

SUB DIVISION: ASCOMYCOTINA

The members of sub division Ascomycotina are commonly called as sac fungi, because of production of sexual spores, ascospores in a sac like structure called ascus. The members of sub divisions Ascomycotina, Basidiomycotina and Deuteromycotina are also considered as higher fungi.

IMPORTANT CHARACTERISTICS OF SUB -DIVISION ASCOMYCOTINA :

1. Produce definite number (usually eight) of sexual spores (ascospores) in a sac like structure called ascus.
2. Mycelium is septate, branched and organized into tissues known as plectenchyma.
3. Production of sexual fruiting body called ascocarp in which asci are produced.
4. Absence of motile spores and presence of asexual spores called conidia.
5. Presence of a short dikaryotic phase in ascogenous hypha or ascogenous cell.

1. **Somatic characteristics:** Mycelium is septate and organized into fungal tissues. Some consists of septate hyphae except in a few cases like yeasts which are single celled. Mycelium is profusely branched (except in yeasts) and the hyphal walls containing chitin. The septum is simple, incomplete, perforated and have a central pore/ septal pore through which cytoplasm and nuclei move from one cell to another cell thus, cytoplasmic continuity is maintained.

2. **Fungal tissues:** Mycelium is mostly organized into fungal tissues known as plectenchyma. These tissues are chiefly associated with fruiting bodies called ascocarps viz., cleistothecium, perithecium, apothecium and ascostroma.

Asexual reproduction: Asexual stage is also called as anamorph or imperfect stage. Asexual reproduction occurs by fission (Yeasts), budding (blastospores) (Yeasts), fragmentation (majority of fungi) chlamydospore and conidia. Conidia are short lived, indefinite (enormous) in number, may be produced directly from somatic hyphae, or from conidiogenous cells or from specialized hyphae called conidiophores. Conidiophores may be short or long, branched or unbranched or may form complex asexual fruiting bodies viz., pycnidium, acervulus, sporodochium and synnemata and the method vary with species and environmental conditions.

3. **Sexual reproduction:** Sexual stage is also called as teleomorph or perfect stage or ascigerous stage / state. Sexual spores are called ascospores which are produced in a sac like structure called ascus. The methods of sexual reproduction

are gametangial copulation, gametangial contact, spermatization and somatogamy. The gametangia are antheridium (male sex organ) and ascogonium(female sex organ). Ascogonium is provided with a hair like structure called trichogyne

(receptive neck of ascogonium), which is often long and functions as a fertilization tube.

4. The asci may be formed by any of the following methods.

A.Direct development of zygote into ascus - eg. In yeasts, the compatible nuclei brought together during plasmogamy, fuse (karyogamy) and the cells containing single diploid nucleus (zygote) directly develops into ascus.

B.Indirect Development of asci from ascogenous hyphae- eg. sexual reproduction and ascus development as exemplified by general life cycle pattern in *Pyronema omphalodes*.

5.Short dikaryotic phase is seen.Plasmogamy and karyogamy are separated both by space and time.

DEVELOPMENT OF ASCUS INDIRECTLY FROM ASCOGENOUS HYPHAE OR LIFE CYCLE OF *PYRONEMA OMPHALODES* :

1.The male sex organ is known as antheridium and the female sex organ is known as ascogonium.

2.During sexual reproduction,the male nuclei from the antheridium pass through the trichogyne into the ascogonium and pairs up with female nuclei to form dikaryon. (they do not fuse thus delaying karyogamy) .

3. The sexual act stimulate the ascogonium to produce a number of swellings/ papillae just opposite to groups of nuclei located in the periphery of the ascogonium.

4. The dikaryons in ascogonium multiply by conjugate division and as these swellings enlarge, the daughter nuclear pair from ascogonium begin to pass into swellings one by one.

5. Eventually, the swellings elongate into ascogenous hyphae. The nuclear pair or dikaryon in ascogenous hyphae undergoes conjugate divisions.Later, septa are formed in ascogenous hyphae in such a way that each cell of ascogenous hyphae is dikaryotic,except the terminal cell which is uninucleate.Thus,the dikaryotic phase in Ascomycotina is represented by ascogenous hyphae where in one

nucleus is ascogonial origin and the other antheridial.

