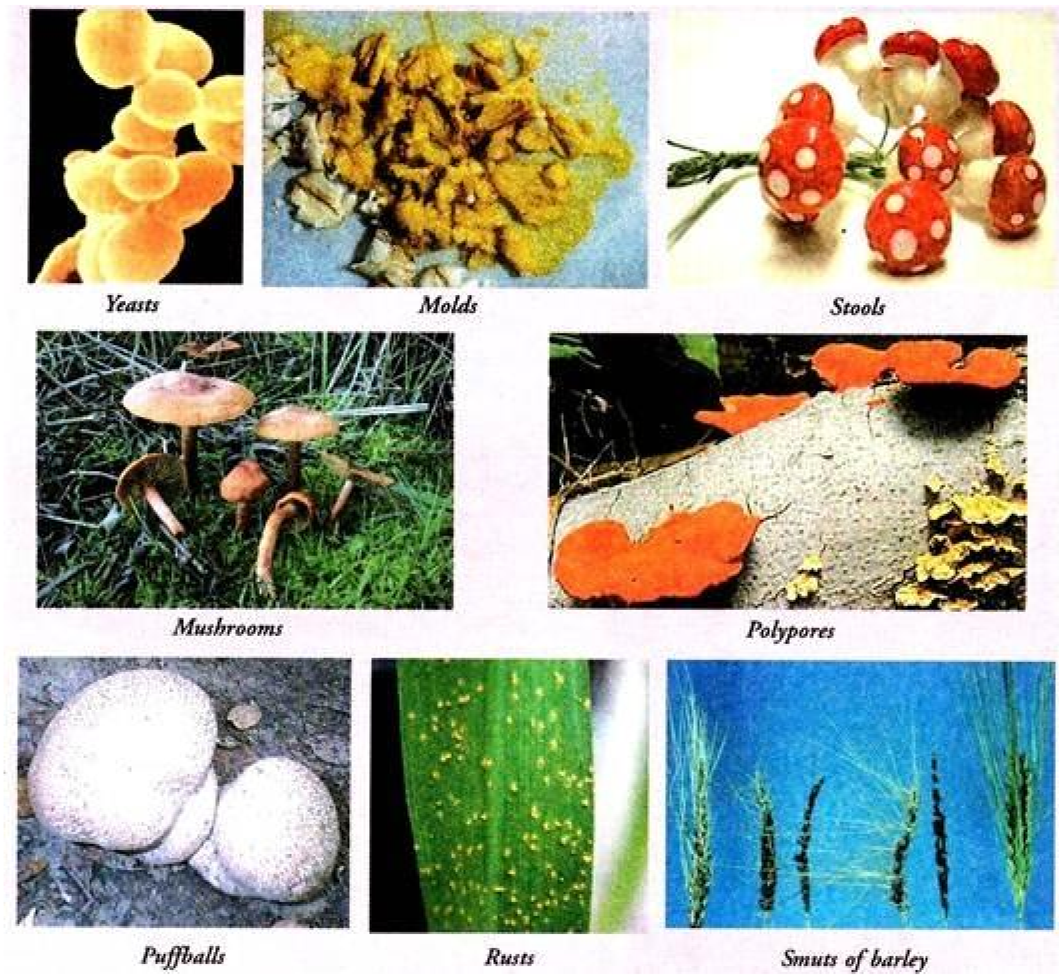
Characters of Fungi

Some of the most important characters of fungi are as follows:

1. Occurrence 2. Thallus organization 3. Different forms of mycelium 4. Cell structure

5. Nutrition 6. Heterothallism and Homothallism 7. Reproduction 8. Classification of Fungi.



1. Occurrence:

Fungi are cosmopolitan and occur in air, water soil and on plants and animals. They prefer to grow in warm and humid places. Hence, we keep food in the refrigerator to prevent bacterial and fungal infestation.

2. Thallus organization:

Except some unicellular forms (e.g. yeasts, Synchytrium), the fungal body is a thallus called mycelium. The mycelium is an interwoven mass of thread-like hyphae (Sing, hypha). Hyphae may be septate (with cross wall) and aseptate (without cross wall). Some fungi are dimorphic that found as both unicellular and mycelial forms e.g. Candida albicans.

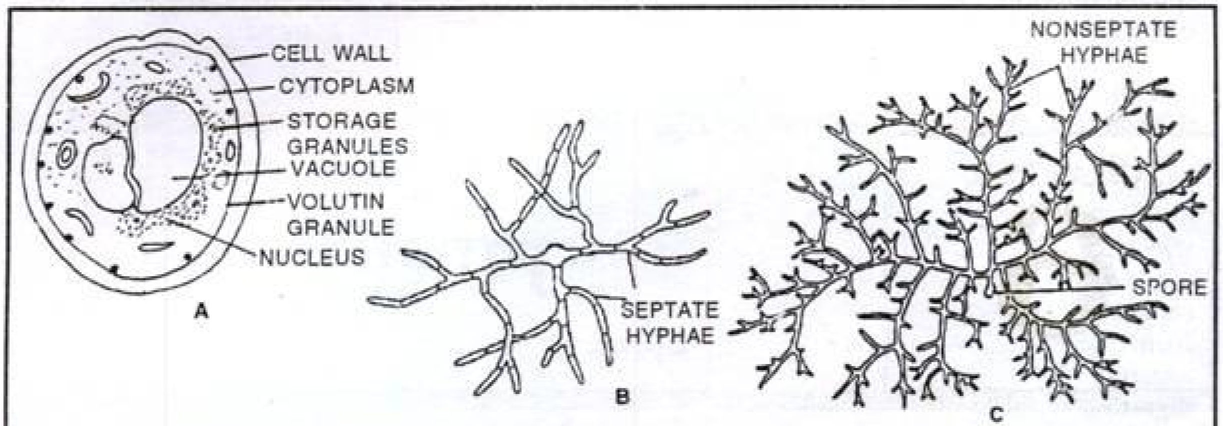


Figure 6.1 Fungi A. Yeast-unicellular thallus B. mycelium with septate hyphae C. mycelium with aseptate or coenocytic hyphae

3. Different forms of mycelium:

(a) Plectenchyma (fungal tissue):

In a fungal mycelium, hyphae organized loosely or compactly woven to form a tissue called plectenchyma.

It is two types:

i. Prosenchyma or Prosoplectenchyma:

In these fungal tissue hyphae are loosely interwoven lying more or less parallel to each other.

ii. Pseudoparenchyma or paraplectenchyma:

In these fungal tissue hyphae are compactly interwoven looking like a parenchyma in cross-section.

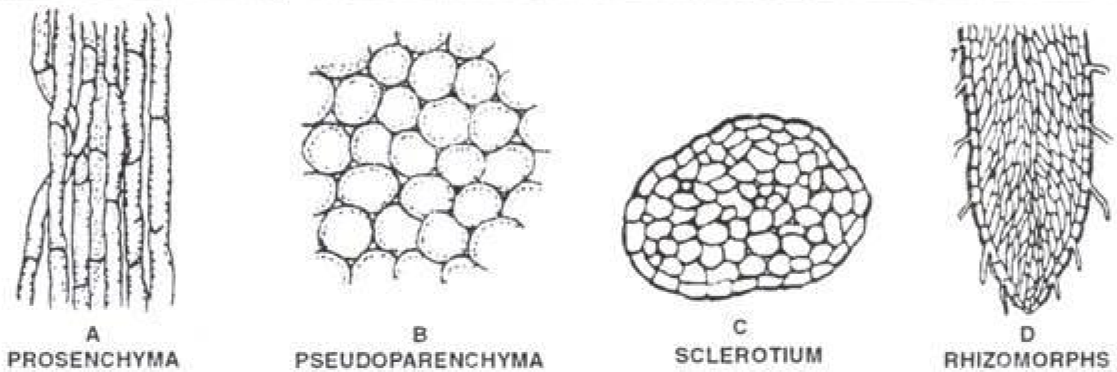


Figure 6.2 Different forms of fungal mycelium

(b) Sclerotia (Gr. Skleros=haid):

These are hard dormant bodies consist of compact hyphae protected by external thickened hyphae. Each Sclerotium germinates into a mycelium, on return of favourable condition, e.g., Penicillium.

(c) Rhizomorphs:

They are root-like compactly interwoven hyphae with distinct growing tip. They help in absorption and perennation (to tide over the unfavourable periods), e.g., Armillaria mellea.

4. Cell structure:

Fungal cell wall composed of chitin (fungal cellulose, $C_{22}H_{54}N_4O_{21}$). In primitive fungi true cellulose with or without chitin found. Plasma-lemma bears occasional coiled ingrowths called lomasomes which lie below cell wall. Cytoplasm contains organelles (Endoplasmic reticulum, mitochondria, ribosome, Golgi bodies etc.) and inclusions (stored foods, pigments and secretory granules).

The cytoplasm at hyphal tip contains Golgi vesicles called chitosomes which filled with cell wall materials. Nucleus and mitochondria are found to connect with ER. Nucleus divides by intracellular mitosis called karyochoresis where nuclear envelop remain intact during nuclear division and internal spindle develop. Reserve food is glycogen and oil.

5. Nutrition:

The fungi lack chlorophyll. Therefore, they cannot synthesiz their own food.

Depending on from where and how they get nutrition, fungi are of following types:

(a) Saprotrophs (= saprobes):

They obtain food from dead and decaying organic matter. They secrete digesting enzymes to outside which digest the substratum and then absorb nutrients, e.g., Mucor, Agarious. Rhizopus (bread mould) etc.

(b) Parasitic:

They obtain food from living .They maybe facultative or obligate. Facultative parasites grow on a variety of tissues and often cause 'soft rot' of the tissue, e.g., Ustilago. The obiigate- parasites absorb through specialized haustoria. The parasitic fungi that grow on surface of host cells and absorb food through haustoria are called ectoparasites or ectophytic parasites (e.g., Mucor, Erisphae). When parasitic fungi grow inside the host tissue arc called endoparasites or endophytic parasites (e.g., Pythium, Puccinia).

(c) Predacious:

Some soil fungi develop ring-like noses to trap annelids, nematodes etc. e.g., Arthrobotrys, Zoophagus, Dactylella etc.

(d) Symbiotic:

They live in mutualistic relationship with another organism by which both are benefited. The two common examples are lichens and mycorrhiza. Lichens are symbiotic associations between fungi and algae. The fungal partner is a member of ascomycetes or basidiomycetes that provides water and nutrients, while the algal partner is a green alga or cyanobacteria that prepares food by photosynthesis.

Mycorrhizas or mycorrhizae (fungus roots in Greek) are the mutualistic symbiotic associations between soil fungi and the roots of most plant species (95% of all plant families are predominantly mycorrhizal). According to the carbohydrate theory (Bjorkman, 1949), the plants that grow in soils deficient in P and N, and high intensity light develop mycorrhizas.

The two most common types of mycorrhizas are the ectomycorrhizas (ECM) and the endomycorrhizas (also known as arbuscular mycorrhiza, AM or VAM). The two groups are differentiated by the fact that the hyphae of ectomycorrhizal fungi do not penetrate the cell wall of the plant's root cells, while the hyphae of arbuscular mycorrhizal fungi penetrate the cell wall.

6. Heterothallism and Homothallism:

A. F. Blakeslee (1904) discovered mating types or genetically distinct strains in Mucor. He called fungi with different mating types are called heterothallic and fungi without mating types are called homothallic. Nowadays we call some fungi and algae homothallic if both male and female gametes produce in the same individual can fertilize each other and heterothallic if the gametes can only be fertilized by gametes from another individual of the same species. Heterothallism introduces variations in the species.

7. Reproduction:

Like most other thallophytes, fungi also reproduce by vegetative, asexual and sexual means. However, asexual reproduction is generally predominant Depending upon the involvement of the entire thallus or a part of it, the fungi may be holocarpic or eucarpic.

(i) Holocarpic:

In this category of fungi the entire thallus gets converted into one or more reproductive bodies. Hence, the vegetative and reproductive phase can never occur at the same time.

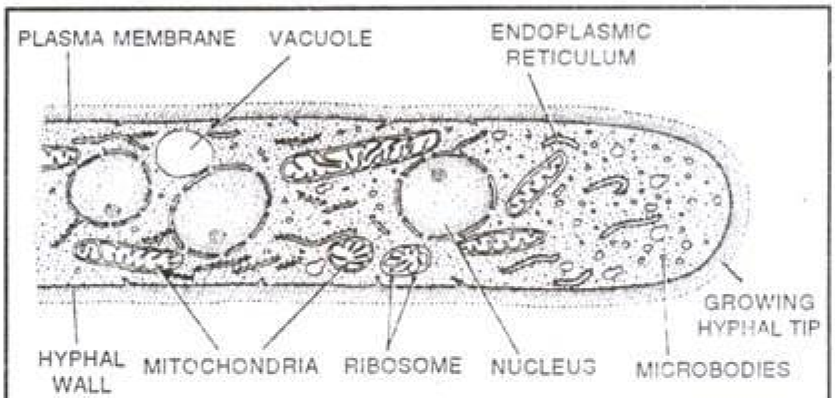


Figure 6.3 Ultrastructure of a hyphal cell near growing tip

(ii) Eucarpic:

Most of the fungi are eucarpic. Here only a part of the thallus is involved in the development of reproductive organs and remaining thallus remains vegetative. In eucarpic fungi, vegetative and reproductive phases exist at the same time.

A. Vegetative Reproduction:

In this type of reproduction, a part of mycelium separate and forms a new individual. The various methods of vegetative reproduction are— fragmentation, budding, fission, sclerotia, rhizomorphs and oidia formation. In case of Rhizopus and Coprinus the hyphae break up into numerous fragments called oidia, each of which give rise to a new mycelium.

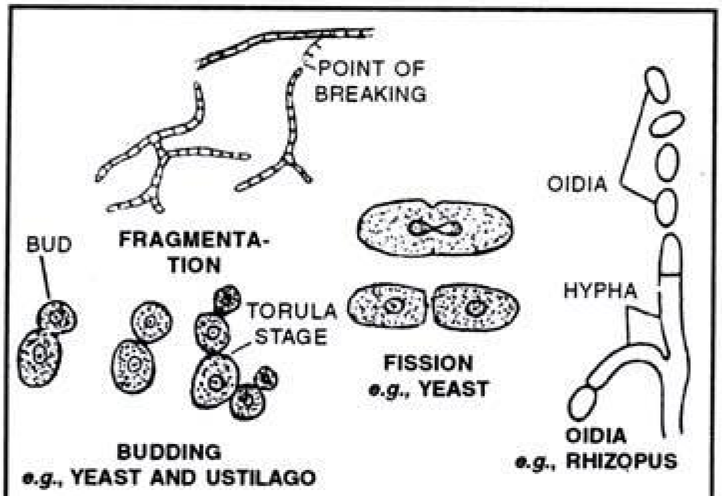


Figure 6.4 Different types of vegetative reproduction in

B. Asexual Reproduction:

It commonly occurs through spores, either motile or non-motile and form in a specialized part of mycelium. The various types of spores are: zoospores, sporangiospores (=aplanospores), conidia, oidia (arthrospores), chlamydospores, gemmae, ascospores, uredospores, basidiospores etc.

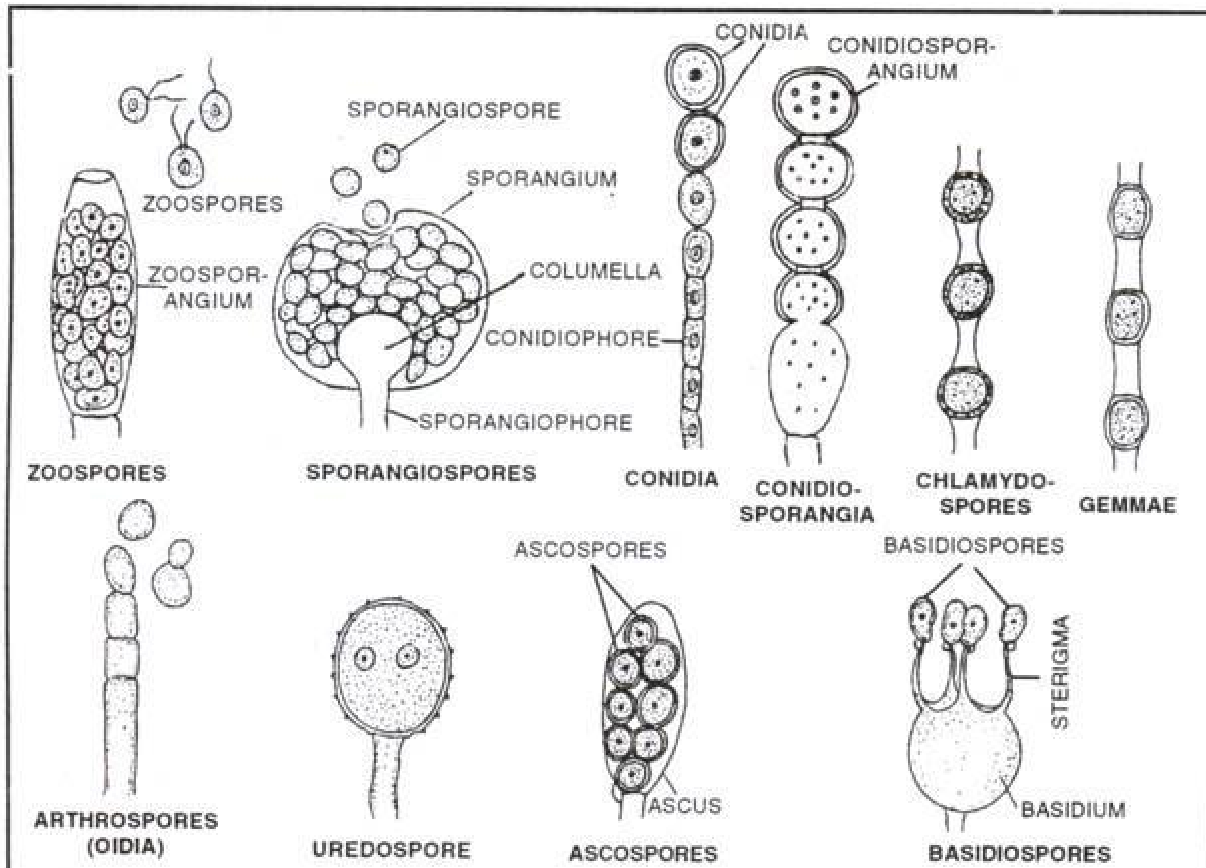


Figure 6.5 Various types of fungal spores.

C. Sexual Reproduction:

It involves the formation and fusion of gametes. Sexual reproduction found in all groups of fungi except deuteromycetes or fungi imperfecti. Sexual reproduction has three distinct phases i.e. plasmogamy (protoplasmic fusion), karyogamy (fusion of nuclei) and meiosis (reduction division of zygote).

The various methods of sexual reproduction in fungi are as follows:

(i) Planogametic copulation:

This is simplest type of sexual reproduction. In this process fusion of two gametes of opposite sex or strains takes place where one or both of the fusing gametes are motile (flagellated). It results in the formation of a diploid zygote.

This process is usually of three types:

(a) Isogamy:

In this process fusing gametes are morphologically similar and motile but physiologically dissimilar. These gametes are produced by different parents e.g. Synchytrium.

(b) Heterogamy:

When the fusing gametes are morphologically as well as physiologically different, the process is known as heterogamy. Heterogamous reproduction is of two types: anisogamy and oogamy. Anisogamy consists of the fusion of two motile gametes where the male gamete is small and more active than the female gamete, e.g., Allomyces. In oogamy the motile male gamete (antherozooid) fuses with the large, non-motile female gamete (egg or ovum), Monoblepharis, Synchytrium etc.

(ii) Gametangial contact:

In this process two gametangia of opposite sex come in contact with one another. The male gametangium (antheridium) transfer male nucleus or gamete into the female gametangium (oogonium) either through a pore at the point of contact or through a fertilization tube, e.g., Phytophthora, Sphaerothera, Alb. go, Pythium etc.

(iii) Gametangial copulation:

In involves the fusion of entire contents of two gametangia to form a common cell called zygote or zygospore, e.g., Mucor, Rhizopus.

(iv) Spermatization:

Some fungi produce many minute, spore-like, single-celled structures called spermatia (nonmotile gametes). These structures are transferred through agencies like water, wind and insects to either special receptive hyphae or trichogyne of ascogonium. The contents migrate into receptive structure. Thus dikaryotic condition is established, e.g. Puccinia.

(v) Somatogamy:

This takes place in fungi where formation of gametes is absent. In such fungi, anastomoses takes place between hyphae and their somatic cells fuse to produce dikaryotic cells, e.g, Agaricus, Peniophora etc.

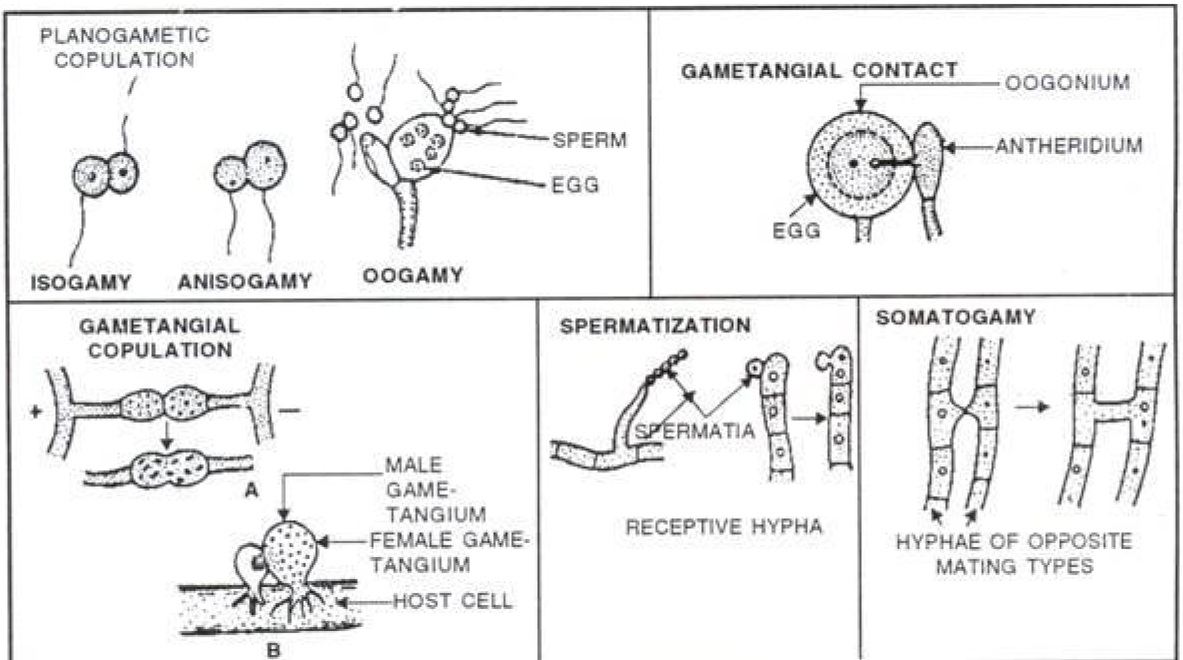


Figure 6.6 Different types of sexual reproduction in fungi.

Rhizopus

Vegetative Structure of Rhizopus Stolonifer:

The vegetative plant body is eucarpic and consists of white cottony, much branched mycelium. The mycelial plant body is differentiated into nodes and internodes (Fig. 4.25A).

The internodal region is the aerial and arching hyphae, known as stolon, which when touches the substratum forms the nodal region. The nodal region bears much branched rhizoid grows downward, inside the substratum for anchorage and absorption of food.

The hyphal wall is microfibrillar and consists mainly of chitin-chitosan. In addition to chitin- chitosan, other substances like proteins, lipids, purines and salts like calcium and magnesium are also present in the hyphal wall.

Inner to the cell wall, cell membrane is present which covers the protoplast (Fig. 4.25B, C). The protoplast contains many nuclei, mitochondria, endoplasmic reticulum, ribosome, oil droplets, vacuoles and other substances. The size of the vacuole enlarges with age by coalescence of smaller vacuoles.

Reproduction in Rhizopus

Rhizopus Stolonifer reproduces by vegetative, asexual and sexual means.

1. Vegetative Reproduction:

It takes place by fragmentation. Due to accidental breakage the stolon may break up into two or more small units. Each unit is capable of growing as mother mycelium.

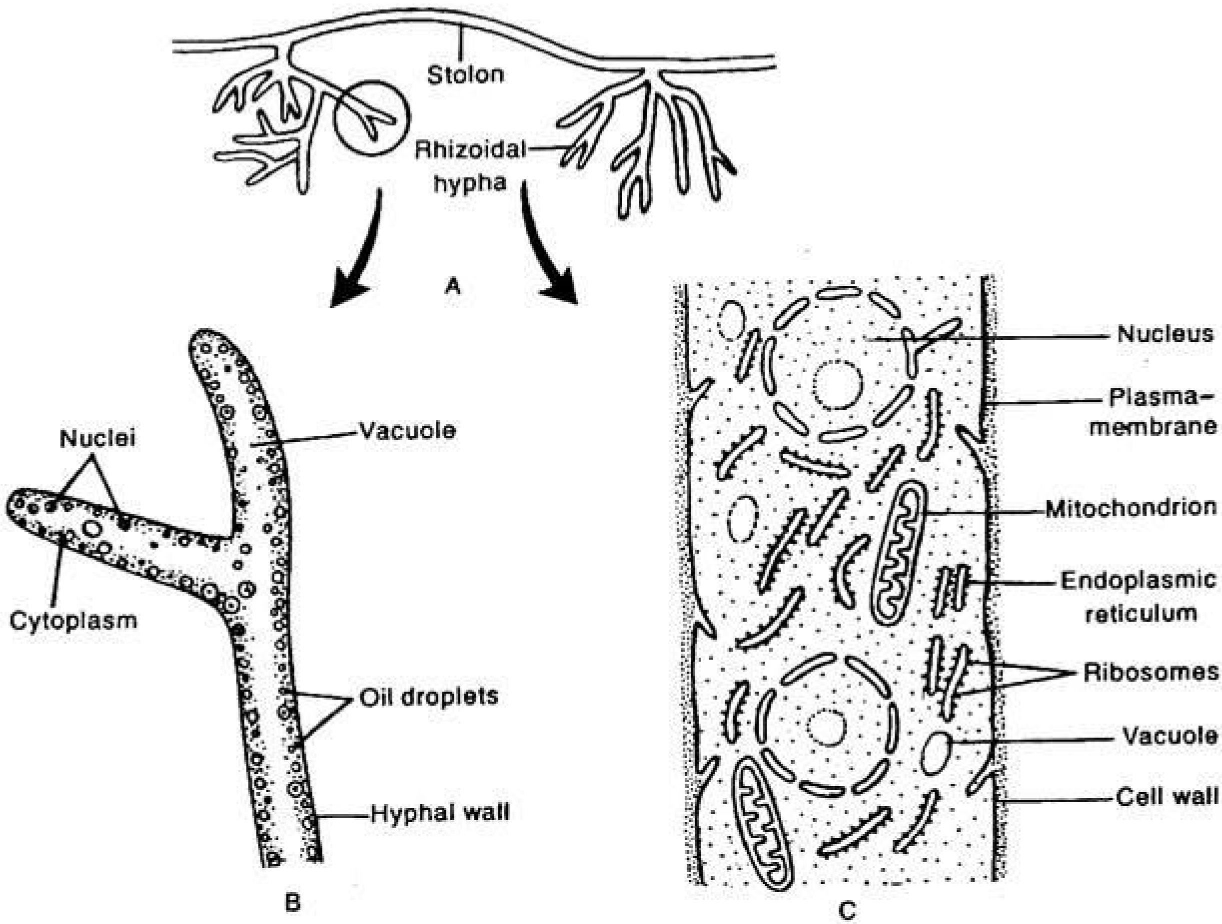


Fig. 4.25 : *Rhizopus stolonifer* : A. Vegetative mycelium, B. Portion of hypha under light microscope, C. Portion of hypha under electron microscope

2. Asexual Reproduction:

It takes place by the formation of sporangiospore and chlamydospore.

(a) Sporangiospore Formation:

During favourable condition, the non-motile spores such as sporangiospores or aplanspores are formed inside the sporangium. The sporangium develops singly at the apex of sporangiophore.

The sporangiophore develops in tuft from the upper side of node opposite to the rhizoidal hyphae (Fig. 4.26B). Initially, a number of elongated hyphae develop aerially from the upper- side of the node which elongate upto a certain height.

The nuclei and cytoplasm push more and more towards the apical side, consequently the apex of the aerial hyphae swells up (Fig. 4.26C). The swollen part enlarges and develops into a large round sporangium (Fig. 4.26D).

With maturity, the protoplast inside the sporangium is differentiated into a thick dense layer of multinucleate cytoplasm towards the peripheral region just inside the sporangia! wall, called the sporoplasm and a vacuolated portion with a few nuclei towards the centre, called columellaplasm. A series of small vacuoles then appears between the sporoplasm and columellaplasm (Fig. 4.26E).

These vacuoles become flattened and coalesce to form a continuous cleavage cavity. This is followed by the formation of a septum towards innerside of the cavity. With further development, the septum becomes dome-shaped and pushes its way into the sporangium (Fig. 4.26F, G).

Protoplast of the sporoplasm then undergoes cleavage to produce many small multinucleate (2-10 nuclei) segments. These segments are transformed into globose non-motile sporangiospores 4.26F, G).

After the maturation of spores, the wall of sporangium dries and columella collapses like an inverted cup with irregular surface. The sporangial wall breaks in different fragments leaving a portion as collar on the sporangiophore. The powdery mass of spores are exposed to the atmosphere (Fig. 4.26H).

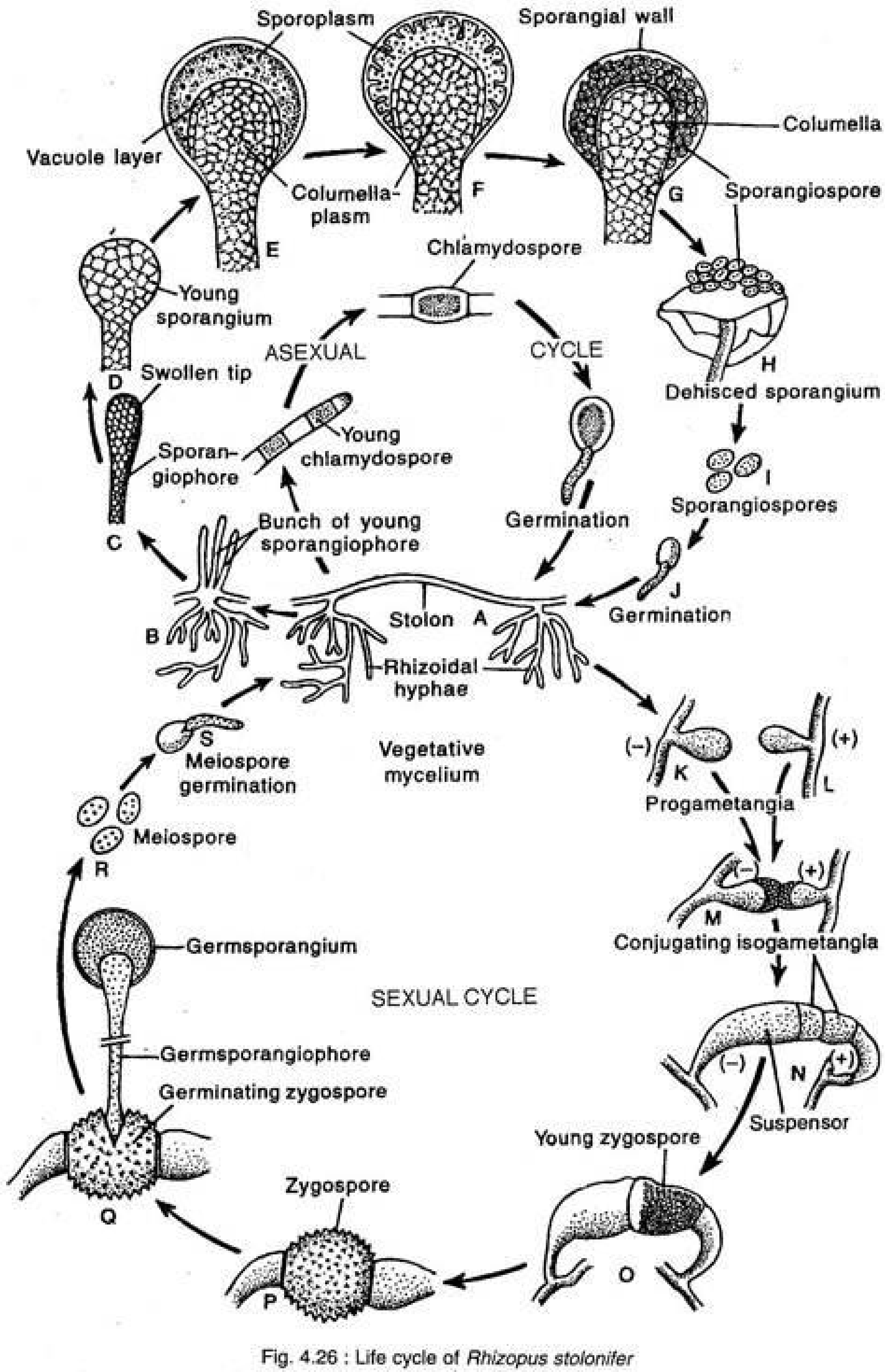


Fig. 4.26 : Life cycle of *Rhizopus stolonifer*

In ideal moisture and temperature, if the spores fall on suitable substratum, they germinate by germ tube to form new mycelia (Fig. 4.26I, J)

(b) Chlamydospore:

During unfavourable condition, thick-walled, nutrition-rich, intercalary mycelium segments arise by septation of mycelium, termed as chlamydospores. They get separated from each other when the connecting mycelium dries up. With the onset of favourable condition, the chlamydospore germinates and gives rise to a new mycelium.

3. Sexual Reproduction:

Sexual reproduction takes place during unfavourable condition by means of gametangial copulation. The gametangia look alike, but equal or unequal in size and, by conjugation, they give rise to zygospore. Most of the species of Rhizopus are heterothallic (Rhizopus. stolonifer), but few species (R. sexualis) are homothallic.

In heterothallic species, zygospores are produced by the union of two gametangia developed from mycelia of compatible strains (Fig. 4.26K, L); whereas, in homothallic species, the uniting gametangia develop from mycelia that derived from a single spore.

When heterothallic species are cultured, two mycelia of compatible strain come near to each other, the mycelia produce small outgrowth, called progametangia (Fig. 4.26 K, L). The apical region of the two progametangia come in close contact (Fig. 4.26M). Nuclei and cytoplasm of each progametangium push more and more towards the apical region which swell up with dense protoplasm.

The rear region becomes vacuolated. A septum is laid down separating the apical region, which is called gametangium; and the basal region, is called suspensor. The undifferentiated multi-nucleate protoplast of the gametangium is called aplanogamete or coenogamete (Fig. 4.26N).

There is much variation in size of the gametangium pairs. In some pairs, the uniting gametangia are equal in size, but in other pairs they are unequal.

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 (Fig. 4.26O, P). The nuclei of opposite gametangia fuse together to form diploid (2n) nuclei and unpaired nuclei gradually degenerate.

The young zygospore enlarges and probably secretes five layered (two in exospore and three in endospore) thick wall, which undergoes a period of rest (Fig. 4.26P).

After resting period, the zygospore germinates. On germination, the innermost layer comes out after cracking the outer walls and produces a promycelium. With further development, the promycelium is differentiated into a lower stalk like germsporangiophore and an upper spherical germsporangium (Fig. 4.26Q).

Meiosis occurs during zygospore germination and the haploid nuclei form haploid spores like sporangiospores inside the germsporangium. These spores are also known as meiospores (Fig. 4.26R). Each meiospore after liberation germinates like sporangiospore, and forms new mycelium like mother thallus (Fig. 4.26S).

Sometimes failure of gametangial copulation results in parthenogenic development of zygospore, by any one gametangium, called azygospore or parthenospore. It is however haploid in nature and its nuclei do not undergo meiosis before spore formation.

Economic Importance of Fungi

Fungi include hundreds of species which are of tremendous economic importance to man. In fact our lives are intimately linked with those of fungi. Hardly a day passes when we are not benefited or harmed directly or indirectly by these organisms.

They play an important role in medicine yielding antibiotics, in agriculture by maintaining the fertility of the soil and causing crop and fruit diseases, forming basis of many industries and as important means of food. Some of the fungi are important research tools in the study of fundamental biological processes.

Some of the fungi particularly mold and yeasts play a negative role by causing spoilage of stored goods such as foodstuffs, textiles, leather, rubber, plastic, timber and even glass.

1. Role of Fungi in Medicine:

Some fungi produce substances which help to cure diseases caused by the pathogenic microorganisms. These substances are called the antibiotics.

The term antibiotic, therefore, denotes an organic substance, produced by a microorganism, which inhibits the growth of certain other microorganisms. The most important antibiotics are produced by the moulds, actinomycetes or bacteria.

They are used to combat the evil effects of pathogenic bacteria and viruses. The use of antibiotics is not limited to disease treatment.

The addition to certain antibiotics in small amounts to the feed of slaughter animals promotes rapid growth and improves the quality of the meat products. Application of an antibiotic to surface of freshly killed poultry preserves the fresh-killed taste during long periods of refrigeration.

The discovery of antibiotic agents as drugs is comparatively a recent history. The role of fungi m producing antibiotic substances was first established by Sir Alexander Fleming in 1929.

He extracted the great antibiotic drug Penicillin from Penicillium notatum. It was the first antibiotic to be widely used. Penicillin is an organic substance lethal to microbes. It is far more effective than ordinary drugs and germicides.

It has no adverse effect on human protoplasm but kills bacteria especially gram-positive type. Penicillin is now produced on a commercial scale all over the world including India from the improved strains of P. notatum and P. chrysogenum.

There is a Penicillin factory at Pimpri in India. The success of penicillin as an antibiotic was later found to be limited. Naturally this led to further research for new antibiotics which would act on pathogenic bacteria and viruses not affected by penicillin.

This research resulted in the discovery of a number of other antibiotics. Of these, streptomycin is another.

Streptomycin - Samples

Streptomycin is obtained from Streptomyces griseus. It is of great value in medicine. It destroys many organisms which are not killed by penicillin particularly the gram-negative organisms. A numbers of antibiotics have also been extracted from Aspergillus cultures.

However, these have not been proved so effective as penicillin. Some of the actinomycetes which are not considered to be true filamentous bacteria are the sources of many antibiotics such as chloromycetin, aureomycin, terramycin, etc.

They inhibit the growth of many pathogenic bacteria and are also used successfully in the treatment of various virus diseases. Many animal and human diseases which do not respond readily to other antibiotics are effectively cured by aureomycin.

The plasmodia of certain species of Myxogastres have been reported to yield soluble antibiotics. These check the growth of certain bacteria and yeasts in culture. The antibiotics play an important role to combat plant diseases as well.

Aureomycin - Samples Chloromycetin - Samples Terramycin - Samples

Griseofulvin which is recovered from mycelium of Penicillium griseofulvum and many other species has antifungal properties. It acts on the hyphae by interfering with wall formation Consequently the hyphal tips curl and cease to grow.

When administered orally it is absorbed into the body where it accumulates in the keratinized tissues of the epidermis and hair. It is thus effective against fungal skin diseases such as ringworms and athlete’s foot disease.

Claviceps purpurea produces sclerotia in the ovaries of the flowers of grasses such as rye The sclerotium is called the ergot of rye. Ergot is used in veterinary and human medicine.

It contains a mixture of alkaloids which cause rapid and powerful contractions of the uterus. The medicine is thus used to control bleeding during child birth. Ergot is highly poisonous. A derivative of ergot known by the name of lysergic acid (LSD) is used in experimental psychiatry.

