

➤ Kingdom Fungi

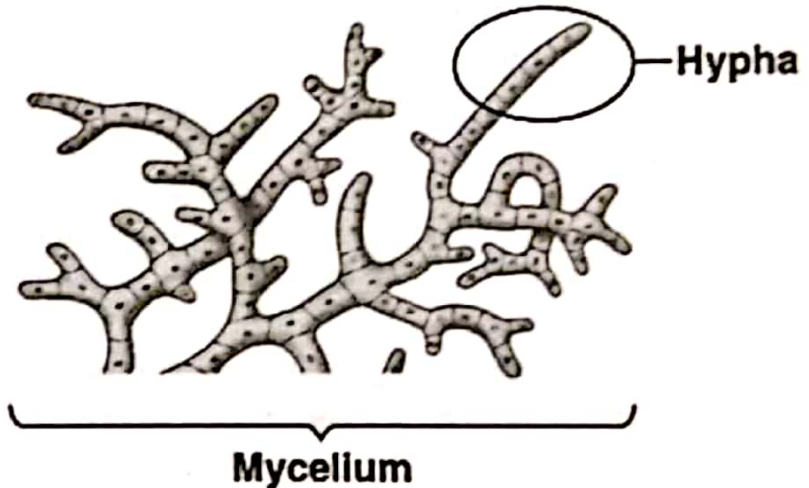
Since the last many decades, Fungi were regarded as plants because of the presence of certain characteristics, but the recent studies have shown differences between Fungi and Plants.

➤ Characteristics that distinguish fungi from plants:

1. **Chlorophyll:** Fungi lack chlorophyll, while the plants have this pigment.
 2. **Cell Wall:** Fungal cell wall is chemically composed of chitin (carbohydrate) while plant cell wall is composed of cellulose.
 3. **Body Structure:** Fungal body is filamentous and not truly multicellular like plants, because the cytoplasm of one fungal cell is continuous through pores with the cytoplasm of adjacent cells.
 4. **Mode of Nutrition:** Fungi are heterotrophic eukaryotes, while plants are autotrophs.
- Due to above mentioned reasons fungi are placed in separate king. "Kingdom Fungi"

➤ General Characteristics of Fungi

1. **Distribution and Habitat:** Fungi is a very large kingdom of organisms comprising of more than 90,000 species. Fungi are found everywhere life exists. The members grow in a variety of habitats occurring in water, air, soil, within and upon the bodies of other living organisms.
2. **Habit:** Fungi range from unicellular microscopic members e.g. yeasts to multicellular, macroscopic members such as mushrooms.
3. **Morphology:** The fungus body or thallus is called mycelium. Mycelium is composed of thin filaments called hyphae. (Singular-hypha)
Sometimes the hyphae are arranged in complex structures e.g. Mushrooms. In Unicellular form true mycelium is not developed but a chain of newly formed cells called pseudo mycelium e.g. yeast.
4. **Structure of Hyphae:** Under microscope, each hypha looks like a transparent tube like structure.



TYPES OF HYPHA

- | | |
|--|---|
| 1. Aseptate hypha | 2. Septate hypha |
| i. They have no septa or Cross walls | i. They have septa or cross walls |
| ii. Such hyphae are found in lower fungi | ii. Such hyphae are found in higher fungi |

