

Chapter 8

FUNGI THE KINGDOM OF RECYCLERS

"The study of fungi is called mycology".

- Q.1** (a) Define fungi. What is a hypha?
 (b) What do you know about mycelium? Differentiate between septate and aseptate mycelia.
 (c) What is the composition of cell wall of fungus? How is this composition beneficial for fungi?

Ans. (a) DEFINITION:

"Fungi are heterotrophic, eukaryotic organisms which have spore bearing structure and cell wall of chitin". (OR)

"The achlorophyllous spore bearing organisms with cell wall of chitin which live as parasite, saporophyte and symbiont are called fungi".

HYPHAE

The long, fine and branched filament as a structural and functional unit of the fungus is called hypha. (Hyphae: Plural).

A hypha may be septate or aseptate, and uninucleated or multinucleated:

A multinucleated or uninucleated cells with cross walls are called **Septate Hyphae**. The hyphae without cross walls are called **Aseptate Hyphae**.

Rhizopus and *Mucor* are examples of aseptate hyphae while penicillium has septate hyphae.

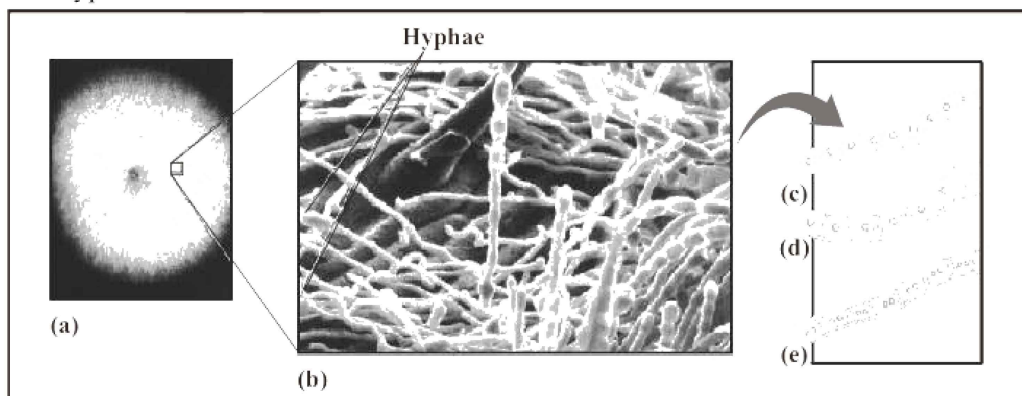


Fig. The fungus body plan: (a) Fungus mycelium growing on agar plate (b) Hyphae of mycelium (c) A coenocytic hypha (d) A septate hypha with porous septa and monokaryotic cells (e) A septate hypha with dikaryotic cell

(b) **Mycelium**

A group of hyphae is collectively called mycelium.

(OR)

“The interwoven hyphae in the form of fungus body is called mycelium”.

The mycelium grows in between the host cells is called **intercellular mycelium**. And the mycelium grows into the cells is called **intracellular mycelium**.

The mycelium having cross walls is known as septate mycelium and mycelium without cross walls is called aseptate mycelium.

(c) **Composition of Cell Wall (CHITIN)**

Fungi have rigid cell wall. The cell wall is made up of CHITIN. In the cell wall chitin is present in fibrillar form. It surrounds the cells.

Chitin is N₂-containing polysaccharide.

Chemically, chitin is a *nitrogen-containing polysaccharide*.

Role of Chitin:

Chitin has tensile strength like cellulose.

It gives shape to the hyphae and prevents osmotic bursting of cells.

Chitin is a “fungal cellulose”.

Due to presence of chitin, cell wall is more resistant to decay.

The cell wall is followed by **Plasmalemma**. It regulates the movement of soluble substances into and out of hypha.

Chitin facilitates the skeleton like structure, as external character of arthropods.

Q.2 (a) Write down characteristics of fungi.

(b) Discuss taxonomic status of fungi.

Ans. (a) CHARACTERISTICS OF FUNGI:

Hyphae: Hyphae are basic *structural* and *functional* units. Hyphae unite and *form mycelium* or body.

Non Photosynthetic: Fungi are *lack of chlorophyll*, so they are non photosynthetic.

Pathogens: They are pathogens of human beings, crops, animals etc.

Moisture Loving: They are moisture and dark loving.

Nutrition: Fungi can be *parasites*, *saprophytes* and *symbionts*.

No Digestion: Digestion does not take place inside the body unlike animals.

Reserve Food: Reserve food material is *glycogen*.

Decomposer: They act as decomposer like bacteria.

Non-Motile: They are non-motile and centrioles are absent.

Chitin: The presence of cell wall is a plant like character, but cell wall is made up of chitin. Chitin containing cell wall is a specific character.

Exoskeleton: Lack of cellulose and presence of chitin show resemblance to animals, specially arthropods have exoskeleton of chitin.

Different Kinds of Spores:

DNA study describes, fungi are different to animals and plants.

- **Zygospor**es, **basidiospor**es, **ascospores** and **conidia** are present in it.
- Fungi have **nuclear mitosis** in which nuclear envelope does not break.
- Fungi **reproduce asexually** as well as **sexually**. Fusion of gametes takes place in sexual reproduction. Asexual reproduction occurs by *spores fission*, *fragmentation* and *budding*.

(b) **TAXONOMIC STATEUS**

+ **Plant Like Characteristics of Fungi**

In the past, the fungi were included in the kingdom of plants due to following characters:

Cell Wall: Cell wall is a specific feature of plants, so fungi also have cell wall.

Lack Centrioles: No centrioles are present in plant cells, thus centrioles are also absent in fungi.

Non-Motile: They are non motile/non locomatory like plants.

+ **Animal Like Characteristics**

Fungi have the following features which are similar to animals:

Lack Chlorophyll: Due to absence of chlorophyll, fungi are heterotrophs. (fungi are not autotrophs).

Lack Cellulose: Absence of cellulose in cell wall, they may be considered as animal.

Presence of Chitin: Chitin is that chemical which is found as an external skeleton (exoskeleton) of arthropods.

Not Starch: Reserve food material is glycogen, not starch.

+ **Neither Plants Nor Animals**

Fungi are not plants because their cell wall is without cellulose and photosynthesis is absent. So all plants have photosynthesis and live as autotroph. While fungi live like heterotroph.

They are also not animals because cell is surrounded by cell wall and they are also non-motile while animals are always motile.

According evolutionary view, some mycologists think that fungi and animal have common ancestor.

DNA's evidence shows, fungi are different from all other organisms.

Specific mitosis is a salient feature of fungi. This is called nuclear mitosis.

"It is the mitosis in which nuclear membrane does not break. At the time of mitosis a pair of spindle pole bodies develop on opposite sides". This intranuclear spindle is made up of microtubules. The spindle pole bodies separate, move towards opposite poles and develop into two daughter nuclei. The entire nuclear mass remains still surround by nuclear envelope.

Q.3 What do you know about yeasts?

Ans. **YEASTS**

Unicellular Fungi (OR) Non-mycelial Fungi.

"Those fungi which have single cell stage in its life cycle and reproduced by budding or fission are called yeasts".

Characteristics of Yeast:

- They exist in *parasite* and *saprophyte* forms.
- The thallus (body) is *non mycelial*.
- Yeasts are *unicellular & microscopic*.
- *Chitinous cell wall* surrounds protoplast.

- Cell wall is thin and delicate.
- Yeasts are *heterotrophic*.
- Yeast protoplasm secretes *zymase* enzymes.
- Zymases change starch into simple sugars.
- During alcoholic *fermentation*, *glucose* is broken down by yeast into *ethyl alcohol* (C_2H_5OH) and carbon dioxide (CO_2) in the absence of oxygen.
- Asexual reproduction takes place by *budding* and *fission*.
- In case of sexual reproduction, *no definite sex organs* are found but they can reproduce by the union of two somatic cells.

Q.4 Define the following:

- | | | |
|-------------------------------|------------------------|----------------------|
| (i) <i>Mushrooms</i> | (ii) <i>Puff Balls</i> | (iii) <i>Yeast</i> |
| (iv) <i>Coenocytic Hyphae</i> | (v) <i>Lignin</i> | (vi) <i>Parasite</i> |
| (vii) <i>Saprotroph</i> | (viii) <i>Predator</i> | (ix) <i>Lichen</i> |
| (x) <i>Mycorrhizae</i> | | |

Ans.

- (i) **Mushrooms:** The macroscopic fungi of basidiomycetes which have *umbrella like pileus* with *gills* and *stipe* are called mushrooms.
- (ii) **Puff Balls:** The *macroscopic* fungi belonging to *basidiomycetes* group with *oval or ball shaped* vision are called puff balls.
- (iii) **Yeasts:** Those fungi which are generally *unicellular* of *ascomycetes* and having ability to convert the *glucose* into *alcohol* and CO_2 are called yeasts.
- (iv) **Coenocytic Hyphae:** (سینوکی هایفای) The basic units of fungi which have *more than one nuclei*.
- (v) **Lignin:** A *polymeric* substance formed from the certain *alcoholic molecules* found in cell wall.
- (vi) **Parasites:** Those organisms which exist on other living bodies for food and shelter are known as parasites. (They may be *ectoparasites*, *endoparasites*, *obligate parasites* and *facultative parasites* etc.)
- (vii) **Saprotroph:** (سپروٹروف) An organism which obtains the food from dead materials (or dead organic materials) is known as saprotroph.
- (viii) **Predation:** An interaction in which an organism destroys or ingests to other organism is called predation. An organism which ingest, destroy or kill the to other organism is called *Predator*.

