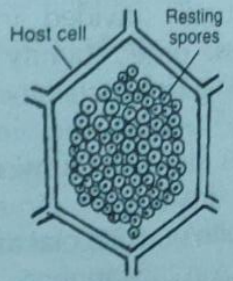
Assimilative phase is not a net-plasmodium, saprophytic



Plasmodium of *Physarum*
Class : Myxomycetes
e.g. *Stemonites, Physarum*

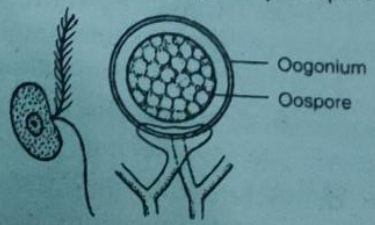
Class-Plasmodiophoromycetes

Assimilative phase is not a net-plasmodium, parasitic



Plasmodiophora brassicae
Class : Plasmodiophoromycetes
e.g. *Plasmodiophora brassicae*

Motile cells (zoospores) present
Perfect state spores typically Oospores



Zoospore and Oospore of *Phytophthora*
Sub-division : MASTIGOMYCOTINA

Motile cells absent

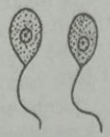
Contd. →

Contd.

Motile cells absent

Sub-division : MASTIGOMYCOTINA

Zoospore uniflagellate (whiplash type)



Synchytrium
Class : Chitridiomycetes
e.g. *Olpidium, Synchytrium*

Zoospore uniflagellate (tinsel type)

Rhizidiomyces
Class : Hyphochytridiomycetes
e.g. *Rhizidiomyces, Rhizidiomycopsis*

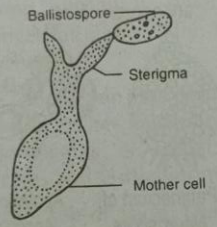
Zoospore biflagellate (one whiplash and other tinsel type)

Phytophthora
Class : Oomycetes
e.g. *Pythium, Phytophthora*

Perfect state present

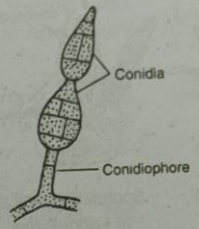
Perfect state absent
Sub-division : DEUTEROMYCOTINA

True mycelium lacking or not well developed



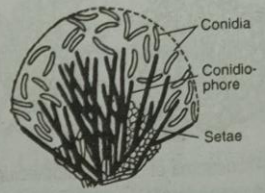
Sporobolomyces roseus
Class : Blastomycetes
e.g. *Sporobolomyces, Bullera*

True mycelium may be sterile or bearing spores directly or on sporophores



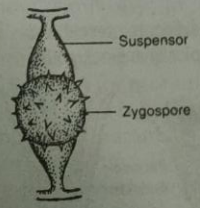
Alternaria
Class : Hyphomycetes
e.g. *Botrytis, Rhizoctonia*

True mycelium aggregated to form pycnidium or acervulus produces spores inside



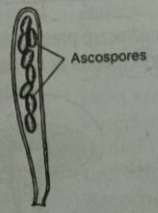
Acervulus of *Colletotrichum*
Class : Coelomycetes
e.g. *Colletotrichum, Pestalotia*

Perfect state spore-Zygospore



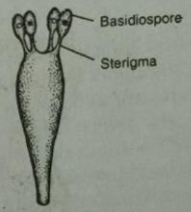
Single zygospore of *Mucor*
Subdivision :
ZYGOMYCOTINA

Perfect state spore-Ascospore



An ascus of *Ascobolus*
Subdivision :
ASCOMYCOTINA

Perfect state spore-Basidiospore



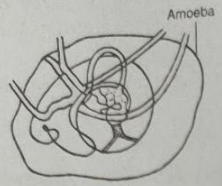
Single basidium of *Agaricus*
Subdivision :
BASIDIOMYCOTINA

Contd.

Contd.