The giant puff ball Clavatia contains an anti-cancer substance calvacin. The eating of these fungi prevents stomach tumours.

Griseofulvin - antifungal

Sclerotia of Ergot

Claviceps purpurea (source of LSD)

2. Role of Fungi in Industry:

The industrial uses of fungi are many and varied. In fact the fungi form the basis of many important industries. There are a number of industrial processes in which the biochemical activities of certain fungi are harnessed to good account.

A brief sketch of some of the most important of these processes is given below:

(i) Alcoholic fermentation:

It is the basis of two important industries in India or rather all over the world. These are brewing and baking. Both are dependent on the fact that the fermentation of sugar solutions by yeasts produces ethyl alcohol and carbon dioxide.

In brewing or wine making industry alcohol is the important product. The other by-product which is carbon dioxide was formerly allowed to escape as a useless thing.

Now carbon dioxide is also considered a valuable by-product. It is collected, solidified and sold as **"dry ice".** In the baking or bread- making industry CO_2 is the useful product.

It serves two purposes:

(i) Causes the dough to rise.

(ii) Makes the bread light.

The other by-product, which is alcohol, is incidental. The yeasts secrete the enzyme complex called zymase which brings about conversion of sugar into alcohol. Many excellent yeast strains are now available.

The yeasts lack diastase. So they cannot break starch into sugar. There are a number of fungi popularly known as the moulds. They secrete a whole range of enzymes and thus bring about fermentation of complex carbohydrates.

In producing industrial alcohol moulds are employed as starters to bring about scarification of the starch. At the second stage yeast is employed to act on the sugar.

Although mould can complete the conversion to sugar but the yield is better if yeast is employed for the second stage. The moulds commonly used for purpose of scarification are Mucor racemosus.

M, rouxii and some species of Rhizopus. Aspergillus flavus is used in the production of African native beer.

(ii) Enzyme preparations:
Takamine on the basis of his intensive study of the enzymes produced by Aspergillus flavus-oryzae series has introduced in the market a few products of high enzymic activity. These are Digestin, Polyzime, Taka diastase, etc. They are used for dextrinization of starch and desiring of textiles.

Cultures of Aspergillus niger and A. oryzae on trays of moist, sterile bran yield a well-known amylase which contains two starch splitting components.

Invertase is extracted from Saccharoymces cerevisiae. It has many industrial uses. It hydrolyses sucrose to a mixture of glucose and fructose.

(iii) Preparation of organic acids:
The important organic acids produced commercially as the result of the biochemical activities of moulds are oxalic acid, citric acid, gluconic acid, gallic acid, fumaric acid, etc.

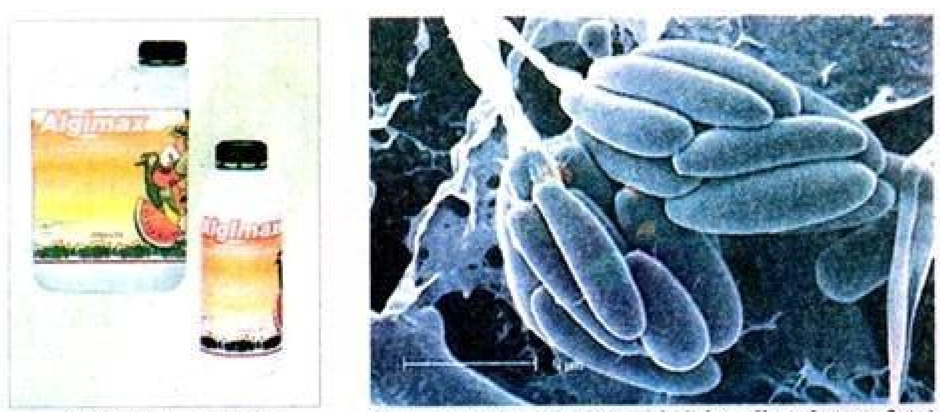
Oxalic acid is the fermentation product of Aspergillus niger. Citric acid is made by mould fermentation. Many species of Penicillium are used for the purpose. The acid is produced on a commercial scale and is cheaper than the acid made from the citrus fruits.

The gluconic acid is prepared from sugars. The moulds chiefly employed for this purpose are some species of Penicillium and Aspergillus.

Gallic acid is prepared on a commercial scale in Europe and America. The details of the method employed, however, are not known. It may be a modification of Calmete's process.

Calmette (1902) obtained the gallic acid as the fermentation product of an extract of tannin by Aspergillus gallomyces.

(iv) Gibberellins:
These are plant hormones produced by the fungus Gibberella fujikuroi which cause a disease of rice accompanied by abnormal elongation. Gibberellin is used to accelerate growth of several horticultural crops.



Gibberellin - Samples *Gibberella fujikuroi (cause of foolish seedling disease of rice)*

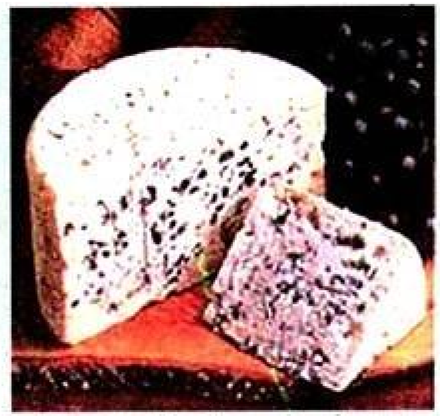
A PLANT HORMONE

(v) Cheese Industry:
Certain fungi popularly known as the cheese moulds play an important role in the refining of cheese. They give cheese a characteristic texture and flavour.

The two chief kinds of mould refined cheese are:
(a) Camembert and Brie types. They are soft.

(b) Roquefort Gorgonzola and Stilton types. They are green or blue veined cheese. The moulds concerned are Penicillium camemberti and P. caseicolum in the first type and P. roqueforti in the second type.

Camembert Cheese - Samples



Roquefort Cheese - Samples

(vi) Manufacture of Proteins:
As a supplement to the normal diet, some fungi particularly the yeasts are employed to synthesize proteins. The yeast (Saccharomyces cerevisiae and Candida utilis) contain high percentage of protein of great nutritive value.

They are grown with ammonia as the source of nitrogen and molasses as the source of carbon. The manufactured product is called Food Yeast. It contains 15% protein and B group of vitamins.

(vii) Vitamins:
The yeasts, are the best source of vitamin B complex. A number of preparations of high potency have been made from the dried yeast or yeast extracts and sold in the market.

A number of moulds and yeasts are utilised in the synthesis of Ergosterol which contains Vitamin D. Riboflavin—another vitamin useful both in human and animal food—is obtained from a filamentous yeast, Ashby gossypii.

(viii) A good many fungi synthesize fat from carbohydrates:
Endomyces vernalis, Penicillium javanicum and Oidium lactis have a high fat content. The microbiological production of fat is, however, too costly for use.

(ix) Antibiotics:
Certain fungi form an important basis of fermentation of Cocaobeans. Mention must also be made here of the use of Lichens in yielding certain dyes and reagents. An important substance is extracted from Roccella lichen.

It forms the basis of litmus paper which is used as an indicator to determine the acidity or alkalinity of a solution.

3. Role of Fungi in Agriculture:
The fungi play both a negative and a positive role in agriculture.

A. Negative Role:
They have a negative value because they are the causative agents of different diseases of our crop, fruit and other economic plants. These fungal diseases take a heavy toll and cause tremendous economic losses.

The modest estimate is that about 30 thousand different diseases (including bacterial and virus) attack the economic plants grown for food or commercial purposes.

The more important of these diseases are:
(i) Damping off disease:
The seedlings of almost every type of plant grown as a commercial crop such as tomatoes, com, cotton, mustard, peas, beans, tobacco, spinach, etc., are prone to this disease. It is caused by a species of Pythium.

(ii) The potato blight:
(Late blight of potatoes) is another destructive crop disease. It does a great damage to the potato tubers. A heavy attack of this disease in Ireland in 1845 destroyed the entire potato crop and caused so severe a famine that over a million Irish people migrated to U.S.A. Besides potatoes, it infects egg plants, tomatoes, etc.