- (ix) **Lichen:** (الفنج) A thallus like structure which is formed by symbiotic association between algae and fungi is called lichen. (You can say, it is a *compound organism*).
- (x) **Mycorrhizae:** (المزعة) A symbiotic association between fungi and roots of plants is known as mycorrhizae.

Q.5 Which fungus may be the largest in the world?

Ans. **LARGEST FUNGS**

Armillaria may be considered as the largest organism. It is also grown/produced rapidly. A single mycelium may produce one kilometer hypha in one day. It is a pathogenic fungus which is belonging to basidiomycetes group.

It has been measured up to 15 hectares. One hectare means 10,000 m².

Note: "Leafless, rootless and stemless plant body is called thallus"

Q.6 (a) What do you know about nutrition of fungi?
 (b) Write notes on fungi as (i). Saprophyte, (ii). Parasite, (iii). Predators (iv). Symbiont.

Ans. **NUTRITION**

Nutrition means feeding or being fed.

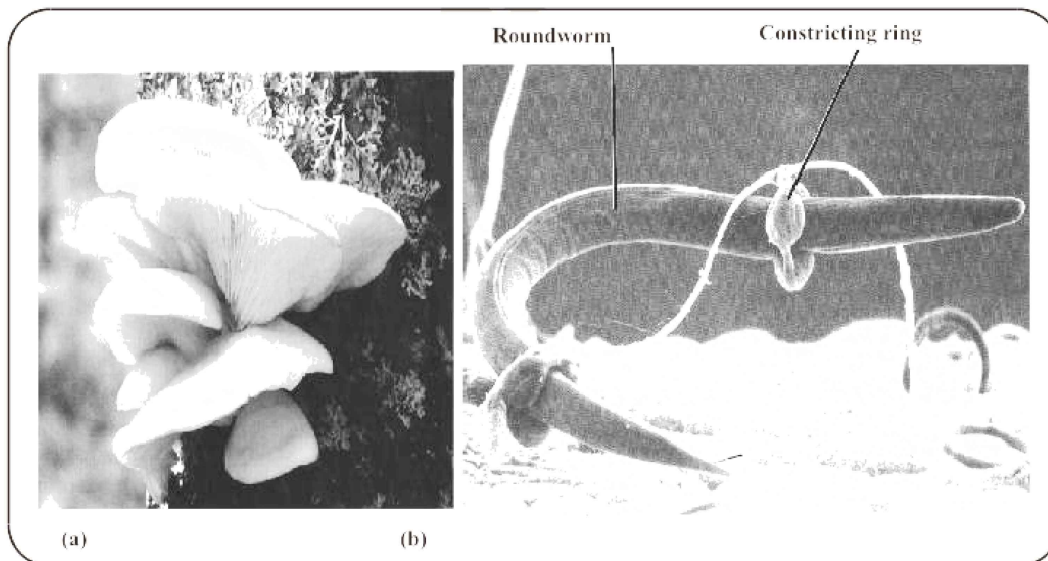


Fig. Carnivorous fungi (a) The oyster mushroom decomposes wood, and also uses nematodes as a source of nitrogen (b) A nematode is trapped in constricting ring of a soil-dwelling carnivorous fungus (*Arthrobotrys* sp.)

FUNGI:

Fungi are unable to manufacture their own food because of absence of chlorophyll. Absence of chlorophyll means “no photosynthesis”. There is no photosynthesis means “organism is heterotroph”.

*The two major kinds of heterotrophs are parasites and saprophytes while fungi heterotrophs are found in **predators** form. Fungi may also survive as a partner of mutual beneficial relationship i.e. **symbiont**.*

(1) SAPROPHYTES (OR) SAPROTROPH

*An organism which obtains the food from dead materials is known as saprotroph or saptrophyte. Saprotrophs are divided into two kinds i.e. **obligative saprotrophs** and **facultative saprotrophs**.*

- (i) **Obligative saprophytes** are those saprophytes which cannot survive without dead materials.
- (ii) **Facultative saprophytes** are those saprophytes which can survive without dead materials. Most fungi are saprotrophs. Sometimes, saprotrophs are also called saprobes. Energy, carbon, nitrogen and food of saprotrophs is obtained from dead organic matter.

Saprotrophs as Decomposer:

Fungi are the decomposers of cellulose and lignin. Both cellulose and lignin are the main components of plant cell wall.

Keep in mind, bacteria cannot break cellulose and lignin, mostly. Saprobic fungi are the major decomposers of the biosphere.

Recycling of the elements like N, C, P, O, H etc. is occurred by fungi and bacteria. These elements are reused by living things.

Fungi secrete enzymes, these enzymes digest dead organic matter. So organic molecules are formed from organic matter by digestion. Then these organic molecules are absorbed back into the fungus.

Fungi anchor their hyphae into the substrate. Those hyphae which anchored into substratum are termed as *rhizoids*.

(2) AS PARASITES

“Those organisms which live on other living organisms for food and shelter are called parasites”.

The fungi are found as *obligative parasites* and *facultative parasites*.

Obligative Parasites are those fungi which can grow only on their living host and cannot grow on available defined growth culture medium.

Facultative Parasites are those organisms which can grow other than specific host. In other words, these fungi have capabilities to grow on artificial growth media.

(3) **AS PREDATORS**

“Those organisms which ingest, destroy or kill the other living bodies, generally for nutrition are called predators”.

The Oyster mushroom (*Pleurotus ostreatus*) is a predator, its preys are *nematodes*. Oyster mushrooms are *carnivores*. They may be *wood eater*. Another fungus *Arthrobotrys* is that predator which trap soil *nematodes* by constricting rings. Constricting rings are modifications of hyphae, these hyphae invade and digest the victim. Some predator secrete sticky substance which holds the prey. *The need of predators is nitrogen and glucose. They absorb the nitrogen from nematodes etc. and glucose from wood. In both cases, predators break and destroy the host.*

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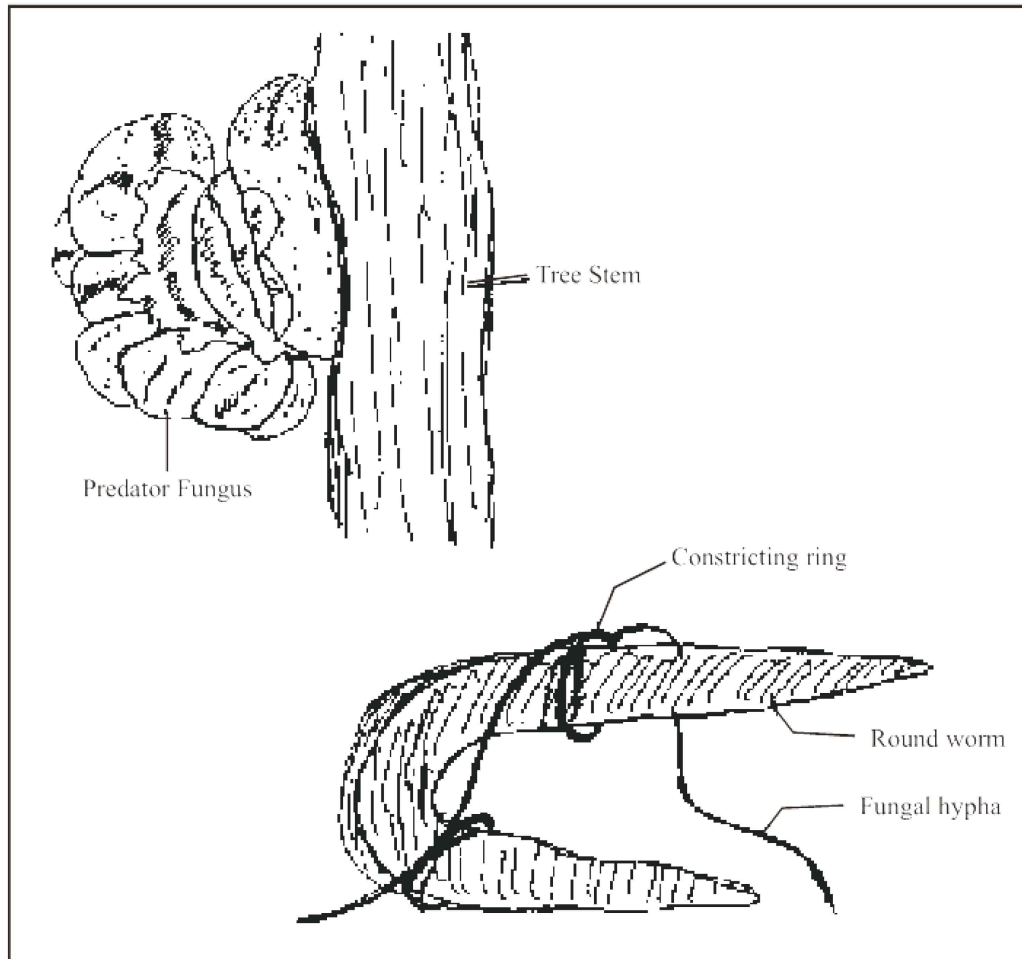
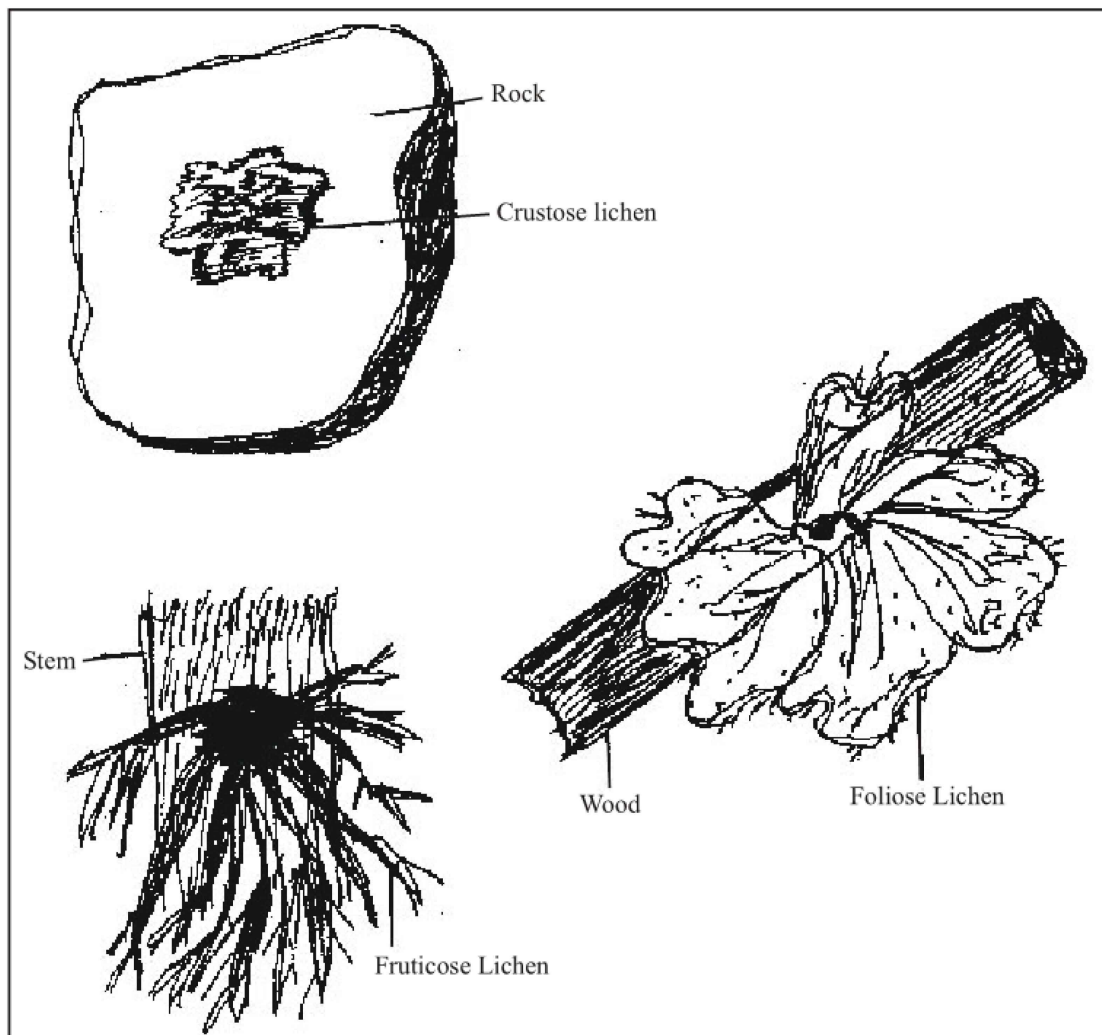


