

Fungi (Multicellular decomposers)

The terms 'fungus' has been derived from the Latin word which means mushroom. The science dealing with the study of fungi is called as mycology. Clausius (1601) may be regarded as one of the earliest writers to describe fungi. The term 'Fungus' was coined by Gaspard and Bauhin. Bauhin (1623) also included the account of known fungal forms in his book *Pinax Theatric Botanica*. Kingdom fungi has been called mycota by Von Arx (1981) and mycetae by Alexopoulos. Anton de Bary is known as 'Father of Modern Mycology and plant pathology'.

Famous Indian Mycologists : Dastur, Mundkar, Prof. K.C. Mehta (associated with study of annual recurrence of wheat rust in India), Thind, Srinivasan, K.G. Mukherji, Chaudhary and Sadasivan are other famous mycologists of India

Thallus organization

The plant body of true fungi (Eumycota) is **thallus**. It may be non-mycelial or mycelial. The non-mycelial forms are unicellular, however, they may form a **pseudomycelium** by budding. In mycelial forms, the plant body is made up of thread like structures called hyphae (sing. hypha). The mycelium may be **aseptate** (non-septate) or **septate**. When non-septate and multinucleate, the mycelium is described as **coenocytic**. In lower fungi the mycelium is non-septate e.g., Phycomycetes. In higher forms it is septate e.g., Ascomycetes, Basidiomycetes and Deuteromycetes. In some forms the plant body is unicelled at one stage and mycelial at the other. Their organization is sometimes described as **dimorphic**.

When the entire mycelium is converted into reproductive structure, the thallus is described as **holocarpic**. However, if only a part of it becomes reproductive, the thallus is called as **eucarpic**.

Specialised formation

In higher forms the mycelium gets organised into loosely or compactly woven structure which looks like a tissue called **plektenchyma**. It is of two types :

Prosenchyma : It comprises loosely woven hyphae lying almost parallel to each other.

Pseudoparenchyma : If the hyphae are closely interwoven, looking like parenchyma in a cross-section, it is called as pseudoparenchyma.

In addition to above, the fungal mycelium may form some specialized structures as under :

Rhizomorphs : It is a 'root or string-like' elongated structure of closely packed and interwoven hyphae. The rhizomorphs may have a compact growing point.

Sclerotia : Here the hyphae gets interwoven forming pseudoparenchyma with external hyphae becoming thickened to save the inner ones from desiccation. They persist for several years.

Stroma : It is thick mattress of compact hyphae associated with the fruiting bodies.

Cell organization

The cell wall of fungi is mainly made up of chitin ($C_{22}H_{34}N_4O_{21}$) and cellulose. While chitin is a polymer of N-acetyl glucosamine, the cellulose is polymer of d-glucose. Precisely, the cell wall may be made up of cellulose-glucan (oomycetes), chitin-chitosan (Zygomycetes), mannan-glucan (Ascomycetes), chitin-mannan (Basidiomycetes) and chitin-glucan (some Ascomycetes, Basidiomycetes and Deuteromycetes). Besides, the cell wall may be made up of cellulose-glycogen, cellulose-chitin or polygalactosamine-galactan.

The cell wall is closely associated with the inner layer, the plasma membrane. In fungi, plasma membrane bears coiled membranes outgrowth called **lomasomes** (Moore and McAlear, 1961).

Fungi cells are eukaryotic. They possess all eukaryotic organelles such as mitochondria, E.R., ribosomes, microbodies, lysosomes, vacuoles and reserve food particles (glycogen, lipid etc.). Golgi body or dictyosome are also not typical. In many cases they are **unicisternal**. The cells lack chloroplast. However, a reddish pigment, **neocercosporin** has been isolated from the fungus *Cercospora kikuchii*. The vacuoles are bound by tonoplast. The genetic material is DNA.

Fungi possess true nucleus having definite nuclear envelope. The nuclear envelope persists during nuclear division. It has called **karyochorisis** by Moore (1965). The nuclear spindle is formed within the nuclear envelope in both mitosis and meiosis. The spindle poles either contain centrioles or spindle pole bodies (SPB) but lack microtubular organization.

Nutrition

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

Parasites : They obtain their food from a living host. A parasite may be **obligate** or **facultative**. The obligate parasites thrive on a living host throughout their life. The facultative parasites are infact saprophytes which have secondarily become parasitic.

Saprophytes : They derive their food from dead and decaying organic matter. The saprophytes may be **obligate** or **facultative**. An obligate saprophyte remains saprophytic throughout its life. On the other hand, facultative saprophyte is infect a parasite which has secondarily become saprophytic.

Symbionts : Some fungal forms grow in symbiotic association with the green or blue-green algae and constitute the **lichen**. A few fungal forms grow in association with the roots of higher plants. This association is called as **mycorrhiza**.

Reproduction

(1) 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.

(2) Asexual reproduction

Oidia : In some mycelial forms the **thallus** breaks into its component cells. Each cell then rounds up into a structure called oidium (pl. oidia). They may germinate immediately to form the new mycelium, e.g., *Rhizopus*.

Chlamyospores : Some fungi produce chlamyospores which are thick walled cells. They are intercalary in position. They are capable of forming a new plant on approach of favourable conditions, e.g., *Rhizopus*, *Saprolegnia*, *Ustilago*.

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**. e.g., *Rhizopus*, *Mucor*.

Zoospores : They are thin-walled flagellate spores which occur in aquatic fungi. These spores are formed in a zoosporangium. The zoospores are of several types :

- Uniflagellate with whiplash type flagellum e.g., *Allomyces*.
- Uniflagellate with tinsel type flagellum e.g., *Rhizidiomyces*.
- Biflagellate with a tinsel type and a whiplash type flagella e.g., *Saprolegnia*.
- Biflagellate with two whiplash type flagella e.g., *Plasmodiophora*.

Conidia : In some fungi the spores are not formed inside a sporangium. They are born freely on the tips of special branches called **conidiophores**. The spores thus formed are called as conidia. e.g., *Penicillium*.

(3) **Sexual reproduction** : With the exception of Deuteromycetes (fungi imperfecti), the sexual reproduction is found 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.

These three events are responsible for the arrival of the following three mycelial phases :

Haplophase : As a result of meiosis the haploid (n) or haplophase mycelium is formed.

Dikaryotic phase : The plasmogamy results in the formation of dikaryotic mycelium ($n + n$).

Diplophase : As a result of karyogamy the diplophase mycelium ($2n$) is formed.

The fungi reproduce sexually by the following methods

Planogametic copulation : In this type of copulation fusion occur between flagellate gamete. It is of three types :

(i) **Isoplanogametic copulation** : Both the fusion gametes are similar and flagellate. e.g., *Synchytrium*.

(ii) **Anisoplanogametic copulation** : The fusing gametes are flagellate, similar in structure but different in size. In which one is small and other one is large. e.g., *Allomyces*.

(iii) **Ooplanogametic copulation** : It is union between a small flagellate male gamete and a large nonflagellate food laden female gamete or ovum. . e.g., *Monoblepharella*.

□ **Gametangial contact** : It involves fusion of two gametangia. In lower forms the female gametangium is called as **oogonium**. The male gametangium is termed as **antheridium**. A contact develops in between the two gametangia and then the male nucleus is transferred into the female directly or through a tube. e.g., *Phytophthora*, *Albugo*.

□ **Gametangial copulation** : In this case the fusion occurs in between the two gametangia. When it occurs in some holocarpic forms where the entire thallus acts as gametangium, the phenomenon is called as **hologamy**. In others, dissolution of cell wall in between the two gametangial brings about gametangial copulation. e.g., *Rhizopus*, *Mucor*.

□ **Spermatization** : Here the uninucleate male gametes called **spermata** are formed in special structures called **spermogonia** or **pycnidia**. The female gametangium is called as **ascogonium** which has a long neck called **trichogyne**. The spermatium attaches itself with the trichogyne and transfers the male nucleus, thus bringing about **dikaryotisation**. e.g., *Puccinia graminis*.

Somatogamy : In higher fungi there is reduction of sexuality to the maximum level. Here two hyphae of opposite strains are involved in fusion thus bringing about **dikaryotization**. e.g., *Penicillium brefeldianum*, *Agaricus*.

Clamp connection

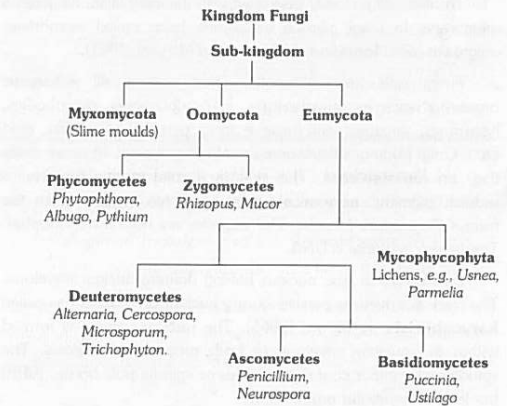
In Basidiomycetes, the dikaryotic cells divide by **clamp connections**. They were first observed by Hoffman (1856) who named it as '**Schnallenzellen**' (buckle-joints). A lateral pouch like outgrowth arises which projects downward like a hook. This pouch or **clamp** becomes almost parallel to the parent cell. The two nuclei now undergo conjugate division in such a way that one spindle lies parallel to the long axis of the cell and the other somewhat obliquely. As a result, one daughter nucleus enters into the clamp.

Heterothallism

Blakeslee, (1904) while working with *Mucor* sp. observed that in some species sexual union was possible between two hyphae of the same mycelium, in others it occurred between two hyphae derived from 'different' spores. He called the former phenomenon as **homothallism** and the later as **heterothallism**. Thus, the homothallic species are self-fertile whereas the heterothallic are self sterile. In heterothallic species the two 'thalli' are sexually incompatible. They are said to belong to opposite strains. Blakeslee designated them as + and - i.e., belonging to opposite strains or mating types. Bipolar heterothallism found in *Mucor* and *Rhizopus*.

Classification

The classification of fungi based on the characteristics of the life cycle involved like nature of somatic phase, kinds of asexual spores, kinds of sporangia, nature of the life cycle and presence or absence of perfect or sexual stage.



Important features of classes

(1) **Phycomycetes (Oomycetes/Algal fungi)** : It is also called lower fungi, mycelium is coenocytic. Hyphal wall may contain chitin or cellulose (e.g., *Phytophthora*). Asexual reproduction occurs with the help of conidio-sporangia. Under wet conditions they produce **zoospores**. Under dry conditions, the sporangia directly function as conidia. Zoospores have heterokont flagellation (one smooth, other tinsel). Sexual reproduction is oogamous. It occurs by gametangial contact where male nucleus enters the oogonium through a conjugation tube. The fertilized oogonium forms oospore. e.g., *Saprolegnia*, *Albugo* (*Cystopus*), *Phytophthora*, *Pythium*, *Sclerospora*, *Peronospora*, *Plasmopara*.

(2) **Zygomycetes (Conjugation fungi)** : Mycelium is coenocytic. Hyphal wall contains chitin or fungal cellulose. Motile stage is absent. Spores (*Sporangiospores/Aplanospores*) are borne inside sporangia. Sexual reproduction involve fusion of coenogametes through conjugation (Gametangial copulation). It produces a resting diploid **Zygospor**. On germination, each zygospor forms a germ sporangium at the tip of a hypha called promycelium e.g., *Mucor*, *Rhizopus*, *Pilobolus*, *Abscidia*, *Saksenea*.

(3) **Ascomycetes (Sac fungi)** : These are unicellular as well as multicellular fungi. In the latter, mycelium is septate. The asexual spores formed in chains are called conidia. The spores are formed exogenously, i.e., outside sporangium. They detach from the parent and form new mycelia. Sexual reproduction is through ascospores, which are formed endogenously (within the mycelium) in a sac like structure called **ascus** (pl. asci). Ascus arranged either in linear order (*Neurospora*) or unorderedly (e.g., *Yeast*). The gametes involved in sexual reproduction are nonmotile compatible and are generally represented as + and -. The fusion of gametes is followed by reductional division that produces haploid ascospores.

The fruiting body called **ascocarp**. Genus penicillium belong to this e.g., *Erysiphe*, *Claviceps*, *Clan*,

The ascocarp are of four types :

(i) **Cleistothecium** : It is an ovoid or spherical fruiting body which remains completely closed e.g., *Aspergillus*, *Penicillium*.

(ii) **Perithecium** : It is a flask shaped fruiting body which opens by a single pore called **ostiole**. e.g., *Neurospora*.

(iii) **Apothecium** : It is a saucer-shaped fruiting body. The asci constitute the fertile zone called **hymenium** e.g., *Peziza*.

(iv) **Ascstroma** : It is not a distinct fruiting body. It lacks its own well defined wall. The asci arise directly with a cavity (locule) of stroma. It is also called as **pseudothecium** e.g., *Mycosphaerella*.

(4) **Basidiomycetes (Club fungi)** : They are the most advanced fungi and best decomposers of wood. These are called club fungi because of a club shaped end of mycelium known as basidium. They have septate multinucleated mycelium. Septa possess central dolipores and lateral clamp connections. The sexual spores called basidiospores are generally four in number. They are produced outside the body (exogenous) unlike ascomycetes where they are endogenous. Two compatible nuclei fuse to form zygote, which undergoes meiosis and forms four basidiospores. The fruiting body containing basidia is a multicellular structure called **basidiocarp**. The common members are edible mushrooms (*Agaricus*), smut (*Ustilago*) and rust (*Puccinia*).

(5) **Deuteromycetes (Fungi imperfecti)** : The group include all those fungi in which sexual or perfect stage is not known. Mycelium is made of septate hyphae. Asexual reproduction commonly occur by means of conidia. e.g., *Alternaria solani*, *Fusarium*, *Gibberella*, *Colletotrichum falcatum*, *Helminthosporium oryzae*, *Cercospora personata*.

Economic importance

(1) Harmful aspects

Crop diseases : Several important crop plants are destroyed by fungal diseases. Some important ones are listed here under :

Table : 1.4-1 Fungal disease in plants

Disease	Causal organism
White rust of crucifers	<i>Albugo candida</i> or <i>Cystopus candidus</i>
Early blight of potato	<i>Alternaria solani</i>
Tikka disease of groundnut	<i>Cercospora personata</i>
Ergot disease of rye	<i>Claviceps purpurea</i>
Red rot of sugarcane	<i>Colletotrichum falcatum</i>

Powdery mildew of wheat	<i>Erysiphe graminis</i>
Powdery mildew of pea	<i>Erysiphe polygoni</i>
Leaf spot of oats	<i>Helminthosporium avenae</i>
Brown leaf spot of rice*	<i>Helminthosporium oryzae</i>
Covered smut of barley	<i>Ustilago hordei</i>
Loose smut of wheat	<i>Ustilago tritici</i> :
Late blight of potato**	<i>Phytophthora infestans</i>
Downy mildew of grapes	<i>Plasmopara viticola</i>
Black rust of wheat	<i>Puccinia graminis-tritici</i>
Brown rust of wheat	<i>Puccinia recondita</i>
Yellow rust of wheat	<i>Puccinia striiformis</i>
Damping off of seedlings	<i>Pythium</i> sp.
Wart disease of potato	<i>Synchytrium endobioticum</i>
Covered smut of jowar (Sorghum)	<i>Sphacelotheca sorghii</i>

*Severe famine of Bengal (1943) which caused death of a large number of people was due to this disease.

