

KINGDOM FUNGI

Fungi is a large kingdom comprising of about 5100 genera and more than 50,000 species. They are achlorophyllous, heterotrophic, spore forming, eukaryotic organisms with thalloid body made up of hyphae (together constituting mycelium). They are **cosmopolitan** in distribution. Some fungi occur in fresh or marine water, others are terrestrial and still others are air borne. The study of fungi is known as **mycology**.

NUTRITION

- They may be **obligate parasites** (obtain food from host plants and die with the death of host) or **facultative saprophytes** (usually parasitic but able to absorb food from decaying host plant as well), **obligate saprophytes** (obtain food from decaying organic matter) or **facultative parasites** (usually saprophytes but can live parasitically under some conditions).

Asexual

Zoospores
Uniflagellate or biflagellate, thin walled, uninucleate structures formed in zoosporangia, e.g., *Phytophthora*, *Albugo*.

Sporangiospores
Nonflagellate spores that develop inside sporangia, e.g., *Mucor*, *Rhizopus*.

Chlamydospores
Thick-walled perennating spores which develop at places along the hyphae by accumulation of protoplasm, rounding off and secretion of thick wall.

Oidia
Usually formed under conditions of excess water, sugar and certain salts, e.g., *Rhizopus*.

Conidia
Nonmotile, thin-walled, exogenous spores, produced in chains upon the tip of hypha called **conidiophore**, e.g., *Aspergillus*, *Penicillium*.

Ascospores
Nonmotile meiospores which are produced inside special sacs called **asci** and are characteristic of Class Ascomycetes.

Basidiospores
Nonmotile meiospores formed exogenously on short outgrowths of club-shaped structure called basidium and are characteristic of Class Basidiomycetes.

Binucleate spores
Dikaryotic spores meant for multiplying the dikaryotic mycelium, e.g., aecidiospores, uredospores in *Puccinia*. Another type of dikaryotic spore is teleutospore or teliospore.

REPRODUCTION

- Fungi may reproduce by vegetative, asexual and sexual means.

Vegetative

Budding

Small outgrowths from vegetative body, cut off and mature to form new individuals, e.g., yeast

Fission

Splitting of vegetative cells into two daughter cells.

Fragmentation

Fragments of vegetative hyphae develop into new individual.

Sexual

Sexual reproduction takes place by following processes:

Oogonium (Female gametangium)
Fertilisation tube
Empty antheridium (Male gametangium)
Ooplasm
Periplasm

Gametangial contact
Here gametes are never released from gametangia, instead the male and female gametangia come in close contact with the help of a fertilisation tube, through which one or more male nuclei migrate to the female gametangium. E.g., *Pythium*

Planogametic copulation
This involves fusion of two naked motile gametes (planogametes). Based upon the nature and structure of gametes, it is of three types: isogamy, anisogamy and oogamy.

Anisogametes
Antherozoid
Ovum
Flagella
Empty antheridium
Oogamy

Isogametangia
Suspensor

Gametangial copulation
This process involves fusion of the entire contents of two compatible gametangia, resulting in karyogamy. E.g., *Mucor*.

Somatogamy
Here sex organs are not at all formed, but two vegetative hyphae or cells take over the sexual function and fuse together. E.g., *Morchella*, *Peziza*.

Spermatisation
In some advanced genera, the sexual process is accomplished by minute spore-like spermatia (male gametes) and specialised receptive hyphae (female gametes). The spermatia are carried by air, water or insects to the receptive hyphae. The contents of the spermatium enter the receptive hyphae through a pore.

Receptive hyphae (Oogonium)
Spermatium
Tachyogone

CLASSIFICATION

- Many botanists have classified fungi in different ways.
- Martin's** (1961) classification of fungi is most prevalent. He classified fungi into Myxomycotina (Slime molds) and Eumycotina (True fungi). Martin further divided Eumycotina into the following classes:

STRUCTURE

- Fungi range from unicellular, uninucleate forms like yeast and *Synchytrium* to thread-like structure called **mycelium** which is made up of a net like mass of tubular filaments called **hyphae**. The hypha is usually branched, tube like structure, having protoplasm with reserve food and bounded by a wall of **chitin**, a nitrogen containing polysaccharide ($C_{22}H_{54}N_4O_{21}$).
- The protoplasm of the hypha may be continuous without cross walls, called **aseptate hypha** or may have transverse partitions or septa, known as **septate hypha**. Septa are seldom complete as they are perforated and may contain plasmodesmata or central pores. When central septal pore possesses a barrel-shaped inflation, as in many basidiomycetes, it is known as **dolipore septum**.
- A membranous vesicle called **lomasome** is found attached to plasma membrane.