Fig. Fungi as Predator

(4) **FUNGI AS A SYMBIONT** (OR) SYMBIOTIC ASSOCIATION OF FUNGI:**EASY TO DRAW***Fig. Lichens***LICHENS**

These are “compound organism” of fungi and algae. They have thallus body structure.

“A thallus structure which is formed by symbiotic association between algae and fungi is called lichen”.

(OR)

“A thallus which is formed by mutual beneficial relationship between algae and fungi is known as lichen”.

Fungal Partner of Lichen:

Mostly *ascomycetes*, and *imperfect fungi* and *few basidiomycetes* are component of lichens.

Algal Partner of Lichen:

Chlorophyta (green algae) and *cyanobacteria* (blue green algae) are photosynthetic component of lichen.

Role of Fungi in Lichen:

In partnership, *fungi provide protection* to algal cells from strong light and desiccation. Algal cells are present within the fungal hyphae. Generally, visible part is fungi.

Role of Algae in Lichen:

Algae *give ready made food* to fungi in lichen. Actually, algae is photosynthetic or autotroph partner of fungi in lichen.

KINDS OF LICHENS

The association of algae and fungi in the lichens results in the formation of thallus type plant body. Lichens are divided into following kinds on the basis of structure or morphology.

Crustose Lichen is a crust like thallus closely adhered to substratum.

Foliose Lichen is a flat thallus like a leaf which is attached to substratum by rhizines.

Fruticose Lichen is branch like thallus.

Occurrence of Lichen:

They are found *on rocks*. Lichens grow on *bark of trees*. Some are found on soil.

Colours of Lichens:

Grey, yellow, red and ***brown*** colours are common. ***In Murree***, these are easily found.

Economic Importance:

These are *bio-indicators* of air pollution. *Drugs, food, perfumes, dyes* and *poison* are produced from lichens. *Biological weathering* also occurred by lichens.

(iv) MYCORRHIZAE

“A mutual beneficial relationship (symbiosis) between fungi and roots of plants is termed as mycorrhizae”.

About 95% vascular plants have mycorrhizae (according to recent study mycorrhizae is 99% in angiosperms).

Role of Fungi in Mycorrhizal Associations:

Fungal hyphae are spread in large area of soil. *Hyphae collect phosphorus, zinc, copper and other nutrients from soil and supply to the roots of plants.* Due to this

function fungal symbionts are called bio-fertilizers. This symbiotic relationship provides good facility for better growth.

Role of Roots in Mycorrhizal Association:

Plants are autotrophs while fungi are heterotrophs, so *plant roots donate food to fungi*. Plants supply organic carbon to fungi too.

Kinds of Mycorrhizae:

Generally, mycorrhizae are divided into two kinds:

- (a) Endomycorrhizae (b) Ectomycorrhizae

(According to the latest research mycorrhizae have almost nine kinds)

(a) Endomycorrhizae:

Endomycorrhizae are that kind of mycorrhizae in which *hyphae enter in the root cells* and modified into branches, coils (arbuscules) and swellings (vesicles).

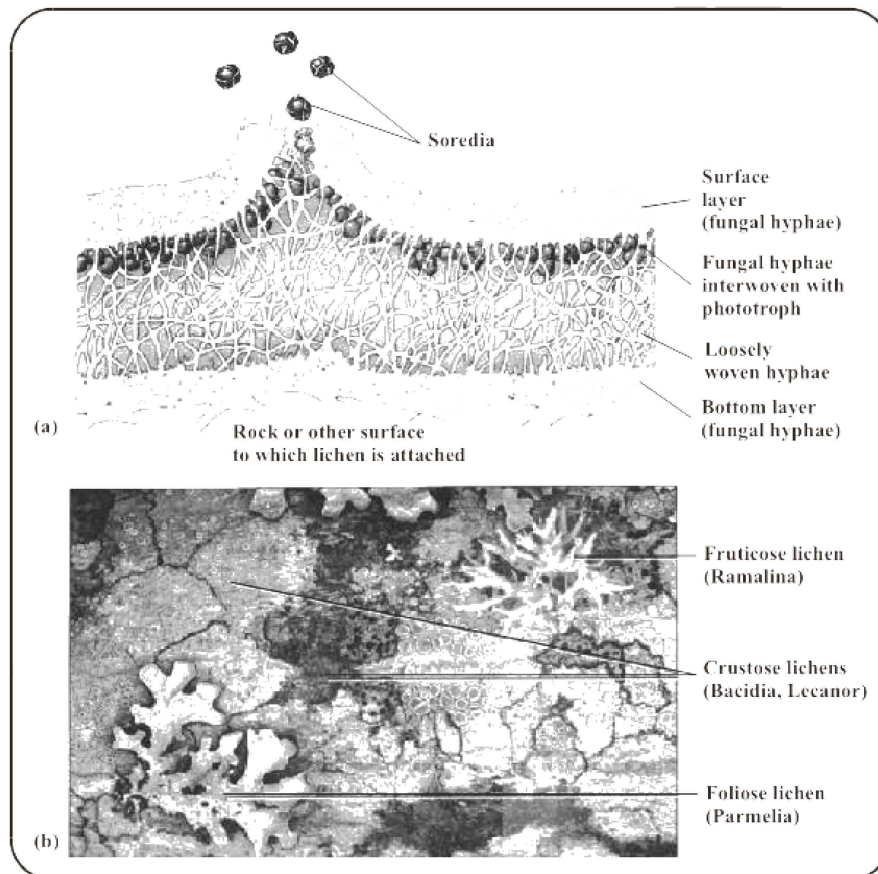
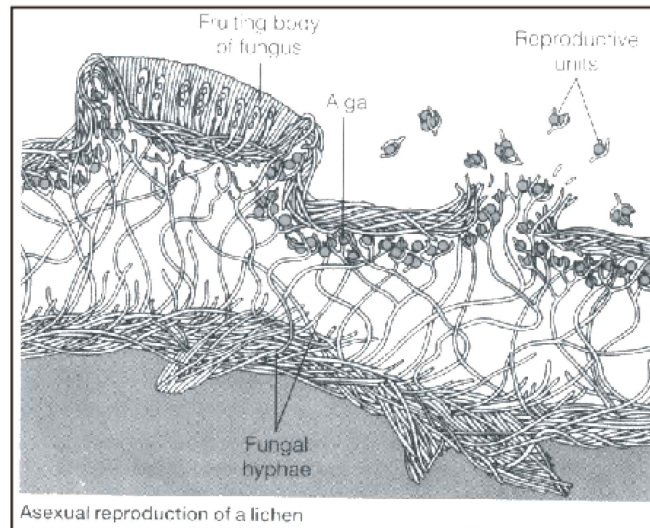


Fig. Lichens (a) Cross section of a typical lichen showing different layers. (b) Different types of lichens varying in size, colour and appearance. Three growth forms – crustose grow tightly attached to rocks, tree trunks etc; foliose are leaf – like, fruticose are branching.