6. The penultimate binucleate cell of ascogenous hypha elongates and bends over to form a hook like cell called as 'hook cell' or 'crozier'. The two nuclei in crozier cell undergoes conjugate division to form 4 nuclei.

7. Now septa are formed in hook cell in such a way that basal and apical cells consist of single nucleus each, and the middle cell consists of two nuclei. This binucleate middle cell is known as 'Crook cell'.

8. Crook cell enlarges and converted into 'Ascus mother cell'. Karyogamy takes place in ascus mother cell fusing two nuclei and forms diploid nucleus ($2n$). Thus, plasmogamy (in ascogonium) and karyogamy (in ascus mother cell) occur at different places. Meanwhile ascus mother cell elongates and develops into ascus.

9. The diploid nucleus undergoes meiosis resulting in the formation of 4 haploid nuclei.

10. These 4 haploid nuclei further undergo mitosis forming 8 haploid nuclei.

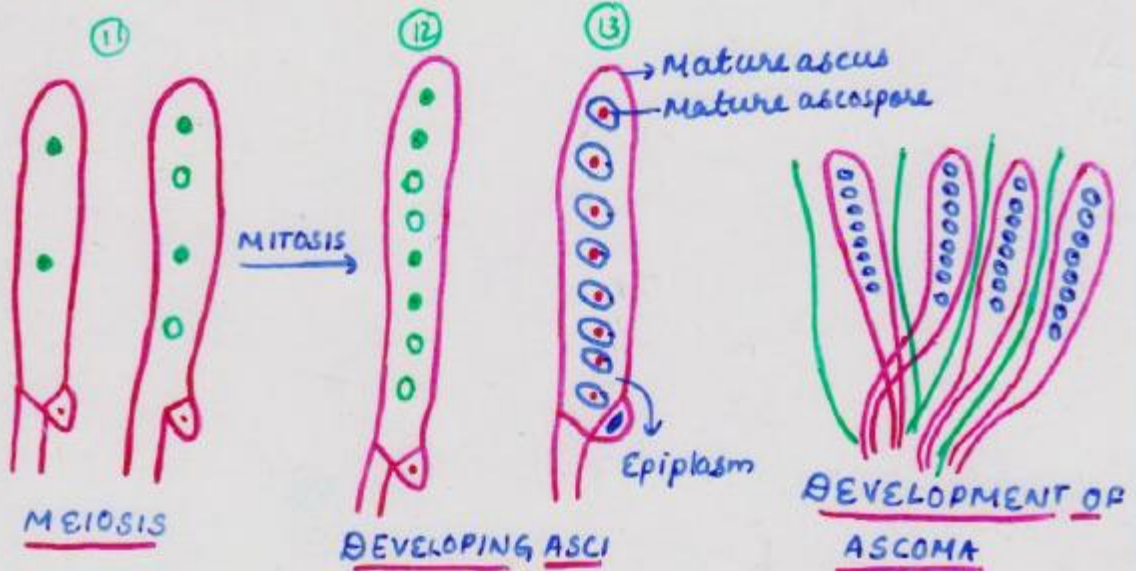
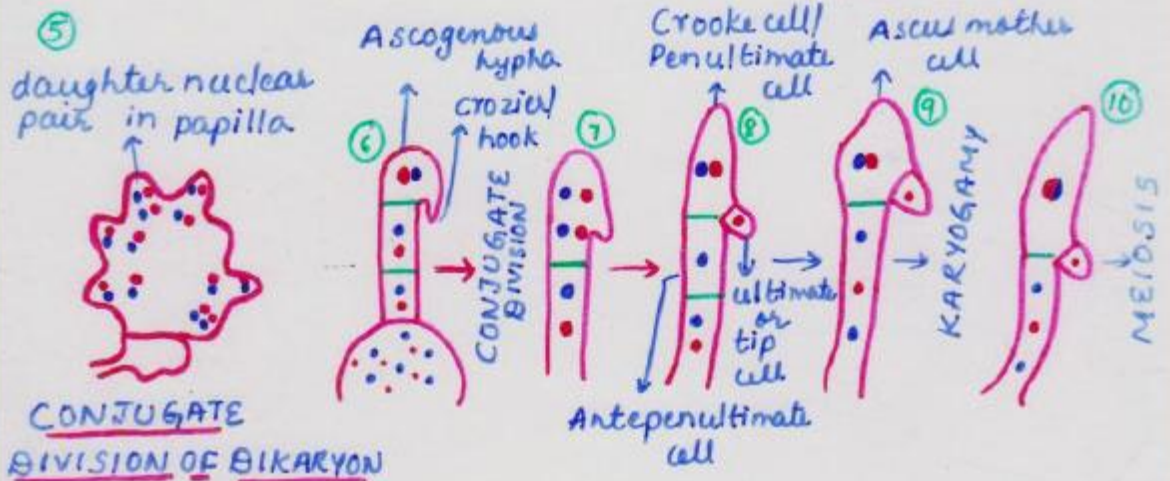
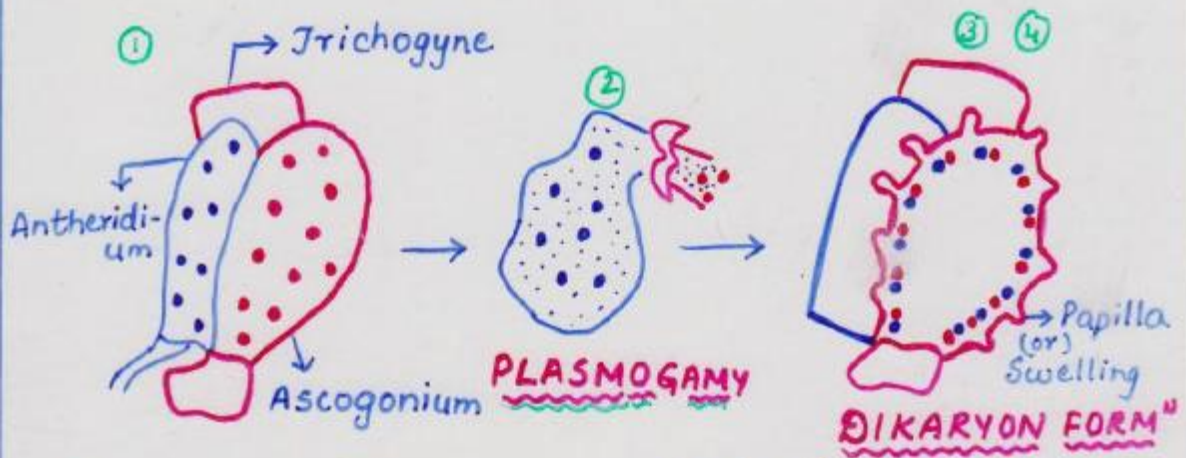
11. The nuclei develop into ascospores by free cell formation. The process of formation of ascospores is called 'Free cell formation' or 'Ascosporogenesis'. The ascospores are formed by aggregation of cytoplasm of the ascus around the nucleus forming definite walls. Epiplasm is the portion of cytoplasm left over, outside the ascospore walls, which supplies nutrients to the developing ascospores.

12. The number of ascospores may be 8, 16, 32, 64, or even more depending on the number of mitotic divisions following meiosis. The ascospores vary in shape, size and some times in color also.

13. Based on compatibility, the members may be homothallic (eg. *Aspergillus*, powdery mildew fungi) or heterothallic (E.g. *Saccharomyces cerevisiae*).

GENERALISED LIFE CYCLE OF ASCOMYCOTINA

Eg: *Pyronema omphalodes*



ASCOSPOROGENESIS = FREE CELL FORMATION

MORPHOLOGY OF ASCI:

Ascus is a sac like structure usually containing a definite number of ascospores (typically eight) formed by a process called free cell formation after karyogamy and meiosis. In majority members of ascomycotina shape of ascus may be elongated, cylindrical, clavate or club shaped, except in some groups where they are globose or ovoid. Asci may be stalked or sessile. Generally ascus represents a single cell but in some ascus may be septate.



IMPORTANT CHARACTERISTICS OF ORDER : ERYSIPTHALES, FAMILY : ERYSIPTHACEAE :

1. Erysiphales is the exceptional order as it produces cleistothecium instead of perithecium. The reason is that the asci are grouped in fascicles or form a basal layer (hymenium) at maturity and ascospores are released violently with force. Cleistothecia are formed on superficial mycelium with out formation of stroma.
2. Members cause a disease called powdery mildew because they produce enormous number of conidia on the surface of infected host plants which appear to the naked eye as a white powdery coating.
3. Mycelium is hyaline and mostly ectophytic
4. Members are obligate parasites of plants and nourishment through haustoria.
5. Asci are persistent, globose to pyriform and explodes at the time of release of ascospores.
6. Important plant pathogenic genera are 1. *Erysiphe* 2. *Leveillula* 3. *Phyllactinia*

4. *Uncinula* 5. *Sphaerotheca* 6. *Podosphaera* 7. *Microsphaera*

Somatic characteristics:

Mycelium is well developed, septate, uninucleate, profusely branched entirely superficial (ectophytic) except *Leveillula* (endophytic) and *Phyllactinia* (semi-endophytic), produce haustoria into epidermal cells to absorb nourishment.

Asexual reproduction :

Asexual reproduction is through conidia produced on conidiophores. Conidiophores are long, erect and hyaline.

Three types of conidial stages are recognised in powdery mildews.

1. *Oidium* 2. *Oidiopsis* 3. *Ovulariopsis*

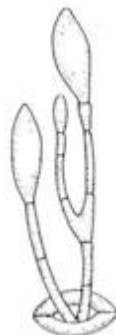
1. ***Oidium (Acrosporium)*** : Mycelium is ectophytic, hyaline. Conidia are developed from a flask shaped mother cell (spore mother cell) formed on a short conidiophore . Conidia are barrel shaped with flat ends and are produced in chains..The conidia are also referred to as meristem arthrospores as these are formed by fragmentation of hyphae. Eg. The perfect stages viz., *Erysiphe*, *Podosphaera*, *Uncinula*, *Sphaerotheca* and *Microsphaera* produce *Oidium* as conidial stage.

2. ***Oidiopsis***: Mycelium is endophytic. Conidiophores may be branched or unbranched, erect, septate, hyaline and emerge through stomata. Conidia are produced singly and cylindrical in shape. Conidia are of two types. a. blunt tip b. pointed tip. Eg. *Leveillula* sp. produce *Oidiopsis* as conidial stage.

3. ***Ovulariopsis***: Mycelium is partly ectophytic and partly endophytic. The conidiophores are hyaline, septate, unbranched, and bear a single conidium. Conidia are rhomboid in shape. In some species, the conidiophores are spiral in shape. Eg. *Phyllactinia subspiralis*. *Phyllactinia* sp .produce ovulariopsis as conidial stage.



Oidium



Oidiopsis



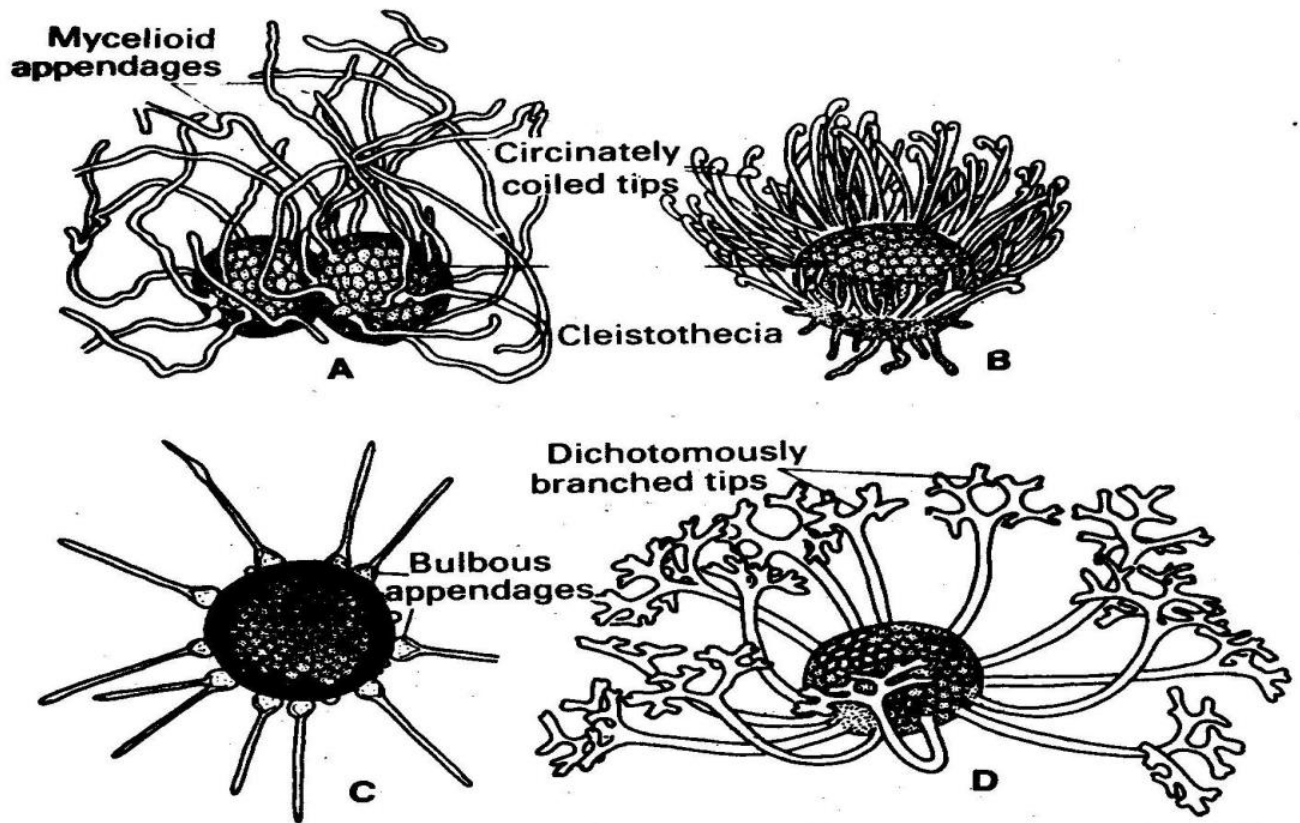
Ovulariopsis

Sexual reproduction:

Some species are homothallic and some are heterothallic. Antheridia and ascogonia are sex organs. Both gametangia are uninucleate. Fruiting body is cleistothecium which is produced on superficial mycelium as a result of gametangial contact. The cleistothecia are first white and finally black in color when mature. The wall is made up of pseudoparenchymatous tissue of several layers called peridium. Overwintering of powdery mildews takes place in cleistothecial stage which are resistant to winter conditions. In perennials, the mycelium may overwinter in the dormant buds of host. In warm weather, many species never form cleistothecia and perpetuate by means of conidia. The cleistothecia are provided with characteristic appendages which vary considerably in length and character.

Types of cleistothecial appendages:

1. **Mycelioid appendages:** These are flexible, flaccid and resemble somatic hyphae. Eg. *Erysiphe*, *Sphaerotheca*, *Leveillula*.
2. **Circinoid / hooked / coiled appendages :** These are rigid with curled or coiled tips. Eg. *Uncinula*.
3. **Dichotomously branched tips:** These are rigid, flattened with dichotomously branched tips. Eg. *Podosphaera*, *Microsphaera*.
4. **Bulbous base with pointed tip:** These are rigid, spear like with bulbous base and pointed tip. Eg. *Phyllactinia*.



Important powdery mildewdiseases:

CROP

1. Pea
2. Cucurbits
3. Grasses
4. Mulberry
5. Chillies
6. Apples
7. Roses

PATHOGEN

- Erysiphe polygoni*
E. cichoracearum
E. graminis
Phyllactinia corylea
Leveillula taurica
Podosphaera leucotricha
Sphaerotheca pannosa