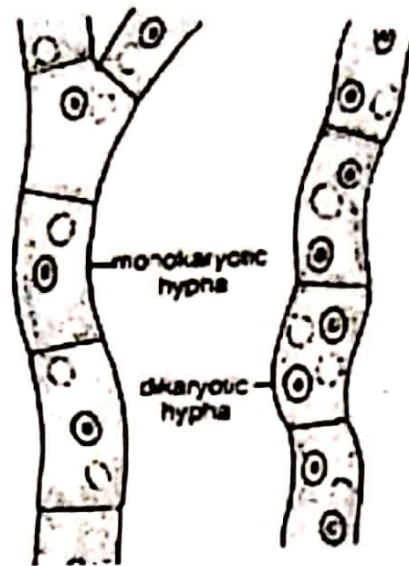
Septate hypha has further two types

i. Monokaryotic or Uninucleate hyphae

Such hyphae have single nucleus in each cells of hyphae

ii. Dikaryotic or Binucleate hyphae

Such hyphae have two nuclei in each cells of hyphae



Monokaryotic and Dikaryotic hyphae

5. Mode of Nutrition: Fungi have the following mode of nutrition.

- a. **Heterotrophs:** Fungi obtain nutrients from other non-living and living organisms e.g.
- ii. **Saprophytic Fungi:** Some fungi obtain nutrients from dead organic matter by secreting digestive enzyme into the substrates. Then they absorb the organic molecules released by the enzymatic action e.g. *Agaricus* (Mushroom), *Rhizopus*, *Mucor* etc.
- ii. **Parasitic Fungi:** Many species of fungi feed upon living tissues of animals and plants. Most of the parasitic fungi cause serious diseases of humans, animals and plants e.g. Rusts, Smuts, Silk worm disease, Salmon fish diseases, Athlete's foot and Ringworm diseases.
- b. **Symbiotic Fungi:** Fungi establish symbiotic association with other organisms, in which both the partners are mutually benefited.
For example: Lichen and Mycorrhizae.

6. **Cell Wall:** The cell wall of fungi is made up of chitin. Chitin is a nitrogen containing polysaccharide. (See structure of chitin chapter 2). Chitin cannot be easily decomposed as compared to cellulose.

7. **Nuclear mitosis:** Nuclear mitosis is the distinguishing feature of Fungi. In nuclear mitosis, nuclear membrane does not break and reform. Mitosis occurs in the nucleus without breaking the nuclear membrane.

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➤ CLASSIFICATION OF FUNGI

Fungi are classified into the following groups:

1. Phylum: Zygomycota

Hyphae: The hyphae are aseptate and coenocytic.

Nutrition: Some members are saprophytes; grow on decaying organic matter, cause rotting of bread, peaches, strawberries and other fruits and also stored sweet potato. Some members live as parasites symbionts of other organisms (i.e. plant, animals).

Reproduction: The members reproduce sexually and asexually. The characteristic sexual spore known as zygospores are formed by the mating of two opposite hyphae (i.e. + hyphae and - hyphae).

Dispersal of Spores: Both sexual and asexual produced spores are dispersed by air.

Example: *Rhizopus stolonifer* (common bread mold)

Rhizopus is an important member of Zygomycota.

Mode of Nutrition: *Rhizopus* is saprophytic fungus, grows on bread. The hyphae form a white or grey mycelium on bread.