HELP LINE**(b) Ectomycorrhizae:**

Ectomycorrhizae is that mycorrhizae in which *fungal hyphae surround the outer cells of roots but do not enter* in the cells. It is common in pines and firs etc. The extended hyphae or mycelia are found all around the soil for collection of nutrients.

Importance of Mycorrhizae:

Endomycorrhizae *enhance the growth* of plants. They act as *bio-fertilizers*.

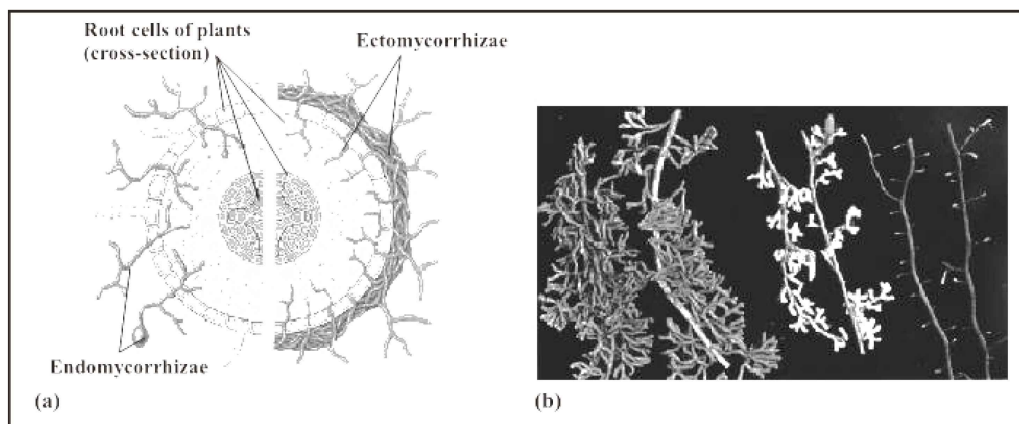
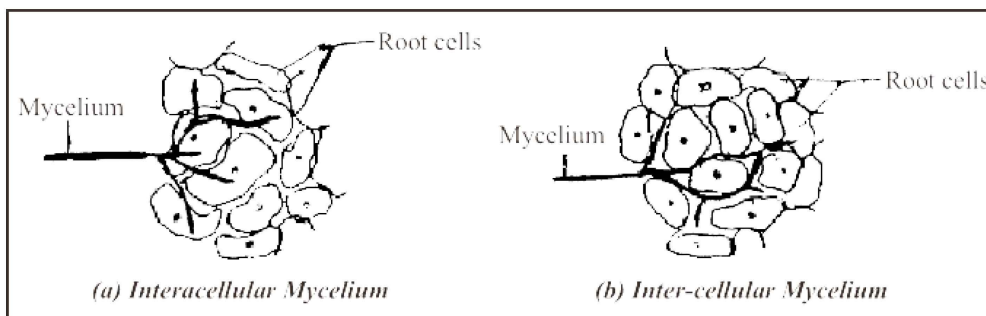


Fig. Endomycorrhizae and ectomycorrhizae. (a) endomycorrhiza (left side of figure), fungal hyphae penetrate and branch out in a root cells. In ectomycorrhiza (right side of figure), fungal hyphae simply grow around but do not penetrate the root cell (b) Ectomycorrhizae on roots of pines.

EASY TO DRAW

- Q.7**
- Discuss the parasitism of fungi.
 - What do you know about saprotroph?
 - Write a note on lichen.
 - What is mycorrhizae? Describe its kinds.

Ans. Consult relevant topics and prepare assignment.

- Q.8** Where fungi grow? Discuss briefly.

Ans. **HABITATS OF FUNGI**

- Generally, fungi are *moist and dark loving*.
- They grow in *organic matter habitats*.
- They have wide temperature range.
- They tolerate from 2-9 pH.
- In sugar or salt (in jam/jelly), they have high osmotic-pressure.
- They can grow as *parasites* of man, plants and animals.
- They are also found as *saprophytes* and *ymbionts*. Fungi also have land adaptations.
- *Glycogen* and *oil droplets* are reserve food materials in fungi.

EXAMINE YOURSELF

Q.9 *Differentiate between followings:*

- (i) *Septate and aseptate mycelium*
- (ii) *Ectomycorrhizae and endomycorrhizae*
- (iii) *Parasites and saprotrophs*
- (iv) *Mushrooms and puff balls.*
- (v) *Lichen and mycorrhizae*
- (vi) *Obligate and facultative parasites.*
- (vii) *Foliose and fruticose lichens.*
- (viii) *Ascomycetes and Basidiomycetes*
- (ix) *Zygomycetes and Deutromycetes*

Ans. Consult different topics of this chapter and prepare this assignment.

Q.10 (a) *Discuss asexual reproduction in fungi.*

(b) *What do you know about sexual rep. in fungi?*

Ans. **ASEXUAL REPRODUCTION**

All group of fungi reproduce asexually. Sexual rep. is found in three groups while imperfect fungi (deutromycetes) have no sexual reproduction.

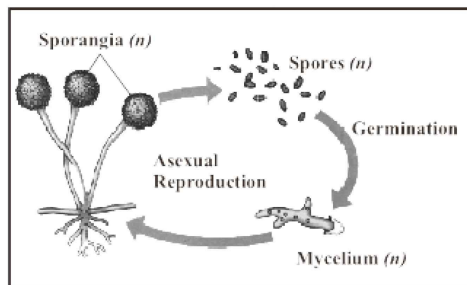


Fig. Spores are released from sporangia and germinate to produce new hypae

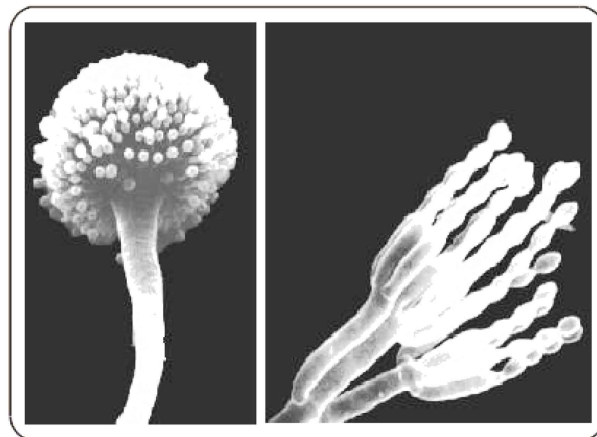


Fig. Conidia cut off at the tip of conidiophores in clusters chains

Asexual reproduction takes place by *spores, conidia, fragmentation and budding.*

(i) By Spores:

Spores are asexual reproductive cells which may grow into new body. They are formed in asexual reproductive structures i.e. *sporangia*.

The formation of spores occur by sexual and asexual process in reproductive structures i.e. sporangia. Sporangia are present on hyphae with complete septa. The sporangia are saclike structures.

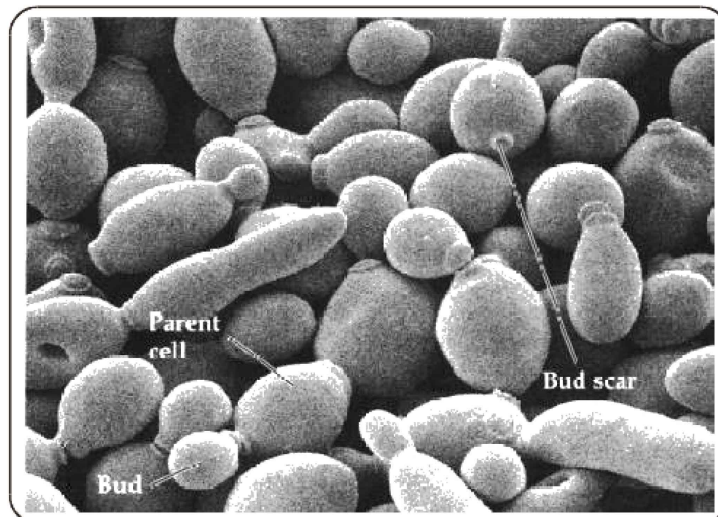


Fig. Micrograph shows yeast (*Saccharomyces cerevisiae*) in various stages of budding

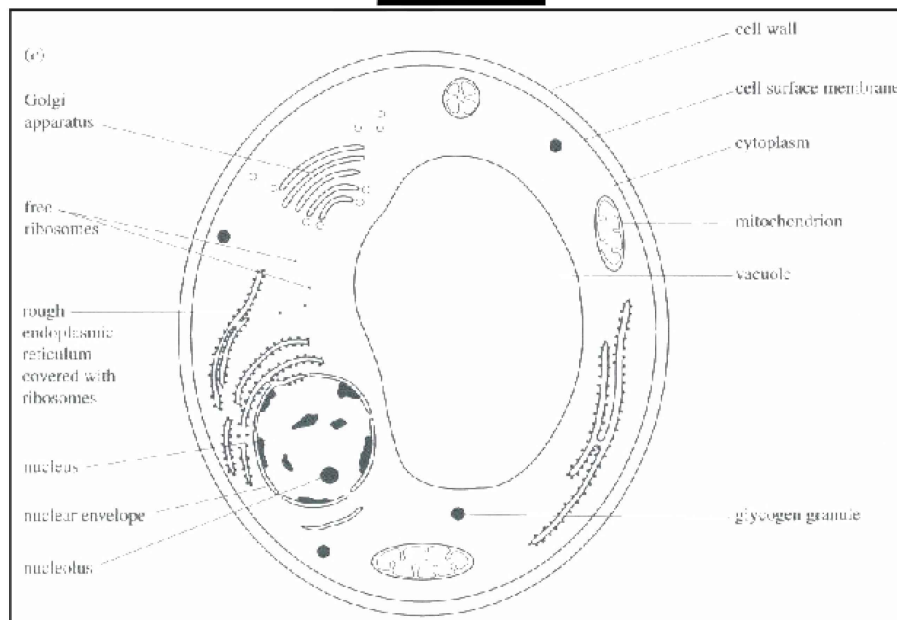
HELP LINE

Fig. Showing yeast

Spores may be uninucleate, multinucleate and non-motile. Non motile spores are also called Aplanospores.

