

Major criteria used in the classification and phylogeny of fungi

1. Morphology
 2. Anatomical Characters
 3. Nutrition and Physiology
 4. Chemistry of Low-Molecular-Weight Compounds
 5. Carbohydrates and Cell Wall Composition
 6. Molecular Methods
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1.Morphology

- **Basic shape of the fungal thallus.**
- **Form, colour and size of the asexual or sexual spore producing structures.**



2. Anatomical Characters

- The arrangement of hyphae comprising the tissues of spore-producing structures
- The arrangement of asci or basidia and also the sterile structures like paraphysis and cystidia within the hymenium.
- Analysis of hyphal structures.
- Histochemical localization of certain compounds by using fluorescent probes and dyes.

3. Nutrition and Physiology

They are of great practical importance in yeasts because of their limited morphological features and absence of sexual sporulation in some.

Features of importance are:

- Whether growth is limited to aerobic/anaerobic conditions or fermentation occurs.
- Whether it can utilize nitrate as a nitrogen source.
- Which sugars and glycosides it can metabolize?
- What is the pattern of susceptibility to various antifungal compounds?

4. Chemistry of Low-Molecular-Weight Compounds

The term **chemotaxonomy** is generally applied to the utilization of low molecular weight compounds in classification and identification

This approach is important to understand **lichen taxonomy** as they are known to produce a wide variety of **secondary metabolites**, such as **pigments**, **colorless compounds**, and **some products in the form of crystals**

This approach relies on procedures such as **Gas Chromatography (GC)**, **Mass Spectrometry (GCMS)**, **High Performance Liquid Chromatography (HPLC)** and **Nuclear Magnetic Resonance (NMR)**.

5. Carbohydrates and Cell Wall Composition

- Fungal walls have a complex structure with specific polysaccharides present in different groups for example the walls of Oomycota contain cellulose, whereas in most other fungi chitin is present.
- Estimates of the amount chitin have been significantly employed in yeast taxonomy.
- Glucose and mannose are the main carbohydrates found on hydrolysis of the walls of all yeasts. However, presence or absence of certain sugars like fucose, galactose, rhamnose and xylose, though in smaller amounts, may also help in classifying yeasts.

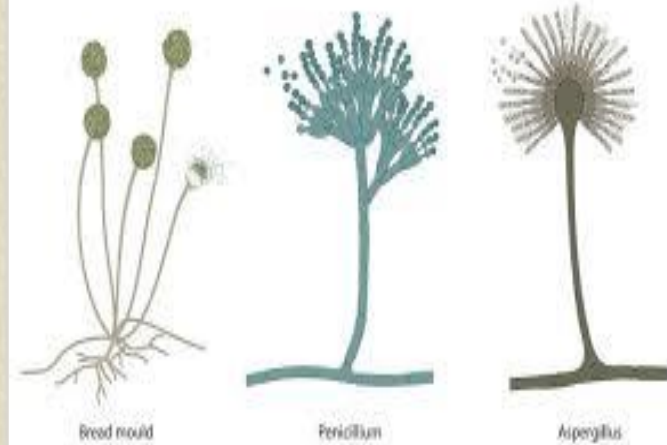
True Fungi versus Slime Moulds

True fungi:

- those that are hyphal
- possess cell walls throughout most of their life cycle
- are exclusively absorptive in their nutrition.

Slime moulds:

- those that do not form hyphae
- lack cell walls during the phase that they obtain nutrients and grow
- are capable of ingesting nutrients by phagocytosis. So they are more common to Protista although they produce fruiting bodies like fungi.
- The most studied of them are the cellular slime moulds and the plasmodial slime moulds or Myxomycetes.



Classification of Fungi – Alexopoulos and Mims 1979)

- The nomenclature is binomial, with a generic and a specific name (eg: *Aspergillus niger*).
- Species are collected in genera, genera in families (suffix -aceae), families in orders (suffix-ales), and orders in classes (suffix-mycetes).
- The division of mycota, or fungi and moulds, includes the true slime moulds (Myxomycetes), the lower fungi (Phycomycetes), and the higher fungi (Eumycetes).
- Alexopolous and Mims proposed fungal classification in 1979. They place the fungi including the slime molds in the kingdom mycetae of the super kingdom Eukaryota which, in addition, includes four other kingdoms.
- They divide the kingdom mycetae into three divisions namely:
 1. Gymnomycota
 2. Mastigomycota and
 3. Amastigomycota
- The division is subdivided into subdivision, classes, sub-classes, and orders.