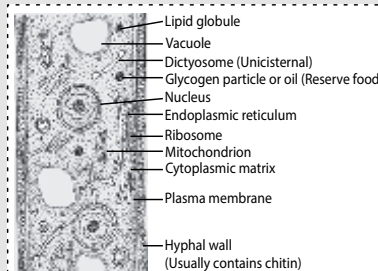


Fig.: Ultrastructure of part of fungal hypha

- In some fungi, hyphae may structurally modify in response to functional needs as:
 - Prosenchyma** : It is formed when the component hyphae lie more or less parallel to one another and unite to form a rather loosely interwoven structure where their individuality is not lost.
 - Pseudo-parenchyma** : It is formed when the hyphae become closely intertwined, forming a tissue which consists of hollow tubes spread in all directions. These lose their individuality.
 - Rhizomorph** : It is a thick strand or root-like aggregation of somatic hyphae which lose their individuality. The entire mass behaves as an organised unit and have higher infection capacity.
 - Sclerotium** : It is a compact globose structure, formed by the aggregation and adhesion of hyphae.
 - Appressorium** : It is a terminal, simple or lobed, swollen structure of germ tubes or infecting hyphae, found in many parasitic fungi.
 - Haustorium** : These are intracellular, absorbing structures of obligate parasites meant for absorbing food material from the host. They may be variously shaped and secrete specific hydrolysing enzymes.

Phycomycetes

- The mycelium is aseptate and coenocytic.
- The sporangia has innumerable sporangiospores (zoospores or aplanospores) formed endogenously.
- Sexual reproduction is oogamous in Oomycetes, and isogamous in Zygomycetes.
- Biflagellate motile cells (zoospores) are produced by many species.
- The zygote is unicellular and simple.
- E.g., *Albugo*, *Phytophthora* (Oomycetes), *Rhizopus*, *Mucor* (Zygomycetes).

Ascomycetes

- The mycelium consists of septate hyphae, possessing central or septal pores. Motile structures do not occur in the life cycle.
- In majority of Ascomycetes, the common mode of asexual reproduction is through the formation of conidia.
- Sexual reproduction takes place through fusion of sex cells, somatic cells, gametangial contact between an antheridium and ascogonium and autogamy.
- Karyogamy is delayed after plasmogamy. Hence, a new transitional phase called dikaryophase appears in the life cycle. The cells of dikaryophase are called dikaryotic cells as each cell possesses two nuclei ($n+n$).
- Some dikaryotic cells function as ascus mother cells. **Ascus** is a sporangial sac peculiar to Ascomycetes. 4-8 haploid meiospores named ascospores are produced internally in each ascus.
- The asci may occur freely or get aggregated with dikaryotic mycelium to form fructifications called **ascocarps**.
- E.g., Yeast, *Aspergillus*, *Penicillium*, *Claviceps*, morels and truffles.

Basidiomycetes

- Basidiomycetes are the most advanced fungi and considered among the best decomposers of wood.
- Motile structures or cells are absent. Mycelia are of two types, primary and secondary.
- Karyogamy is delayed after plasmogamy. A new transitional phase called dikaryophase appears in the life cycle. It produces dikaryotic secondary mycelium. Secondary mycelium is long lived, profusely branched septate hyphae possessing dolipores.
- Hook-shaped outgrowths called **clamp connections** are found on the sides of septa which are meant for proper distribution of dikaryons at the time of cell division.
- Karyogamy and meiosis occur in club-shaped structures known as **basidia**. A basidium commonly produces four meiospores or basidiospores exogenously at the tip of fine outgrowths called **sterigmata**.
- The fungi may or may not produce fructifications called **basidiocarps** that vary in size from microscopic to macroscopic forms.
- E.g., *Puccinia*, *Ustilago*, *Agaricus*, bracket fungi, etc.

Deuteromycetes

- Deuteromycetes is an artificial class of fungi which has been created to include all those fungi in which sexual stage is either absent or not known.
- Some of the deuteromycetes are unicellular like yeast.
- The mycelium is usually septate. Coenocytic forms are not known.
- Asexual reproduction often occurs by conidia along with some other types of spores.
- It is believed that most members of deuteromycetes are actually ascomycetes in which sexual reproduction is either absent or yet to be discovered.
- E.g., *Colletotrichum*, *Helminthosporium*, *Trichoderma*.