Spores are formed from vegetative body of various processes other than sexual process. Sometimes, these are called *asexual spores*.

When spores fall on suitable place, they grow. It is the general mean for reproduction of fungi. It is the rapid method. Spores of fungi not required water for dispersal. They are dispersed by wind, animals, insects and rain etc.

CONCEPTUAL CHART

Certain spores are produced by sexual methods:

- (i) *Zygospor*
- (ii) *Ascospores*
- (iii) *Basidiospores*

These are called sexual spores.

CONIDIA: “The non-motile, asexual spores which are not formed in sporangium but develop singly or in chain on hypha are called conidia”.

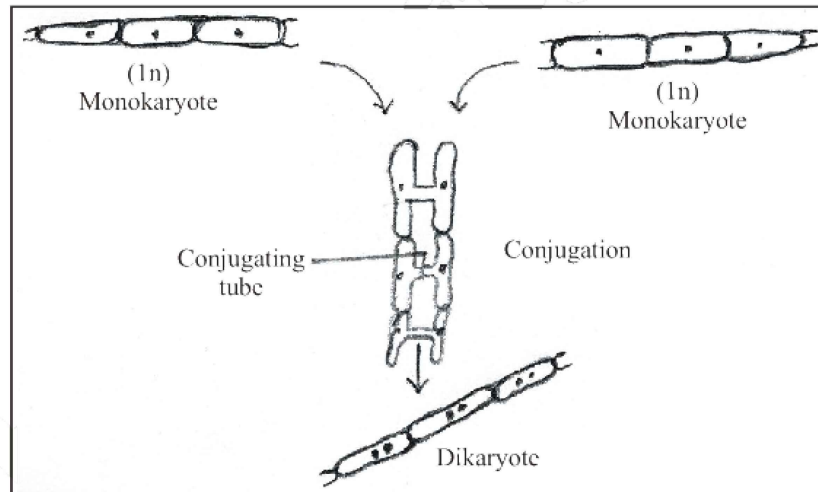


Fig. Showing dikaryotization

Conidia are different to spores, because conidia are not produced in sporangium. The specific hypha on which single conidium or cluster or chain of conidia developed is called Conidiophore. Conidia may be produced in large number. They can survive many days.

By Fragmentation: The kind of asexual reproduction in which certain hyphae break from mycelium and develop into new mycelium or individual is called fragmentation.

In other words, the division of a vegetative body into one or more fragments each of which grows into a new individual.

By Budding: The kind of asexual reproduction in which development of small outgrowth is occurred as a bud from vegetative body. This bud is separated and grows into new individual.

* (Vegetative means asexual or body)

Sexual Reproduction: Sexual reproduction in fungi involves the union of two nuclei of different genetics. This process has particular sequence.

- (i) **Plasmogamy:** Union between the two protoplasts is called plasmogamy. During plasmogamy two nuclei come close to each other for mating.
- (ii) **Karyogamy:** Union or fusion of two nuclei is called karyogamy.

In zygomycetes fusion of cytoplasm (plasmogamy) and fusion of nuclei (karyogamy) occur immediately. But in case of basidiomycetes and ascomycetes, karyogamy is delayed after plasmogamy. In this way, two nuclei of different parent cells and genetic constitution co-exist in same hypha. When two nuclei of different genetic type co-exist is called dikaryon. The hypha which contains two nuclei is called dikaryotic hypha. Two nucleated (dikaryotic) hypha is also called **heterokaryotic** hypha. This condition is found long time in the life, generally. Haploid cell or hypha becomes diploid by karyogamy.

MEIOSIS: After karyogamy, meiosis takes place. Thus diploid condition is changed into haploid by meiosis. In this way, sexual spores are formed. Ascospores & Basidiospores are formed in specific structures. A sac like structure in which 8 **ascospore** are formed i.e. Ascus. A group of **ASCI** in a special body is called **ASCO CARP**. This is the specific character of ascomycetes (sac fungi).

Basidiospores are sexual spores of group **Basidiomycetes**. “Those sexual spores which are formed in **basidium** are called **basidiospores**. Basidium is a particular structure on which 4 basidiospores are formed. A group of **basidia** is known as basidiocarp.

Phylum	Typical examples	Sexual reproduction	Asexual reproduction	Hyphae
Zygomycota (zygomycetes)	Rhizopus (black bread mould) Pilobolus (splitting fungus)	Zygospores	Non-motile spores form in sporangia	Aseptate (non septate) multinucleate
Ascomycota (ascomycetes or sac-fungi)	Yeasts, Morels, truffles, powdery mildews, moulds.	Ascospores inside sac-like asci	Conidia cut off from tips of conidiophores.	Septate, lengthy dikaryotic phase

Basidiomycota (basidiomycetes or club fungi)	Mushroom, rusts, smuts, puff balls, bracket fungi.	<i>Basidiospores</i> borne on club shaped basidia	Uncommon	Septate, lengthy dikaryotic phase
Deuteromycota (deuteromycetes imperfect fungi)	<i>Aspergillus</i> , <i>Penicillium</i> , <i>Alternaria</i>	<i>Sexual phase has not been observed</i>	<i>Conidia</i>	

Q.11 Write a note on zygomycetes (or) conjugating fungi.

(OR)

Which type of fungi are included in zygomycetes OR zygomycota?

(OR)

What are the characteristics of zygomycetes?

Ans. **ZYGOMYCETES**

“A kind of fungus in which zygospores are formed is called zygomycetes”.

Examples: *Rhizopus* (black mold) and *Mucor*.

NUTRITION: They are *saprob* generally.

SUBSTRATUM: Mostly grow *on decaying animals and plants*. They are also grown *on bread*, cooked food and dung.

MYCELIUM: Mycelium is *aseptate* and *branched* generally. There are grey and white *coeocytic* hyphae.

ASEXUAL REPRODUCTION: In zygomycetes, asexual reproduction takes place by non motile spores i.e. *aplanospores*. Spores are produced in sporangium. Asexual spores germinates into new mycelium.

SEXUAL REPRODUCTION:

Sexual reproduction occurs due to presence of *zygospores*.

These are sexual spores. Zygospores are formed by conjugation process.

When strain or hypha strain or gametes or hyphal fuse together then zygospore is formed.

This *zygote* is modified into *zygospore*.

Meiosis takes place when zygospore germinates and haploid spores are formed.

“Due to presence of conjugation and zygospore formation, they are called conjugating fungi or zygomycetes”.

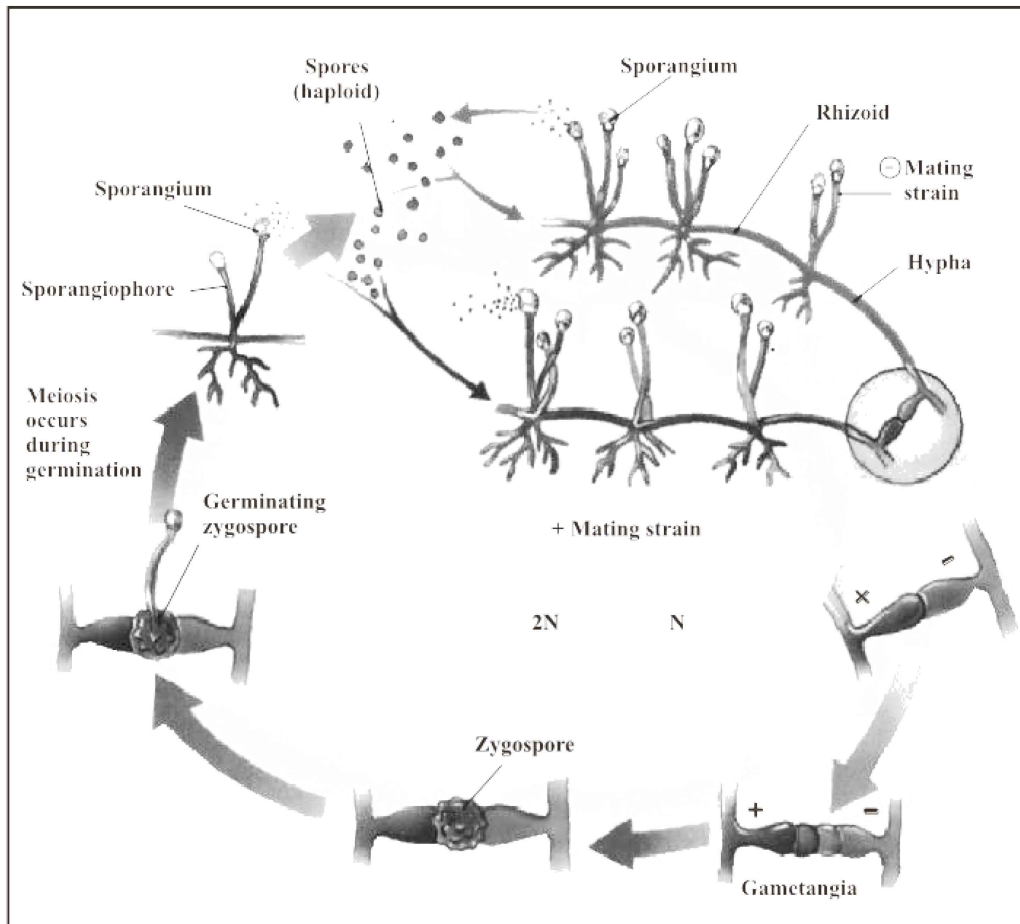
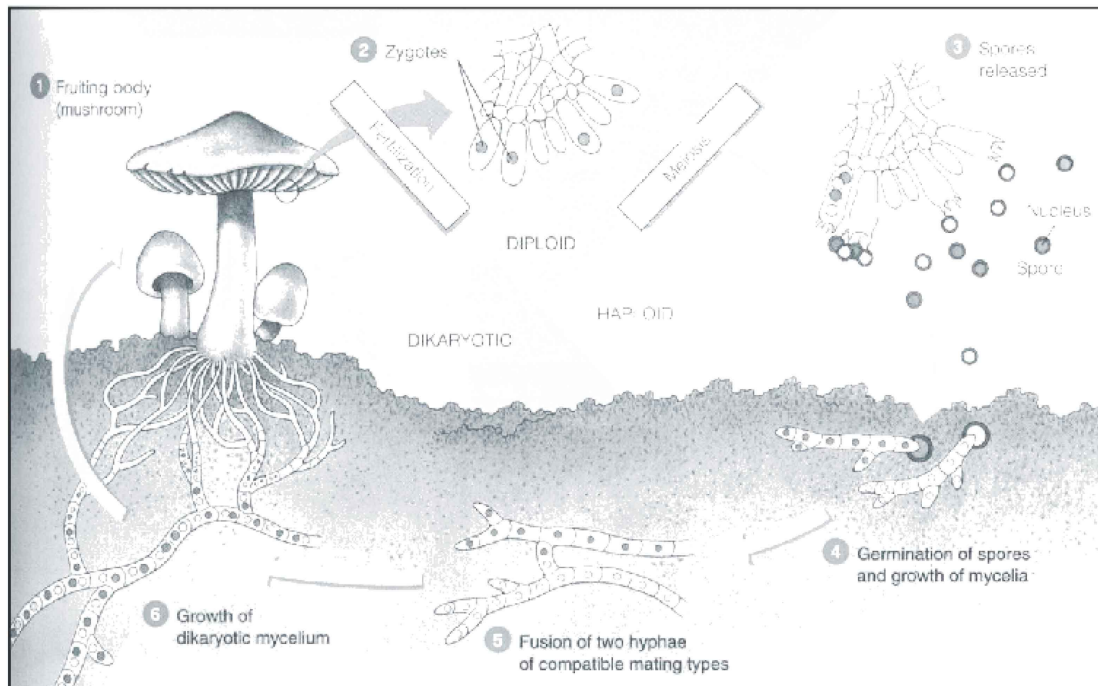


Fig. Life cycle of Rhizopus (black bread mould), a Zygomycete. Zygote formed by fusion of gametangia directly develops into a resulting zygospore.

HELP LINE

Q.12 (a) Define Ascomycetes, Ascus and Ascocarp.

(b) Give the salient features of ascomycetes.

Ans. (a) ASCOMYCETES

“Those fungi in which ascospores are found in asci (ascus) called ascomycota”.

The most important feature of the ib (ascomycetes) is *saclike ascus* in which **8 ascospores** are present.

A group of asci in the form of fruiting body is called ascocarp.

(b) GENERAL FEATURES:

Largest Group: It is the largest group of fungi with 60,000 species.

50% Symbionts: About 50% are partners of lichen, *symbiont* in mycorrhizae and morels.

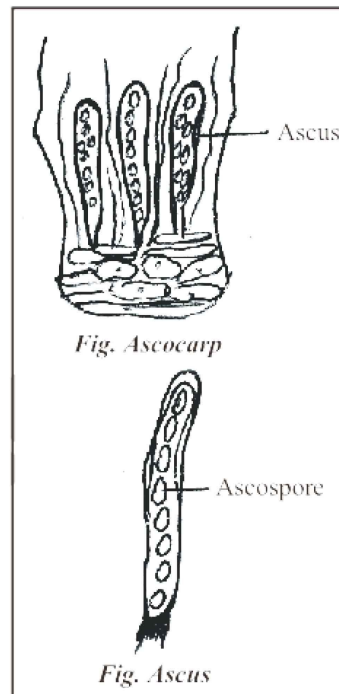
Terrestrial and Aquatic: Ascomycetes are terrestrial mostly but few are in marine and fresh water.

Unicellular and Multicellular: They are unicellular (yeast) to multicellular.

Parasites: Mostly parasites within host, only powdery mildews show ectoparasite condition (upon the surface).

Septate Mycelia: Branched mycelia with cross walls i.e. septate. They have *lengthy dikaryotic phase*.

Ascospores, Ascus, Ascocarp: *Eight ascospores* (sexual spores) are formed in ascus. A fruiting body with a group of asci is called ascocarp. Ascocarps may be cup or flask shaped and spherical shaped.

EASY TO DRAW

Ascospores are haploid (IN), because they are formed by meiosis.

Asexual Reproduction by Conidia and Budding

Asexual reproduction takes place by non motile conidia. Conidia are naked spore which produced conidiophore.

Unicellular yeast are also members of ascomycetes. Yeast are asexually reproduced by budding.

Sexual Reproduction by Ascospores

Sexual reproduction occurs by ascospores in both multicellular and unicellular (yeasts).

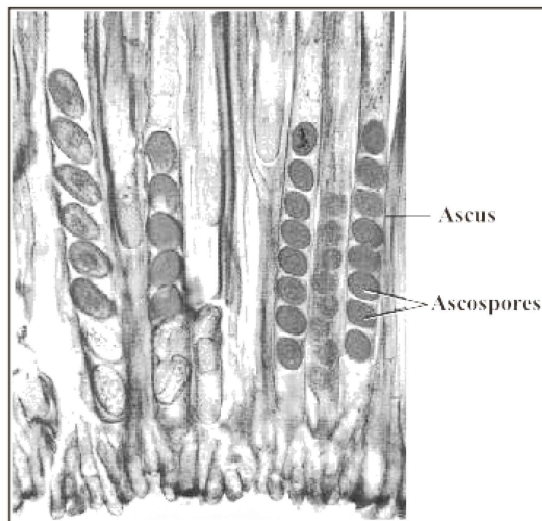


Fig. Asci and Ascospores. Each ascus contains eight haploid ascospores.

- Q.13** (a) What is Basidium? What is Basidiocarp?
 (b) What are basidiospores and how do they form?
 (c) What are particular characters of basidiomycetes?

Ans. (a) BASIDIUM

“A sexual reproductive structure in which sexual spores i.e. basidiospores are formed, called basidium”.

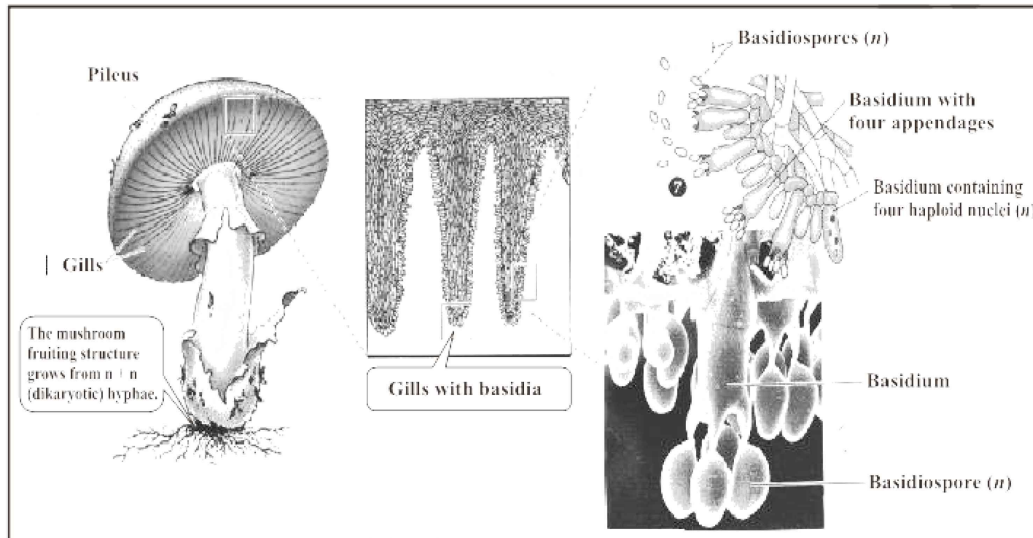


Fig. Basidiomycetes. A mushroom's fruiting structures. The gills on underside of mushroom's cap are lined with basidia, on which basidiospores are produced.

EASY TO DRAW

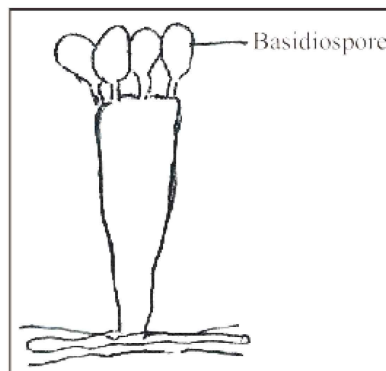


Fig. Basidiocarp

(b) BASIDIOSPORES:

“The haploid sexual spores which formed by basidium after meiosis are called basidiospores”.

(c) GENERAL CHARACTERS OF BASIDIOMYCETES**Common Examples:**

Mushrooms, (Edible)

Puff Balls

Bracket/club fungi

Rust and *smut* are the common and familiar names of basidiomycetes.