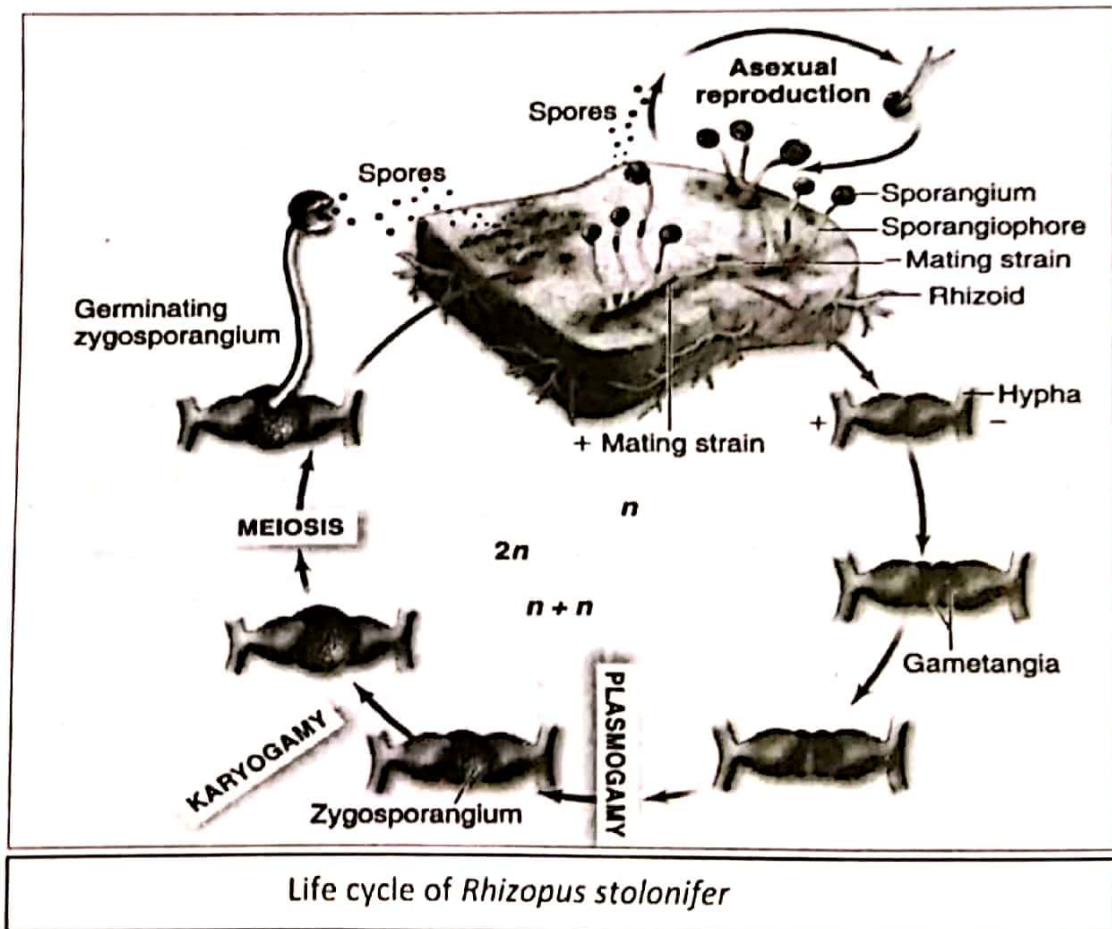
Reproduction: *Rhizopus* reproduces both sexually and asexually.

Asexual reproduction: In asexual cycle, upright branches arise from stolons, known as sporangiophore.

Sporangiophore bears sporangium at its tip. Many of spores are formed by meiosis in each sporangium. The haploid spores are dispersed by air. The spores, when fall on moist food, grow into new mycelia.

Sexual Reproduction: The hyphae of two opposite strains (+,-), bear structure at its tips known as gametangia. It bears gametes. Gametangia fuse with each, plasmogamy and karyogamy take place;

result in the formation of zygospores (zygote). Meiosis occurs in mature zygospores. Then sporangiophore arise from zygospores, it bears sporangium having spores. Spores, when fall on suitable substratum germinate into new mycelia.