KINGDOM - MYCETEAE

**DIVISION –
GYMNOMYCOTA**

SUBDIVISION – 1

ACRASIOGYMNOMYCOTINA

CLASS – Acrasiomycetes

SUBDIVISION – 2

PLASMODIOGYMNOMY-
COTINA

CLASS – Protosteliomycetes

CLASS- Myxomycetes

**DIVISION -
MASTIGOMYCOTA**

SUBDIVISION – 1

HAPLOMASTIGOMYCOTINA

CLASS – Chytridiomycetes

CLASS – Hyphochytridiomycetes

CLASS – Plasmodiophoromycetes

SUBDIVISION – 2

DIPLOMASTIGOMYCOTINA

CLASS - Oomycetes

**DIVISION –
AMASTIGOMYCOTA**

SUBDIVISION -1

ZYGOMYCOTINA

Class – Zygomycetes

Class- Trichomycetes

SUBDIVISION -2

ASCOMYCOTINA

CLASS – Ascomycetes

SUBDIVISION -3

BASIDIOMYCOTINA

CLASS – Basidiomycetes

SUBDIVISION -4

DEUTEROMYCOTINA

CLASS - Deuteromycetes

CLASSIFICATION OF FUNGI (ALEXOPOULOS & MIMS, 1979)

Kingdom: Myceteae

(Achlorophyllous, saprobic/parasitic organisms, cell wall chitinous, mode of nutrition absorptive)

(On the basis of presence or absence of cell wall, centriole and flagellate cells in life cycle)

Divisions: (3)

1. Gymnomycota

- Cell wall absent
- Phagotrophic fungi

2. Mastigomycota

- Flagellate cells produced during life cycle
- Centriole present during cell division

3. Amastigomycota

- Centriole absent
- Spindle pole bodies functioning during cell division
- Flagellated cells not produced during life cycle

CLASSIFICATION OF FUNGI (ALEXOPOULOS & MI)

Division: 1. Gymnomycota

Sub-Divisions (2)

1. Acrasiogymnomycotina

- Soma is myxamoeba Followed by pseudoplasmodium &
- Finally turn into sporocarp
- **Single class:**
 1. Acrasiomycetes

2. Plasmodiogymnomycotina

- Soma is myxamoeba with foliose pseudopodia or true plasmodium
- **Two classes:**
 1. Protosteliomycetes
 2. Myxomycetes

CLASSIFICATION OF FUNGI (ALEXOPOULOS & MIA)

Division: 2. Mastigomycota

Sub-Divisions (2)

1. Haplomastigomycotina (Zoospore Uniflagellate)

Three classes:

1. Chytridiomycetes

(posteriorly uniflagellate zoospores)

2. Hyphochytridiomycetes

(Aquatic fungi with anteriorly uniflagellate cells)

3. Plasmodiophoromycetes

(parasitic fungi with non cellular multinucleate thalli)

2. Diplomastigomycotina (Zoospore Biflagellate, meiosis gametangial)

One class:

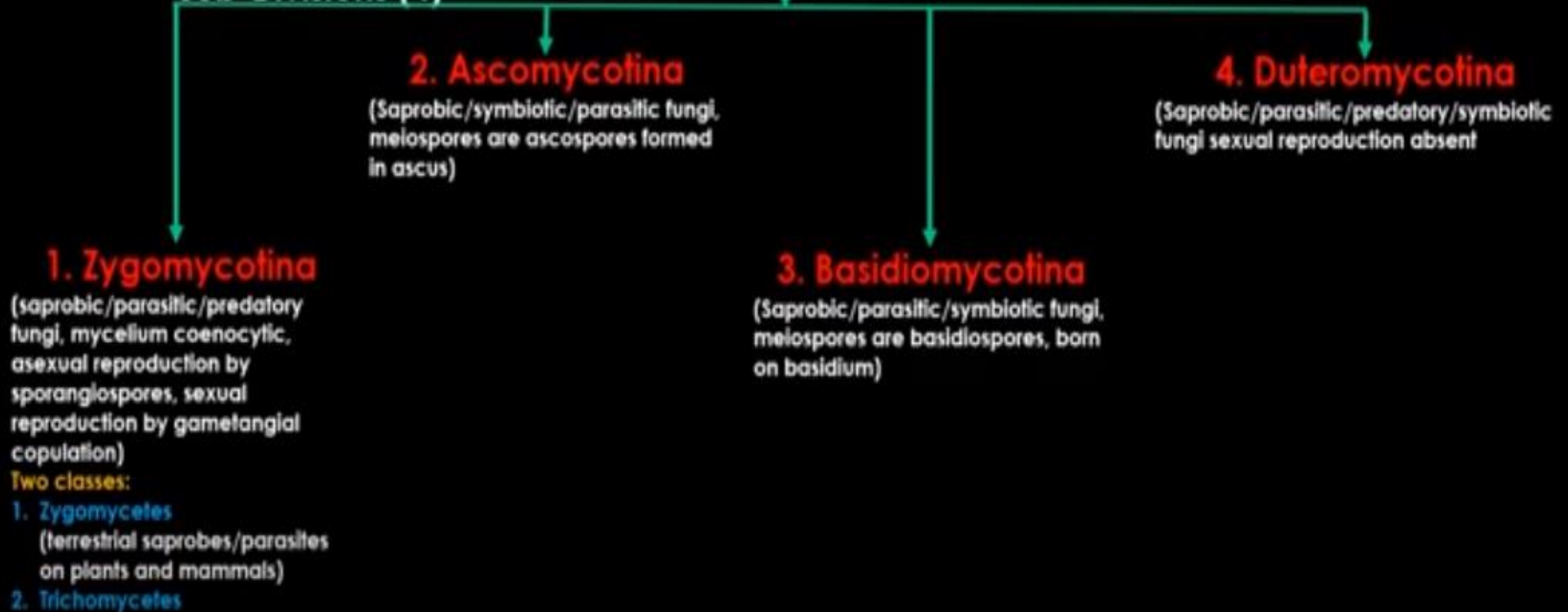
1. Oomycetes

(mycellium coenocytic, cell wall made up of glucans & cellulose in Leptomytales cell wall made up of chitin)

CLASSIFICATION OF FUNGI (ALEXOPOULOS & MIMS, 1979)

Division: 3. Amastigomycota

Sub-Divisions (4)



Commensals or ectoparasites on arthropods

Division I Gymnomycota

- It includes phagotrophic organism devoid of cell walls.
- This division comprises two subdivisions.
- These are Acrasiogymnomycotina and Plasmodiogymnomycotina.



Plasmodium



Sorocarp

Division Gymnomycota

Subdivision 1. Acrasiogymnomycotina

It includes a single class Acrasiomycetes.

Class 1. Acrasiomycetes

- Lacks flagellated cells except for one species. The class comprises two subclasses.
- Acrasiomycetidae and Dictyosteliomycetidae.



Subdivision 2. Plasmodiogymnomycotina

It is divided into two classes:

Class 1 Protosteliomycetes

Class 2. Myxomycetes



Division II Mastigomycota

- Includes fungi with absorptive nutrition, unicellular or filamentous, mycelium coemocytic.
- It comprises two sub divisions:

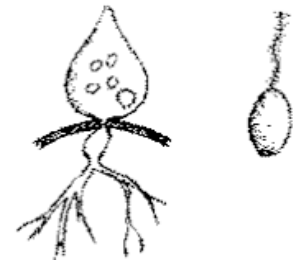
Sub division 1 Haplomastigomycotina

- Includes fungi with uni-or, bi-flagellate zoospores.

Class 1 Chytridiomycetes- Fungi producing zoospores furnished with a single whiplash flagellum inserted at the posterior end.

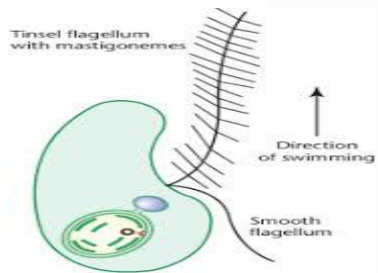


Class 2 Hyphochytridiomycetes- Motile cells with a single tinsel flagellum inserted at the anterior end.



Class 3 Plasmodiophoromycetes- Parasitic fungi producing biflagellate motile cells with both the flagella of whiplash type inserted at the anterior end.

Sub division 2. Diplomastigomycotima Sexual reproduction oogamous, zoospores biflagellate.



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Class 1 Oomycetes

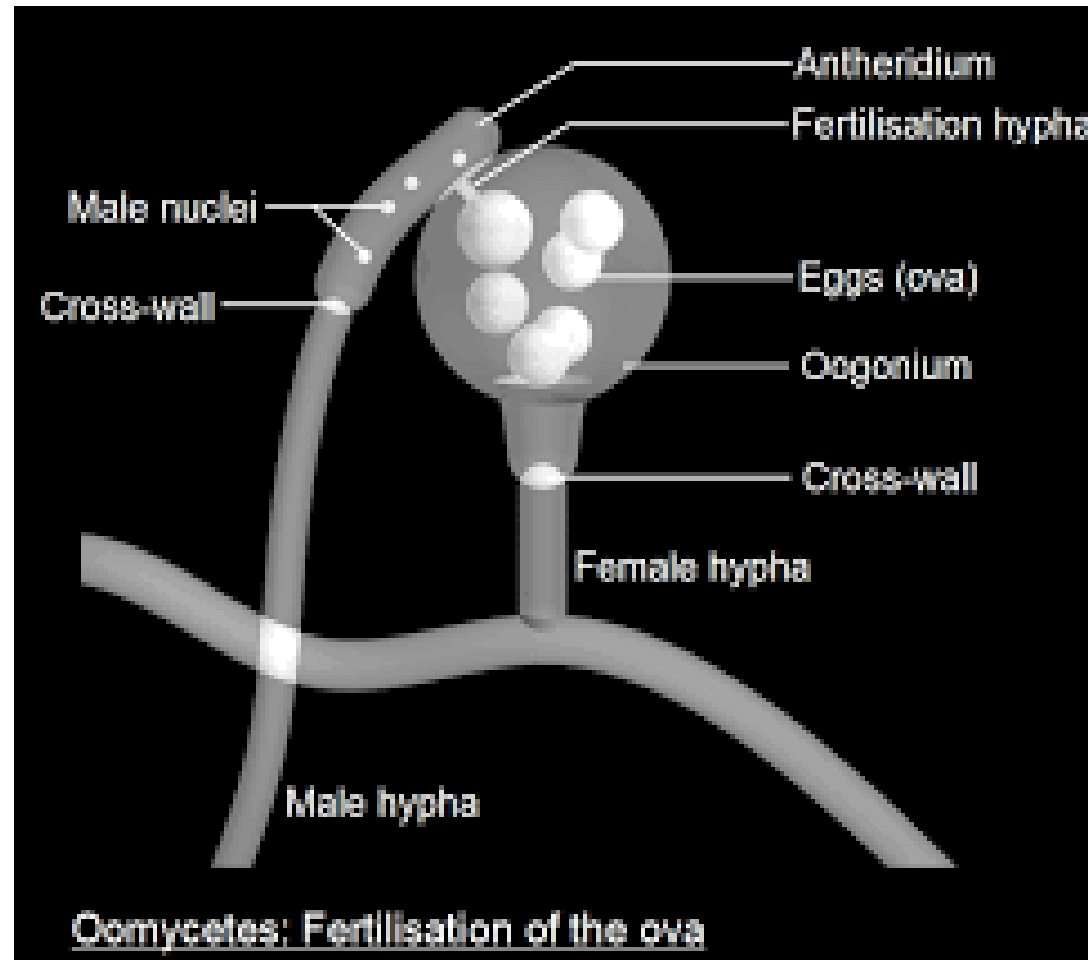
- It comprises four orders:

Order 1 Lagenidiales

Order 2 Saprolegnales

Order 3. Leptomitales

Order 4. Peronosporales



Division III Amastigomycota

Fungi with absorptive nutrition, motile cells lacking, mycelium aseptate or septate.

This includes four sub divisions:

Sub division 1 Zygomycotina

Class 1 Zygomycetes – it includes six orders.

Class 2 Trichomycetes – it comprises five orders.

Sub division 2 Ascomycotina

Fungi usually with a septate mycelium producing haploid ascospores in sac like cells called asci.

Class 1 Ascomycetes- divided into five sub classes:

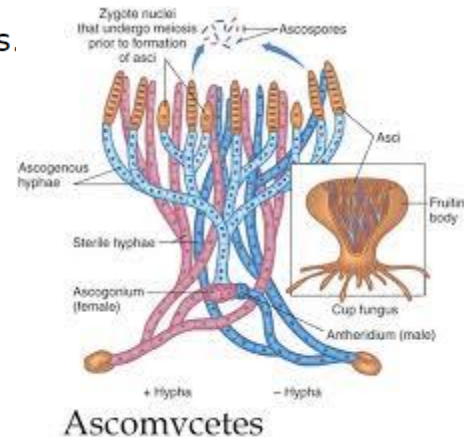
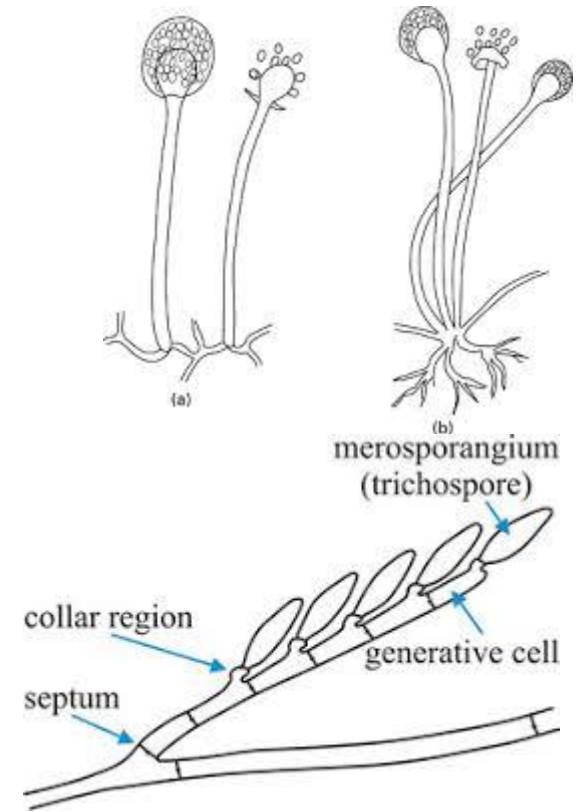
Sub class 1. Hemiascomycetidae- comprising three orders.

Sub class 2. Plectomycetidae- Five orders

Sub class 3. Hymenoascomycetidae – Ten orders

Sub class 4 Laboulbeniomycetidae – Two orders

Sub class 5 Loculoascomycetidae – Five orders



Sub division 3. Basidiomycotina

Septate mycelium, produces basidiospores, exogenously on various types of basidia.

Class 1 Basidiomycetes: it is split into 3 sub classes:

Sub class 1 Holobasidiomycetidae

Sub class 2 Phragmobasidiomycetidae

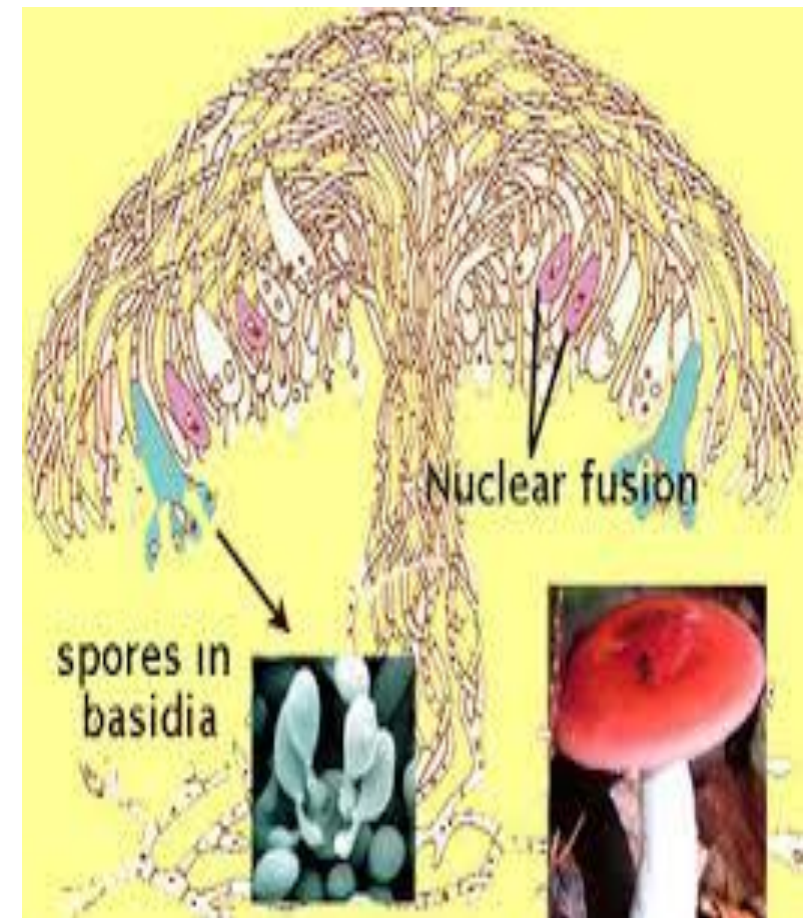
Sub class 3 Teliomycetidae

Sub division 4. Deuteromycotina

Sub division 4: Deuteromycotina

It includes imperfect fungi in which sexual stage is unknown. It comprises a single form class.