Subdivision : ZYGOMYCOTINA

Saprobic or if parasitic or predaceous having mycelium immersed in host tissue

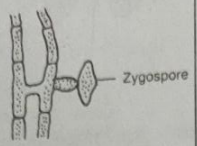


Thallus of *Cochlonema verrucosum*

Class : Zygomycetes

e.g. *Rhizopus, Cochlonema*

Generally associated with arthopods and mycelium not immersed in host tissue



Harpella

Class : Trichomycetes

e.g. *Asellaria, Enterobotryus*

Subdivision : ASCOMYCOTINA

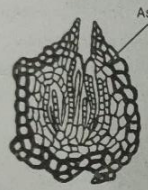
Ascocarp absent

Naked asci of *Taphrina* on host surface

Class : Hemiascomycetes

e.g. *Protomyces, Taphrina*

Ascocarp an ascostroma

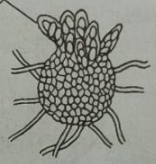


Ascostroma of *Mycosphaerella*

Class : Loculoascomycetes

e.g. *Venturea, Pleospora*

Ascocarp cleistothecium

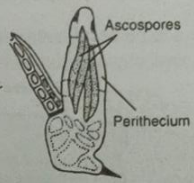


Cleistothecium of *Erysiphe*

Class : Plectomycetes

e.g. *Aspergillus, Penicillium*

Ascocarp perithecium, ectoparasite of arthopods

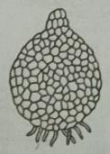


Sporulating thallus of *Laboulbenia formicarum*

Class : Laboulbeniomycetes

e.g. *Laboulbenia, Stigmatomyces*

Ascocarp perithecium, not ectoparasite of arthopods



Perithecium of *Neurospora dodgei*

Class : Pyrenomycetes

e.g. *Claviceps, Xylaria*

Ascocarp apothecium

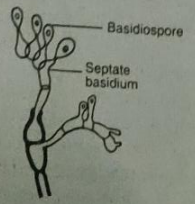
Apothecia of *Ascobolus scatigenus*

Class : Discomycetes

e.g. *Peziza, Ascobolus*

Subdivision : BASIDIOMYCOTINA

Basidiocarp lacking



Germinated teleutospore of *Puccinia graminis*

Class : Teliomycetes

e.g. *Puccinia, Ustilago*

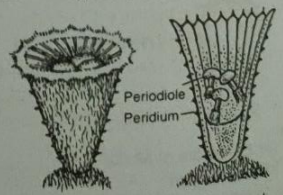
Basidiocarp present and typically gymnocarpous or semiangiocarpous

Basidiocarp of *Agaricus*

Class : Hymenomycetes

e.g. *Agaricus, Polyporus*

Basidiocarp present and typically angiocarpous



A basidiocarp of *Cyathus* and V.S. of basidiocarp of *Cyathus*

Class : Gasteromycetes

e.g. *Cyathus, Geastrum*

Mode of nutrition in Fungi-

Fungi are not able to synthesize their own food due to absence of chlorophyll,thus perform heterotrophic mode of nutrition obtaining food from external sources.They live as parasites, saprophytes or in symbiotic association. The fungi produce exoenzymes and endoenzymes. The exoenzymes like cellulase,amylase and pectinase help complex food materials in their substrate to break into simpler substances which are then absorbed by them. After entering inside the cell, the endoenzymes make these absorbed substances acceptable for growth and nutrition of fungi.

A)Parasites- They obtain their food from living body of both plants and animals. Parasites are divide into two groups: **obligate parasites and facultative parasites**.

1)Obligate parasites- Fungi those can live only on living host,but neither on dead decaying material nor on artificial culture medium are the obligate parasites,e.g- ***Albugo candida*** causes white rot of crucifers.

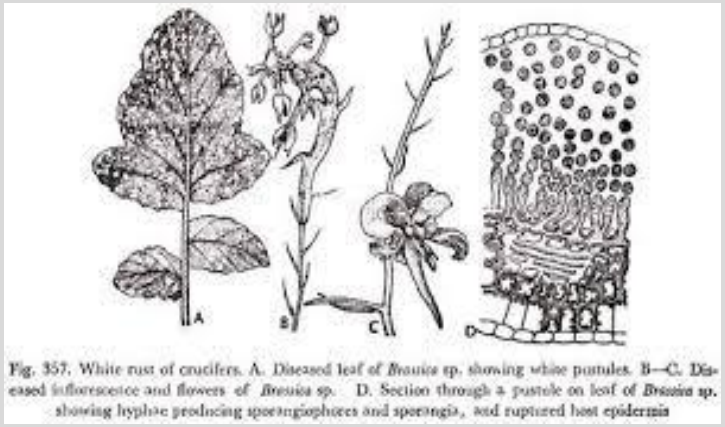
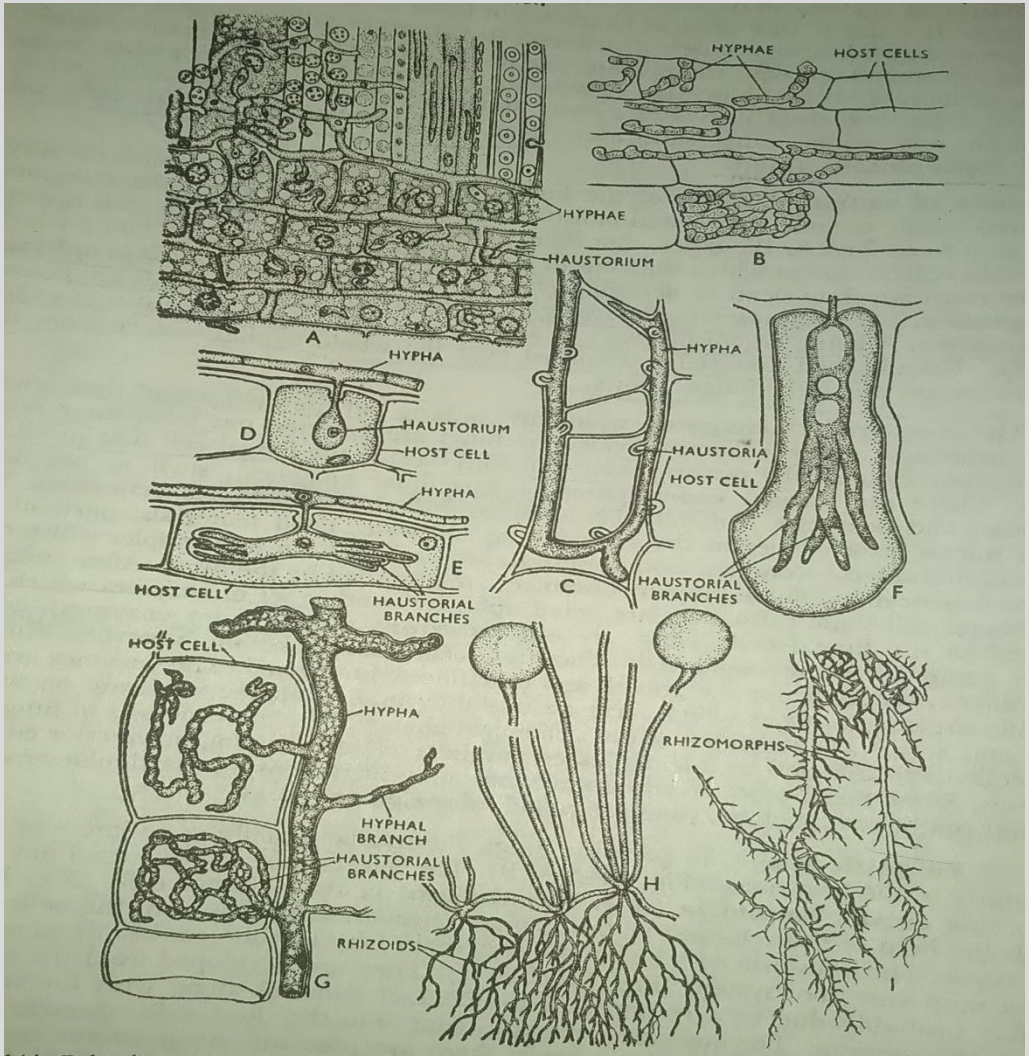


Fig. 357. White rust of crucifers. A. Diseased leaf of *Brassica* sp. showing white pustules. B—C. Diseased inflorescence and flowers of *Brassica* sp. D. Section through a pustule on leaf of *Brassica* sp. showing hyphae producing sporangiophores and sporangia, and ruptured host epidermis

2)Facultative parasites- Fungi which are actually saprophytes, but on certain conditions can grow as parasites and cause diseases, and cause diseases, e.g. ***Pythium debaryanum*** *causes* damping off of chilli seedling.

In parasitic fungi, the hyphae usually grow inter or intracellularly in the host tissue. Fungi produce different structures inside the host tissue, like haustoria(sing-haustorium), appressoria(sing-appressorium) for absorption of nutrients.



144. Behaviour of fungal hyphae. A. Intercellular hyphae of *Cronartium* sp. in stem of *Pinus* s
tracellular hyphae of *Helminthosporium avenae* in the cells of *Avena sativa*. C—G. Various types
oria. H. Rhizoids penetrating substratum in *Rhizopus stolonifer*. I. Rhizomorphs of *Merulius* s

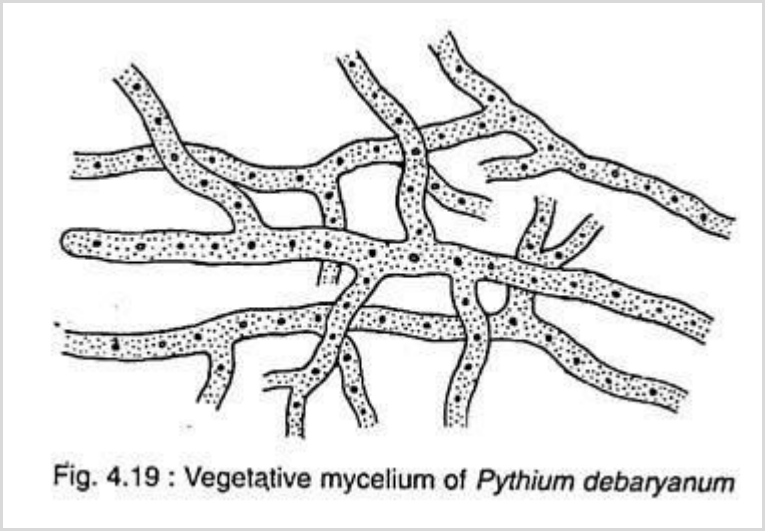
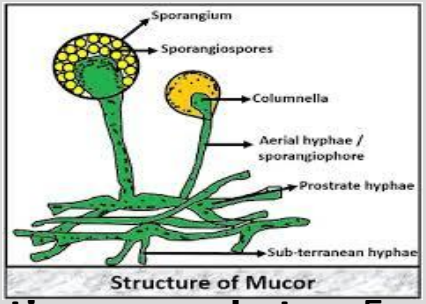


Fig. 4.19 : Vegetative mycelium of *Pythium debaryanum*

B)Saprophytes- They obtain their food from dead organic matters. They are also divided into two groups:obligate saprophytes and facultative saprophytes.

1)Obligate saprophytes- Fungi which obtain their food from dead and decaying organic matters and not from any living plants or animals are the obligate saprophytes, e.g, ***Mucor***



Structure of Mucor

2)Facultative saprophytes- Fungi which are actually parasites, but on certain conditions can grow as saprophytes are called facultative saprophytes,e.g, *Fusarium*

Symbiosis: Lichens and Mycorrhiza This is the mutual association of fungi with other plants where both are benefited. The partners are called symbionts. Lichen is an example of symbiosis where there is an association between fungi and algae.
Mycorriza- when fungi live in intimate association with some other unlike living organims deriving mutual benefit,they are also known as symbionts. A symbiotic, non pathogenic association of various fungi and bryophytes, pteridophytes and flowering plants is called mycorrhiza. The mycorrhiza maybe ectotrophic or endotrophic. When the fungal hyphae remain restricted on the surface of the roots forming a mantle or sheath of light pseudoparenchymatous fungal tissue which sends branches inward between the cortical cells of the roots and outward in the soil, is ectotrophic,
and the fungus enters into the roots, where it is frequently kept restricted to well marked layers, the external sheath is lacking is endotrophic.

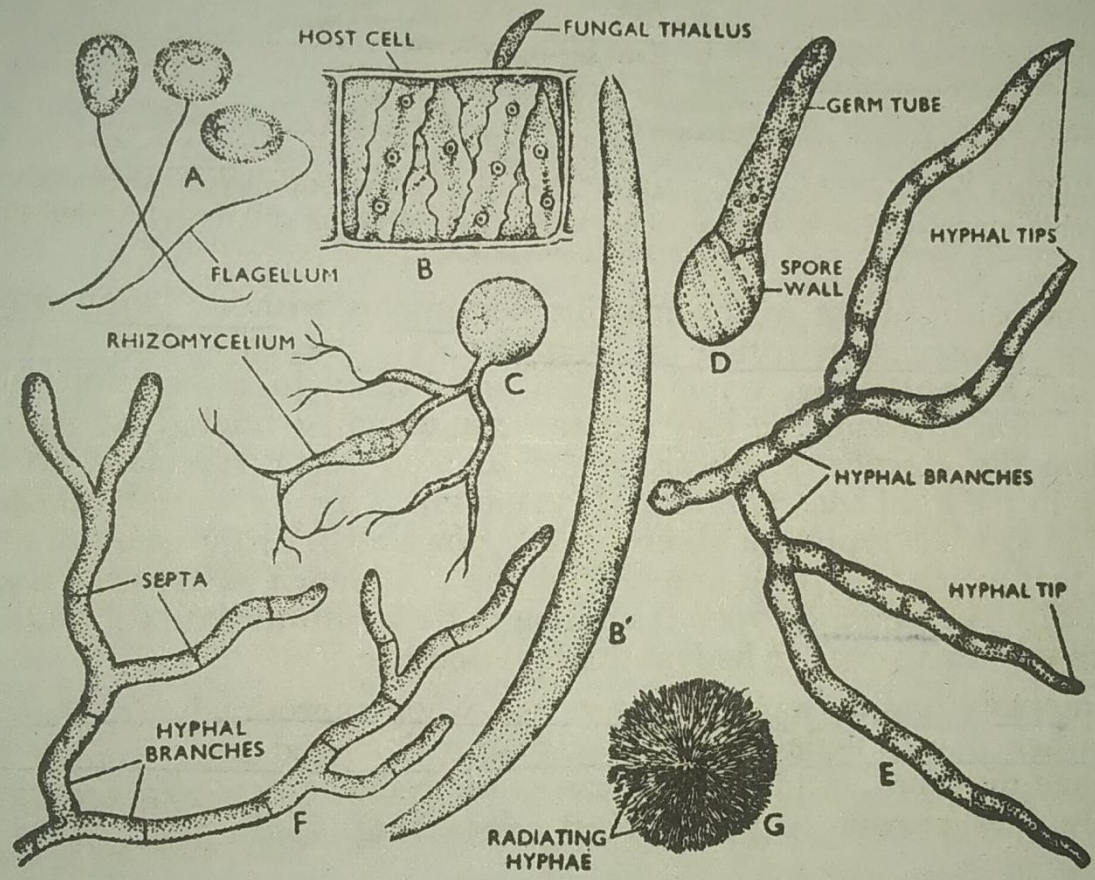


Fig. 134. Variations in the somatic structures of the Fungi. A. Unicellular uninucleate rounded with a single flagellum in *Synchytrium* sp. B-B′. Unicellular uninucleate elongated in *Harpochytrium* sp. C. Rhizomycelium in *Nowakowskiella* sp. D. Spore germination by germ tube. E. Aseptate hyphae. F. Septate

Thallus Organization-The assimilative body , or somatic body, or vegetative body of a fungus is a thallus. It ranges from **unicellular uninucleate** being **rounded,elongated** or **lobed** in shape with or without having cell wall developed around it, a **filamentous branched** structure called **mycelium** to a poorly developed rhizoid like system resembling mycelium known as **rhizomycelium**. Despite this apparent simplicity, fungi show great diversity in size, metabolic activity and organization of specialized structures.

When unicellular, thalli produce bud cells in succession, these may remain attached to one another in a chain called pseudomycelium, it can be seen in Yeast.

Some of the pathogenic fungi have a mycelial thallus in the host but a yeast like thallus in culture.e.g,*Taphrina,* these produce **dimorphic** thalli.

Hypha-Each individual filament of the mycelium is a hypha(pl.hyphae) which is usually a branched tube like structure having protoplasm with reserve food bounded by a wall . Hyphae maybe hyaline or variously coloured. Hyphal branching maybe of various types; **Dichotomous,verticillate, cymose and racemose.** In dichotomous branching,the apex of the hypha ceases elongationg and forks into two equal branching.

Septa-The protoplasm of the hypha maybe continuous without being interfered by cross wall or transverse partition called septa, hence called aseptate or interrupted by various kinds of septum called septate. An aseptate hypha is nothing but a multinucleate tube like structure,a coenocyte and the vegetative body is thus coenocytic. Septa contain various types of pores of various types(refer to point 5 of general characteristics).

Depending on the number of nuclei in each cell, the septate hyphe maybe mainly of the following types; With multinucleate cells, with binucleate cells known as dikaryotic hyphae, each nucleus usually derived from a different parent cell, the corresponding mycelium is dikaryotic mycelium;
having only one nucleus in each cell,called monokaryotic hyphae,the mycelium being monokaryotic mycelium.
The mycelium maybe very narrow or wide in thickness with branches ramifying in all directions which are either narrow or wide angled. The hypha in most fungi, is developed by the rapid elongation accompanied by branching of a tube like or filament like structure known as a germ tube which again originates from germination of a spore. The hypha ramifies spreading over or within a substratum,(from where it draws nurtition) producing a hyphal colony . The hyphal colony is composed of radiating hyphae which have a tendency to grow in all directions starting from a central point and ultimately to develop a spherical colony.

Animals, plants, and fungi are the three major multicellular groups of the domain Eukaryota. Eukaryotes are organisms with complex cells which have features such as mitochondria and nuclei.

Affinities with plants and animals-

With Plants-

The existence of thread like filaments,
the antheridial branches and oogonia of the water molds and particularly the zoospores produced by these forms of fungi naturally suggested alga as their nearest relatives. Many fungi are **superficially plant-like organisms**. They grow visible structures that **resemble plants or plant parts**. On a microscopic level, **plants and fungi both have cell walls**, a feature that metazoan (animal) cells lack.

According to this view, Fungi are collateral groups of algae i.e,they are no more than algae which in the course of their evolution have lost their chlorophyll and **chytridiales have evolved from unicellular algae, saprolegniales from siphonales and zygomycetes from conjugales and higher fungi from red algae.** This view was mainly supported by Pringsheim, Cohn, Sachs, Brefeld and others.

However, the physiological processes of Algae and fungi are different and evolutionary changes in metabolism to give rise to fungi from algae seemed impossible. Also through physiological and cytological studies it has beeen established that the Algae and Fungi are parallel lines of evolution rather one originating from the other, both having unicellular motile ancestors.

With Animals

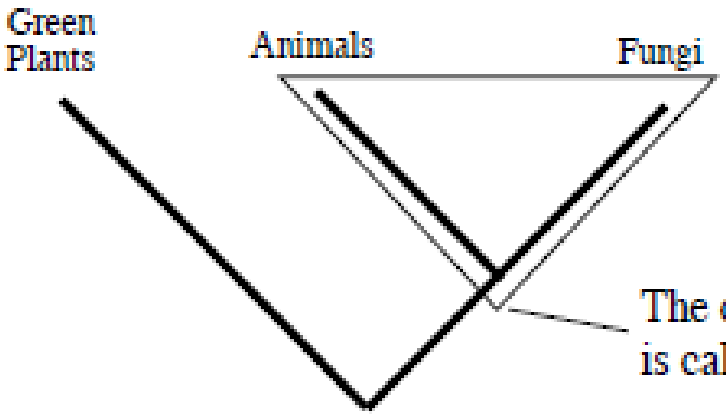
The most obvious similarity between fungi and animals is their **trophic level**, that is, their place in the food chain. **Neither fungi nor animals are producers** as plants are. Both must use external food sources for energy.

Fungi and animals share a molecule called **chitin** that is not found in plants. Fungi and many invertebrate animals use this complex carbohydrate for structural purposes. In fungi, chitin is the structural component of the cell walls. In animals, it appears in hard structures such as the exoskeletons of insects and the beaks of octopuses and other mollusks. On a molecular level, chitin is similar to the plant molecule cellulose, used in plant cell walls and other structures, but the chitin molecule has a modification that makes it stronger than cellulose.

Gobi first proposed this view of origin of Fungi from protozoa, Dangeard,Cavers,Cook,martin, langeron,Heim,Ingold supported this view. They said that derivation of fungi from algae presents more difficulties than does a theory of protozoan origin. If the product of metabolism and and type of flagella are taken into consideration then fungi must have originated from protozoa and not algae. In other words, **animals have a more recent common ancestor with fungi than with plants, and the mushrooms in your salad are more closely related to you than to the lettuce.**

Our Cousins the Fungi

- Fungi and animals are more closely related to one another than either group is to plants.
- This has been determined through molecular phylogenetic analyses.



The clade of fungi and animals is called the **opisthokonts**

Conclusion- It should be considered as a separate taxonomic unit. In the words of Alexopoulos and Mims(1979) “The fungi are neither plants not animals: they are fungi”. Due to many distinctive chareacteristics, Fungi are placed in a separate kingdom in the modern systems of classification of living organisms like the Whittaker’s Five kingdom system of classification.

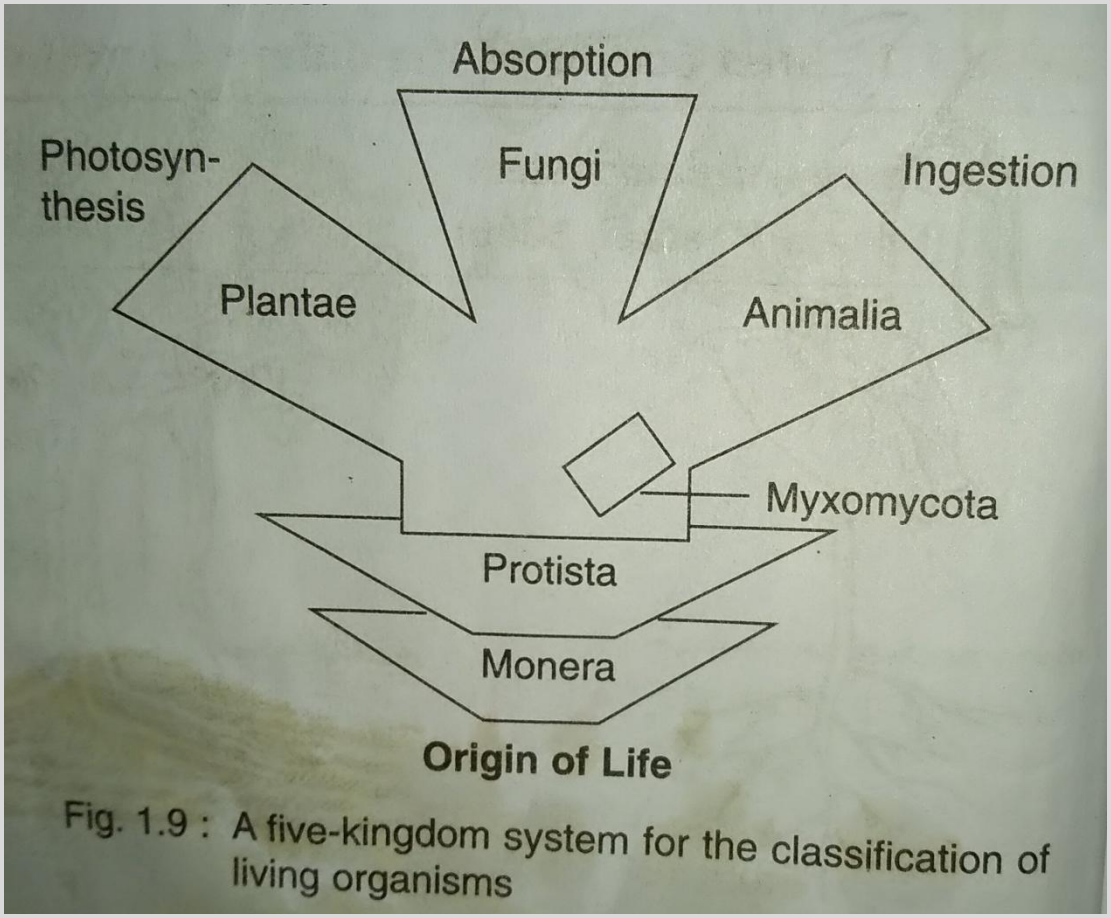


Fig. 1.9 : A five-kingdom system for the classification of living organisms

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