

Fungi

Mucor

Penecillium

Economic Importance

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Fungi

Thallus Organisation

The plant body of true fungi is a thallus. It may be non-mycelial or mycelial. The non-mycelial forms are unicellular. In mycelial forms, the plant body is made up of thread-like structures called hyphae (sing. hypha).

Cell Organisation

The cell wall of fungi is mainly made up of chitin..

Nutrition

The fungi are achlorophyllous organisms. Hence, they cannot prepare their food. They live as heterotrophs *i.e.*, as parasites and saprophytes. Some forms live symbiotically with other green forms.

Parasites: They usually obtain their food from a living host. A parasite could be facultative or obligate. The obligate parasites survive and settle on a living host throughout their life. The facultative parasites are saprophytes that have turned parasitic.

Saprophytes: These organisms procure their nutrition from dead and decaying organic matter. The saprophytes are either obligate or facultative. An obligate saprophyte remains saprophytic during its entire lifetime. While a facultative saprophyte is nothing but a parasite that has secondarily become saprophytic.

Symbionts: Some fungi develop in symbiotic association with the green or blue-green algae. These constitute the lichen. Here the algal component is photosynthetic. While the fungal component plays the reproductive part.

Reproduction

Vegetative Reproduction

- **Fragmentation:** Some forms belonging to Ascomycotina and Basidiomycotina multiply by breakage of the mycelium.
- **Budding:** Some unicelled forms multiply by budding. A bud arises as a papilla on the parent cell and then after its enlargement separates into a completely independent entity.
- **Fission:** A few unicelled forms like yeasts and slime moulds multiply by this process.

Asexual Reproduction

- **Sporangiospores:** These are thin-walled, non-motile spores formed in a sporangium. They may be uni- or multinucleate. On account of their structure, they are also called as aplanospores.
- **Zoospores:** They are thin-walled, motile spores formed in a zoosporangium.
- **Conidia:** In some fungi, the spores are not formed inside a sporangium. They are born freely on the tips of special branches called conidiophores. Thus, these spores are conidia.

Sexual reproduction: With the exception of Deuteromycotina (Fungi imperfecti), we find sexual reproduction in all groups of fungi. During sexual reproduction, the compatible nuclei show a specific behaviour which is responsible for the onset of three distinct mycelial phases. The three phases of nuclear behaviour are as under:

- **Plasmogamy:** Fusion of two protoplasts.
- **Karyogamy:** Fusion of two nuclei.
- **Meiosis:** The reduction division.

Mucor (Black mold)

Kingdom: Fungi
Div: Mycota
class: Zygomycetes
Order: Mucorales
family: Mucoraceae

The genus *Mucor* (L. muceo, be moldy) is represented by about 80 species, found throughout the world commonly known as mold.

They grow mostly as saprophytes on decaying fruits and vegetables, in soil, on various food- stuff-like, jellies, jams, syrups. *M. mucedo*, is a coprophilous species (grows on dungs of herbivorous animals like cow etc.), known as black mold.

Vegetative structure

The vegetative plant body is eucarpic, consists of white cottony coenocytic much-branched mycelium. The mycelia ramify all over the substratum. The hyphae are usually prostrate, but some of them penetrate into the substratum and serve the function of both anchorage and absorption of nutrients .

The hyphal wall is microfibrillar, consist mainly of chitin-chitosan. Inner to the cell wall, cell membrane is present which covers the protoplast. The protoplast contains many nuclei, mitochondria, endoplasmic reticulum, ribosomes, oil droplets, small vacuoles and other substances .

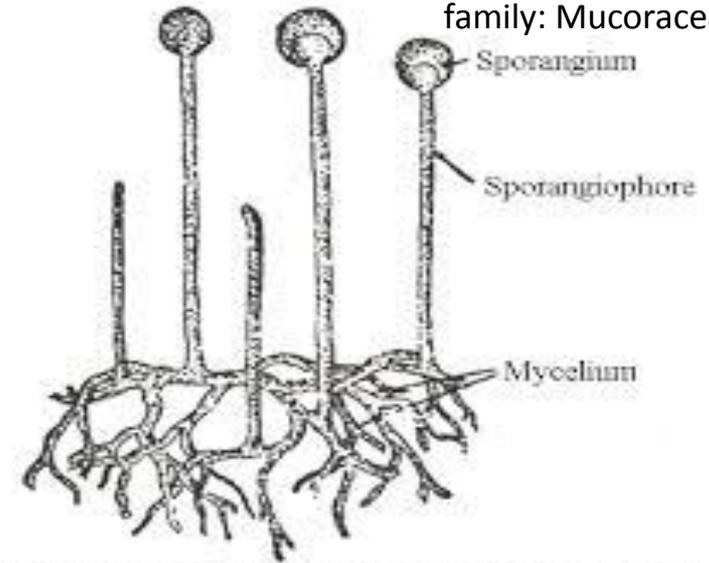


Fig: *Mucor*. Mycelium with sporangiophore and sporangia

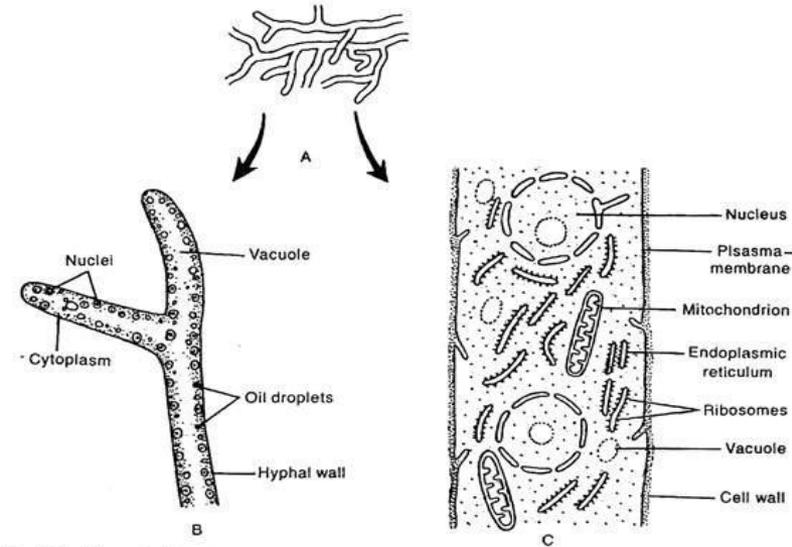


Fig. 4.27 : *Mucor* : A. Vegetative mycelium, B. Portion of hypha under light microscope, C. Portion of hypha under electron microscope

• **Reproduction in Mucor:**

Vegetative reproduction: It takes place by fragmentation. Due to accidental breakage, the mycelium may break up into two or more units. Each unit is capable to grow as mother mycelium.

Asexual Reproduction:

It takes place by the formation of sporangiospore, oidia and chlamyospore .

(a) Sporangiospore Formation: During favourable condition, the nonmotile spores known as sporangiospores or aplanospores are formed inside the sporangium.

The sporangiophores develop singly and scatteredly on the upper side of the superficial mycelium . The young sporangium is generally white. At maturity, it turns into black due to production of spores. A large dome shaped structure called columella is present in the centre of sporangium. They are haploid as they are produced on haploid mycelium.

Dehiscence of sporangium takes place after maturation of spores. Minute needle-shaped crystals of calcium oxalate are formed on the external surface of sporangium wall. They imbibe water and make the wall soft and later exert pressure on the wall that results in the . the sporangium to rupture. The dehisced sporangium thus shows a dome-shaped columella with attached spores at the top and remains of the sporangial wall as collar around its base. The spores are dispersed chiefly by insect and also by wind.

Chlamyospore:

During unfavourable condition, thick-walled, nutrition rich, intercalary mycelium segments are developed by septation of mycelium which are termed as chlamyospores. In favourable condition, the chlamyospore germinates and gives rise to a new mycelium.

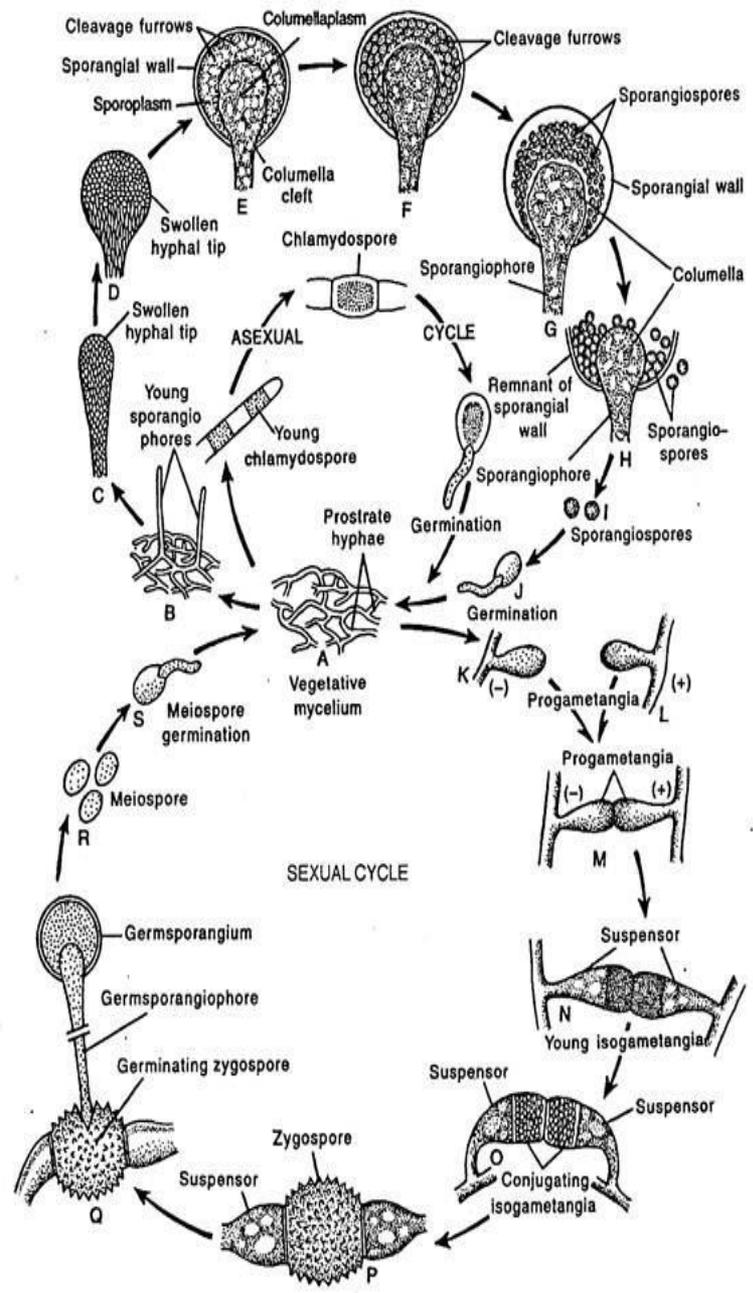


Fig. 4.28 : Life cycle of *Mucor mucedo*

Sexual Reproduction:

Sexual reproduction takes place by means of gametangial copulation. The gametangia look alike and by conjugation, they give rise to zygospore. Most of the species of *Mucor* are heterothallic but few species are homothallic. zygospores are produced by the union of two gametangia. When two mycelia of compatible strains come close to each other, the mycelia produce small outgrowth, called progametangia. The apical region of the two progametangia come in close contact. A septum is laid down, separating the apical region, which is called gametangium; and the basal region is called suspensor. After maturation of gametangia, the common wall at the point of their contact dissolves and the protoplast of both the gametangia unite to form zygospore. The nuclei of opposite gametangia fuse together to form diploid ($2n$) nuclei, unpaired nuclei gradually degenerate. The diploid nuclei undergo meiosis before resting stage of zygospore. The young zygospore enlarges and probably secretes five layered (two in exospore and three in endospore) thick wall, of which the outer one is black and warty. The zygospore then undergoes a period of rest.

Germination After resting period, the zygospore germinates and the innermost layer comes out after cracking the outer walls and produces a promycelium. The content of the zygospore migrates into the tip of the promycelium. The haploid nuclei form haploid spores called sporangiospores. These spores are also known as meiospores. Each meiospore, after liberation, germinates like sporangiospore and forms a new mycelium.

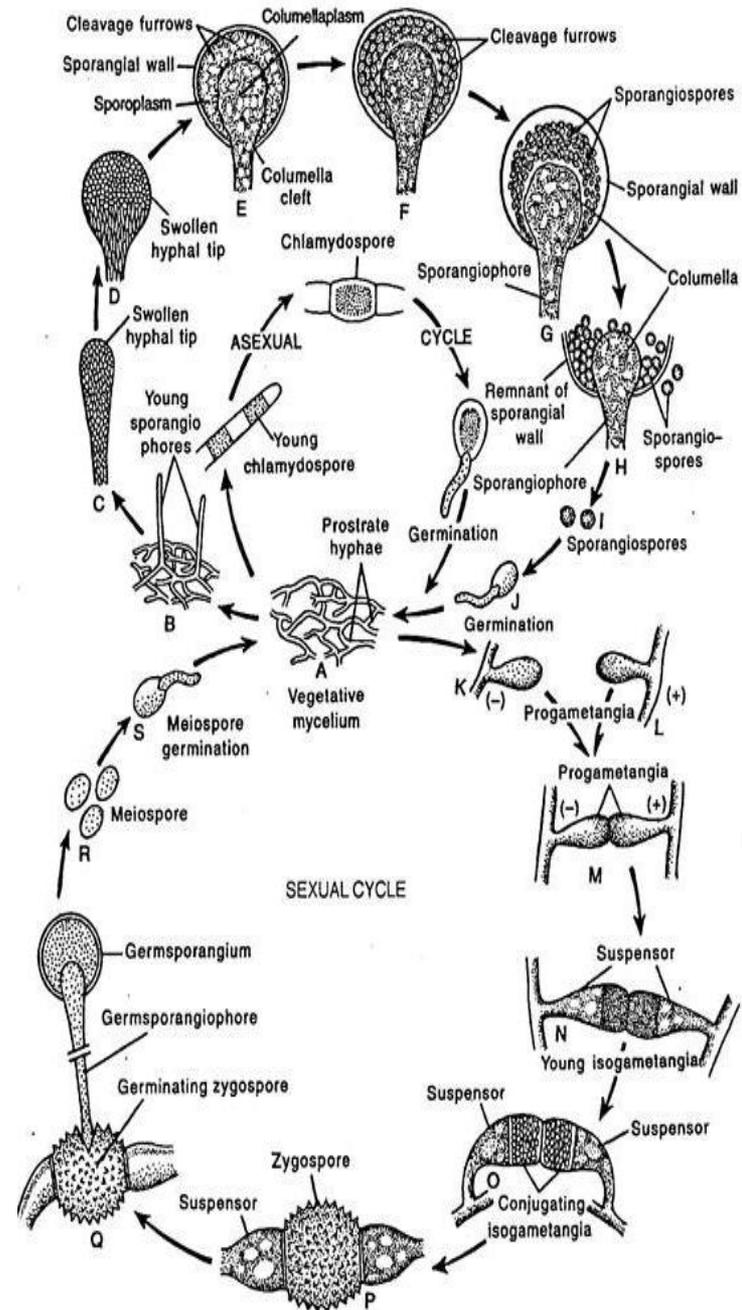


Fig. 4.28 : Life cycle of *Mucor mucedo*

Penicillium

The vegetative structure of *Penicillium* is a multicellular mycelium. The mycelium is made up of highly branched, multinucleated and septate long thread-like filamentous structure known as hyphae. It becomes colored due to production of colored conidia.

The cell wall is made up of 4 layers. Outermost is glucan, next protein, third is chitin and fourth is pectic or hemicellulose.

The plasma membrane surrounds cytoplasm containing Mitochondria, ribosomes and ER.

The food is stored in the form of oil globules

Reproduction

Vegetative reproduction is by fragmentation and each of the fragments develops separately making a complete mycelium

Asexual reproduction takes place in the special structures called **conidiophore**. Conidiophores may be unbranched or branched and differentiate into **metulae**

Number of flask-shaped **phialide** cells develop at the end of each metulae, which form **conidia**

Kingdom: Fungi
Div: Ascomycota
class: Eurotiomycetes
Order: Eurotiales

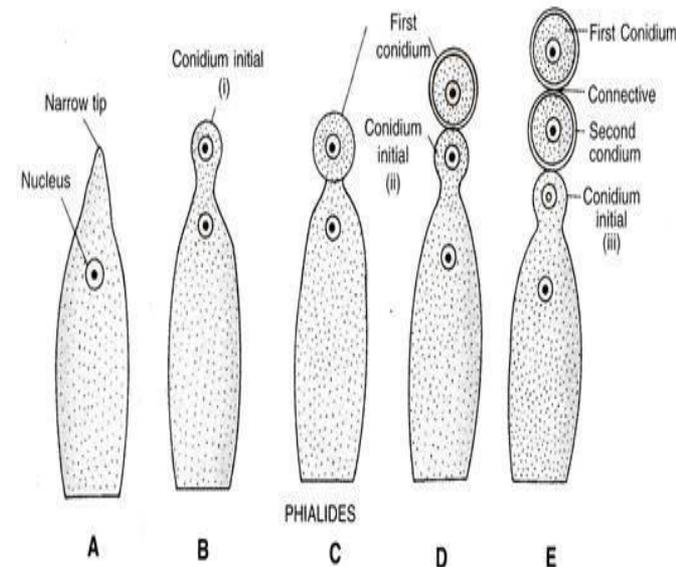
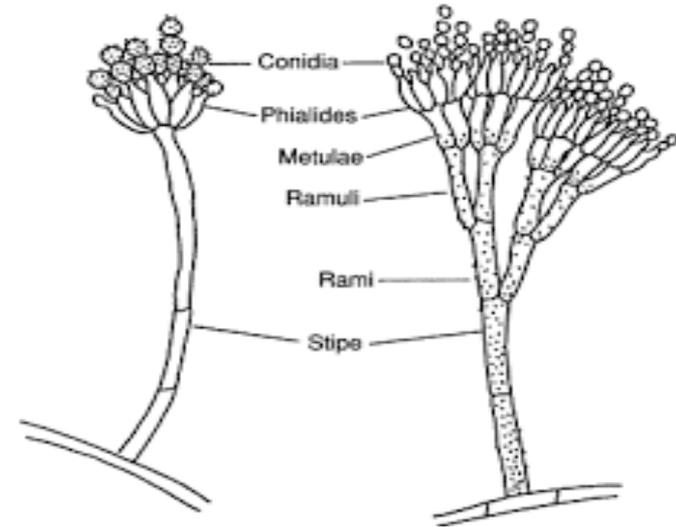


Fig. 10.11 (A-E). *Penicillium* sp. Stages showing development of conidia in chains.

Sexual reproduction is by the formation of ascospores

Some species of *Penicillium* are homothallic and some are heterothallic (The male and female sex organs are antheridium and ascogonium).

Ascogonium: One of the cells of the vegetative mycelium develops into ascogonium, which is unicellular having a single nucleus. The nucleus of ascogonium undergoes repeated division to produce 32 to 64 nuclei. **Antheridium:** The developing antheridium branch coils around the ascogonium and the apical part of it is separated by septa forming a unicellular antheridium having a single nucleus.

Fertilization: After maturation, antheridium bends and touches the ascogonial wall and at the point of contact, cell wall dissolves and cytoplasm of both the cells get intermixed. The process is known as **plasmogamy**. There occurs an intermediate **dikaryon phase**, which is a **dikaryotic stage** with 2 nuclei ($n+n$) present in the cell. The ascogonium repeatedly divide by partition of the wall forming many binucleate cells arranged one above another. The terminal dikaryotic cell swells up forming ascus mother cell. **Karyogamy** (fusion of the two nuclei) occurs in the cell forming diploid cell ($2n$). The diploid zygote undergoes first meiosis and then mitosis to form 8 nucleus. Each accumulates some cytoplasm resulting in the formation of **8 ascospores**

Formation of Ascocarp: With the septation of ascogonium and development of ascogenous hyphae, a large number of sterile hyphae grow up around the sexual apparatus. The ensheathing sterile hyphae get interwoven to form a hollow ball-like structure, the peridium which surrounds and protects the ascogenous hyphae as they grow and branch within. This is the ascocarp. The asci within the ascocarp are scattered. The ascocarp of *Talaromyces* is of indefinite growth. It continues to increase in size even after the after the ascospores begin to mature

Phialide cells divide mitotically forming a conidium. Phialide cells again divide pushing the first conidium towards outside and the second conidium is formed. This process repeats resulting in a chain of conidia, found in a basipetal succession. The conidia may be blue, green or yellow in colour and oval or elliptical in shape. Conidia get detached from the parent after maturation and dispersed by the wind. They get attached to a suitable substratum and germinate

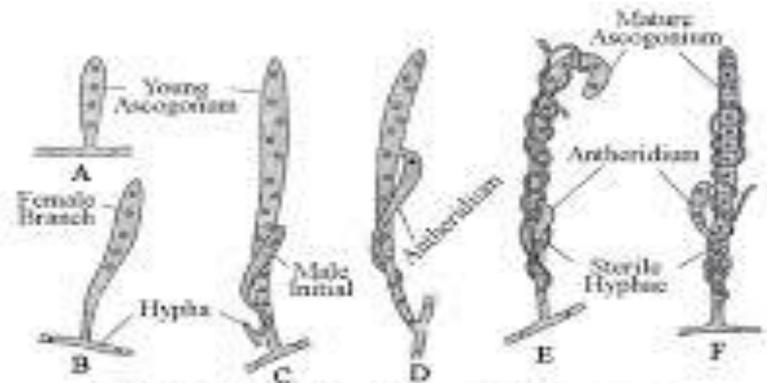


Fig: *Penicillium*. Sexual reproduction (early stages)

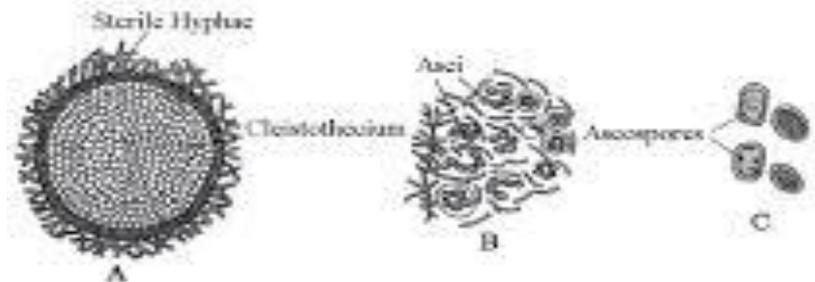


Fig: *Penicillium*. Sexual reproduction (later stage). (A) Cleistothecium, (B) Asci, (C) Ascospores.

- **Economic Importance**

- Some members of the Mucorales are commonly used to ferment foods. The fermentation of foods is nutritionally important because the fungi contribute substantially to the nutritional value of the foods.
- it produce important industrial products such as lactic acid, amylases, rennin and organic such as fumaric acid. Other species are used in industrial fermentations in the conversion of starch into sugar.
- the preparation of Chinese cheese called sufu from soybeans with the help of the mucor *Actinomucor*.
- Many diseases of fruits that occur during storage and transit are caused by the Mucorales.
- Some species of *Rhizopus*, *Mucor* and *Absidia* attack stored grains.
- Some species of Mucorales are known to cause the fatal diseases called Mucoromycosis in domesticated animals and man. This infects lungs, brain and other organs, particularly in man.
- *Penicillium* species are very important economically. They produce many food products, organic acids, antibiotics and mycotoxins.
- **Cheese production**- many *Penicillium* species are used in the production of different kinds of cheese, e.g. blue cheese, *P. camemberti* forms Camembert and Brie cheese and *P. roqueforti* forms Roquefort cheese
- **Enzymes and Organic acids production**- many *Penicillium* species are used in the production of organic acids such as citric acid, gluconic acid, tartaric acid and enzymes like amylases, proteases, cellulase, lipase and pectinase
- **Antibiotic (Penicillin) production**- In 1929 **Alexander Fleming** isolated the antibiotic **Penicillin** from penicillium, which inhibited the growth of Gram-positive bacteria. Later **Florey and Chain** extracted and produced Penicillin from the moulds to treat soldiers of the world war II
- **Penicillin** is produced by *Penicillium chrysogenum* (earlier known as *Penicillium notatum*). The naturally occurring penicillins are **Penicillin G (Benzylpenicillin)**, which is given by intramuscular injection and **Penicillin V (Phenoxymethylpenicillin)** given orally to treat various infections.
- Penicillin act by inhibiting enzymes responsible for the cell wall formation of bacteria and activating enzymes responsible for the breakdown of the protective wall of the bacteria.
- *Penicillium* species are also used in the production of antifungal drug and tumour suppressing compounds
- *Penicillium* species are also used in **mycoremediation**, i.e. bioremediation process using fungus to clean the environment due to their ability to breakdown xenobiotic compounds

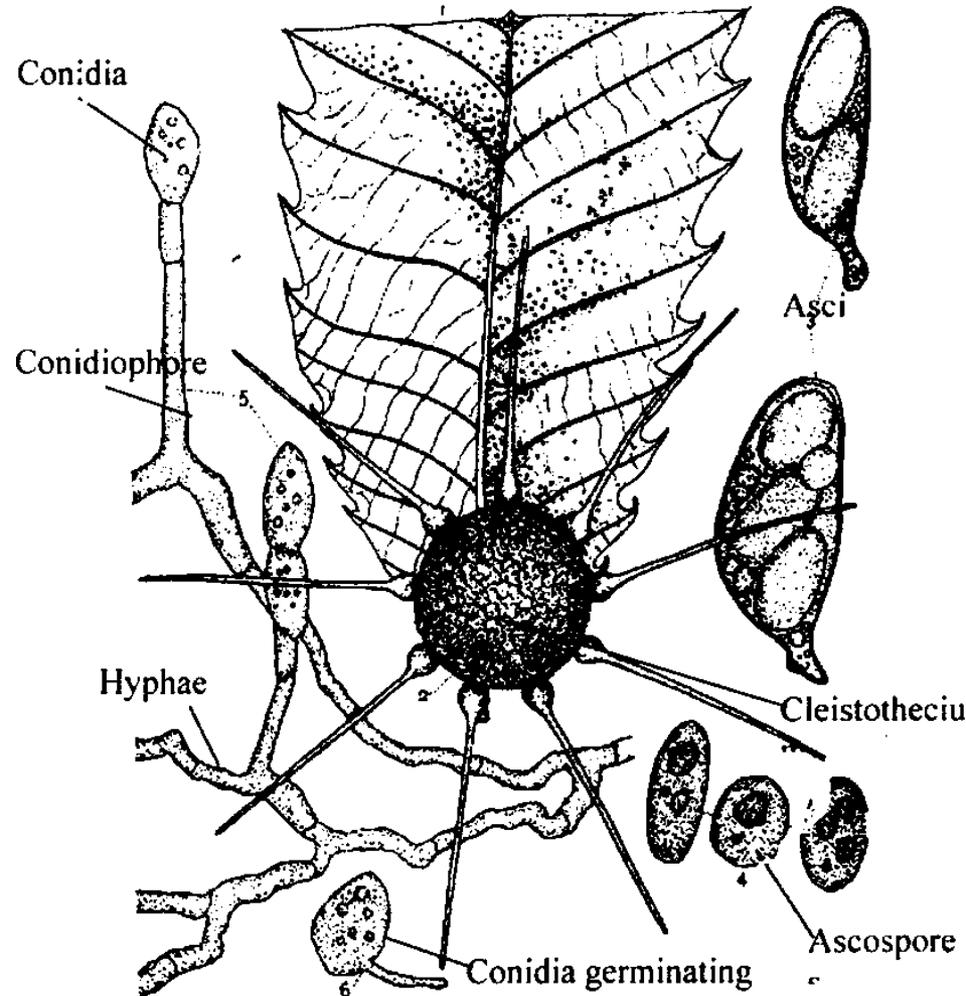
Phyllactinia

Kingdom: Fungi
Phylum: Ascomycota
Class: Leotiomycetes
Order: Erysiphales
Family: Erysiphaceae

- There are number of species of genus **Phyllactinia**. *P. dalbergiae* is commonest species found growing on the leaves of *Dalbergia sissou*. The specimens can be collected in abundance during the winter on the fallen leaves of shisham. This fungus is an obligate parasite.
- It is a plant pathogen distributed in temperate regions, *P. gultata* causes a **powdery mildew** on leaves and stems on a broad range of host plants.

Structure

- Its mycelium grows on the surface of leaves forming a whitish con ring. The hyphae send their short branches or **haustoria** through stomata of host in the epidermal or other mesophyll cells. Haustoria are used to absorb food from the host tissues. Its hyphae are hyaline, much branched and septate. These form a whitish mat on the surface of leaves.



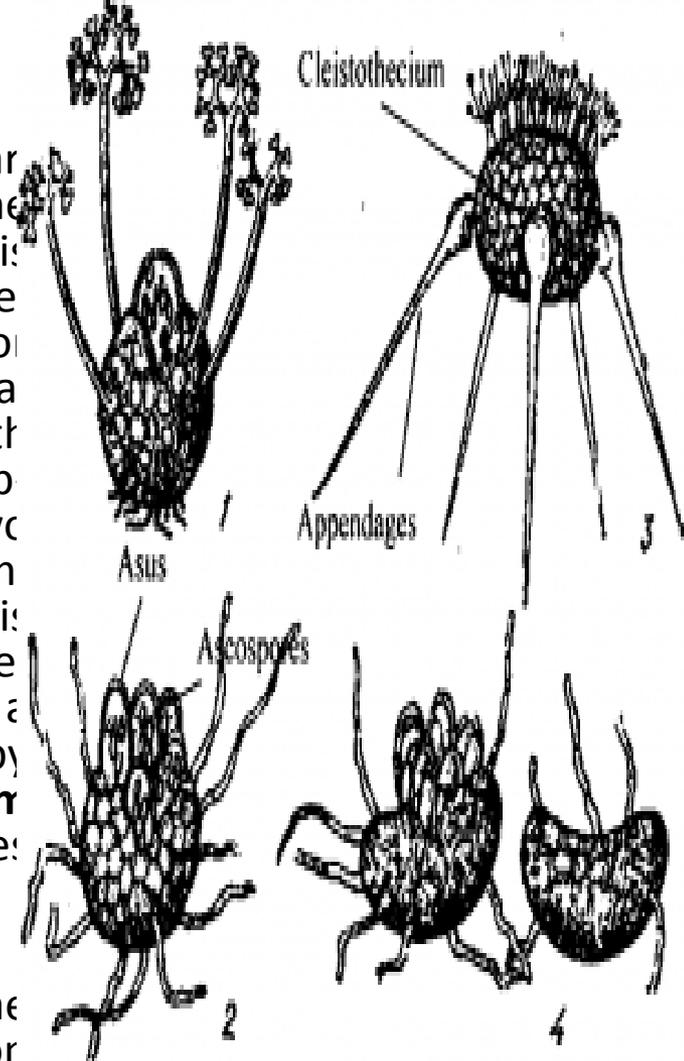
Reproduction

Asexual reproduction

- The fungus reproduces asexually by producing unicellular hyaline conidia. The wall of conidia is two layered. The outer layer is smooth and thin. But the inner layer is comparatively thicker. There are marking on its surface. These conidia are formed at the tips of short or long **conidiophores**. These come out of the host stomata. The conidia are elongated, slightly spindle-shaped with blunt ends. The conidium detaches and fall. The sub terminal cell of conidiophores divides again in two daughter cells. The upper cells develop new conidium. Thus conidia are formed singly and no conidia chain is formed. The conidia are produced in abundance. Therefore, the leaf surface appears to be covered by a white powdery mass., Therefore, this disease is known by the name of **Powdery Mildew**. The conidia form **germ tube** after germination. This germ tube infects new leaves of the host.

Sexual reproduction

- Sexual reproduction occurs in later summer. The hyphae produce **ectophytic mycelium**. The conidia production stops during sexual reproduction. Young cleistothecia start developing on the ectophytic mycelium. The colour of cleistothecia changes from white to black. The fruit-bodies are produced as a stimulus of sexual reproduction. Therefore, these cleistothecia represent the perfect stage.