Form Class Deuteromycetes with three form sub classes namely Blastomycetidae, Coelomycetidae and Hyphomycetidae.



On the basis of the organisation of the vegetative thallus, the morphology of reproductive structures, the way of spores production and particular life cycle involved the kingdom mycota is classified into following divisions.

Phycomycetes

- It includes the simplest type of fungi. It is also called as Algae-Fungi because most of the characteristics of them are similar to algae like Vaucheria.
- They have simple thallus which is unicellular or coenocytic or aseptate filaments.
- They reproduce asexually by the formation of zoospores or non-motile spores.
- Sexual reproduction is isogamous or heterogamous which takes place by gametangial contact.
- The diploid phase is represented by zygote.
- Phycomycetes has been classified into subclasses: oomycetes and zygomycetes.

Oomycetes

- Oomycetes range from a primitive unicellular thallus to a profusely branched filamentous mycelium.
- Many members of them are terrestrial and obligate parasites.
- Asexually they reproduce by biflagellate zoospores.
- Sexual reproduction is oogamy that involves the fusion of male and female gametes to form oospore.
- Oospore undergoes meiosis to produce haploid biflagellate zoospores.
- Example; *Phytophthora infestans*(causes potato blight)

Zygomycetes

- The group is named zygomycetes because a diploid resting spore called the zygospore is formed during the life cycle.
- They are mostly saprophytic, some others are parasites on plants and animals.
- The vegetative body is mycelium which is well developed, profusely branched and coenocytic.
- The absence of motile sexual or asexual cells.
- The asexual reproduction takes place by sporangiospores, aplanospores or by conidia.
- Sexual reproduction occurs by conjugation of gametangia resulting in the formation of zygospore.
- Examples; Rhizopus, Mucor etc

Ascomycetes

- The species of ascomycetes are called the sac fungi because they produce sexual pores within the sac-like vascus.
- General Characteristics
- Ascomycetes are mostly terrestrial occurring as saprophytes or parasites.
- They have well-developed, branched, septate mycelium except yeast. Yeast is a unicellular fungus.
- Asexually they reproduce by non-motile spores, conidia, oidia or chlamydospores.
- Sexual reproduction takes place by the fusion of gametangia of opposite mating types.
- There is absence of motile cells.
- Examples, Saccharomyces cerevisiae, Penicillium, Aspergillus etc.

Basidiomycetes

- The members of basidiomycetes are saprophytic or parasitic. The group is named basidiomycetes as they produce the basidiospores at the club-shaped basidium during sexual reproduction.
- Mycelium is highly developed, profusely branched and septate.
- The mycelia are differentiated into two mating types; (+ve) and (-ve).
- There are two kinds of mycelium; primary mycelium and secondary mycelium.
- Asexual reproduction takes place by fragmentation, budding, oidia, conidia or chlamydospore.
- The dikaryotic cell is formed during sexual reproduction.
- The absence of motile cell throughout the life cycle.
- Basidiomycetes are the most advanced fungi as their fructifications are often large and prominent.
- Examples; Mushrooms, Puccinia, Ustilago etc.

Deuteromycetes (The Imperfect Fungi)

- Deuteromycetes comprises more than 17000 species of the diverse habits and habitats. It is considered as an artificial class of fungi.
- The fungi are saprophytes as well as parasites. Parasitic fungi cause serious diseases to plants, animals including human beings.
- Some of them are unicellular while others are multicellular.
- They reproduce asexually by conidia along with some other types of spores.
- The sexual reproduction is entirely absent.
- The asexual stage or imperfect stage in Deuteromycetes is well defined. But the sexual or perfect stage is absent in life cycle, therefore, they are called 'Fungi Imperfecti'.
- Example; Alternaria, Fusarium, Helminthosporium etc.