**Famous famine of Ireland (1845) is associated with this disease which caused death of lakhs of people.

Diseases in human beings : Some important ones are :

Table : 1.4-2 Fungal disease in human

Disease	Causal organism	Place of infection
Athletes foot	<i>Epidermophyton floccosum</i>	Foot
Ring worm	<i>Trichophyton</i> sp., <i>Microsporium</i> sp.	Skin
Moniliasis	<i>Candida albicans</i>	Nails
Aspergillosis	<i>Aspergillus niger</i> , <i>A. flavus</i> , <i>A. terreus</i>	Lungs
Torulosis	<i>Cryptococcus neoformans</i>	Lungs, CNS

Spoilage of food : Some forms like *Rhizopus*, *Mucor*, *Aspergillus*, *Cladosporium* grow on food articles and spoil them. *Cladosporium* grows even at a temperature of -6°C .

Aflatoxins : They are produced mainly by *Aspergillus flavus* and *A. parasiticus*. They are well known for their carcinogenic effect. e.g., Aflatoxin B_1 , B_2 , M_1 , M_2 , G_1 , G_2 .

Poisonous fungi : Some fungi are extremely poisonous e.g., *Amanita phalloides* ('death cup'), *A. verna* and *Boletus satanus*. Forms like *Coprinus*, *Psilocybe* are less poisonous. The fungus *Amanita phalloides* produces toxins like α -**amanitin**, **phalloidin** etc. which are very poisonous.

Ergotism : The fungus causing 'ergot' disease of rye (*Secale*) is *Cleviceps purpurea*. It contains many poisonous alkaloids in their sclerotia. It causes poisoning in human beings. Its acute condition is called as '**St. Anthony's fire**'.

Hallucinogenic drugs : The hallucinogenic drug LSD (Lysergic acid diethylamide) is extracted from *Cleviceps purpurea* as also from *Inocybe*. Besides, the mushroom *Amanita muscaria* is also hallucinogenic.

Rotting of wood : Rotting of wood is caused due to degradation of lignin and cellulose. It is brought about by fungi like *Polyporus* sp., *Fomes* sp. and *Ganoderma* sp., *Fomes* like *Fusarium*, *Penicillium* leave stains on the wood.

Allergies : Spores of *Mucor*, *Aspergillus*, *Penicillium*, *Puccinia* etc., present in the atmosphere cause allergies.

Deterioration of articles : Forms like *Aspergillus*, *Cladosporium*, *Rhizopus*, *Chaetomium*, *Alternaria* deteriorate cork, rubber, leather, textile and even plastics.

(2) Useful aspects

Food : Forms like *Agaricus bisporus*, *Agaricus campestris*, *Podaxon*, *Proclaxia*, *Morchella esculenta*, *Lentinus edodes*, *Clavaria gigantea*, *Volvariella volvacea* are edible. The yeast *Saccharomyces cerevisiae* is used for making '**yeast cake**', when mixed with cereal flour, the yeasts produce a preparation called **incaparina**. The **Single Cell Protein (SCP)** obtained from yeasts, *Penicillium*, *Fusarium* etc. are used as substitute of protein food. *Rhizopus oligosporus* when processed with soyabeans yield a food preparation called '**tempeh**'. It has high protein contents.

Organic acids : Several organic acids are commercially produced by fungi, some of which are given hereunder :

Table : 1.4-3 Fungi as a source of organic acids

Organic acids	Source
Citric acid	<i>Aspergillus niger</i>
Gallic acid	<i>Penicillium glaucum</i>
Gluconic acid	<i>Aspergillus niger</i> , <i>Penicillium purpurogenum</i>
Fumaric acid	<i>Rhizopus stolonifer</i> , <i>Mucor</i> sp.
Lactic acid	<i>Rhizopus nodosus</i>
Kojic acid	<i>Aspergillus flavus</i>
Oxalic acid	<i>Aspergillus niger</i>

Flavouring of food : *Penicillium roquefortii* and *P. camemberti* are employed for flavouring cheese.

Brewing and baking : Yeasts are generally used in bakeries and breweries. e.g., *Saccharomyces cerevisiae*.

Antibiotics : The antibiotics are chemicals produced by living organisms that kill other living organisms. The first known antibiotic is **penicillin** that was extracted from *Penicillium notatum* by A. Flemming, (1944). Raper (1952) also extracted the same antibiotic from *P. chrysogenum*. Besides, several other antibiotics have been extracted since then.

Table : 1.4-4 Fungi as a source of antibiotics

Antibiotics	Source
Griseofulvin	<i>Penicillium griseofulvum</i>
Cephalosporin	<i>Acremonium</i> sp.
Ramycin	<i>Mucor ramannianus</i>
Jawaharin	<i>Aspergillus niger</i>
Patulin/Clavacin	<i>A. patulum/ A. clavatus</i>
Fumigallin	<i>Aspergillus fumigatus</i>
Frequentin	<i>Aspergillus cyclospium</i>
Chloromycetin	<i>Streptomyces venezuelae</i>

Other chemicals : Various chemicals have been obtained from different kinds of fungi. Yeast are good source of glycerol and enzymes like zymase, invertase and lipase. Cellulases are obtained from *Aspergillus*. Some alkaloids are also obtained from fungi e.g., Ergotinine, Ergotretine and Ergobasine from *Cleviceps purpurea*. Gibberellins (plant hormones) are obtained from *Gibberella fujikuroi*. Another hormone, trisporic acid is obtained from *Mucor mucedo*.

Biological assays : The fungi can detect the presence of certain chemicals present in the medium even in traces e.g., *Aspergillus niger* for Mn, Pb, Zn, Cu, Mo etc.

Vitamins : Various vitamins have been obtained from different kind of fungi.

Table : 1.4-5 Fungi as source of vitamins

Vitamins	Source
Vitamin A	<i>Rhodotorula gracilis</i>
Vitamin B ₂	<i>Eremothicum ashbyii</i>
Thiamine B ₁	<i>Saccharomyces cerevisiae</i>
Riboflavin B ₂	<i>Saccharomyces cerevisiae</i>

In biological control : Soil inhabiting fungus *Trichoderma* kills *Pythium* fungus (root rot fungus). Similarly *Penicillium Vermiculatum* checks *Rhizoctonia solani*.

Many species of *Neurospora* have been used as convenient organisms for genital and biochemical studies. *Neurospora* is also known as *Drosophila* of plant kingdom.

Description of some important fungus

Rhizopus/Mucor

Habitat : They are cosmopolitan and saprophytic fungus, living on dead organic matter. *Rhizopus stolonifer* occur very frequently on moist bread, hence commonly called **black bread mold** *Mucor* is called **dung mold**. Both are called **black mold** or **pin mold** because of black coloured pin head like sporangia. Besides, it appears in the form of white cottony growth on moist fresh organic matter, jams, jellies, cheese, pickles, etc.

Structure : The vegetative body or thallus consists of well branched, aseptate and multinucleate (coenocytic) mycelium on the surface of substratum. The mature mycelium is distinguishable into three types of hyphae :

(1) **Stoloniferous hyphae (Stolons) :** These hyphae grow horizontally on the surface of substratum. They are relatively stout and less branched than other hyphae. Certain portions of the stolons called nodes, give out rhizoids and sporangiophores.

(2) **Rhizoidal hyphae :** They arise in clusters from the lower side of each node and are repeatedly branched. The rhizoids penetrate the substratum and serve as anchors for the superficial mycelium. These hyphae secrete enzymes like amylase and maltase into the substratum and absorb the digested food.

(3) **Sporangiophores :** They are erect, aerial, unbranched reproductive hyphae that arise in clusters from the upper side of each node. Each sporangiophore develops single terminal sporangium which is filled with spores. In *Mucor* there is no such distinction. In *Mucor*, the hyphae develop singly. There is no holdfast or apparant node. The hyphal wall is made up of chitin or fungus cellulose, a polymer of glucosamine ($C_8H_{13}O_5N$)_n.

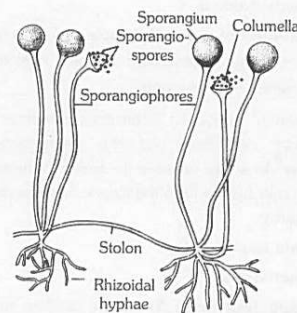


Fig : 1.4-1 *Rhizopus* – Habit sketch showing stolon, rhizoidal hyphae and sporangiophores

Reproduction : They reproduce by vegetative, asexual and sexual methods.

(1) **Vegetative reproduction :** It takes place by fragmentation. If stolon breaks accidentally into small segments, each part grows into a new mycelium.

(2) **Asexual reproduction :** It occurs by three types of non-motile mitospores, sporangiospores, chlamydospores and oidia.

Sporangiospores : The sporangiospores are also called **aplanospores**. They are thin walled, non-motile, multinucleate spores formed in a sporangium. A vertically growing mycelium acts as sporangiophore. Its tip now shows accumulation of food and nuclei. A septum now appears separating the **outer sporangium** from the **inner columella**. The sporangium dehisces irregularly due to collapse of columella and the spores are dispersed.

Chlamydospores : These are the perennating spores formed when the fungus starts facing dry conditions. The protoplasm of hyphae collects at certain places, rounds off accumulates a lot of food materials and develops thick wall to become chlamydospores.

Arthrospore or Oidia : In liquid, sugary and acidic pH medium the hyphae of *Rhizopus* and *Mucor* undergo septation and form small rounded reproductive cells called oidia. They multiply by budding like yeast. The budded condition is called **torula stage**. It takes part in alcoholic fermentation. On transfer to a suitable solid medium, each oidium forms a new mycelium.

(3) **Sexual reproduction :** Sexual reproduction takes place by conjugation between two multinucleate but single celled gametangia. The gametes are isogamous and non-motile.

The species of *Rhizopus* may be **heterothallic** (*R. stolonifer*) or **homothallic** (*R. sexualis*). But mostly heterothallic in both *Mucor* and *Rhizopus*. In homothallic species sexual union is brought about between two hyphae of the same mycelium whereas in heterothallic species it occurs between two hyphae derives from different compatible strains i.e., positive (+) and negative (-).

The two mycelial branches growing towards each other are called **progametangia**. Their tips become rich in food and nuclei. They enlarge and come in contact with each other. A septum is laid down separating the terminal **gametangium** from the proximal **suspensor**. The gametangium has dense cytoplasm and many nuclei whereas the suspensor has vacuolated cytoplasm with fewer nuclei. Each gametangium behaves as an coenogamete. The two gametangia fuse with each other. **Plasmogamy** is followed by pairing of nuclei of opposite strains. The unpaired nuclei degenerate. This is followed by **karyogamy**. The **zygospore** so formed develops a dark coloured thick wall and undergoes rest. It is also believed that karyogamy is delayed till the germination of zygospore.

On the arrival of favourable conditions the zygospore germinate. The outer wall ruptures and the inner protrudes out in the form of promycelium. The promycelium grows vertically upward and forms a terminal **germsporangium**. It is generally believed that meiosis occurs in the germ sporangium. Each diploid nucleus forms four haploid nuclei, of which three degenerate.

Occasionally, failure of gametangial copulation results in parthenogenous development of zygospores which are called **azygospore** (parthenospores).

Life cycle is haplobiontic.

Economic importance

(1) **Spoilage of food** : Exposed bread and other food particles are spoiled by *Rhizopus*.

(2) **Soft rot** : *Rhizopus* species attack sweet potato, apple and strawberry producing soft rot or leak disease. Germinating maize grains are also attacked.

(3) **Mucormycosis** : *Mucor pusillus* and *M. ramosissimus* may attack internal human organs, including lungs alimentary canal and nervous system.

(4) **Fermented foods** : Temph (a solid food from soyabean) and sufu (chinese cheese) are prepared with the help of *Rhizopus* and *Mucor* respectively.

(5) **Chemicals** : Citric acid prepared by *Mucor* from molasses, fumaric acid and cortisone by *Rhizopus stolonifer*, Lactic acid by *R. stolonifer* and *R. nodosus* and alcohol by *R. oryzae* and *M. javanicus*.

Yeast

Habitat : Yeast is a saprophytic fungus of ascomycetes, found on substratum which is rich in sugars e.g., sugarcane, juice, fruits (palms, grapes), milk etc. Some species are found on animal excreta.

Structure : Yeast was first described by Anton Van Leeuwenhoek in 1680. Yeast are nonmycelial or unicellular, which is very small and either spherical or oval in shape. However, under favourable conditions they grow rapidly and form **false mycelium** or **pseudomycelium**. Individual cells are colourless but the colonies may appear white, red, brown, creamy or yellow. The single cell is about 10 μm in diameter. The cell is surrounded by a rigid cell wall which is having proteins (7.8%), lipids (8.5 – 13.5%), Chitin (1 – 2%). Besides, there are 2 important polysaccharides glucon (30 – 35%) and mannan (about 30%).

Yeasts are facultative aerobes i.e., they are anaerobes but can also survive under aerobic conditions and respire aerobically as well. The yeast cells secrete extracellular enzyme **zymase** which converts complex sugars into simple soluble sugars that can easily be assimilated.

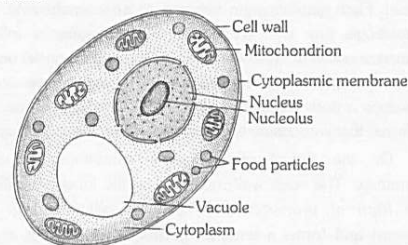


Fig : 1.4-2 Electron micrograph of single yeast cell

Reproduction : Yeast reproduces by vegetative or asexual and sexual methods.

(1) **Vegetative reproduction** : Yeast reproduce vegetatively either by budding or by fission.

By budding : It is the common method of reproduction in yeasts (e.g., *Saccharomyces*) under favourable conditions (i.e., when growing in sugar solution). During this process a small bud like out growth appears at one end of the parent cell which gradually enlarges in size (unequal division of cytoplasm takes place) The nucleus enlarges and divides **amitotically** into two daughter nuclei.

By fission : It is a common method of reproduction in yeasts (e.g., *Schizosaccharomyces*). During fission the parent cell elongates and its nucleus divides into two daughter nuclei. The two nuclei separate apart. It is followed by a transverse cytokinesis by formation of a transverse septum which develops centripetally. The two cells separate apart and behave as uninucleate vegetative thalli.

(2) **Sexual reproduction** : Sexual reproduction in yeast takes place during unfavourable conditions, particularly when there is less amount of food.

The sex organs are not formed in yeasts and the sexual fusion occurs between the two haploid vegetative cells or two ascospores which behave as gametes. The two fusing gametes are haploid and may be **isogamous** or **anisogamous**. Such kind of sexual reproduction is called **gametic copulation**. It is the best example of **hologamy** i.e., the entire vegetative thallus is transformed into reproductive body. The sexual fusion leads to the formation of diploid zygote. The zygote behaves as an ascus and forms 4 – 8 haploid ascospores after meiosis. These liberate and function as vegetative cells.

Guilliermond (1940) has recognised three types of life cycle in yeasts.

(1) **Haplobiontic life cycle** : This type of life cycle is common in *Schizosaccharomyces octosporous*, a homothallic species.

(2) **Diplobiontic life cycle** : This type of life cycle is found in *Saccharomyces ludwigii*.

(3) **Haplodiplobiontic life cycle** : This type of cycle is found in *Saccharomyces cerevisiae* in which haploid and diploid both types of generations are found.

In addition to above, in *Schizosaccharomyces pombe*, two adjoining sister cells fuse and this phenomenon is called **adelphogamy**. In some yeasts e.g., *Debaryomyces*, the mother and daughter cells fuse to form the zygote and this phenomenon is called **pedogamy**.

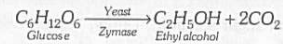
Economic importance

Useful activities

(1) **Baking industry** : Yeast are used in manufacture of bread. Kneaded flour is mixed with yeast and allowed to ferment. Yeast convert starch into sugars and sugar into CO_2 and alcohol

with help of enzyme zymase, CO_2 is released when effervescence takes place due to which bread become spongy and gets swollen and is of light weight.

(2) **Brewing industry** : Brewer's yeast or Baker's yeast is *Saccharomyces cerevisiae* and wine yeast is *Saccharomyces ellipsoidens*. They perform alcoholic fermentation.



(3) **Food yeast** : Yeast from brewing industry is harvested and used as food yeast. It is rich in protein and vitamins-B (Riboflavin). Special food yeasts are *Torulopsis* (protein), *Endomyces* (fat) and *Cryptococcus* (both).

Harmful activities

- (1) Fermentation of fruits and fruit juices by yeast cells makes their taste unpleasant.
- (2) Parasitic species of yeast like *Nematospora* causes diseases in tomato, cotton and bean.
- (3) Parasitic yeast cause diseases in human beings (e.g., cryptococcosis, blastomycosis and torulosis).

Albugo

Habitat : *Albugo* is a member of phycmycetes. It is an obligate parasite and grows in the intercellular spaces of host tissues. It is parasitic mainly on the members of families Cruciferae, Compositae, Amaranthaceae and Convolvulaceae, The disease caused by this fungus is known as **white rust** or **white blisters**.

The most common and well known species is *Albugo candida* which attacks the members of the mustard family (Cruciferae). It is commonly found on **Capsella bursa pastoris** (Shepherd's purse) and occasionally on radish, mustard, cabbage, cauliflower, etc. The reserve food is oil and glycogen.

Structure : The plant body of the fungus is mycelial and eucarpic. The mycelium is intercellular, branched, aseptate and multinucleate (coenocytic). The mycelium produces finger like or globular haustoria which enter into the host cells to absorb the food material. The mycelial wall is made up of cellulose-glucan.

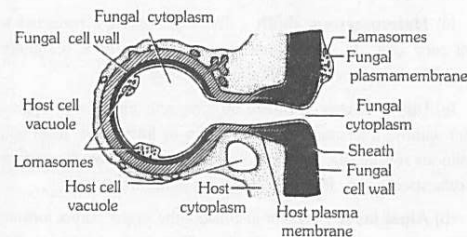


Fig : 1.4-3 *Albugo* – Ultra structure of haustorium (diagrammatic)

Reproduction : The fungus *Albugo* reproduces asexually as well as sexually.

(1) **Asexual reproduction** : Asexual reproduction takes place by the formation of sporangia or conidia. The fungal mycelium collects below the host epidermis and forms sporangiophores (conidiophores). These are club-shaped and multinucleate. The sporangiophores cut sporangia in basipetal manner, that is, the oldest and first formed are at the top and the youngest and last formed are at the base.

If water is available sporangia forms about 4 – 12 (usually eight) zoospores within two minutes of their formation. The zoospores are kidney shaped and laterally biflagellate (unequal).

If water is not available, the sporangia germinate directly by forming germ tubes.

(2) **Sexual reproduction** : The sexual reproduction is oogamous type and takes place with the help of **antheridia** and **oogonia**. The antheridia and oogonia are multinucleate in the beginning but become uninucleate by disorganization of nuclei. The antheridia are club-shaped and the oogonia are globular. Both sex organs develop terminally on the hyphae. There is a single egg (oosphere) surrounded by periplasm. At the time of fertilization, a **receptive papilla** develops on one side of the oogonium through which the fertilization tube enters into the oogonium. Inside the oogonium the male nucleus fuses with the egg nucleus. The diploid zygote develops a warty wall and becomes the **oospore**. The diploid nucleus undergoes meiosis, followed by several mitotic divisions. After a period of rest, the oospore germinates and produces reniform, biflagellate (dissimilar and laterally) zoospores. The zoospores are first released into a vesicle and then to the outside. They swim for some time, encyst and then germinate to form germ tubes. Most part of the life cycle of *Albugo* is **gametophytic**. The sporophytic phase is limited only to the oospore stage.

Aspergillus(Psalliota)

- (1) *Aspergillus* is the common laboratory weed which also grows on a number of food stuffs.
- (2) *A. oryzae* is used to prepare alcohol by saccharification of rice starch.
- (3) *A. niger* is used to produce citric acid from molasses.
- (4) *A. oryzae* and *A. niger* are also used for production of various enzymes.
- (5) *A. flavus* is a serious health hazard because of their toxic effect on food caused by secretion of 'aflatoxin' in contaminated food.
- (6) Some species cause aspergillosis, a disease a man and animals.

Agaricus

(1) *Agaricus* is a group of macrofungi that grows in rich organic matter. They are commonly known as **mushrooms**.

(2) **Habitat** : They grow in rich organic soil. During rainy season they are abundantly found in shady places growing on rotten logs of tree trunks.

(3) **Structure** : The mature plant body of the fungus is divided into two parts :

(i) **Vegetative mycelium** : The vegetative mycelium runs hidden in soil. This **perrenating stage** after somatogamy becomes dikaryotic called as **rhizomorph**.

(ii) **Fruit body** : It is formed during rainy season. The above ground part of the fungus is generally referred to as **sporophore or basidiocarp**. It is the most conspicuous part of the fungus. The binucleate mycelium of the soil gives rise to the sporophore. The sporophore is divided into two parts.

□ **Stipe or stalk** : It is the basal part of the sporophore consisting of cylindrical fleshy body having pinkish white colour.

□ **Pileus or cap** : It is umbrella shaped. It is formed by swelling of the tip of stipe. On the ventral side develops hymenial layers of gills from the centre towards periphery.

Internally gill is also composed of pseudoparenchymatous tissue distinguished into :

- (i) **Trama** : The central part
- (ii) **Sub-hymenium** : Located on both sides of trama and is sterile
- (iii) **Hymenium** : Fertile layers bearing basidia

(4) **Reproduction** : Only type of reproduction is somatogamy between two negative and positive strains of somatic hyphae which results in formation of dikaryotic rhizomorph. Rhizomorph forms fruit body which bears basidia. Each basidium has two nuclei of different strains which undergo fusion forming diploid nucleus. This nucleus undergoes meiosis to form four nuclei two of +ve and two of -ve strain. The nuclei are pushed into four finger like projections called as **sterigmata**. Nuclei are pushed into each sterigmata so as to form **basidiospores**. They are thrown on the substratum where they germinate to haploid vegetative hyphae.

(5) **Economic importance of Agaricus** : *A bisporus* and *A. campestris* are edible.

Lichens

The term lichen was first given by Theophrastus for superficial growth on bark of *Olea europea* (olive) tree. A lichen is structurally organised entity consisting of the permanent association of a fungus and an alga. The fungal component of a lichen is called **mycobiont** (mostly ascomycetes) and the algal component is called **phycobiont** (mostly blue-green alga). The fungus provides the structural covering that protects alga from unfavourable conditions, i.e., drought, heat etc. It also traps moisture from the atmosphere and anchors the lichens to a substrate. The alga prepares organic food (e.g., mannitol) by the process of photosynthesis from carbon dioxide. If the algal component is a cyanobacterium (blue-green alga), it fixes atmospheric nitrogen in addition to preparation of food. The relationship between the two is that of consortium, symbiosis or mutualism. Crombie (1885) gave the **master and slave hypothesis** for this association (also called husband and wife association) and in this association fungal partner is having upper hand. It is also known as **helotism**. Micheli (1729) describe 300 species of lichens. Dual nature of lichen was studied by Schwendener (1897). Ahmadjian (1963)

considers fungus to be a controlled parasite. The phenomenon of controlled parasitism is called **helotism**. The study of lichen is called **lichenology**.

Habitat : Lichens are cosmopolitan in distribution. Their growth is very slow. Some lichens growing in arctic regions are believed to be 4500 year old. The lichens which grow on stones are called **saxicolous** (e.g., *Dermatocarpon*) and those growing on barks of tree are called **corticolous** (e.g., *Usnea*, *Parmelia*, *Graphis*). Some lichen developing on wood are called **lignicolous** (e.g., *Cyphelium*) and those growing on soil are called **terricolous** (e.g., *Cladonia*, *Lecidea*). A few lichens are aquatic (e.g., *Peltigera*, *Verrucaria margacea*). The lichens generally do not grow near smoky industrial areas where atmosphere is polluted. *Cladonia rangiferina*, commonly known as **reindeer-moss** grows luxuriantly in tundra region and form the food of animals like the reindeer and caribou (musk ox).

Classification : Hole (1967) divided lichens into 3 classes :

(1) **Ascolichens** : When fungal partner belongs to ascomycetes. Most lichens are ascolichens. Ascolichens are further divided into :

Gymnocarpeae : Fruiting body is apothecium.

Pyrenocarpeae : Fruiting body is perithecium.

(2) **Basidiolichen** : When the fungal partner belongs to basidiomycetes.

(3) **Lichen Imperfecti** : When the fungal component belongs to fungi imperfecti.

Structure

(1) **External structure** : The lichens vary in their size and shape. However, three main types are recognised on the basis of their habit, growth, form and mode of occurrence.

(i) **Crustose or Crustaceous lichens** : These lichens occur as crust over rocks, soil or tree barks, e.g., *Graphis*, *Haematomma*.

(ii) **Foliose or Foliaceous lichens (Leafy lichens)** : They are leaf like lobed structure which are attached to substratum by rhizoid like organs, e.g., *Parmelia*, *Peltigera*.

(iii) **Fructicose or Filamentous lichens** : They are branched shrubby lichens but small base e.g., *Cladonia*, *Usnea*.

(2) **Internal structure** : The bulk portion of lichen thallus is formed by fungal partner. The alga constitutes about 5% of the lichen body. Internally the lichens are of two types :

(i) **Homoiomerous thalli** : Algal cells and fungal hyphae are uniformly dispersed throughout the thallus, e.g., *Collema*.

(ii) **Heteromerous thalli** : The algal cells are restricted to algal zone only. In these forms fungal component is dominant. Usually the heteromerous thalli show 4 distinct zones.

(a) **Upper cortex** : Formed by compactly interwoven hyphae either without interspaces between them or interspaces filled with gelatinous substances. A cuticle like layer is present on the surface. In some species e.g., *Parmelia* breathing pores are present.

(b) **Algal layer** : Present just below the upper cortex forming photosynthetic zone of the thallus. This layer is also called **gonidial layer**.

(c) **Medulla** : Occurs nearly in the middle of the thallus beneath the algal layer, the hyphae are loosely interwoven in this layer, *Parmelia*, *Graphis*.

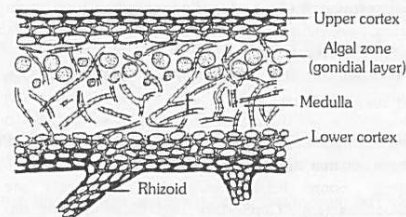


Fig : 1.4-4 Transverse section of a foliose lichen

(d) **Lower cortex** : Comprising of closely packed dark coloured hyphae rhizoids arise from this layer.

Special structures and Propagules : The following specialized structures and propagules are associated with lichen thalli :

(1) **Breathing pores** : The upper surface of some lichens, particularly the foliose lichens is provided with pores. Here the fungal hyphae are loosely arranged. They help in aeration.

(2) **Cyphellae** : Loosely arranged areas in lower cortex are cyphellae and these also help in gaseous exchange. Cyphellae are analogous to stomata of higher plants.

(3) **Cephalodia** : These are gall like outgrowths present on the upper surface of the thallus. They are distinguishable into cortex and medulla with similar fungal but different algal components from that of the main thallus. Lichens having two algal and one fungal partner are called **diphycophilous**. The cephalodia are meant for retaining moisture e.g., *Peltigera*.

(4) **Isidia** : These are coral like, simple or branched outgrowths present on the upper surface of the thallus. They have the same algae and fungal component as that of the main thallus. They help in photosynthesis as also in vegetative propagation e.g., *Parmelia*, *Peltigera*.

(5) **Soredia** : It is a powdery mass comprising both algal and fungal components formed in a postule like structure called **soralium**. The soralia arise from the algal zone lying just below the upper cortex e.g., *Physia*, *Parmelia*.

Reproduction : Lichens reproduce both by asexual and sexual methods.

(1) **Asexual reproduction**

Fragmentation : The main thallus breaks into small pieces which grow as independent thalli.

Rejuvenation : Plants like *Cladonia* show this unique phenomenon. It becomes young again. The older parts of the thallus die whereas the young branches continue to grow.

Conidia : In several lichens the fungal component forms conidia on conidiophores. They form new fungal mycelium which with suitable algal component form the lichen.

Pycniospores : The conidia formed in a flask shaped structures lying embedded in the thallus (pycnidia) are called as pycniospores. The pycniospores form new fungal mycelium which constitute the lichen on coming in contact with suitable algal component.

(2) **Sexual reproduction** : Sexual reproduction in lichen is performed only or mainly by its fungal component. So, the structure of the reproductive organs is dependent upon the type of their fungal partner.

Economic importance

(1) **Pioneer of vegetation** : Lichens are considered as pioneers in initiating a plant succession on rocks. These are the first plant group which play an important role in the formation of the soil. So lichens are called as **formers of nature or soil builders**.

(2) **Food and Fodder** : Reindeer moss (*Cladonia rangiferina*) of the arctic region is used as food for reindeer and cattle. Iceland moss (*Cetraria islandica*) is ground up and mixed with wheat and made into cakes in Iceland. Rock tripe (*Umbilicaria*) has been eaten by travellers when they face starvation in arctic regions.

