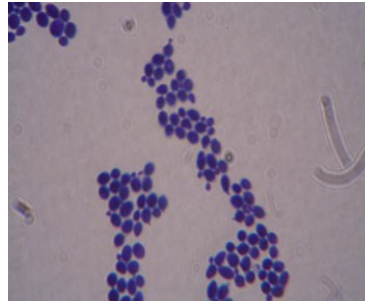


INTRODUCTION TO FUNGI

These are eukaryotic, spore-producing, achlorophyllous organisms with absorptive nutrition that generally reproduce both sexually and asexually and whose usually filamentous [cells arranged in long threads], branched somatic structures, known as hyphae, typically are surrounded by cell-walls.

Many fungi produce only single cells (unicells [cells not attached by strong bonds. Independently acting individual cells]. If they lack flagella, such cells are called yeasts [saprotrophic, unicellular fungi of the Ascomycota or Basidiomycota]. Yeasts can

reproduce by budding [method of mitotic asexual reproduction in which a new cell is formed as a small outgrowth of the parent cell], which causes the famous "shmoo [describes the shape of budding yeast cells]" morphology.



IMPORTANCE OF FUNGI

Fungi have a lot of harmful as well as beneficial effects on life as a whole

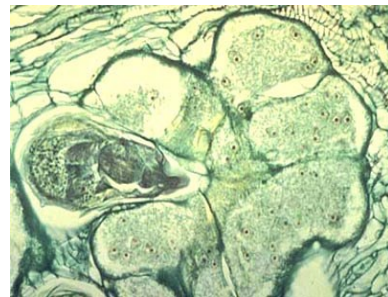
Harmful aspects:

- Lather, paper, timber and textile industry has been destroyed by the fungi.
- Food industry specially pickles and pasteurized foods are destroyed.
- Cause field crop diseases. Members of Phylum *Plasmodiophoromycota* cause two important infections i.e. Hypertrophy and Hyperplasia.

Hypertrophy: (adj. hypertrophic)

abnormal increase in the size of cells in a tissue or organ, often resulting in the formation of galls or tumors

(giant-cells in feeding site of root-knot nematode, *Meloidogyne incognita*).



CLASSIFICATION OF FUNGI

FUNGAL SYSTEMATICS

Taxonomy is the practice and science of classification

Taxonomy: The study of classification of organisms into taxa or groups on the basis of **similarities and differences** i.e. morphology, host specialization, physiological characters, genetic characters between organisms is known as taxonomy.

Primitively, living things were classified only into two kingdoms using morphological characteristics:

1. Animal kingdom
2. Plant kingdom

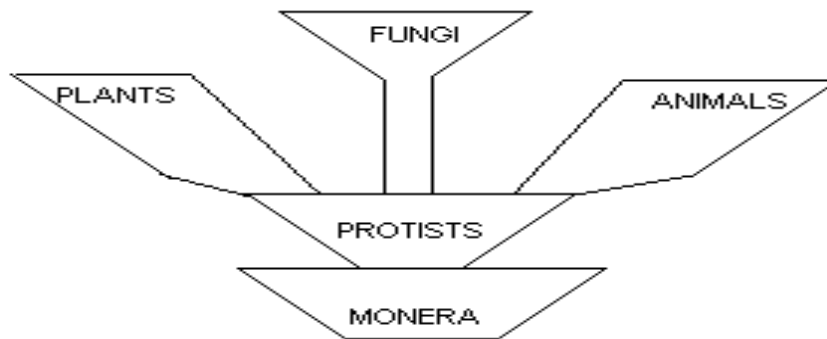
[Linnaeus's classification (1753): He said

2. if a thing simply exists, it is **mineral**,
3. if it is living it is **vegetable**
4. if it has some sensations, it is **animal**.

So simply he classified living things into **plants** and **animals**.]

Whittaker's classification (1969): He classified the living things into five kingdoms on the basis of their **morphology**, **level of organization**, and **mode of nutrition** as followings:

1. Monera
2. Protista
3. Animalia
4. Plantae
5. Fungi



Monophyletic Group: A group that contains an ancestor and all its descendants.

Polyphyletic Group: The groups that do not share a close common ancestor.

Paraphyletic Group: A group that includes some relatives of a common ancestor, but not all of them.