Late Blight on Potato Tuber


Late Blight on Potato Leaves

(iii) Downy mildews of grapes:
It ruins the vine yards and thus causes heavy losses to the crop. When the disease was first introduced into France from U.S.A, it caused a havoc to the vine yards.

Almost all the French vine yards were destroyed before Bordeaux mixture, which proved an effective fungicide against this disease, was discovered.

Downy Mildew of Grapes

(iv) Ergot disease of rye:

It is an important disease of a cereal crop—rye. It results in the formation of poisonous sclerotia in the rye kernel. It is called ergot of rye. Ergot is highly poisonous to man. Ergot poisoning causes hallucinations, insanity and finally death.

Ergot on Rye

(v) Apple scab:

It is a serious disease of the apple crop. It lowers the quality as well as quantity of the fruit.

Apple Scab on fruits

(vi) Brown rot of stone fruits:

It causes enormous losses in the fruit crop of apricots, cherries, plums and peaches.

Brown Rot of Stone Fruits

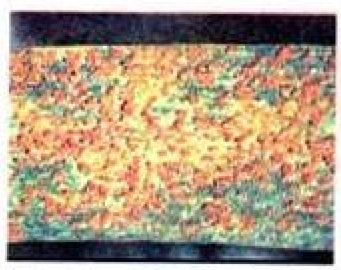
(vii) Smut diseases of corn, wheat, oat and other cereal crops cause serious reduction in the yield and quality of grain.

(viii) Red rot disease of sugarcane:

It is a serious disease of sugarcane whose incidence has increased during the last few years, particularly in the northern parts of the country.

(ix) Rust diseases:

They attack our cereal crops and forest timber. Some of them such as black stem rust, yellow rust and orange rust are a serious threat to our wheat crop.



Orange Rust on leaves

Red rot of Sugarcane

(x) Blackarm, Wilt and root rot of cotton:

These diseases of cotton, which is a very important commercial crop of our country, take a heavy toll of the crop every year.

(xi) Pore fungi:

They are the common wood rotters. They destroy timber and lumbar.

·Wilt of Cotton | Root rot of Cotton | Wood Rotting Pore Fungi

The above-mentioned diseases caused by fungi are thus responsible for a huge loss to our crop and other economic plants. The pathogenic fungi are always a nuisance to the agriculturists.

They affect the agricultural economy of our country seriously. The farmer and the Agriculture department must wage a constant war against them.

It will not be out of place if a brief mention is made here of some of the human diseases caused by the fungi. Some species of Aspergillus such as A. fumigatus, A. flavus, and A. niger are human pathogens.

They cause disease collectively known as aspergilloses such as aspergilloses of lungs, external ear, etc. Many parasitic Fungi Imperfecti live in the mucous membranes of throat, bronchi and lungs and cause infection of mouth and lungs.

A few fungi cause skin discoloration. Others (Trichophytoneae) are the causative agents of a disease known as athlete's foot. The well-known skin disease 'ring worm' and barber's itch are also fungal diseases.

Monilia—a member of the class Fungi Imperfecti—causes a throat or mouth disease known as thrush. A few fungi cause serious diseases of domestic animals. Some fungi produce diseases among annoying insects harmful to crop and thus help to destroy them and keep them in check.

Entomopathogenic Fungus-Pandora

Thrush

Aspergilloses

Athelete's Foot

TABLE I

List of some important plant diseases caused by fungi

	Name of the disease	Pathogen
1.	Club root of Crucifers	*Plasmodiophora brassicae*
2.	Wart disease of potato	*Synchytrium endobioticum*
3.	Stem Rot of Papaya	*Pythium aphanidermatum*
4.	Damping off of seedlings	*Pythium sp.*
5.	Late blight of potato	*Phytophthora infestans*
6.	White rust of crucifers	*Albugo candida*
7.	Downy mildew of peas	*Peronospora pisi*
8.	Green ear disease of Bajra	*Sclerospora graminicola*
9.	Powdery mildew of peas	*Erysiphe polygoni*
10.	Powdery mildew of wheat	*Erysiphe graminis*
11.	Leaf curl of peaches	*Taphrina deformans*
12.	Stem gall of coriander	*Protomyces macrosporous*
13.	Ergot disease of rye	*Claviceps purpurea*
14.	Rust of wheat	*Puccinia graminis*
15.	Rust of pea	*Uromyces pisi*
16.	Rust of gram	*Uromyces ciceris-arieteni*
17.	Rust of Linseed	*Melampsora lini*
18.	Covered smut of barley	*Ustilago hordei*
19.	Loose smut of wheat	*Ustilago nuda*
20.	Bajra smut	*Tolyposporium penicillariae*
21.	Grain smut of Jowar	*Sphacelotheca sorghi*
22.	Bunt of wheat	*Tilletia tritici*
23.	Early blight of potato	*Alternaria solani*
24.	Wilt of pigeon pea	*Fusarium oxysporum*
25.	Red rot of sugarcane	*Colletotrichum falcatum*
26.	Tikka disease of groundnuts	*Cercospora personata*
27.	Stripe disease of barley	*Helminthosporium graminieum*

TABLE II

List of some common disease of human beings caused by fungi

	Name of the disease	Pathogen
1.	Aspergillosis	*Apsergillus flavus, A. niger*
2.	Blastomycosis	*Blastomyces dermatidis*
3.	Otomycosis	*Aspergillus fumigatus*
4.	Neuritis	*Mucor pusillus*
5.	Onychomycosis	*Trichophyton purpureum*
6.	Candidiasis	*Candida albicans*
7.	Histoplasmosis	*Histoplasma capsulatum*
8.	Geotrichosis	*Geotrichum candidum*
9.	Chromomycosis	*Cladosporium immitis*
10.	Allergy	Spores of *Aspergillus, Chaeotomium etc*
11.	Dermatomycosis	*Trichoderma viride*

TABLE III

List of some animal diseases caused by fungi.

Name of the disease	Pathogen
Penicillosis	Spp. of *Penicillium*
Aspergillosis	Spp. of *Aspergillus*
Athelete foot	*Tinea rubrum*
Ringwarm	*Trichophytom, Microsporum*
Mucomycosis	*Mucor, Rhizopus*

In addition to causing diseases in plants, human beings and domestic animals as described above, the fungi also play the following harmful roles:

(a) Destruction of timber:

Several fungi such as Polyporus, Serpula lacrymans, Fusarium negundi, Coniophora cerebella, Lentinus lapidens and Penicillium divaricatum cause destruction of valuable timbers by reducing the mechanical strength of the wood.

(b) Destruction of textiles:

Several fungi are able to grow on cotton and woolen textiles causing their destruction. These include spp. of Alternaria, Penicillum, Aspergillus, Mucor and Fusarium. Spp. of Stachybotrys causes destruction of cotton in storage. Chaetomium globosum is reported to cause greatest damage to textiles.

Timber Destruction

Stachybotrys Damaging Paper

(c) Destruction of Paper:

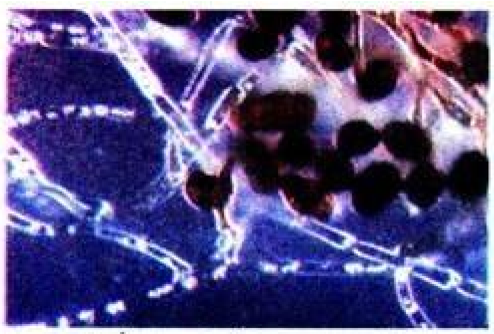
Paper pulp wood is destroyed by the growth of Polyporus adustus, Polystictus hirsutus etc. several fungi such as species of Chaetomium, Aspergillus, Stachybotrys, Alternaria, Fusarium, Dematium, Mucor, Cladosporium etc. cause extensive damage to paper of books, newspapers and paper industry.

B. Positive Role of Fungi:

Some soil fungi are beneficial to agriculture because they maintain the fertility of the soil. Some saprophytic fungi particularly in acid soils where bacterial activity is at its minimum cause decay and decomposition of dead bodies of plants and their wastes taking up the complex organic compounds (cellulose and lignin) by secreting enzymes.