It takes place by the usual production of **antheridia** and **Ascogonia**.

- Plasmogamy occurs in **ascogonium**. It gives rise to the **ascogenous hyphae**. [these hyphae ultimately produce asc at their tips. Kai yogamy and meiosis takes place in the **asci** before ascospores formation.
- The** vegetative hyphae grow around this developim, sexual apparatus. It forms a **pseudoparenchymatous tissue**. These tissues ultimately form the wall of the cleistothecium with characteristic appendages on the surface.
- The infected leaves can be easily recognized by examining the the, fallen leaves under the 3albergiae plants during autumn o the following winter.

Fruiting body: Cleistothecia visible to the naked eye as black dc on the surface of the leaves. These fruiting bodies are rounded, ball like structures without any opening. Such fruit-bodies arc known is **cleistothecia**. It has globose structure. The characteristic feature of these fruit-bodies is the presence of long, stiff, pointed appendages on the surface called **crown**. These appendages are swollen at the base to form **bulbous** part. The wall of the cleistothecium is **pseudoparenchymatous**. There are many **asci** within each cleistothecium. Each ascus has 2-4 **ascospores** instead of the usual 8 ascospores.

Rupturing of cleistothecium: The base of bulbous appendage is thick walled above and thin walled below. The appendages bend downward on drying. Thus thin part buckles inwards. It causes downward pressure of the appendages tips. It frees the cleistothecium from the mycelium. Now cleistothecium attach to leaves. The ascospores become mature in the asci. Now the inner cells of the cleistothecium absorb water. It swells to rupture the cleistothecium. Asc also burst. Thus ascospores are discharged.

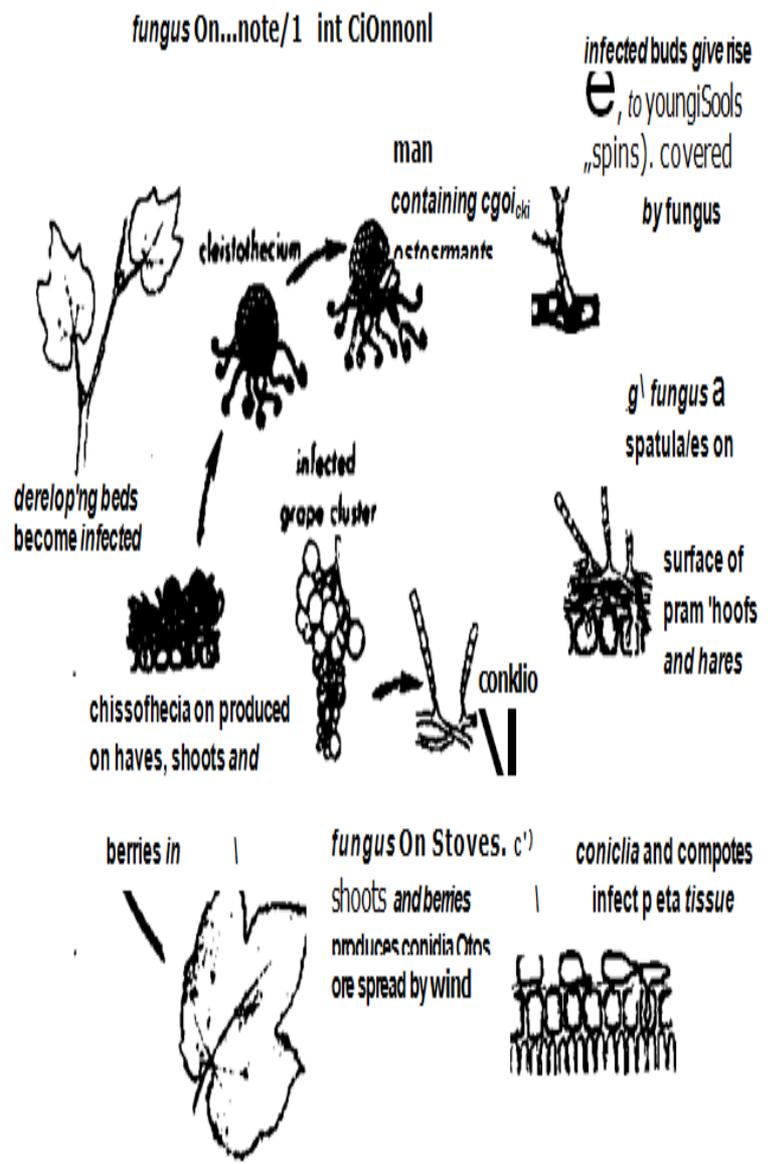


Fig: Life cycle