(3) **Medicinal uses** : Dog lichen (*Peltigera canina*) was used as medicine for hydrophobia in ancient days and Lungwort (*Lobaria pulmonaria*) was used for the diseases of lungs. Usnic acid obtained from *Usnea* (old man's beard) and *Cladonia* sp. is used as broad spectrum antibiotic. It is effective against gram positive bacteria. *Lobaria pulmonaria*, *Cetraria islandica* are used in respiratory diseases particularly T.B., *Roccella montagnei* in angina, *Parmelia sextatilis* in epilepsy and *Usnea barbata* in urinary troubles.

(4) **In perfumery** : *Ramalina* and *Evernia*, having sweet scented thalli, are used in the preparation of **Dhup, Havan Samagri** and **soap**. Perfumes are extracted from *Evernia prunastri* and *Lobaria pulmonaria*.

(5) **In tanning and dying** : Lichens like *Cetraria islandica* and *Labaria pulmonaria* are used in tanning. A red dye is obtained from *Ochrolechia* sp. whereas *Parmelia* sp. yield a brown dye. *Litmus* used as acid-base indicator is obtained from *Roccella montagnei* and *Lasallia pustulata*. An **orchill** dye is obtained from *Roccella* and *Lecanora* which is purified as orcein and used as a biological stain.

(6) **In brewing and distilling** : The lichens contain carbohydrates in the form of **lichenin**. *Cetraria islandica* and *Cladonia rangiferina* (yield upto 66% of the polysaccharides) are used to obtain alcohol in Sweden and Russia.

(7) **Indicators of air pollution** : Lichens are very sensitive to SO_2 and grow only in SO_2 free atmosphere. So lichens like *Usnea* are used as indicators of air SO_2 pollution.

(8) **As poison** : Some lichens are poisonous also such as *Letharia vulpina* due to **vulpinic acid**, *Cetraria juniperina* due to **pinastrinic acid**, *Parmelia molliuscula* due to **selenium**, *Xanthoria parietina* due to **beryllium** and *Evernia furfuracea* due to **chlorine**.

(9) **Other uses** : Some lichen yield important chemicals e.g., salazinic acid (*Ramalina siliquosa*), **Lecanoric acid** (*Parmelia subrudecta*) and **squamatic acid** (*Cladonia crispata*) etc. In hot season, *Usnea* gets dry and becomes highly inflammable. It easily catches fire and causes forest fires.

Mycorrhizae

The term 'mycorrhizae' was coined by Frank (1885). It is an association between a fungus and the root of a higher plant e.g. Pine, Birch, *Eucalyptus*, *Ficus* etc. The actively growing roots of higher plants get infected by fungi. As a result, the roots are modified (i.e., become tuberous, nodulated, coralloid, etc.) to accommodate fungi. The root cells and fungi directly transmit nutrient substances to each other. Mycorrhiza is an example of **symbiosis** or **mutualism**.

Types of mycorrhizae : Mycorrhizae are classified into three categories :

(1) **Ectotrophic mycorrhiza** : It occurs only in about 3% of plant species, majority of which are forest trees, viz. pines, spurs, firs, oaks, beeches, birches, eucalyptus etc. The fungus partner is commonly a basidiomycetes. In this type of mycorrhizae, the fungus completely encloses the rootlet in a sheath or mantle of tissue formed of compact hyphal cells and penetrates only between the cells of root cortex. The ectomycorrhizal fungus cannot exist saprotrophically in nature without a plant host association. Such roots are devoid of root hair, root cap and may become unforked, bifurcate, nodular or coralloid.

(2) **Endotrophic mycorrhiza** : In this kind of mycorrhizae the fungus does not form an external mantle but lives within the root. The endomycorrhizae are further divided into three groups :

(i) **Ericaceous mycorrhizae** : The fungus forms dense intracellular coils in the outer cortical cells.

(ii) **Orchidaceous mycorrhizae** : These are associated with orchid roots. The fungus forms association from the time when the orchid seeds germinate.

(iii) **Vesicular-arbuscular mycorrhizae (VAM)** : The fungi of this group mostly belong to zygomycetes. This type is significant in agriculture because it occurs in a large number of crop plants. The fungal hyphae develop some special organs, called **vesicles** and **arbuscules**, within the root cortical cells.

(3) **Ectoendotrophic mycorrhiza** : This type of mycorrhiza sharing characteristics of both ecto and endotrophic mycorrhizas. The fungus forms a hyphal mantle and **Hartig net** as do the ectotrophic mycorrhiza and also establish haustoria and hyphae coils in the epidermal and cortical cells, like the ectotrophic mycorrhizas. The external hyphae deliver organic compounds absorbed from the humus to the root cells. One of the best studied examples of ectoendotrophic mycorrhizas is the mycorrhiza of *Monotropa indica*, the **Indian pine**.

Advantages of mycorrhizal association

(1) The fungal hyphae increase a plant's uptake of certain nutrients from the soil, particularly phosphorus, copper, zinc, nitrogen and potassium.

(2) The mycorrhizal hyphae permeate the soil and help the absorption of water by host more efficiently.

(3) The mycorrhizal plants need less fertilizer and can even grow better on the infertile soils. They withstand high doses of heavy metals and acid rain pollution.

(4) The fungi produce various growth promoting substances which help the plants to grow better.

(5) Due to mycorrhizal association, the higher plants develop resistance to soil borne diseases (due to phytolaxins released by fungi), drought resistance and tolerate salinity, pH and temperature extremes.

T Tips & Tricks

☞ Poisonous mushrooms like *Amanita* are commonly called Toad stools.

☞ *Penicillium* is known as blue mould.

☞ Father of Indian mycology and Plant pathology : E.J. Butler.

☞ Smallest fungus : Yeast with a size of 3–15 μm \times 2–10 μm .

☞ Nitrogen fixing fungi : Some species of *Rhodotorula* and *Saccharomyces*.

☞ Fungi inhabiting wood are known as epixylic.

☞ Autoecious fungus completes its life cycle on one host e.g., coffee rust (*Hameilia*). Heteroecious fungi require two hosts to complete their life cycle e.g., *Puccinia* (wheat rust).

☞ Fungi grow on tree are called as lignicolous fungi (*Polyporus*).

☞ Keratimorphic fungi appear on nails, feathers, hairs, hoofs.

☞ Biotrophic parasite (Gaumann, 1946). Absorbs nutrients from living host/cells.

☞ Nectrotrophic parasite (Gaumann, 1946). Kills host cells for obtaining nourishment.

☞ Species of *Morchella* are commonly known as 'morels', 'sponge mushrooms' or 'gucchi'.

☞ Most suitable temperature for growth of mushrooms is 30 to 37° C.

☞ Bioactive molecule, cyclosporine A, that is used as an immunosuppressive agent in organ-transplant patients, is produced by the fungus *Trichoderma polysporum*.

- ☞ The species of Polyporus are commonly called 'bracket fungi' or 'self fungi'.
- ☞ Phytoalexin are secreted by plants in response to fungal reactions. They are generally phenolic compound.
- ☞ Coprophilous fungi grow on dung e.g., *Pilobolus crystallinus*.
- ☞ Largest fungus is 'Giant puffball'.
- ☞ Dolipore septum : In Basidiomycetes, the septum becomes barrel shaped around a central pore. Dolipore septum may be surrounded by pore cap.
- ☞ Guinea pig of plant kingdom is *Aspergillus flavus*.
- ☞ Biobleaching : Fungus *Phanerochaete chrysosporium* can bleach paper pulp better than bleaching power.
- ☞ *Mycena* is a fungus that produces latex.
- ☞ Parisexuality in fungi was first described by G.Pontecorva and Ropers (1952) in *Aspergillus nidulans*.

Ordinary Thinking

Objective Questions

Fungi (General)

- The term 'fungus' was coined by
(a) Gaspard Bauhin (b) De Bary
(c) E.J. Butler (d) Sadasivan
- Who among the following is given the honour of "Father of Modern Mycology"
(a) Stanley (b) Bawden
(c) De Bary (d) Micheli
- Mycology (Mycetology) is a branch which deals with the study of [AMU (Med.) 1998; KCET 2000]
(a) Viruses (b) Algae
(c) Bacteria (d) Fungi
- Which of the following antibiotic is active against fungus [Odisha JEE 2008]
(a) Streptomycin (b) Polyenes
(c) Tetracycline (d) Neomycin
- Basidiospores are borne on the tip of [Odisha JEE 2008]
(a) Mycelium (b) Ascocarp
(c) Flagella (d) Aplanospore
- The highest number of species in the world is represented by [CBSE PMT (Pre.) 2012; NEET 2013]
(a) Fungi (b) Mosses
(c) Lichens (d) Algae
- Which one of the following matches is correct [AIPMT (Cancelled) 2015]

(a)	<i>Alternaria</i>	Sexual reproduction absent	Deuteromycetes
(b)	<i>Mucor</i>	Reproduction by Conjugation	Ascomycetes
(c)	<i>Agaricus</i>	Parasitic fungus	Basidiomycetes
(d)	<i>Phytophthora</i>	Aseptate mycelium	Basidiomycetes

- A group of fungi with septate mycelium in which sexual reproduction is either unknown or lacking are classified under [NCERT; Pb. PMT 2000; JIPMER 2002; AFMC 2010]
(a) Phycomycetes (b) Deuteromycetes
(c) Ascomycetes (d) Basidiomycetes
- Fungal spores produced asexually at the tips of hyphae are called [AFMC 2005]
(a) Sporangiohores (b) Anthospores
(c) Conidiophores (d) Meiospores
- Match column I with column II and select the correct option

Column I (Kingdom)		Column II (Class)	
A.	Morels	1.	Deuteromycetes
B.	Smut	2.	Ascomycetes
C.	Bread mould	3.	Basidiomycetes
D.	Imperfect fungi	4.	Phycomycetes

[KCET 2007; Kerala PMT 2011; AIPMT 2015]

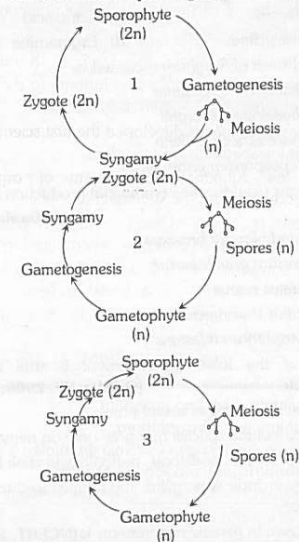
- (a) A-3, B-4, C-1, D-2 (b) A-2, B-3, C-4, D-1
(c) A-4, B-1, C-2, D-3 (d) A-3, B-4, C-2, D-1
(e) A-2, B-1, C-4, D-3
- All fungi can be called as [CBSE PMT 1993; CMC Vellore 1993; MP PMT 2000]
(a) Heterotrophs (b) Autotrophs
(c) Saprophytes (d) Parasites
- Which of the following does not contain chlorophyll
(a) Fungi (b) Algae
(c) Bryophyta (d) Pteridophyta
- Which of the following is famous mycologist of India
(a) P. Maheshwari (b) M.O.P. Iyengar
(c) K. Sharma (d) Sadasivan
- Who gave the parasitic nature of fungus in plants
(a) Pasteur (b) Anton De Bary
(c) Robert Koch (d) J.F. Kuhn
- Thread like filaments of fungi are known as [NCERT; Manipal 1995]
(a) Conidia (b) Mycorrhiza
(c) Sporangium (d) Hyphae
- In 1943 the causal organism and host of Bengal famine was [EAMCET 1995; BHU 1995, 2008]
(a) Wheat rust by *Puccinia*
(b) Blast of rice by *Pyricularia oryzae*
(c) Blast of rice by *Xanthomonas oryzae*
(d) Brown leaf spot of rice by *Helminthosporium oryzae*
- Destruction of 50% maize plants in USA (1970) due to infection of
(a) *Hemileia vastratrix*
(b) *Helminthosporium oryzae*
(c) *Claviceps purpurea*
(d) *Ustilago maydis*
- Choose the wrong statements [AIPMT 2015]
(a) Neurospora is used in the study of biochemical genetics
(b) Morels and truffles are poisonous mushrooms
(c) Yeast is unicellular and useful in fermentation
(d) Penicillium is multicellular and produces antibiotics

19. Which one of the following has haplontic life cycle [CBSE PMT 2009]
 (a) *Funaria* (b) *Polytrichum*
 (c) *Ustilago* (d) Wheat
20. The following is an example of saprophytes [KCET 1998]
 (a) Mushroom (b) Lichen
 (c) Unicellular algae (d) Ferns
21. The cell wall of fungi is made up of [NCERT; RPMT 1997, 99; CPMT 1998, 2009; MP PMT 2001; Odisha JEE 2004; NEET (Phase-I) 2016]
 (a) Chitin (b) Cellulose
 (c) Pectin (d) Suberin
22. Which one is the wrong pairing for the disease and its causal organism [CBSE PMT 2009]
 (a) Late blight of potato – *Alternaria solani*
 (b) Black rust of wheat – *Puccinia graminis*
 (c) Loose smut of wheat – *Ustilago nuda*
 (d) Root-knot of vegetables – *Meloidogyne sp*
23. Facultative saprophyte is
 (a) A parasite which can live as a saprophyte
 (b) Always a parasite
 (c) Always a saprophyte
 (d) May acquire parasitic mode of life
24. Which of the following is not correctly matched [AIIMS 1998]
 (a) Root knot disease – *Meloidogyne javanica*
 (b) Smut of bajra – *Tolysporium penicillariae*
 (c) Covered smut of barley – *Ustilago nuda*
 (d) Late blight of potato – *Phytophthora infestans*
25. The disease of potato responsible for famous famine of Europe was caused by or late blight of potato is caused by [RPMT 1997; CPMT 2000; BVP 2000; HPMT 2005; BHU 2006; DPMT 2007]
 (a) *Colletotrichum falcatum* (b) *Phytophthora infestans*
 (c) *Potato mosaic virus* (d) *Alternaria solani*
26. During the process of decomposition in which stage complex organic matter convert into inorganic ions and salts by fungi [GUJCET 2015]
 (a) Mineralization (b) Catabolism
 (c) Fragmentation (d) All of the above
27. When fungi feed on dead organic matter, they are known as [CPMT 1999]
 (a) Dimorphic (b) Parasites
 (c) Saprophytes (d) None of these
28. According to their modes of nutrition, the fungi are classified into [CBSE PMT 2000]
 (a) One category (b) Three categories
 (c) Four categories (d) Six categories
29. Which of the following divisions of fungi includes 'Club fungi' [KCET 2000]
 (a) Zygomycota (b) Ascomycota
 (c) Deuteromycota (d) Basidiomycota
30. Aflatoxins are produced by [MP PMT 2000, 12]
 (a) Bacteria (b) Viruses
 (c) Fungi (d) Nematodes
31. Wart disease caused by *Synchytrium endobioticum* is found in [JIPMER 2002]
 (a) Cabbage (b) Potato
 (c) Pea (d) Groundnut
32. Septum in eumycota fungi, bearing a complex pore is designated as a [BHU 2002]
 (a) Coenocyte (b) Septate hypha
 (c) Dolipore septum (d) Secondary simple pore
33. Which of the following secretes toxins during storage conditions of crop plants [CBSE PMT 2002]
 (a) *Fusarium* (b) *Penicillium*
 (c) *Aspergillus* (d) *Colletotrichum*
34. Which of the following produces spores, but lacks vascular structure [KCET 2002]
 (a) Pteridophytes (b) Gymnosperms
 (c) Fungi (d) Dicots
35. The hyphae of *Aspergillus* are [AFMC 2002]
 (a) Aseptate and multinucleate
 (b) Septate and multinucleate
 (c) Aseptate and uninucleate
 (d) Septate and uninucleate
36. Asexual reproduction in fungi takes place by [Odisha JEE 2010; BHU 2012]
 (a) Endospore (b) Gametangia
 (c) Exospores (d) Conidiospore
37. Gametangial copulation (conjugation) is common in
 (a) Zygomycetes (b) Ascomycetes
 (c) Phycomycetes (d) Deuteromycetes
38. Dikaryon formation is characteristic of
 (a) Ascomycetes and basidiomycetes
 (b) Phycomycetes and basidiomycetes
 (c) Ascomycetes and phycomycetes
 (d) Phycomycetes and zygomycetes
39. Plasmogamy is fusion of [NCERT; AIIMS 1997]
 (a) Two haploid cells including their nuclei
 (b) Two haploid cells without nuclear fusion
 (c) Sperm and egg
 (d) Sperm and two polar nuclei
40. Cellulose is the major component of cell walls of [CBSE PMT 2008]
 (a) *Pseudomonas* (b) *Saccharomyces*
 (c) *Pythium* (d) *Xanthomonas*
41. Chitin present in fungal wall has a formula [AMU (Med.) 1996; Chd. CET 1997]
 (a) $(C_{22}H_{54}N_4O_{21})_n$ (b) $(C_{21}H_{54}N_4O_{22})_n$
 (c) $(C_{22}H_{54}N_4O_{13})_n$ (d) $(C_{22}H_{24}N_4O_{21})_n$
42. A dikaryotic cell has [DPMT 1997]
 (a) Two haploid nuclei
 (b) Diploid zygotes
 (c) Two similar nuclei
 (d) Two dissimilar haploid nuclei
43. Algal fungi are placed in [MP PMT 1997]
 (a) Ascomycetes (b) Basidiomycetes
 (c) Phycomycetes (d) Deuteromycetes
44. The fungus that may cause disease in human beings is
 (a) *Puccinia* (b) *Aspergillus*
 (c) *Cystopus* (d) *Rhizopus*

45. Which of the following is not of fungal origin
[Odisha JEE 2010]
(a) Calvacin (b) Citric acid
(c) Tetracycline (d) Ergotamine
46. Covered smut of *Sorghum* is caused by [BHU 2002]
(a) *Sphacelotheca cruenta*
(b) *Sphacelotheca sorghii*
(c) *Sphacelotheca reiliana*
(d) *Tolyposporium ehrenbergii*
47. The fungus used for the commercial production of SCP is [Kerala PMT 2009]
(a) *Pentadiplandra brazzeana*
(b) *Fusarium graminearum*
(c) *Brassica napus*
(d) *Bacillus thuringiensis*
(e) *Phytophthora infestans*
48. Which of the following statement is true about fungi imperfecti [Odisha JEE 2008; BHU 2008]
(a) They do not have sexual phase
(b) They include species that prey only on nematodes
(c) They include toadstools, puffballs and stink horns
(d) They include *Aspergillus*, the fungus used to make soya sauce
49. Fungus used in genetic experiments is [NCERT; RPMT 1998]
(a) *Rhizopus* (b) *Mucor*
(c) *Neurospora* (d) *Claviceps*
50. The fungus which grows on dung is called [MP PMT 2010, 12]
(a) Humicolous (b) Lignicolous
(c) Coprophilous (d) Fungicolous
51. Match column I with column II and choose the right option
- | Column I | | Column II | |
|-----------------------|----|----------------|--|
| A. <i>Rhizopus</i> | 1. | Ascomycetes | |
| B. <i>Penicillium</i> | 2. | Basidiomycetes | |
| C. <i>Ustilago</i> | 3. | Deuteromycetes | |
| D. <i>Alternaria</i> | 4. | Zygomycetes | |
- [CPMT 1995; Pb. PMT 1999; BVP 2000; RPMT 2005; Kerala PMT 2010]
- (a) A-4, B-3, C-1, D-2 (b) A-2, B-3, C-4, D-1
(c) A-4, B-1, C-2, D-3 (d) A-3, B-4, C-2, D-1
(e) A-2, B-1, C-4, D-3
52. A coprophilous fungus is [JIPMER 2000]
(a) *Trichoderma* (b) *Pilobolus*
(c) *Fusarium* (d) *Humicola*
53. Fungal hyphae are able to penetrate the host with the help of [CBSE PMT 2001]
(a) Mechanical pressure (b) Softening by enzymes
(c) Both (a) and (b) (d) Suckers and hooks
54. Fungi differ from algae in being
(a) Coenocytic
(b) Without motile gametes
(c) Without unicellular forms
(d) Without chlorophyll and possessing chitinised wall
55. What is true [RPMT 2002]
(a) Toadstool is an edible fungus
(b) Rust fungi are homoecious
(c) Parathecium is fruiting body
(d) In mushroom gills produce basidia
56. A combined solution of copper sulphate and calcium hydroxide which is used as a fungicide is
(a) Fehling solution (b) Folin's mixture
(c) Carminative mixture (d) Bordeaux mixture
57. Parasexuality is involved with [RPMT 2006]
(a) Fusion of gamete and protoplast
(b) Fusion of male gamete with secondary nucleus
(c) Fusion of protoplast
(d) Fusion of male and female gamete
58. The disease which occur at irregular intervals and locations are known as
(a) Epiphytotic diseases (b) Endemic diseases
(c) Sporadic disease (d) Epidemic diseases
59. Reserve food material of fungi is [BHU 1994, 2000; KCET 1998; MP PMT 2000; CBSE PMT 2000; Odisha JEE 2004, 05]
(a) Starch (b) Protein
(c) Glucose (d) Glycogen
60. The disease produced by fungus *Ustilago* are known as smuts because [CBSE PMT 1994]
(a) They parasitise cereals
(b) The affected host becomes completely black
(c) Their mycelium is black
(d) They produced sooty mass of spores
61. A type of life cycle in which plasmogamy, karyogamy, haplodization take place but not at specific place in life cycle of an organism is called as [RPMT 2002]
(a) Parasexuality (b) Heterozygosity
(c) Homozygosity (d) Asexuality
62. Deuteromycetes are known as fungi imperfecti because [AIIMS 2012; AFMC 2012]
(a) Their zygote undergoes meroblastic and holoblastic cleavage
(b) Only asexual stages are known
(c) They have aseptate mycelium
(d) They are autotrophic
63. Match the different types of spores listed under column I with the names of the organisms given under column II. Choose the answer which gives correct combination of the alphabets of the two columns
- | Column I
Spores | Column II
Organisms |
|--------------------|------------------------|
| A. Ascospores | p. Diatoms |
| B. Endospores | q. <i>Agaricus</i> |
| C. Auxospores | r. Bacteria |
| D. Basidiospores | s. Yeast |
| | t. <i>Nephrolepis</i> |
- [KCET 1997]
- (a) A = s, B = r, C = p, D = q
(b) A = s, B = p, C = r, D = q
(c) A = s, B = p, C = t, D = q
(d) A = s, B = t, C = p, D = q

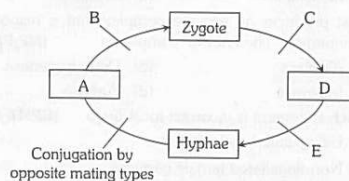
64. Which of the following is the characteristic feature of ascomycetes [MHCET 2000]
(a) Hyphae (b) Spores
(c) Zoospores (d) Ascospores
65. Phycomycetes is a class in kingdom [DPMT 2006]
(a) Protista (b) Fungi
(c) Plantae (d) Animalia
66. Fungal flagellum originates from [Odisha JEE 2005]
(a) Dictyosome (b) Kinetosome
(c) Glyoxysomes (d) Oxysomes
67. Parasexuality was 1st discovered in [DPMT 2003; BVP 2004]
(a) Bacteria (b) Virus
(c) Fungi (d) None of these
68. Phytoalexins are secreted by plants in response to fungal reaction. These compounds are generally [DPMT 2003; BVP 2004]
(a) Proteins
(b) Glycoproteins
(c) Phenolic compounds
(d) Lipids
69. The chemical produced by the host plant to protect themselves against fungal infection is [MHCET 2002; Pb. PMT 2004]
(a) Toxin (b) Phytoalexin
(c) Phytotoxin (d) Hormone
70. Clamp connection is found in [Odisha JEE 2004; BHU 2006; MP PMT 2009]
(a) Basidiomycetes
(b) Ascomycetes
(c) Saccharomycetes
(d) Haplomycetes
71. Black rust of wheat is caused by [MHCET 2000; BVP 2004; BHU 2008; CBSE PMT (Mains) 2010]
(a) *Puccinia graminis* (b) *Ustilago*
(c) *Pythium* (d) None of these
72. Which of the following fungi is found useful in the biological control of plant disease [CPMT 2004]
(a) *Penicillium notatum*
(b) *Phytophthora parasitica*
(c) *Mucor mucido*
(d) *Trichoderma viridae*
73. Ergot fungus produces [MHCET 2004]
(a) Charas (b) LSD
(c) Marijuana (d) Ganja
74. Chloromycetin is obtained from [MHCET 2004]
(a) *Saccharomyces cerevisiae*
(b) *Streptomyces venezualae*
(c) *Streptomyces griseus*
(d) *Streptomyces erythraeus*

75. Which of the following correctly represents the type of life cycle patterns from the options given [Kerala PMT 2008]



- (a) 1. Diplontic 2. Haplodiplontic 3. Haplontic
(b) 1. Haplodiplontic 2. Haplontic 3. Diplontic
(c) 1. Haplontic 2. Diplontic 3. Haplodiplontic
(d) 1. Diplontic 2. Haplontic 3. Haplodiplontic
(e) 1. Haplontic 2. Haplodiplontic 3. Diplontic
76. Which of the following is an edible 'Fungi' [BHU 2005; CPMT 2009]
(a) *Mucor* (b) *Penicillium*
(c) *Agaricus* (d) *Rhizopus*
77. Saprophytic and parasitic modes of nutrition are found in [CPMT 2001, 05]
(a) Bacteria (b) Viruses
(c) Fungi (d) Both (a) and (c)
78. *Claviceps purpurea* grows as parasite [CPMT 2005]
(a) In human gut (b) In sugar cane roots
(c) On pine needles (d) On fruits of grasses
79. In addition to absence of chlorophyll what is the other difference between fungi and higher plants [DPMT 2006]
(a) Type of nutrition and composition of cell wall
(b) Cell type
(c) Nucleus
(d) Reproduction
80. Which one of the following fungi contains hallucinogens [CBSE PMT 2014]
(a) *Neurospora* sp. (b) *Ustilago* sp.
(c) *Morchella esculenta* (d) *Amanita muscaria*
81. Bakanae disease was due to [Wardha 2005]
(a) Fungi toxin
(b) Growth hormones released by fungal infection
(c) Inadequate nutrients
(d) Change in photoperiods

82. The disease root-knot of brinjal is caused by [Kerala PMT 2006]
 (a) *Fusarium udum* (b) *Phytophthora infestans*
 (c) *Meloidogyne incognita* (d) *Pseudomonas rubriligneans*
 (e) *Xanthomonas citri*
83. Select the false statement [Kerala PMT 2006]
 (a) Scientists who study and contribute to the classification of organisms are known as systematists
 (b) Carolus Linnaeus developed the first scientific system of naming species
 (c) A five Kingdom arrangement of organisms was introduced by R. H. Whittaker
 (d) Genus is a group of species which are related and have less characters in common as compared to species
 (e) Phycomycetes are called club fungi because of a club shaped end of mycelium known as basidium
84. Red rot of sugarcane and white rust of radish are respectively caused by [Odisha JEE 2005, 11; Kerala PMT 2006]
 (a) *Albugo candida* and *Cercospora*
 (b) *Colletotrichum* and *Fusarium*
 (c) *Pythium* and *Phytophthora*
 (d) *Albugo candida* and *Puccinia graminis*
 (e) *Colletotrichum* and *Albugo candida*
85. Identify from the following examples, a fungus which is of medicinal importance [KCET 2006]
 (a) *Agaricus* (b) *Saccharomyces*
 (c) *Penicillium* (d) *Cercospora*
86. Which one of the following is true for fungi [NEET (Karnataka) 2013]
 (a) They lack a rigid cell wall
 (b) They are heterotrophs
 (c) They lack nuclear membrane
 (d) They are phagotrophs
87. The given below figure shows a generalized life cycle of a fungus. The suitable terms for A, B, C, D and E are [NCERT]



	A	B	C	D	E
(a)	Meiosis	Mitosis	Spore	Fertilization	Dikaryotic phase
(b)	Dikaryotic phase	Fertilization	Meiosis	Spore	Mitosis
(c)	Fertilization	Meiosis	Mitosis	Dikaryotic phase	Amitosis
(d)	Mycelium	Mitosis	Meiosis	Fertilization	Spore

88. Which one of the following is wrong for fungi [NEET (Phase-II) 2016]
 (a) They are both unicellular and multicellular
 (b) They are eukaryotic
 (c) All fungi possess a purely cellulosic cell wall
 (d) They are heterotrophic

Mucor and Rhizopus

1. The pathogen *Microsporium* responsible for ringworm disease in humans belongs to the same Kingdom of organisms as that of [CBSE PMT (Mains) 2011]
 (a) *Rhizopus*, a mould (b) *Ascaris*, a round worm
 (c) *Taenia*, a tapeworm (d) *Wuchereria*, a filarial worm
2. Coenogametes are formed in [CPMT 1999]
 (a) *Albugo* (b) *Saccharomyces*
 (c) *Rhizopus* (d) *Alternaria*
3. Arrange the following in correct sequence with reference to sexual reproduction in *Rhizopus*
 (I) Formation of germ tube
 (II) Formation of zygophores
 (III) Formation of warty wall layer of zygospore
 (IV) Secretion of trisporic acid
 The correct sequence is [EAMCET 2009]
 (a) IV, III, II, I (b) IV, II, III, I
 (c) II, I, IV, III (d) I, III, II, IV
4. Which of the following environmental conditions are essential for optimum growth of *Mucor* on a piece of bread
 A. Temperature of about 25°C
 B. Temperature of about 5°C
 C. Relative humidity of about 5%
 D. Relative humidity of about 95%
 E. A shady place
 F. A brightly illuminated place
 Choose the answer from the following options [CBSE PMT 2006]
 (a) B, D and E only (b) B, C and F only
 (c) A, C and E only (d) A, D and E only
5. In *Mucor*, asexual reproduction takes place by
 (a) Motile zoospores (b) Spores
 (c) Zoogametes (d) Zygospores
6. Which one of the following life cycle is associated with *Mucor*
 (a) Haplontic (b) Diplontic
 (c) Isomorphic (d) Heteromorphic
7. Zygospores are formed in [MP PMT 1995; AFMC 2002; Odisha JEE 2005]
 (a) *Puccinia* (b) *Penicillium*
 (c) *Alternaria* (d) *Mucor* / *Rhizopus*
8. Which one is wrong statement [AIPMT 2015]
 (a) *Mucor* has biflagellate zoospores
 (b) Haploid endosperm is typical feature of gymnosperms
 (c) Brown algae have chlorophyll a and c and fucoxanthin
 (d) Archegonia are found in bryophyta, pteridophyta and gymnosperms
9. Columella is a specialized structure found in the sporangium of [CBSE PMT 1999; BHU 1999; CPMT 2004; Bihar CECE 2006]
 (a) *Ulothrix* (b) *Rhizopus*
 (c) *Spirogyra* (d) None of these

10. Which of the following induces sexual reproduction in *Mucor/Rhizopus*
(a) Indole acetic acid (b) Trisporic acid
(c) Gibberellic acid (d) Citric acid
11. In *Rhizopus*, hyphae are [RPMT 2002]
(a) Branched, septate and uninucleate
(b) Branched, aseptate and multinucleate
(c) Unbranched, aseptate and multinucleate
(d) Unbranched, septate and coenocytic
12. Multinucleated filament of *Rhizopus* is [RPMT 1997; BCECE 2005]
(a) Coenocytic (b) Conidia
(c) Heterothallus (d) Homothallus
13. *Mucor* shows [MP PMT 2002]
(a) Isogamy (b) Anisogamy
(c) Oogamy (d) None of the above
14. Sporangiospores of *Mucor* are [MP PMT 2002]
(a) Haploid (b) Diploid
(c) Triploid (d) Polyploid
15. For *Mucor* zygospore is [DPMT 2007]
(a) Thick walled resting spore
(b) Haploid in structure
(c) Result of asexual reproduction
(d) Germinates to form zoospores
16. The zygospore in *Rhizopus* develops into [J & K CET 2002]
(a) Zygospore (b) Promycelium
(c) Progametangium (d) Gametangium
17. The reduction division in the life cycle of *Rhizopus* occurs
(a) At the time of germination of zygospores
(b) During the formation of germ sporangium
(c) During asexual reproduction
(d) During the formation of gametangium
18. Which of the following plant and its mode of nutrition is not correctly matched [AIIEE Pharmacy 2003]
(a) *Cuscuta* – Stem parasite
(b) *Mucor* – Autotroph
(c) *Orobanche* – Root parasite
(d) *Drosera* – Insectivorous
19. Which one of the following fungus shows heterothallism [BHU 1999; MHCET 2001]
(a) *Erysiphe* (b) *Peziza*
(c) *Rhizopus* (d) *Peronospora*
20. Common bread mould is [MP PMT 1996, 2010, 12; CBSE PMT 2001]
(a) *Rhizopus oryzae* (b) *Rhizobium* species
(c) *Rhizopus nedosus* (d) *Rhizopus stolonifer*
21. In *Rhizopus* if conjugation fails, gametangia behave as zygospore. It is called as [AIIMS 2000]
(a) Conidia (b) Parthenospore
(c) Gametangia (d) Sporangiospore
22. Yeast like budding of oidia in *Mucor/Rhizopus* is called [MP PMT 2001]
(a) Palmella (b) Chantransia
(c) Torula (d) Gongrosira
23. Mode of nutrition in *Rhizopus* is [AFMC 1993]
(a) Parasitic (b) Symbiotic
(c) Saprophytic (d) Autotrophic
24. Mycelium of *Mucor/Rhizopus* is [MP PMT 2000]
(a) Aseptate and unicellular (b) Septate and unicellular
(c) Septate and multicellular (d) Coenocytic
25. Food stored in *Rhizopus/Mucor* as [CBSE PMT 1992; RPMT 1996, 2000]
(a) Protein and steroids (b) Sugar and oil
(c) Protein and starch (d) Glycogen and oil
26. The wall of *Rhizopus* hypha is composed of [MP PMT 2001; PET (Pharmacy) 2013]
(a) Cellulose (b) Chitin
(c) Pectin (d) Hemicellulose

Yeast and Albugo

1. Botanical name of species which cause white rust of cruciferae [RPMT 2002, 06]
(a) *Peronospora parasitica* (b) *Puccinia graminis*
(c) *Pythium debaryanum* (d) *Albugo candida*
2. Fungus without any mycelium is [BHU 2000; MHCET 2000]
(a) *Albugo* (b) *Agaricus*
(c) *Puccinia* (d) *Saccharomyces*
3. Branched, aseptate, coenocytic mycelium present in [RPMT 2002]
(a) *Aspergillus* (b) *Albugo*
(c) *Penicillium* (d) *Erysiphae*
4. Yeast produces an enzyme complex that is responsible for fermentation. The enzyme complex is [MP PMT 2013]
(a) Aldolase (b) Dehydrogenase
(c) Invertase (d) Zymase
5. Which statement is incorrect for *Albugo* [RPMT 1995, 96]
(a) Biflagellated male gametes
(b) Non-flagellated female gametes
(c) Biflagellated zoospores
(d) All of the above
6. Which of the following is an unicellular sac-fungus [Kerala PMT 2011]
(a) *Claviceps* (b) *Saccharomyces*
(c) *Penicillium* (d) *Neurospora*
(e) *Aspergillus*
7. Yeast is not included in protozoans but in fungi because [Manipal 2005]
(a) It has no chlorophyll
(b) Some fungal hyphae grow in such a way that they give the appearance of pseudomycelium
(c) It has eukaryotic organisation
(d) Cell wall is made up of cellulose and reserve food material as starch

8. Mycelium in *Albugo* is [RPMT 1995]
(a) Intracellular (b) Intercellular
(c) Surface of host (d) Surface of flower
9. In *Albugo* the food reserve is mostly [RPMT 1995]
(a) Glycogen (b) Volutin granules
(c) Protein granules (d) Fat
10. Yeast is divided under the class [CPMT 2003]
(a) Basidiomycetes (b) Deuteromycetes
(c) Ascomycetes (d) Zygomycetes
11. Which organism is used to obtain the single cell protein [AMU (Med.) 2005]
(a) Bacteria (b) Yeast
(c) Filamentous Fungi (d) All of the above
12. In manufacture of bread, it becomes porous due to release of CO_2 by the action of [CBSE PMT 2002]
(a) Virus (b) Yeast
(c) Bacteria (d) Protozoans
13. Pseudomycelium is formed in [BHU 2002]
(a) Yeast (b) *Rhizophora*
(c) *Aspergillus* (d) *Synchytrium*
6. Mycorrhiza works as [CPMT 1998; BHU 2002]
(a) Modified root
(b) An organism for vegetative propagation
(c) A root hair in adverse condition
(d) Mechanical tissue for support
7. Which statements is wrong about lichens [CBSE PMT 1996]
(a) Some species are eaten by reindeers
(b) Lichens are indicators of pollution
(c) They grow rapidly about 2cm per day
(d) They have symbiotic relationship between alga and fungus
8. Fungal partner of a lichen is commonly [BHU 1996]
(a) Ascomycetes (b) Basidiomycetes
(c) Phycmycetes (d) Deuteromycetes
9. Mycorrhizal association occurs in *Pinus*, *Ficus* and [HPMT 2000]
(a) *Utricularia* (b) Legumes
(c) *Eucalyptus* (d) *Azadirachta*
10. Fungus/Lichens which grow on wood is [AFMC 2004]
(a) Terricolous (b) Saxicolous
(c) Lignicolous (d) Corticolous

Lichen and Mycorrhiza

1. 'Mycorrhizae' are useful for plants mainly due to their following attribute [CPMT 1993, 94, 2004; BHU 1994, 2001; Pb. PMT 1999; DPMT 2003, 06; RPMT 2006]
(a) Fixing atmospheric nitrogen
(b) Enhanced absorption of nutrients from soil
(c) Killing insects and pathogens
(d) Providing resistance against abiotic stresses
2. In lichens, sexual reproduction belongs to [BHU 1994]
(a) Fungal partner only
(b) Algal partner only
(c) Fungal and algal partners (both)
(d) Either fungal partner or algal partner (not both)
3. Which one of the following pairs is correctly matched [AIIMS 2003, 07]
(a) Rhizobium - Parasite in the roots of leguminous plants
(b) Mycorrhizae - Mineral uptake from soil
(c) Yeast - Production of biogas
(d) Myxomycetes - The disease ring worm
4. Mycorrhiza is a [CPMT 1994]
(a) Long thin root
(b) Association of root and fungus
(c) Root like underground stem
(d) Parasitic root
5. The symbiotic association of fungi and algae is called [CPMT 1996, 98; AFMC 1998; KCET 2000; Chd. CET 2000; CBSE PMT 2001; J & K CET 2012]
(a) Lichen (b) Mycorrhiza
(c) Both (a) and (b) (d) Mycoplasma
11. Short twisted strands of hyphae which serves as anchors for lichens [Odisha JEE 2008]
(a) Mycelium (b) Rhizines
(c) Roots (d) Rhizoids
12. A teacher was explaining about a constant physical contact involving almost equal physiological interdependence in two different thaloid forms. He was trying to explain one of the following [EAMCET 2009]
(a) Mycorrhizal association
(b) Establishment of heterothallism
(c) Operation of heterothallism
(d) Advent of lichen formation
13. In majority of lichens, there is association of [CBSE PMT 2001]
(a) Green algae and ascomycetes
(b) Green algae and basidiomycetes
(c) Blue green algae and ascomycetes
(d) Blue green algae and basidiomycetes
14. Lichen is [BHU 2008]
(a) Saprophytic (b) Parasitic
(c) Holozoic (d) Autotrophic
15. Lichens grow at a very slow rate (1 mm per year). In how many years a lichen matures
(a) 1 - 4 years (b) 4 - 8 years
(c) 100 years (d) 20 - 25 years
16. There exists a close association between the algae and the fungus within a lichen. The fungus [CBSE PMT 2005]
(a) Fixes the atmospheric nitrogen for the alga
(b) Provides protection, anchorage and absorption for the alga
(c) Provides food for the alga
(d) Releases oxygen for the alga

17. An example of endomycorrhiza is [CBSE PMT (Mains) 2010]
(a) *Nostoc* (b) *Glomus*
(c) *Agaricus* (d) *Rhizobium*
18. Lichens are ecologically important as they
(a) Purify air
(b) Are pioneers of barren rocks
(c) Are symbionts of algae and fungi
(d) Are associated with mycorrhizal roots
19. Reindeer moss is [AFMC 1996; RPMT 1999]
(a) *Sphagnum* (b) *Marchantia*
(c) *Cladonia rangiferina* (d) None of these
20. Association of fungus with roots of tracheophytes is [BVP 2002]
(a) Mycorrhiza (b) Commensalism
(c) Helotism (d) Amensalism
21. Which one of the following helps in absorption of phosphorus from soil by plants [CBSE PMT (Pre.) 2011]
Or
Which one of the following microbes forms symbiotic association with plants and helps them in their nutrition [CBSE PMT (Pre.) 2012]
(a) *Azotobacter* (b) *Glomus*
(c) *Aspergillus* (d) *Trichoderma*
22. Mycorrhiza is a relationship of roots of *Pinus* and [BVP 2001; MHCET 2001]
(a) Fungus (b) Alga
(c) Bacteria (d) Ants
23. Which of the following symbiotic association is not useful as biofertilizer [MHCET 2002]
(a) *Rhizobium* and leguminous roots
(b) Algae and fungi
(c) *Azolla* and *Anabaena*
(d) Roots of higher plants and fungi
24. Mycorrhiza exhibits the phenomenon of [CBSE PMT 1994; BVP 2002]
(a) Antagonism (b) Endemism
(c) Parasitism (d) Symbiosis
25. Helotism is a term used for the symbiosis of [MHCET 2003]
(a) Algae and bacteria (b) Algae and bryophytes
(c) Algae and pteridophytes (d) Algae and fungi
26. Litmus is obtained from [Odisha JEE 2004]
(a) Lichen (b) Algae
(c) Fungi (d) Protozoa
27. Lichens are well known combination of an alga and a fungus where fungus has [CBSE PMT 2004; Pb. PMT 2004; CPMT 2005]
(a) A parasitic relationship with the alga
(b) A symbiotic relationship with the alga
(c) A saprophytic relationship with the alga
(d) An epiphytic relationship with the alga
28. *Cladonia rangiferina* is a/an [BHU 2004]
(a) Algae (b) Lichen
(c) Fungus (d) Angiosperm

N Q NCERT

Exemplar Questions

1. Naked cytoplasm, multinucleated and saprophytic are the characteristics of [NCERT]
(a) Monera (b) Protista
(c) Fungi (d) Slime molds
2. An association between roots of higher plants and fungi is called [NCERT]
(a) Lichen (b) Fern
(c) Mycorrhiza (d) BGA
3. A dikaryon is formed when [NCERT]
(a) Meiosis is arrested
(b) The two haploid cells do not fuse immediately
(c) Cytoplasm does not fuse
(d) None of the above
4. Mycobiont and Phycobiont are found in [NCERT]
(a) Mycorrhiza (b) Root
(c) Lichens (d) BGA
5. With respect to fungal sexual cycle, choose the correct sequence of events [NCERT]
(a) Karyogamy, Plasmogamy and Meiosis
(b) Meiosis, Plasmogamy and Karyogamy
(c) Plasmogamy, Karyogamy and Meiosis
(d) Meiosis, Karyogamy and Plasmogamy
6. Members of phycocyanes are found in
i. Aquatic habitats
ii. On decaying wood
iii. Moist and damp places
iv. As obligate parasites on plants
Choose from the following options [NCERT]
(a) None of the above (b) i and iv
(c) ii and iii (d) All of the above

G T Critical Thinking

Objective Questions

1. Which of the following is not matched correctly [Kerala PMT 2011]
- | | | |
|----------------------|---|-----------------|
| (a) <i>Anabaena</i> | - | Cyanobacteria |
| (b) <i>Amoeba</i> | - | Protozoa |
| (c) <i>Gonyaulax</i> | - | Dinoflagellates |
| (d) Thermoacidophils | - | Archaeobacteria |
| (e) <i>Albugo</i> | - | Chrysoophytes |
2. 'Torula condition' occurs in [MP PMT 2001]
(a) *Rhizopus* (b) *Ulothrix*
(c) *Spirogyra* (d) *Riccia*

3. Match the following and choose the correct combination from the options given

Column I (Group)	Column II (Example)
A. Eubacteria	1. <i>Trichoderma</i>
B. Dinoflagellates	2. <i>Albugo</i>
C. Phycomycetes	3. <i>Gonyaulax</i>
D. Deuteromycetes	4. <i>Anabaena</i>

[J & K CET 2012; Kerala PMT 2012]

- (a) A-1; B-2; C-3; D-4 (b) A-2; B-3; C-4; D-1
(c) A-4; B-3; C-2; D-1 (d) A-3; B-4; C-1; D-2
(e) A-4; B-3; C-1; D-2
4. A fungus which requires only one single host for completion of its life cycle is called [Chd. CET 2000]
(a) Heteroecious (b) Autoecious
(c) Heterothallism (d) Heterosporous
5. Fungi can be stained by [AFMC 1993; BVP 2000]
(a) Safranin (b) Iodine
(c) Lactophenol (d) Cotton blue
6. Asci are formed in
(a) *Ascobolus* (b) *Saccharomyces*
(c) *Penicillium* (d) All the above
7. No need of water for fertilization in [RPMT 1995]
(a) *Ulothrix* (b) *Albugo*
(c) Bryophyta (d) Pteridophyta
8. Ray fungi are [BHU 1995]
(a) Ascomycetes (b) Basidiomycetes
(c) Actinomycetes (d) Phycomycetes
9. Which one of the following group of fungi is sometimes known as "fungal waste basket"
(a) Phycomycetes (b) Ascomycetes
(c) Basidiomycetes (d) Deuteromycetes
10. In *Puccinia*, infection from barberry leaf to wheat plant is caused by [JIPMER 2001]
(a) Pycnospores (b) Aecidiospores
(c) Uredospores (d) Teleutospores
11. Powdery mildews of crops are caused by [AIIMS 2001; MHCET 2003; Odisha JEE 2012]
(a) Bacteria (b) Ascomycetes (*Erysiphe*)
(c) Phycomycetes (d) Basidiomycetes
12. Which of the following fungal disease spreads by seed and flowers [CBSE PMT 2002]
(a) Corn stunt (b) Covered smut
(c) Potato root (d) Loose smut of wheat
13. The edible part of mushroom is [CPMT 2003; BHU 2006; WB JEE 2011]
(a) Basidiocarp (b) Tertiary mycelium
(c) Primary mycelium (d) Secondary mycelium
14. Which one single organism or the pair of organisms is correctly assigned to its or their named taxonomic group [CBSE PMT (Pre.) 2012]
(a) *Paramecium* and *Plasmodium* belong to the same kingdom as that of *Penicillium*
(b) Lichen is a composite organism formed from the symbiotic association of an algae and a protozoan
(c) Yeast used in making bread and beer is a fungus
(d) *Nostoc* and *Anabaena* are examples of protista

15. Which option shows incorrectly matched group

[GUJCET 2014]

- (a) Pseudopodiospore – *Plasmodium* – Sporulation
(b) Gemmules – *Spongilla* – Budding
(c) Zoospores – *Aspergillus* – Sporulation
(d) Conidia – *Penicillium* – Asexual reproduction
16. Catabolism Considering mode of asexual reproduction, match the Column I with II and select the correct option

	I	II
A.	Yeast	I. Fragmentation
B.	<i>Penicillium</i>	II. Zoospores
C.	Filamentous algae	III. Budding
D.	<i>Chlamydomonas</i>	IV. Conidia

[MHCET 2015]

- (a) A-III, B-IV, C-I, D-II (b) A-II, B-III, C-I, D-IV
(c) A-IV, B-III, C-II, D-I (d) A-III, B-II, C-I, D-IV

Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

- (a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
(c) If the assertion is true but the reason is false
(d) If both the assertion and reason are false
(e) If the assertion is false but reason is true

1. Assertion : Symbiosis is furnished by mycorrhiza.
Reason : In mycorrhiza, symbiosis is established between fungus and alga. [AIIMS 1995]
2. Assertion : Fruticose are well branched leafy lichens.
Reason : These lichens are upright and have pendulous organisation and are attached to substratum by a discoid structure. [AIIMS 1996]
3. Assertion : Aflatoxins are produced by *Aspergillus flavus*.
Reason : These toxins are useful to mankind. [AIIMS 2000, 13]
4. Assertion : Deuteromycetes lack sexual reproduction.
Reason : Fungi show three type of reproduction asexual, sexual and vegetative.
5. Assertion : "Fungi imperfecti" does not show alternation of generation.
Reason : The diploid phase is present in only zygote.
6. Assertion : *Rhizopus* and *Mucor* are used in liquor industry.
Reason : They cause fermentation.
7. Assertion : *Morels* and *Truffles* are edible fungi.
Reason : Ascocarps are edible.
8. Assertion : *Saccharomyces ellipsoidens* is Baker's yeast and *Saccharomyces cerevisiae* is Wine yeast.
Reason : Yeast is used to make dry ice.

9. Assertion : Yeast are the best source of vitamin B complex.
Reason : *Ashbya gossypii* is a filamentous yeast.
10. Assertion : *Claviceps* produces lysergic acid.
Reason : It is carcinogenic.
11. Assertion : Mushrooms are called fairy rings.
Reason : Mushroom consists of two parts-stipe and pileus.
12. Assertion : Basidiocarps are called fungus flowers.
Reason : The beautiful fruit bodies are found in Basidiomycotina.
13. Assertion : Fruticose lichens have the simplest thallus.
Reason : The thallus is attached only at the base by a flattened disc.
14. Assertion : The fungi are widespread in distribution and they even live on inside other plants and animals.
Reason : Fungi are able to grow anywhere on land, water or on other organisms because they have a variety of pigments, including chlorophyll, carotenoids, fucoxanthin and phycoerythrin. [AIIMS 2005]

Answers

Fungi (General)

1	a	2	c	3	d	4	b	5	a
6	a	7	a	8	b	9	c	10	b
11	a	12	a	13	d	14	c	15	d
16	d	17	d	18	b	19	c	20	a
21	a	22	a	23	a	24	c	25	b
26	b	27	c	28	b	29	d	30	c
31	b	32	c	33	c	34	c	35	b
36	d	37	a	38	a	39	b	40	c
41	a	42	d	43	c	44	b	45	c
46	b	47	b	48	a	49	c	50	c
51	c	52	b	53	c	54	d	55	d
56	d	57	c	58	c	59	d	60	d
61	a	62	b	63	a	64	d	65	b
66	b	67	c	68	c	69	b	70	a
71	a	72	b	73	b	74	b	75	d
76	c	77	d	78	d	79	a	80	d
81	b	82	c	83	e	84	e	85	c
86	b	87	b	88	c				

Mucor and Rhizopus

1	a	2	c	3	b	4	d	5	b
6	a	7	d	8	a	9	b	10	b
11	b	12	a	13	a	14	a	15	a
16	b	17	a	18	b	19	c	20	d
21	b	22	c	23	c	24	d	25	d
26	b								

Yeast and Albugo

1	d	2	d	3	b	4	d	5	a
6	b	7	b	8	b	9	a	10	c
11	c	12	b	13	a				

Lichen and Mycorrhiza

1	b	2	a	3	b	4	b	5	a
6	c	7	c	8	a	9	c	10	c
11	b	12	d	13	c	14	d	15	b
16	b	17	b	18	b	19	c	20	a
21	b	22	a	23	b	24	d	25	d
26	a	27	b	28	b				

NCERT Exemplar Questions

1	d	2	c	3	b	4	c	5	c
6	d								

Critical Thinking Questions

1	e	2	a	3	c	4	b	5	d
6	d	7	b	8	c	9	d	10	b
11	b	12	d	13	a	14	c	15	c
16	a								

Assertion and Reason

1	c	2	e	3	c	4	b	5	c
6	a	7	a	8	b	9	b	10	c
11	b	12	a	13	e	14	c		

Answers and Solutions

Fungi (General)

- (a) The term fungus was used by Gaspard Bauhin (1560-1624).
- (c) Father of modern mycology and plant pathology is H.A. De Bary (a German botanist).

8. (b) Due to the presence of mentioned characters in question, this group is also called fungi imperfecti.
9. (c) Conidia are non-motile spores produced exogenously by constrictions at the tip of special hyphae called conidiophores.
11. (a) Heterotrophs : Fungi (lack chlorophyll) obtain their nutrition from the extracellular digestion and absorption of the digested material such mode of nutrition is called heterotrophic and the organism called heterotrophs.
13. (d) T.S. Sadasivan work on physiology of infection by *Fusarium*. Other famous Indian mycologists are K.C. Mehta, B.B. Mundkar and C.V. Subramaniam.
14. (c) Koch postulates are applicable to bacteria and fungi as pathogen.
16. (d) Brown leaf spot of rice is a seed born disease, which is caused by *Helminthosporium oryzae*.
18. (b) Morel and truffles are edible and members of Ascomycetes in fungi.
20. (a) Mushroom is a basidiomycetes fungus, which is grow on dead and decay matter.
24. (c) Covered smut of barley is caused by *Ustilago hordei*.
25. (b) Late blight of potato is a seed born disease which is caused by *Phytophthora infestans*. The disease is characterised by brownish to blackish dead areas on the tip and margin of the leaflet leading to blighting of the whole leaf. So the tuber formation is reduced.
27. (c) All fungi are heterotrophs in their nutrition. Some are depends upon organic matter known as saprophytes.
28. (b) Modes of nutrition is three types :
(a) Saprophytic (b) Parasitic (c) Symbiotic (Mycorrhiza).
29. (d) The members of division basidiomycota (class basidiomycetes) are commonly called club fungi because the basidia are club shaped.
30. (c) Aflatoxins are produced by fungi (*Aspergillus flavus*).
32. (c) The septum of higher fungi is more complex dolipore (Latin dolium = a large jar). It is a barrel shaped pore with open end.
33. (c) *Aspergillus flavus* grows on stored cereal grains, groundnut and areca nut produce a carcinogenic toxin called aflatoxin.
35. (b) The mycelium of *Aspergillus* consist of branch septate hyphae. Cells of hyphae are multinucleate.
37. (a) In gametangial copulation two gametangia come in contact and fuse completely to form a zygote or zygospore. It is found in members of zygomycetes, e.g., *Rhizopus* and *Mucor*.
39. (b) It is the first stage of sexual reproduction in which the cytoplasm of two sex cells fuse with each other. The nuclei of sex cells come close to each other but do not fuse. Thus the resulting cell becomes binucleate or dikaryon.
43. (c) Many scientist (Sachs, 1874; Bessey, 1950) believe that fungi, particularly class Phycmycetes, have evolved from siphonaceous green algae. Both the group have some common features such as presence of coenocytic thalli, flagellated zoospores, streaming movement and mode of sexual reproduction. Therefore Phycmycetes is called algal fungi.
44. (b) The fungus *Aspergillus* produces aflatoxins which are carcinogenic and may cause cancer in human beings.
49. (c) Many species of *Neurospora* have been used as convenient organisms for genetical (one gene – one enzyme theory by Beadle and Tatum) and biochemical studies. *Neurospora* is also known as *Drosophila of plant kingdom*.
52. (b) Coprophilous fungi grow on dung. e.g., *Pilobolus crystallinus*.
56. (d) Bordeaux mixture was the first fungicide to be discovered. It is discovered by proff. Millardet of Bordeaux university. This mixture consists of copper sulphate, lime and water (calcium hydroxide). This mixture is called holy water of plant pathology and effective against white rust, mildews and blights.
57. (c) Parasexuality is related with protoplast fusion and found in fungus.
58. (c) Sporadic disease occurs occasionally at irregular intervals in fewer area and only few plants in a locality are infected, e.g., Blotch disease of cucumbers, angular leaf spot of cotton.
64. (d) In ascomycetes, diploid nucleus divided by meiosis and then by mitosis to form 8 (sometimes only 4) haploid ascospores. These sexually produced ascospores remain inside the sac like structure called ascus.
67. (c) Parasexuality was first discovered by Pontencorvo and Roper (1952) in a fungus *Aspergillus nidulans*. Parasexuality help in recombination without meiosis and fertilization.
68. (c) Phytoalexins are phenolic compound produce in the host cell for defense in response to fungal infection (Muller and Borger, 1940). These chemicals inhibit growth of the parasite.
70. (a) In many members of basidiomycetes cells division accompanied by clamp connection. These are bridge (hook) like connection. They function as bypass hyphae through which nuclei migrate to make all of mycelium dikaryotic.
71. (a) *Puccinia graminis tritici* causes black rust of wheat.
73. (b) LSD (Lysergic acid diethylamide) is the most powerful hallucinogen. It is a crystalline amidated alkaloid obtained from ergot. i.e., an extract got from a fungus *Claviceps purpurea*, that is parasite on rye.

74. (b) Chloromycetin is an antibiotic which obtained from *Streptomyces venezuelae*.
76. (c) The fructifications of certain fungi are used as nutritous and delicious food e.g., *Agaricus bisporus* and *A. campestris* (mushrooms).
77. (d) Both are heterotrophic in their mode of nutrition, so they are saprophytic or parasitic.
78. (d) *Claviceps purpurea* (ergot fungus) causes ergot of cereals especially of rye (*secale cereale*).
79. (a) Fungi lack chlorophyll, therefore, heterotrophic in nature. Their cell wall is formed of chitin (fungus cellulose). The cells in higher plants and fungi is eukaryotic i.e., possess a well developed nucleus.
80. (d) *Amanita muscaria* is noted for its hallucinogenic properties, with its main psychoactive constituent being the compound muscimol.
81. (b) Bakane disease of rice is caused by *Fusarium moniliforme*. The perfect stage of this fungus is *Gibberella fujikuroi* (ascomycete). *Gibberella* produces the plant hormone gibberellin.
88. (c) Cell wall of fungi is made up of chitin and polysaccharides.

Mucor and Rhizopus

2. (c) Each progametangium of *Rhizopus* undergoes division to form gametangium and suspensor. The two gametangia are in contact with each other. They contain multinucleate protoplasts that behave as aplanogamete or coenogamete.
5. (b) In asexual reproduction of *Mucor* three type of non-motile mitospores are produced. i.e., sporangiospores, chlamydo-spores and oidia.
7. (d) Fusion of coenogametes (*Rhizopus* and *Mucor*) produced a diploid resting spore called zygospore.
9. (b) The sporangium of *Rhizopus* is appear to be divide into two regions, i.e., Outer fertile sporiferous zone and a central sterile columella. The protoplast of the sporiferous zone cleave mitotically to form dark coloured multinucleate spores.
10. (b) The process is initiated by the secretion of trisporic acid which stimulates the formation of special hyphae, called zygophores, from both of the compatible mycelia (+) strain and (-) strain.
12. (a) The hyphae are aseptate and multinucleate (i.e., Coenocytic).
13. (a) Both (+) and (-) progametangium are similar in structure.

14. (a) Sporangiospores are produced in large number inside the sporangia of *Mucor*, which are borne over special hyphae known as sporangiophore. These spore are produced during asexual reproduction.
16. (b) Sexual reproduction results in the formation of diploid zygospore. The zygospore absorbs water and swell. The exospore ruptures and the endospore protrudes out in the form of a hypha, called promycelium.
19. (c) When in *Rhizopus* (+) and (-) strains are found separately (physiologically), then this condition is called as heterothallism.
20. (d) *Rhizopus* (pin mould or black mould) grows on bread and hence also called bread mould.
22. (c) In liquid medium, rich in sugar and acidic pH, the hyphae of *Rhizopus/Mucor* produce small rounded oidia, which multiply by budding like yeast. This budding condition is called torula stage.

Yeast and Albugo

4. (d) The yeast cells secrete extracellular enzyme-zymase which converts complex sugar into simple soluble sugar.
8. (b) The mycelium is intercellular branched, aseptate and multinucleate. The mycelium produces finger like or globular haustoria which enter into the host cells to absorb the food material.
10. (c) True yeast bear asci which are not organized into ascocarps. e.g., *Schizosaccharomyces*, *Saccharomyces*, *Saccharomycodes*, *Zygosaccharomyces*, *Nematospora*. Therefore, yeast are classified under ascomycetes.
12. (b) Selected strains of *Saccharomyces* are used as Baker's yeast. It is available as powder or cake. The same is added to flour during kneading. Yeast secretes amylase (change some starch to maltose), maltase (maltose to glucose) and zymase (glucose to ethyl alcohol and CO₂). The dough swells up or leavens. Leavened dough is baked. Both alcohol and CO₂ evaporate. The bread becomes soft and porous.
13. (a) Yeast reproduces by means of budding. Sometime the bud starts forming new bud before it separates from parent cell. This may result in formation of branched and unbranched chains of bud which is called as pseudomycelium.

Lichen and Mycorrhiza

2. (a) Sexual reproduction in lichen is performed only or mainly by its fungal component.
6. (c) In adverse conditions ectomycorrhiza work as root hairs to absorb water as in *Pinus*. Because gymnosperms do not have root hair.
7. (c) Lichen are slow growing and grow at the rate of 1 mm per year.

13. (c) In lichens fungus partner or mycobiont (mostly ascomycete) and an algal partner called photobiont or phycobiont (mostly blue-green alga).
17. (b) *Nostoc* – BGA, *Agaricus*-Basidiomycetes, *Rhizobium*-Eubacteria
18. (b) Lichens are considered as pioneers in initiating a plant succession on rocks.
19. (c) Reindeer moss (*Cladonia rangiferina*) of the arctic region is the used as food for reindeer and cattle.
21. (b) *Glomus* is a endomycorrhiza for phosphorus absorption.
24. (d) Mycorrhiza is a symbiotic association of a saprophytic fungus with the roots of higher.
25. (d) Helotism is a form of symbiosis in which one partner benefits more than the other. e.g., Fungus in lichen thallus benefits more than the alga.
26. (a) Litmus used as acid-base indicator is obtained from *Roccela montagnei* and *Lasollia pastulata*.
4. (b) Sexual reproduction is absent (as the sexual stage is absent) in the artificial group of fungi called fungi imperfecti or deuteromycetes.
5. (c) Fungi imperfecti is that group of fungi where only the imperfect stage (asexual stages) is present. The only known method of reproduction is by conidia (asexual reproduction). As sexual reproduction is absent in this group therefore diplophase is also absent.
6. (a) Both *Rhizopus* and *Mucor* species are used in alcoholic fermentation. The two produce a number of organic acids like citric acid, lactic acid and fumaric acid.
7. (a) The fructifications of some ascomycetes, i.e., ascocarps are edible, e.g., morels, truffles.
8. (b) The two common yeasts used by brewing industry are *Saccharomyces cerevisiae* (Beer or Baker's yeast) and *S. ellipsoidens* (Wine Yeast). In the baking or brewing industry CO_2 is the useful product. It is collected, solidified and sold as "dry ice".
9. (b) The yeasts are the best sources of vitamin B complex. Riboflavin (B_2) is obtained from a filamentous yeast *Ashby gossypii*.
10. (c) A derivative of ergot known by name of lysergic acid (LSD) is used in experimental psychiatry, as it is a hallucinogen.
11. (b) The basidiocarps or mushrooms often lie in rings. Therefore, are spoken as fairy rings. Each basidiocarp consists of two parts-stipe and pileus. The stipe or stalk is fleshy. Pileus is umbrella-like cap of the mushroom.
12. (a) The fruit bodies of Basidiomycotina, called basidiocarps are most attractive and beautiful of all fungi and therefore are called fungus flowers.
13. (e) Fruticose lichens have a most complex thallus which is slender and freely branched. The branches may be cylindrical or ribbon-like and form thread-like or twig-like tufts. The thallus is attached only at the base by a flattened disc.
14. (c) Fungi are considered ubiquitous i.e., they occur in a variety of habitats. Most of them are moisture loving and terrestrial and few (e.g., *Monoblepharis*) are aquatic. Fungi may be **epiphytic** (i.e., live on plants e.g., *Armillaria*), **saprophytic** (i.e., grow in dead organic matter e.g., *Mucor*), **symbiotic** (i.e., live with association with other plants e.g., lichen, mycorrhiza) and **predacious** (e.g., *Dactyldela*) and parasitic (e.g., *Erysipi*) fungi are non-chlorophyllous i.e., devoid of chlorophyll hence cannot prepare their own food. They are heterotrophic and show absorptive type of nutrition.

Critical Thinking Questions

5. (d) Fungi can be stained with cotton blue. This stain provide blue colour of chitinous cell wall.
6. (d) *Ascobolus*, *Saccharomyces* and *Penicillium* belong to ascomycetes.
7. (b) In algae (*Ulothrix*), bryophytes and pteridophytes, water is necessary for fertilization.
9. (d) Duteromycetes is also known as fungal waste basket because its lack perfect sexual stage.
11. (b) Powdery mildew diseases are characterized by the presence of fungal mycelium, conidiophore and conidia as white powdery patches on the host. Powdery mildew is caused by fungi which belongs to ascomycetes.
12. (d) Loose smut of wheat is caused by *Ustilago tritici*, which is seed borne disease.
13. (a) Basidiocarp is a fruiting body of basidiomycetes. It is a edible part of mushroom.
14. (c) *Saccharomyces cerviciae* is a yeast used in making bread (Baker's yeast) and commercial production of ethanol.
15. (c) *Aspergillus* do not produce motile spore (zoospore).

Assertion and Reason

1. (c) Mycorrhiza represents mutualistic symbiosis between fungus and roots of higher plants. Fungus helps in absorption of minerals and water. Fungus also gets food from plant.
2. (e) Fruticose are well branched shrubby lichens with upright and pendulous organization. These are attached to substratum by a discoid structure. Plant body can be divided into prostrate, leafy and lobed thallus.
3. (c) Aflatoxins, are produced by *Aspergillus flavus*. Contaminated food is the main source of infection. This toxin causes aflatoxicosis which may lead to haemorrhage and disease of liver.

Fungi (Multicellular decomposers)

Self Evaluation Test

- In all members of Ascomycetes, the number of ascospores and their arrangement in an ascus are as follows
(a) Eight ascospores in a linear order
(b) Four ascospores in a linear order
(c) Either eight or four ascospores, but always in a linear order
(d) Either eight or four ascospores in a linear order or unordered
- Cleistothecium is present in [RPMT 1999]
(a) Only in *Aspergillus*
(b) All Ascomycetes
(c) *Penicillium* and *Aspergillus*
(d) Hemi-ascomycetes
- In mushroom, fungal tissue which formed central part of a gill is [RPMT 1999]
(a) Strema (b) Trema
(c) Sub-hymenium (d) Hymenium
- Fungi causing hair loss are [JIPMER 1999]
(a) Keratophilous (b) Pyrophilous
(c) Coprophilous (d) None of these
- Fungi differ from other kingdoms in being [DPMT 2001]
(a) Unicellular consumer (b) Unicellular decomposers
(c) Multicellular consumer (d) Multicellular decomposer
- LSD is obtained from [CPMT 1998; AFMC 2000; BVP 2002; MH CET 2005]
(a) *Clavatia* (b) *Claviceps*
(c) *Amantia* (d) *Trichoderma*
- Aflatoxicosis of poultry is caused by [AIIMS 2000]
(a) *A.flavus* (b) *A.fumigatus*
(c) *Candida albicans* (d) *Rhizopus*
- Which one secretes pheromones for the function [BHU 1994; Pb. PMT 1999]
(a) *Rhizopus* for formation of zygospore
(b) All fungi for sexual reproduction
(c) Yeast for mating
(d) Plants for growth and development
- VAM represents [HP PMT 1994; Haryana PMT 1994; CMC 2002; AFMC 2006; WB JEE 2011]
(a) Saprophytic fungi (b) Symbiotic fungi
(c) Saprophytic bacteria (d) Symbiotic bacteria
- Heterothallism in *Mucor* was first reported by [MP PMT 1993; RPMT 1997; BVP 2001, 02]
(a) Robert Hooke (b) Blakeslee
(c) Louis Pasteur (d) Fleming
- Collumella is found in [BHU 1999]
(a) *Mucor / Rhizopus* (b) *Spirogyra*
(c) *Moss* (d) Both (a) and (c)
- In *Mucor* sp. usually isogamy takes between [MP PMT 1997]
(a) Same strains (b) + and - strains
(c) Zygosporangia (d) Microspores
- What is VAM [MP PMT 2011]
(a) Endomycorrhizae (b) Ectomycorrhizae
(c) Both (d) None
- Motile sperms are absent in [MP PMT 2013]
(a) *Rhizopus* (b) *Funaria*
(c) Fern (d) *Cycas*
- Which pair of the following belongs to basidiomycetes [CBSE PMT 2007]
(a) Birds nest fungi and Puffballs
(b) Puffballs and *Claviceps*
(c) *Peziza* and Stink horns
(d) *Morchella* and Mushrooms
- Which of the following structure helps in the respiration of lichens [AIIMS 2002]
(a) Soredia (b) Cyphella
(c) Isidia (d) Cephalodia
- Life cycle of yeast is [RPMT 1999; Odisha JEE 2012]
(a) Haplodiplobiontic (b) Haplobiontic
(c) Diplobiontic (d) All of the above
- Meiosis occur in yeast in
(a) Ascospores (b) Ascus mother cell
(c) Ascus (d) None of the above
- Conidia of *Albugo* are arranged [RPMT 1995]
(a) Irregularly (b) Acropetally
(c) Basipetally (d) Intercalary
- Yeast is important source of [CPMT 1993, 94; BHU 1999; MP PMT 1999]
(a) Proteins (b) Riboflavin
(c) Vitamin C (d) Sugars
- Zoospore of *Albugo* possesses flagella [RPMT 1995, 96]
(a) Two similar and apical
(b) Four similar and medium
(c) Four apical
(d) Two dissimilar and laterally
- Lichens multiply by [Odisha JEE 1995]
(a) Conidia (b) Oidia
(c) Ascospores (d) Soredia
- Claviceps* is a member of [DPMT 2006]
(a) Ascomycetes (b) Basidiomycetes
(c) Zygomycetes (d) Phycomycetes
- A harmful lichen is [MHCET 2001]
(a) *Lobaria* (b) *Cladonia*
(c) *Usnea* (d) *Rocella*
- Sometimes, in yeast, the conjugation takes place between a parent cell and a bud. It is called [KCET 2001; AFMC 2006]
(a) Isogamy (b) Syngamy
(c) Pedogamy (d) Parthenogenesis
- Fusion of gametangia in *Rhizopus* is [AFMC 2002]
(a) Planogametic copulation (b) Gametangial contact
(c) Gametangial copulation (d) Spermatogamy

27. In yeast, cell wall contains [AFMC 1999]
 (a) Amylose and glucose
 (b) Glucose and mannose
 (c) Glucose and muramic acid
 (d) Sucrose and mannose
28. A plant example in which reproductive structures lack a layer of sterile vegetative cells surrounding the egg [BHU 1994, 2008]
 (a) *Funaria* (b) *Riccia*
 (c) *Saccharomyces* (d) *Cycas*
29. Yeast is [AIIMS 1997; MP PMT 2010]
 (a) Purely aerobic
 (b) Anaerobic
 (c) Rarely anaerobic
 (d) Both aerobic and anaerobic
30. Which one of the following is wrongly matched [CBSE PMT (Pre.) 2011]
 (a) Cassia - Imbricate aestivation
 (b) Root pressure - Guttation
 (c) *Puccinia* - Smut
 (d) Root - Exarch protoxylem
1. (d) Each ascus has 4 to 8 endogenously produced meiospores called ascospores arranged either in linear order (*Neurospora*) or unorderedly (Yeast).
 2. (c) *Penicillium* and *Aspergillus* have cleistothecium fruiting body.
 3. (b) Mature gill composed of a central core called trama which is made up of parallel or loosely interwoven hyphae.
 4. (a) Keratophilous fungi appear on nails, feathers, hairs etc.
 8. (a) In *Rhizopus*, zygospore formation is induced by the hormones trisporic acid B and C.
 11. (d) Collumella : It is the structure made up of sterile cells e.g., *Mucor/Rhizopus* and in moss.
 15. (a) Bird's nest fungi – *Cyathus*, Puffballs – *Lycoperdon clavatia*.
 18. (c) In class ascomycetes meiosis occurs in ascus mother cell but in yeasts meiosis occurs in zygote and there is no ascus mother cell. Zygote function directly as naked ascus produces ascospores arranged in unordered manner.
 20. (b) Yeast from brewing industry is harvested and used as a food. It is rich in protein and vitamin-B (Riboflavin).
 21. (d) In *Albugo* diploid nucleus undergoes meiosis, followed by several mitotic division. After a period of rest, the oospore germinates and produced reniform, biflagellate zoospores.
 22. (d) Each soredia form a new thallus under favorable condition.
 24. (c) In hot season, *Usnea* get dry and become highly inflammable. It easily catches fire and causes forest fire.
 25. (c) In some yeast e.g., *Zygosaccharomyces chevalieri*, the mother and daughter cells fuse to form the zygote and this phenomenon is called pedogamy.
 29. (d) Yeast are facultative aerobes i.e., they are anaerobes but also survive under aerobic conditions and respire aerobically as well.
 30. (c) *Puccinia* - rust fungi.

AS Answers and Solutions

1	d	2	c	3	b	4	a	5	d
6	b	7	a	8	a	9	b	10	b
11	d	12	b	13	a	14	a	15	a
16	b	17	d	18	c	19	c	20	b
21	d	22	d	23	a	24	c	25	c
26	c	27	b	28	c	29	d	30	c

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