Phylum Zygomycota

Phylum Zygomycota has two classes;

1. Zygomycetes
2. Trichomycetes

Characteristics of Class *Zygomycetes*:

1. Production of a thick walled resting spore called a zygospor (Gr. *Zygos* = yoke + *spora* = seed, spore). These zygospores are produced by the fusion of two isogametangia. These Zygosporangia are produced within **Zygosporangium**.
2. Mycelium is extensive and hyphae are coenocytic.
3. Asexual reproduction is by sporangiospores although some species produce other types of spores.
4. On the sporangiophore a large no. of small structures are found these are known as sporangiola.
5. Some species are dimorphic (having the capacity to grow as a single cell like yeast or to produce mycelia).
6. Flagellate (motile) cells and centrioles are absent.
7. The tissue that gives rise to spores is called *prymordia*.

Habitat:

They are found in a variety of habitats such as soil, dung, fruits, flowers, stored grains, fleshy plant organs, mushrooms, invertebrates and vertebrates, including humans.

Nutrition: They are facultative as well as obligate parasites of plants, true fungi and animals and predators of animals. A few species form mycorrhizal association with plant roots.

Classification: [Benjamin].

Class *Zygomycetes* has following orders;

1. Mucorales [**important**]
2. Entomophthorales
3. Zoopagales
4. Dimargaritales
5. Kickxellates
6. Endogonales
7. Glomales

- Mucoraceous fungi have well developed mycelium which is coenocytic.
- They are saprobes that occur on dung, soil, and other organic debris.
- It causes **soft rot** of potato and strawberry during storage and shipping e.g. *Rhizopus* and *Mucor*.

PHYLUM ASCOMYCOTA

CHARACTERISTICS:

1. Member of Ascomycota and Basidiomycota are called higher fungi.
2. Sac like structure is produced which is known as ascus.
3. Within ascus (Pl. asci) spores known as ascospores are produced, which are usually eight (8) in numbers?
4. This group consists of 1500 species and includes ascus forming yeasts, black and green molds, powdery mildews, cup fungi, morels and truffles.
5. Hyphae or mycelium is well developed with distinct walls which are made up of chitin.
6. Hyphae are septate and septa of the hyphae have a simple pore and woronin bodies are present.
7. Woronin bodies are spherical, hexagonal or rectangular structures that are usually associated with a septum and can only be visible with an electron microscope.
8. There is a free cell formation after karyogamy and meiosis.
9. Types of Ascocarp: In ascomycetes the wall appears two layered, with a thick, translucent inner layer (endotunica) and a dense, thin outer layer (exotunica).

There are **three types of ascocarp** on the basis of these layers.

- a) Prototunicate: It has only single layer, which is delicate, and there is no opening. OR When the ascus is covered by thin and delicate membrane. Ascospores are released by breaking of thin and delicate wall of ascus.
 - b) Unitunicate: The two layers are so arranged that they are fused and difficult to distinguish. OR If the inner and outer walls are more or less rigid and do not break during spore dispersal.
 - c) Bitunicate: The two layers are quite separate and easily distinguished. OR If the inner wall is elastic enough than the outer wall and expand enough during spores dispersal.
10. The somatic phase of ascomycetes may be single-celled, mycelial or dimorphic.

Fruiting body of ascomycetes in which asci are produced is called Ascocarp [(syn. ascoma) sexual fruiting body of an ascomycetous fungus that produces asci and ascospores; e.g. apothecium, ascostroma, cleistothecium, perithecium, pseudothecium].


11. Asexual reproduction may be carried out by fission, fragmentation, budding or formation of chlamydospores [thick-walled or double-walled asexual resting spore formed from hyphal cells (terminal or intercalary) or by transformation of conidial cells that can function as an overwintering stage]
12. Sexual reproduction is by gametangial contact, by somatogamy and spermatization.
13. Heterothallic fungi may be unifactorial (bipolar) or bifactorial (tetra polar).
14. Concentric bodies are present in the lichen forming ascomycetes.
15. A definite layer of asci, whether naked or enclosed in an ascocarp, is called a Hymenium [continuous, spore-bearing layer of a fungus fruiting body (hymenium of asci on the surface of an apothecium of *Monilinia fructicola*)].