Basidiospores: Basidiospores are chief distinguished features. Four haploid spores are found in each basidium. Basidiospores are those sexual spores which are reason of the name of “Basidiomycetes”.

Basidium: Sexual reproductive structure is called basidium.

Septate Mycelium: Septate branched mycelia are found in this fungi.

Primary Mycelium: Primary mycelium which develops from basidiospore is uninucleated cells. Basidia never develop on uninucleate mycelium.

Dikaryotization: When two hyphae of uninucleated cells fuse then dikaryotic mycelium or secondary mycelium is formed. It is the long phase of life cycle.

The conversion of primary mycelium into secondary mycelium is called Dikaryotization.

Fruiting body remains dikaryotic while whole body of mushroom is dikaryotic.

Q.14 What are rust and smut and how smut attack on wheat?**Ans. RUST AND SMUT:**

Puccinia sp. is most common member of basidiomycetes which causes rust disease in different plants.

Ustilago tritici is most common smut fungus. It causes smut disease i.e. loose smut in wheat.

The *teliospore* of *Ustilago tritici* carried by wind.

Teliospore attacks on healthy flowers of wheat.

It *germinates on flower* and *mycelium penetrates in the ovary* of flower.

Mycelium grows inside ovary and then becomes dormant in seed.

As soon as, seed germinates the mycelium also start germination, plant and mycelium germinate together.

At last, smut spores are **formed in the kernal** (kernel). These spores destroys the kernel completely.

The covering of the wheat grains breaks exposing the black spores i.e. smut spores which may attack again.

(Generally, rust and smut have not basidiocarp).

Q.15 (a) What do you know about rusts and smuts?

(b) What is dikaryotization?

(c) What are teliospores?

Ans. (a) Rust and Smut (See answer in previous Q.)

(b) Dikaryotization

It is **binucleated condition of hypha of basidiomycetes**. It is **lengthy phase** of life cycle. The whole mushroom body contains dikaryotization.

In beginning, primary mycelia with uninucleated hyphae fuse and form dikaryotic hyphae or mycelia.

(c) Teliospores

“The thick walled resting spores which are found in rusts and smuts are called Teliospores”.

Teliospores are carried by wind.

They attack on healthy flower from infected plant.

Mycelium enters in ovary then teliospore remains dormant (resting) within seed.

In next season, when seed of wheat is sown, it grow within plant, and ultimately attack on kernel.

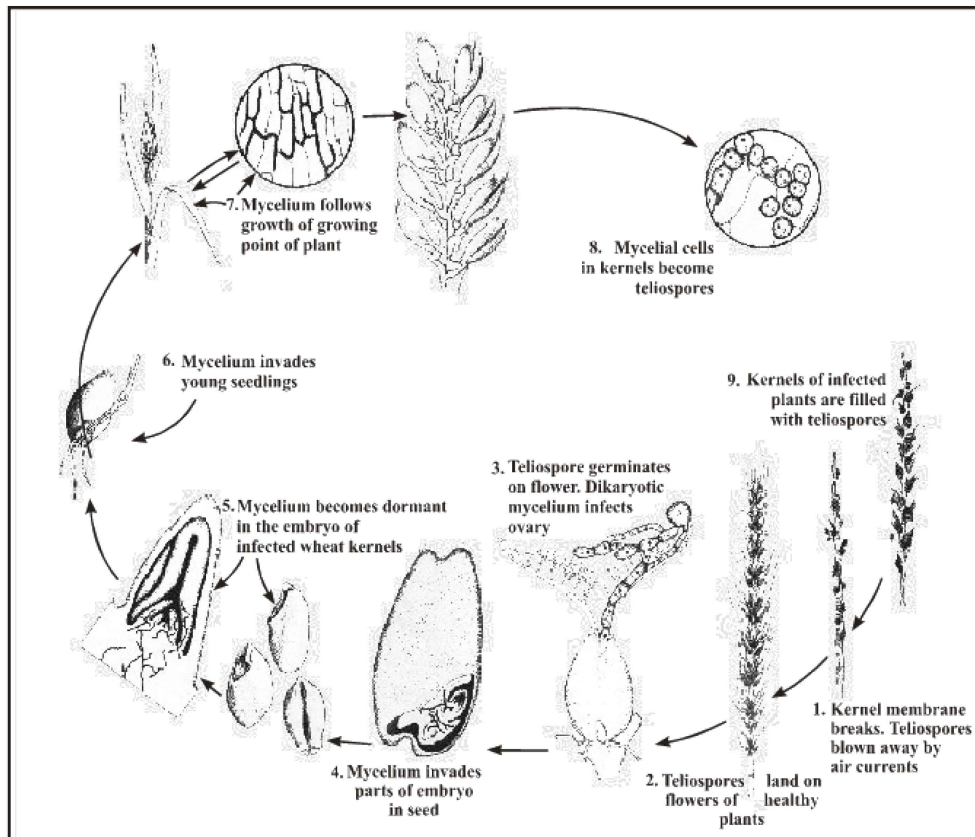


Fig. Disease cycle of loose smut of wheat caused by a club – fungus (*Ustilago tritici*)

Q.16 What is cell wall? Which kinds of cells are found in different organisms?

(OR)

Q. What do you know about cell wall? What are different chemical compositions in bacterial cell wall, fungal cell wall and plant cell wall?

Ans. **CELL WALL**

“Cell wall is the outer covering of a plant cells, fungal cells, algal cells and bacterial cells”.

This external covering contains different chemicals in different kingdoms. Four kingdoms (Monera, protista, fungi and plantae) have cell wall as external covering. *Only protozoa group of protista is without cell wall in these four kingdoms. Kingdom animalia is only one kingdom in which cell wall is absent.* “The cell wall is secreted by protoplasm”.

General chemicals of different kinds of cell walls are:

Cellulose (polysaccharides) Lipids, Liposaccharide

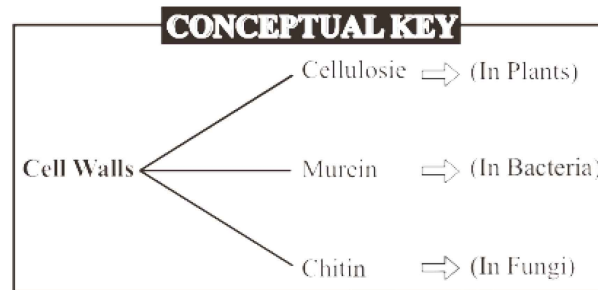
Lignin Proteins, lipoprotein

Suberin Murein (*peptidoglycan*)

Cutin Chitin (*N₂ containing proteins*)

Silica Techoic acid

Inorganic salts



PLANT CELL WALL

Cellulose is the major chemical of plants cell wall.

- Cellulose is polysaccharide of carbohydrates.
- *Lignin, suberin, silica, cutin* and *inorganic salts* are additional chemicals of cell wall.

BACTERIAL WALL

Murein:

(*Peptidoglycan*) is the major chemical of bacterial wall.

- Murein is a compound of ***proteins plus carbohydrates***.
- Lipopolysaccharides, lipoproteins, techoic acid and lipotechoic acids are also in different cases.

FUNGAL CELL WALL

Chitin is the major chemical of fungal cell wall.

- Chitin is nitrogen containing proteins.
- Insoluble glucan element is additional one.

SHORT QUESTIONS

Q.1 Why do some fungi are called “Rust Fungi”?

Ans. **RUST FUNGI**

Members of fungi (telomycetes) belonging to basidiomycota have reddish brown spores.

Due to these reddish brown spores these fungi are popularly called Rust Fungi- Brown pustules on the stems and leaves provide rusty appearance.

Q.2 What are differences between spore and conidium?

Ans.

SPORE	CONIDIUM
(i) Spore is an asexual, reproductive cell, formed in sporangium.	(i) Conidium is an asexual reproductive cell which formed on mycelium <i>without sporangium</i> .
(ii) It may be motile and non motile.	(ii) It is always non motile.
(iii) Spores are found in all types of plants, algae and fungi.	(iii) Conidia are found in fungi.

Q.3 Why do deuteromycetes are famous as imperfect fungi?

Ans. Because of the absence any sexual phase, these fungi are commonly called “Imperfect Fungi”.

These are imperfect, because sexual spores like ascospores, basidiospores and zygosporangia are absent in it. But, they can reproduce asexually by conidia.

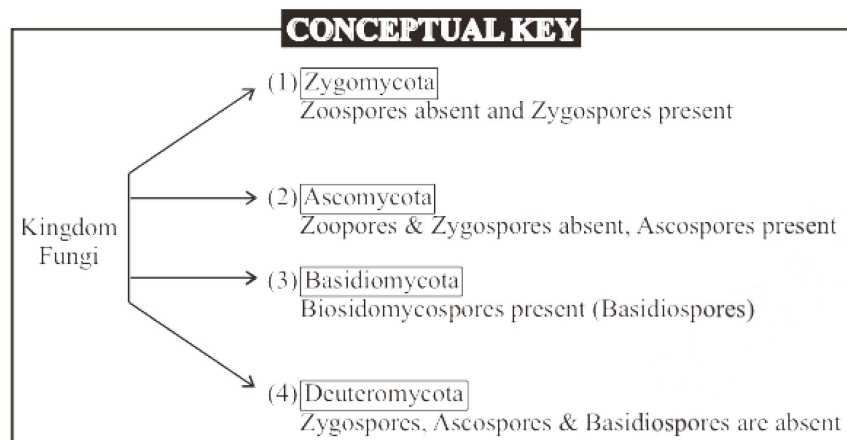
Q.4 What are the differences between Rust and Smut?

Ans.

RUST	SMUT
(i) Attack on stems and leaves.	(i) Attack on grains of inflorescence.
(ii) <i>Rusty appearance</i> may be red, yellow, orange and black etc.	(ii) Grains transform into <i>black powdery mass</i> or black dusty masses.
(iii) Caused by <i>Puccinia</i> spp.	(iii) Caused by <i>Ustilago</i> spp.

Q.5 Key out the summary of fungal classification.

Ans.

**Q.6 Which fungi have teliospores and where they rest/dormant?**Ans. **TELIOPORES AND DORMANCY OF TELIOPORES**

The member of basidiomycetes which causes rust and smut in different plants have teliospores. The rust and smut are belonging to teliomycetes class of basidiomycetes.

In case of smut fungi (*Ustilago* sp.), teliospores attack on flower (inflorescence) and penetrates its mycelium into ovary. They remain resting/dormant in ovary of seed upto next growing.

Q.7 Why myxomycetes (slime molds) and oomycetes (water molds) have been excluded from true fungi?Ans. **REASON OF EXCLUSION OF SLIME MOLOS AND WATER MOLDS FROM FUNGI**

- (i) Myxomycetes and oomycetes are *without chitin* in cell wall. For the membership of fungi or true fungi chitin is essential in cell wall.
- (ii) Slime molds and water molds *have centrioles* but centrioles are absent in fungi. Thus these two major features are the reason to expulsion of myxomycetes and oomycetes from fungi. Now, these are included in kingdom protista i.e. fungi like protists.

- Q.8** (a) Write general features of deuteromycetes.
 (b) What do you know about penicillium?

Ans. “Fungi without perfect stage or without sexual phase are included in Deuteromycota or imperfect fungi”.

DEUTEROMYCETES:

- **Imperfect fungi** means fungi without zygospores, ascospores and basidiospores.
- Fungi placed temporary in deuteromycetes, after discovery of sexual phase, organisms are shifted to their proper group.
- Mycelium consisting of well developed, branch and **septate hyphae**.

Reproduction:

- **Sexual reproduction absent.** Asexual reproduction occurs by asexual spores i.e. conidia.
- **Conidia** are non-motile asexual spores. They may be elongated, spherical or curved. They are not produced in sporangia. Conidia are directly produced on **conidiophores**.
- Classification of Deuteromycetes also depends upon the basis of DNA sequence.

Examples:

<i>Penicillium</i>	<i>Fusarium</i>
<i>Aspergillus</i>	<i>Helminthosporium</i>
<i>Alternaria</i>	

(b) **PENICILLIUM**

Penicillium sp. is also called **blue or green molds**. It is saprotrophic. *Penicillium* is found on bread and decaying food.

Branched and Septate: It has septate hyphae which are branched.

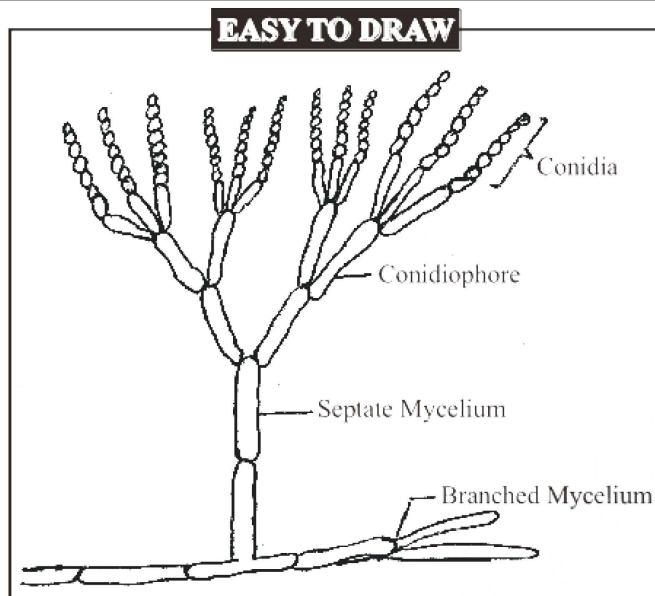
Distribution of Conidia: Its conidia are present almost everywhere in the air.

Vegetative Reproduction: Vegetative mycelium breaks up into two or more fragments, each develops into a new mycelium.

Asexual Reproduction: Conidia developing on conidiophores are the means of asexual reproduction. Conidiophores are branched. Conidiophore branches terminate into clusters. Cluster is brush like structure.

Color (Blue or Green): The color of fungal colony is due to conidia.

Economic Importance: *Penicillium notatum* is used for production of **antibiotic penicillin**.

Fig. *Penicillium*

BENEFICIAL FUNGI

Q.9 What are ecological benefits of fungi?

OR

Give ecological importance of fungi.

Ans. Fungi are very important as **decomposers** and **symbionts**, so they have great ecological importance.

In following three ways, fungi may be economically important.

(i) Mycorrhizae:

The mycorrhizal fungi improve the growth of plants with which they are associated. The vascular plants (95%) have such a kind of association.

(ii) Lichens:

The lichens growing on rocks break them during the course of ecological succession. They are very good bioindicators of air pollution as they are highly sensitive to pollution.

(iii) Bioremediation:

Some fungi are also used for bioremediation. They degrade and thus remove poison and pollutants of organisms, from the environment.

Q.10 What are the commercial benefits of fungi? (OR)

Write down commercial importance of fungi.

Ans. **COMMERCIAL IMPORTANCE**

Following are the commercial benefits of fungi to human beings.

(i) As Edibles:

- (a) Certain fungi are edible. About 200 species of mushrooms such as *Agaricus* sp., *morels* e.g., *Morchella esculenta*, truffles like *tuber* sp. are among the most common fungi.
- (b) Some mushrooms are poisonous such as toads tools like *Amanita* (may also be called as death cap or death angel) and jack-O lantern mushrooms.
- (c) The reindeer moss (actually a lichen) is used as food for reindeer and some large animals in arctic, sub-arctic and boreal regions of world.

(ii) Use in Food Industry:

Certain fungi are used in food industry:

- (a) Because of the **fermentation ability**, yeasts like *Saccharomyces cerevisiae* are used in the production of bread and liquor.
- (b) *Penicillium* spp. are used for giving **flavour**, aroma and particular colour to cheese.
- (c) *Aspergillus* spp. are used for giving *citric acid*, *soy sauce* and *soy paste*.

(iii) Use in Antibiotics and Drugs:

Fungi may also be a source of antibiotics and drugs e.g:

- (a) “*Penicillin*” is obtained from *penicillium notatum*. It was first discovered by Alexander Fleming in 1928.
- (b) “*Lovastrin*” is used for lowering blood cholesterol.
- (c) “*Cyclosporine*” is used for organ transplantation.
- (d) “*Griseofulvin*” is used to inhibit fungal growth.
- (e) “*Ergotine*” is used to relieve headache migraine.

(iv) As Natural Dyes:

Some important natural dyes are obtained from lichens and they are used in the fertile industry.

(v) Use in Genetics and Molecular Biological Research:

Fungi are widely used in genetic and molecular biological research because fungi have rapid growth and reproduction e.g., yeasts were the first eukaryotes to be used by

genetic engineers. Fungi show visible and clear appearing characters. In 1983, a functional artificial chromosome was made in *saccharomyces cerevisiae*. The same yeast was completely studied in 1996. Yeasts are also being investigated for production of hormones. Pink bread, mold i.e. *Neurospora erassa* has also been used for genetic research.

HARMFUL FUNGI

Q.11 Discuss the economic losses due to attack of fungi. (OR) What do you know about harmfulness of fungi?

Ans. **ECONOMIC LOSSES DUE TO FUNGI**

Following are some of the economic losses caused by fungi:

(i) Plant Diseases:

Fungi are responsible for many serious plant diseases because they can breakdown cellulose, legnin and even cutin by producing several enzymes e.g.

- (a) **Rusts** and **smuts of wheat, corn** and rice cause extensive damages and also starvation to death of many people.
- (b) Some other diseases like **powdery mildews** of grapes, rose and wheat etc. Ergot of eye, **red rot** of sugarcane, **potato wilt**, **apple's scab** and **brown rot of peaches**, plums, apricots and cherries are also very important.

(ii) Animal Diseases:

Fungi cause many animal diseases:

- (a) **"Ringworm"** and **"Athlete's foot"** are superficial fungal infections of skin caused by certain imperfect fungi e.g., *condidi albicans* and a yeast causes oral and vaginal infections too.
- (b) **"Histoplasmosis"** is caused by inhaling spores of a fungus. It is a serious infection of lungs.
- (c) **"Aspergillosis"** is caused by inhaling spores of *Aspergillosis* Spp. which is very serious disorder.
- (d) **"AIDS"** may also be caused in the persons having "Aspergillosis" but defective immune system.
- (e) **"Aflatoxins"** is a type of cancer caused by carcinogenic fungus i.e. *Aspergillus flavus*.
- (f) **"Ergotism"** is caused by eating bread made from purple ergot-contaminated rye flour. Nervous **tensions**, **psychontic delusion** and gangrene may also be occurred. Ergot also causes nervous spasm and convulsions.

(iii) **Damage to Food, Wood, Fiber and Leather:**

Fungi also cause serious damage to **food, wood**, fiber and leather.

- (i) About 15-50% of world's fruit is lost each year due to fungal attack.
- (ii) Wood rotting fungi destroy not only living trees but also structural timber.
- (iii) Bracket/shelf fungi cause a lot of damage to stored out lumber as well as stands of timber of living trees.

Q.12 *What do you know about benefits of fungi? Discuss in details. (OR) Discuss harmfulness of fungi. (OR) How animals are effected by fungi? (OR) Discuss the plant destroy by fungi. (OR) Write down wood and timber destroy by fungi.*

Ans. Consult previous questions.