Life cycle of *Rhizopus stolonifer*

2. Phylum: Ascomycota (Sac Fungi)

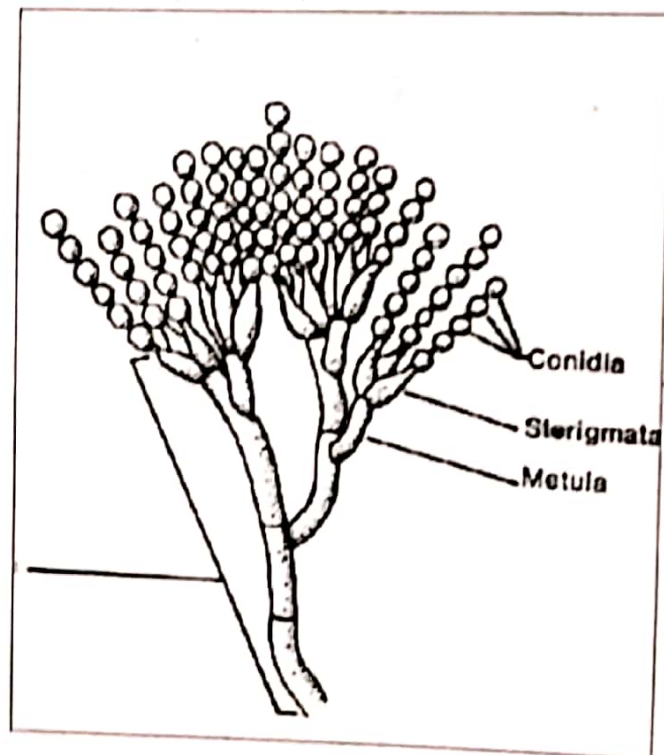
> Characteristics

- i. Ascomycota is also known as sac-fungi, form half of the total fungi.
- ii. They produce sexual spores known as ascospores within Sac-like structure known as asci (ascus Singular).
- iii. The fruiting bodies of Ascomycota are known as ascocarp. Ascocarps are Apothecium, Perithecium, Cleistothecium and Hysterothecium.
- iv. The sexual phase occurs in ascocarp.
- v. Ascocarp range in size from microscopic to macroscopic form.
- vi. Asci are produced in ascocarp.
- vii. Asexual reproduction takes place by means of conidia. Conidia are produced in chains at the end of conidiophore.

Economic Importance of Ascomycota

> Beneficial aspect

1. More than 40% species live in symbiotic association with green algae and cyanobacteria forming Lichens.
2. Some members form mycorrhizal association with roots of higher plants.
3. Some members act as decomposer of plant materials.
4. Pencillin (drug) is obtained from a fungus called *Penicillium*.
5. Yeast is used in bakery and brewery industry.



Structure of *Penicillium*

Harmful aspect

Some members of Ascomycota attack on crops and ornamental plants, causing disease known as powdery mildew etc.

3. Phylum: Basidiomycota (Club Fungi)

Basidiomycota is also known as club fungi due to their club-shaped basidia.

Mycelium: Mycelium is always multicellular and freely branched. It is white, bright-yellow or orange. The members grow in moist and wet places e.g. on rotting woods, leave or on organic matter.

Types of mycelium in Basidiomycota

The mycelium passes through three distinct stages of development.

- i. **Primary mycelium: (Monokaryotic mycelium):** In primary mycelium each cell is uninucleate possessing a haploid nucleus.
- ii. **Secondary mycelium (Dikaryotic mycelium):** In secondary mycelium, each cell contains two haploid nuclei. It is formed by union of primary mycelia.
- iii. **Tertiary mycelium:** When secondary mycelium becomes more complex and give rise to fruiting bodies (Basidiocarps), it is called tertiary mycelium.

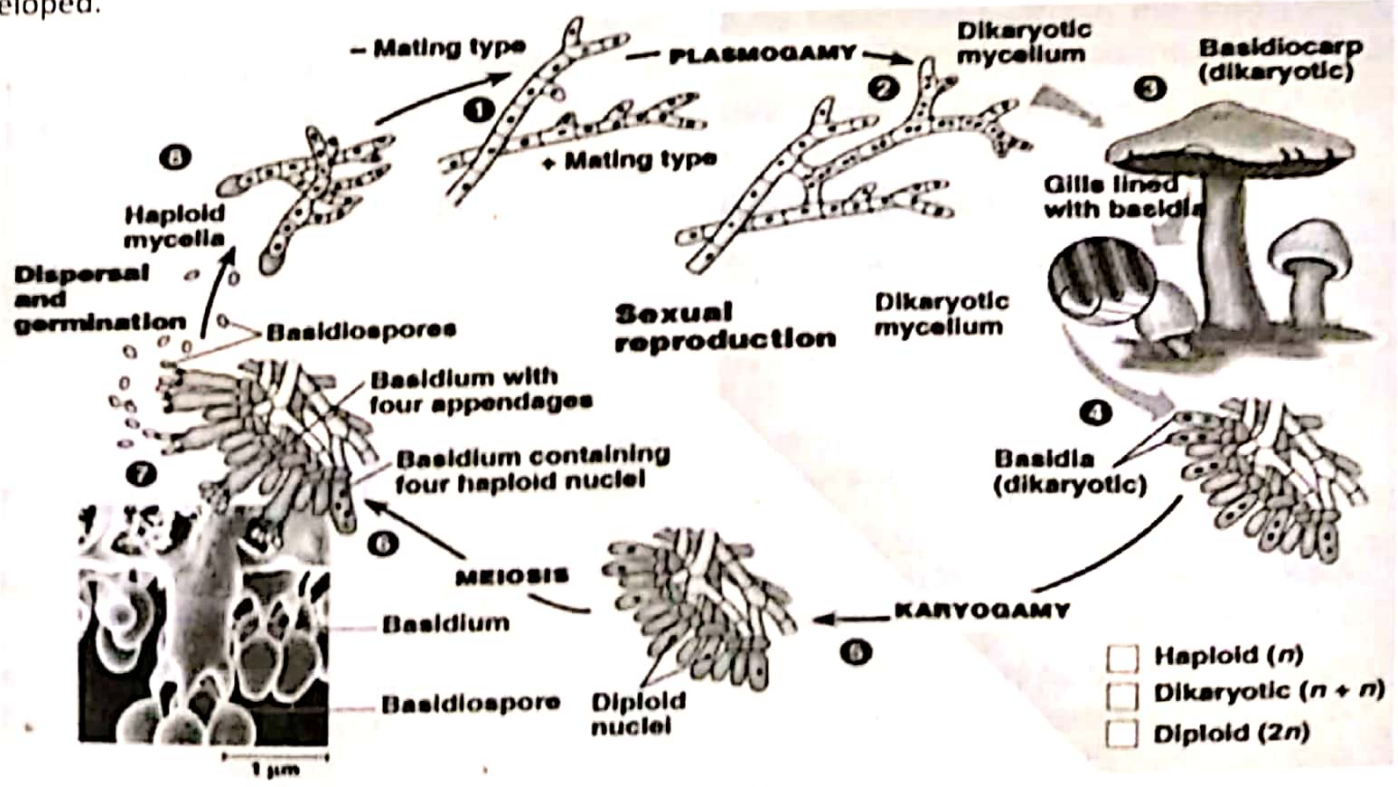
Reproduction:

Sexual reproduction in Basidiomycota is different from all other groups of fungi. Reproductive structures i.e. antheridia and oogonia are never formed. Sexual reproduction involves the conversion/change of haplophase into diplophase or monokaryotic phase to dikaryotic phase by various method e.g. somatogamy, spermatization.

Life cycle of Basidiomycota

The characteristic spores of Basidiomycota are Basidiospores. Basidiospores germinate into haploid mycelia. Haploid mycelium mate with each other. Plasmogamy takes place as a result of somatogamy. Dikaryotic mycelium and then fruiting body (basidiocarp) is developed. Club-shaped basidia are arranged inside the basidiocarp.

Karyogamy occurs in basidium, then meiosis take place forming four haploid nuclei and basidiospore are developed.



Life Cycle of *Agaricus* (Mushroom)

Examples: Mushroom, Puff ball, Shelf fungi, Smut and Rust.

➤ IMPORTANCE OF FUNGI

Fungi play important role in human life.

1. **Role in pharmaceutical industry:** Since ancient times, Fungi have been used in medicines. For example;
 - Ergotamine obtained from *claviceps purpurea* is used to relieve delivery of babies and migraine headache.
 - Pencillin, the first discovered antibiotic is obtained from *Penicillium chrysogenum*.
 - Cephalosporin is a broad spectrum antibiotic, obtained from *cephalosporium acremonium*.
 - Griseofulvin is an antibiotic obtained from *Penicillium* species, used against fungal infections of hair, nail, skin, athlete's foot and ringworm.
 - Cyclosporine is a broad spectrum antibiotic, used as an immuno suppressant drug in organ transplantation.
2. **Role in food industry:** *Saccharomyces cerevisiae* (yeast) is used in baking and wine making industries. Yeast is used for carbohydrate fermentation, converting it into ethanol and carbon dioxide.
3. **Role in research fields:** Yeast is mostly used in the biological research projects due to its rapidly increasing generation time and provides biological genetic informations. It contains 6000 genes.
In soft drink industry, *Aspergillus* species are used to produce citric acid for colas.
4. **Edible fungi:** Certain fungi are used for their food values e.g.
 - Mushroom (*Agaricus*) is popular food throughout the world. It is used in various forms e.g. Mushroom pizzas.
 - Fungi are also used in certain types of cheese for their peculiar flavor and taste.
 - The fruiting bodies (ascocarp) of *Morchella esculanta* (Morel) and *Melanosporium* (truffle) are highly demanded for their flavor and medicinal value.
 - Ectomycorrhizae of some plant families are also edible.
 - Yeast is also used for their nutritional value because it contains vitamin B and about 50 percent protein.
5. **Symbiosis:** Fungi develop symbiotic associations with other organisms e.g. Lichens and Mycorrhizae.
 - **Lichen:** It is a symbiotic association between phycobiont (algal member) and mycobiont (fungal member).
Algal partner: This partner is photosynthetic. Algal partner is cyanobacteria, green algae or sometimes both embedded in hyphae of the fungus.
Fungal partner: Most of the visible body of the Lichen consists of its fungal partner. Fungal partner absorb nutrients directly nutrients from algal partner by penetrating specialized hyphae in their cell wall.

Importance of lichens

1. Lichens are pioneers in ecological succession in extremely harsh and dry habitats.
2. Lichens are variously colored, because of the pigments that have role in protecting the algal partner from intense sun rays.
3. The pigments are extracted from Lichens and used as natural dyes.
4. Lichens acts as ecological indicator of air pollution.

➤ Mycorrhizae (Mykos- fungus, rhizae- root)

Mycorrhiza is also a symbiotic association between Fungus and roots of higher plants. About 80% of vascular plants roots are involved in this mutualistic symbiotic association.

Fungus Role: The fungal hyphae absorb nutrients from soil act as root hair for plant. Mycorrhizae help in direct transfer of phosphorus, Zinc, Copper and other nutrients from the soil into the plant roots.

Higher Plant Role: The higher vascular plant supplies organic nutrient to the fungus.

Types of Mycorrhizae:

- | | | | |
|----|-----------------|-----|-----------------|
| i. | Ectomycorrhizae | ii. | Endomycorrhizae |
|----|-----------------|-----|-----------------|
- i. **Ectomycorrhizae:** In such association, the fungal hyphae grow intercellularly in root cells of hosts but do not penetrate in them. The fungal hyphae absorb the nutrients from host cells through special structure known as haustoria.
 - ii. **Endomycorrhizae:** In such association, the fungal hyphae grow intracellularly in root cells of hosts.

6. **Fungi as recycler:** Fungi and Bacteria are the main decomposers in biosphere. Saprophytes are greater in number than parasites in the ecosystem. Saprophytes decompose the dead bodies of plants and animals and release the substances back into the environment. The substances thus released become available to the next generation of organisms. Fungi in this way recycle the nutrients in nature and are called recyclers. Saprophytes have a good enzyme system to decompose dead organic matter.

Fungi clean the environment by decomposing the dead bodies of plants and animals and thus they are also known as scavengers.

7. **Food Spoilage:** Fungi cause food spoilage of non preserved food. e.g. bread, Jams and cooked food etc. Fungi secrete poisonous substances in to the food material. It makes the food unfit for eating, it makes the food carcinogenic (cancer causing) and poisonous.

8. **Pathogenic Fungi:** Fungi cause diseases of plants, animals and humans.

- i. **Plant diseases:** Fungi cause diseases in agricultural crops, ornamental and fruit plants etc e.g. Cereals diseases are rust and smut. Rust is caused by *Puccinia*. Smut is caused by *Ustilago*.

About 50% of world's fruits are lost due to fungal diseases each year.

Fruit diseases are:

- Peach leaf curl
- Pear leaf spot

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- Downy mildew etc

Other crops diseases caused by fungi

- Red rot of sugar cane
- Late blight of potato and tomato etc

ii. **Animal diseases:** Fungi also cause serious diseases in animals e.g.

- Ring worms disease in dogs and horses is caused by *Trichophyton* and *Microsporum* species.
- Abortion in animals is caused by *Aspergillus* species.
- Carp and Salmon fish disease is caused by *Saprolegnia parasitica*.

iii. **Human diseases:** Fungi cause infection in all parts of the human body especially in skin.

- *Rhizopus* and *Mucor* species cause infection in lungs, brain and gastric tissues.
- *Microsporum furfur* is the cause of dandruff disease.
- *Candida* species is the cause of throat and mouth, pulmonary, nails, and genital organs diseases.
- *Neurospora* and *Fusarium* species cause infection in corneal tissues of eye.
- *Aspergillus* species cause Aspergillosis disease which resemble tuberculosis disease symptoms.
- *Trichophyton* species cause Athlete's foot disease in humans.

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