The enzymes convert the fatty carbohydrate and nitrogenous constituents into simpler compounds such as carbon dioxide, water, ammonia, hydrogen sulphide, etc.

Some of these return to the soil to form humus and the rest of the air from where they can again be used as raw material for food synthesis. There are fungi in the soil which produce more ammonia from proteins than the ammonifying bacteria.



Soil Fungi

Soil mushrooms enhancing soil fertility

Besides, many saprophytic fungi of decay maintain the never ending cycle of carbon dioxide which is a most important raw material for plant photosynthesis in nature.

They also bring about rot, decay and decomposition of animal and plant remains releasing plant nutrients in a form available to green plants as food. The soil fungi utilize many inorganic salts.

These are prevented from being lost from the soil by leaching. Some fungi form mycorrhizal association with the roots of certain plants and help them in their nutrition.

Such plants will grow satisfactorily only when the mycelium of the appropriate fungal partner is present in the soil. The fertile soil contains twice as much living fungus cell material as the material from bacteria and other soil microorganisms.

Giberrrelin produced by Gibberella fujikuroi is used as growth hormone accelerating plant growth.

Gibberellin spray accelerates plant growth

Mycelial hypha

Many insect pests can be controlled by the growth of fungi such as Empusa sepulchrasis, Metarrhizium anisopliae, Cordyceps melothac etc.

Some common fungal inhabitants of the soil help to combat diseases caused by soil borne fungi. Trichoderma lignorum and Gliocladium fimbriatum are found in damp soils. They have an inhibitory effect on the growth of the mycelium of Pythium.

They serve to suppress fungi causing the damping off disease of the seedlings and thereby influence favourably the growth of crops.

Metarhizium - an entomopathogenic fungus

Drechsler (1937) reported that there are some predacious fungi (Fig. 17.1 A-C) in the soil. They trap and destroy the nematodes (eel worms). Some species of these predatory soil fungi form loops on the mycelium (A). These loops act as nooses.

They tighten and strangle the nematodes as they try to pass through (B). The mycelium later sends out special hyphae (C) to absorb nutrition from the captive. Some predatory soil fungi produce conidia which are sticky.

As the nematodes pass through the soil the stickly conidia stick to their bodies. There the conidia germinate to produce hyphae which penetrate into the tissues of the host and absorb nourishment.

At the National Botanical Research Institute, Lucknow and at several other national institutes, fungi are being tested as biopesticides especially as nematicides and as fungicides.

An important fungus being used as nematicide is Beauveria bassiana against borers, thrips, and aphids. Trichoderma viride and T. harzianum are other examples which are used against a large number of soil-borne pathogens.

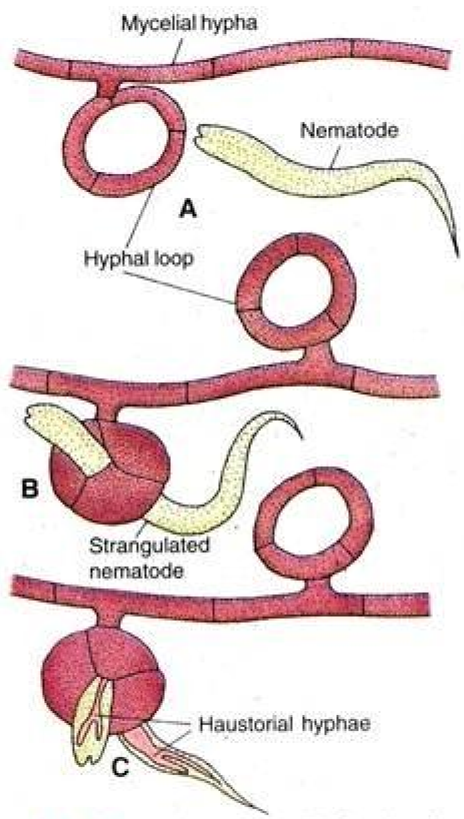


Fig. 17.1. *Predacious Fungi.* Explanation in the text.

4. Role of Fungi as Food and as Food Producers:

Many species of fungi are edible, about 2000 species of them have been reported from all over the world. Of these, about 200 are said to occur in the Western Himalayas.

Many edible fungi are of great economic value as food. They are regarded as delicacies of the table. There are said to be over 200 species of edible fungi.

The fructifications of some fungi such as the field mushroom Agaricus campestris (dhingri), Podaxon podaxis (Khumb), the honey coloured mushrooms, the fairy ring mushrooms, the puff balls (Lycoperdon and Clavatia), morels (Morchella, guchhi), and truffles are edible.

The content of available food in them is not high but they supply vitamins and are valuable as appetisers. Yeasts and some filamentous fungi are valuable sources of vitamins of the B-complex.

A few of the mushrooms are fatally poisonous, some cause only discomfort. To the former category belong Amanita.

Amanita

The fungi are also important as producers of foodstuffs. Certain species of Penicillium are active in the refining of certain kind of cheeses. Some fungi, such as red bread mold, Neurospora sitophila and others, complete their sexual life cycle in a few days and thus make ideal organisms for the study of the laws of heredity.

The slime molds (Physarum polycephalum) are now widely used in research. P. polycephalum has proved an excellent experimental organism for the study of DNA synthesis, meiotic cycle and the mechanism of protoplasmic streaming.


Penicillium digitatum on Bread Aspergillus on Bread

Many fungi are responsible for spoilage of food stuffs. Penicillium digitatum causes rotting of citrus fruits. Milk and milk products are spoiled and made unfit for human use due to the growth of several fungi such as Mucor, Aspergillus, Penicillium, Oidium and Fusarium Mucor mucedo and spp. of Aspergillus grow on bread and spoil it. Oidium lactis develops the fishy odour of butter causing damage to the butter.

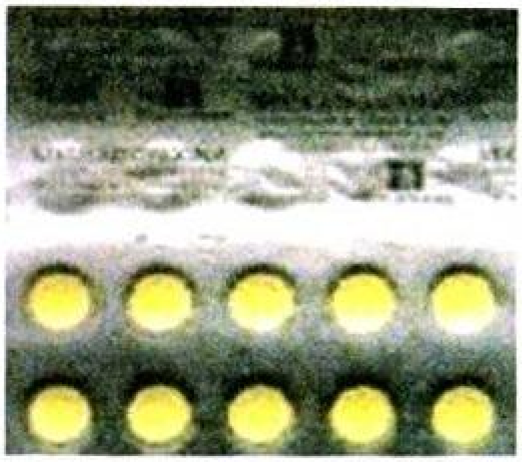
In tropical conditions, many fungi such as Mucor sp., Penicillium, Neurospora, Fusarium, Aspergillus etc., grow on meat causing sufficient spoilage.

Aflatoxins the most potent carcinogenic agent-are produced by Aspergillus flavus, A. fumigatus, A. parasiticus and Penicillium islandicum on dried foods and groundnut meal.

Aflatoxins are reported to bind with DNA and prevent its transcription arresting protein synthesis. These are responsible for liver cancer in animals and human beings.

Mushroom toxins are produced by several poisonous mushrooms. These cause diarrhoea vomiting, liver damage, complete unconsciousness etc. Mushroom toxins are commonly produced by Amanita phalloides, spp. of Helvella and some species of Inocybe.

Ergot toxins produced by Claviceps purpurea contain poisonous alkaloids like ergotamine, ergometrimine, ergocrystinine, ergocrystinine and ergonovin. These cause diarrhoea, abdominal pain, vomiting and psychiatric disturbances.



Ergotamine - a poisonous alkaloid produced by Claviceps purpurea

Fungi as Test Organism:

During the last two decades, the fungi has been used to test various biological .processes. Since they grow very fast and require a short period to complete their life cycles, the fungi are best suited for use as test organisms.

Fungi form very good research material for genetical studies and other biological processes Genus Neurospora has become very good material for genetic studies while Physarum polycephalum is used to study steps in DNA synthesis, morphogenesis and mitotic cycle.

To detect the presence and quantity of vitamin B in given sample, Neurospora crassa is commonly used. Similarly Aspergillus niger is used for detection of trace elements like zinc, nickel and copper even when they are present in very minute quantities.