Filamentous Ascomycetes

I. Plectomycetes (Cleistotheacial ascomycetes)

Characters:

- Those Ascomycetes which have closed ascocarp are called Cleistotheacial Ascomycetes or Plectomycetes.
- Asci are thin walled, pyriform, globose and evanescent (delicate).
- Asci are scattered at various levels within the ascocarp without forming a hymenium (a basal layer of asci).
- Ascospores are unicellular.
- Ascocarp is typically cleistotheacial.
- Various types of anamorphs or conidial forms are characteristics of various orders and families.
- Members of this group produce powdery mildews in their hosts.
- **Powdery mildew** is the superficial powdery mass of fungus on different plant parts.

Taxonomic Status		
Taxonomic category	Genus/ species	Disease caused
Order: Erysiphales Family: Erysiphaceae 	<i>Erysiphe graminis</i>	Powdery mildews in cereals
	<i>E. cicharacearum</i>	Powdery mildews of cucurbits
	<i>E. polygoni</i>	Powdery mildews of peas
	<i>Phylactinia dalbergiae</i>	Powdery mildews of shishum
	<i>Podosphaera leucotricha</i>	Powdery mildews of Apples
	<i>Uncinula nector</i>	Powdery mildews of grapes
Order: Eurotiales Family: Trichocomaceae	<i>Eurotium</i> sp	

Filamentous Ascomycetes

II. Pyrenomycetes (Perithecial Ascomycetes)

PHYLUM BASIDIOMYCOTA

Characters of Basidiomycetes (Basidiomycetes is not a class name but the members of *phylum Basidiomycota* are commonly known as basidiomycetes):

- They produce their sexual spores known as **Basidiospores**.
- Basidiospores are produced outside of a specialized, microscopic spore producing structure called **Basidium**.
- Basidiospores of most species are known as **ballistospores** which are discharged from the basidium forcibly.
- As a result of Karyogamy, Plasmogamy, and meiosis four (4) basidiospores are produced in each basidium. The basidiospores are haploid and may be uninucleate or binucleate at maturity.
- Extensive dikaryophase occurs.
- Mycelium is septate.
- A dolipore septum is present between the two hyphal cells which regulate the flow of particles across the cells.
- There is also the presence of a clamp connection between two hyphal cells that ensures the dikaryotic condition in each new cell of the secondary mycelium.
- Mycelium of most heterothallic basidiomycetes passes through three distinct stages of development before it completes its life-cycle i.e.
 - a. Primary,
 - b. Secondary, and
 - c. Tertiary mycelial stages.

Phylum Oomycota

Phylum Oomycota contains a single class i.e. *Oomycetes*

Characters of Class *Oomycetes*:

1. On the basis of different biochemical and molecular characteristics they can be separated from true fungi.
2. Biflagellate zoospores are present (anterior flagellum directed forward is tensile type while the posterior flagellum directed backward is whiplashed type). Due to the presence of two different types of flagella they are termed as **Heterokont**.
3. Ultra structure of zoospores separates them from Chytridiomycetes.
4. There are two types of zoospores:
 - i. Primary spores (**Pyriiform**): These are pear shaped.
 - ii. Secondary spores (**Reniform**): These are kidney shaped.
5. Those members in which both types of spores are formed are called dimorphic and those having only one type are called monomorphic.
6. Species may be aplanetic, Monoplanetic, Diplanetic, or polyplanetic.
7. Diploid thallus is present with the presence of gametangial meiosis.
8. Members of this class are Eucarpic and holocarpic.
9. Their cell-wall contains β -glucans, an amino acid hydroxyproline and cellulose.
10. Mitochondria have tubular cristae.
11. Sporangia may produce zoospores or can directly germinate and behave as conidia.

Reproduction:

1. **Asexual Reproduction:** It occurs by means of Sporangia, which will directly germinate and at that time called conidia.
2. **Sexual Reproduction:** It occurs by the fusion of two dissimilar gametes i.e. Antheridium and Oogonium. This type of reproduction is known as **Oogamous** as a result of which thick walled resting spores are produced known as oospores.

Classification:

It has following orders:

1. Leptomitales
2. Lagenidiales
3. Saprolegniales
4. Rhipidiales
5. Peronosporales

But *Peronosporales* is the important one.

Peronosporales:

- They are Eucarpic and cause various diseases e.g. Damping off, Downy Mildew, and White Rust.
- Zoospores may be within a sporangium or an evanescent (delicate) vesicle.
- Monomorphic only reniform zoospores are produced.
- This order has following families:
 1. Pythiaceae
 2. Peronosporaceae
 3. Albuginaceae

1. Pythiaceae: