Unit- IV
(Bryophyta and Fungus)

Part – A

Short answer type questions :

1. Who is called "Father of Indian Bryology"?

Ans. Shiv ram Kashyap is called "Father of Indian Bryology".

2. What is the function of elaters in Bryophytes?

Ans. Elaters found in capsules of bryophytes play important role in their bursting. The hygroscopic nature of elaters allow them to absorb moisture, the swelling of elater exerts pressure on the walls of capsules, which ultimately leads to bursting of the capsules.

3. Write any two differences between Pteridophytes and Bryophytes.

Ans. The following differences are found between bryophytes and pteridophytes:-

1. In Bryophyta plant body is simple, saccular and vascular tissues are absent whereas in Pteridophyta plant body is differentiated into root, stem and leaves. Well developed vascular tissues and Mechanical tissues are present in Pteridophyta.
2. In Bryophyta, sporophyte is dependent on gametophyte while in Pteridophyta it is independent.

4. "Club fungi" is the common name of.

Ans. The Basidiomycetes members like **Agaricus**

5. Gemma cups are found in which Bryophyte?

Ans. Marchantia

6. What is gemma cup?

Ans. Gemmae cups are cup-like structures containing gemmae. The gemmae are small discs of haploid tissue and they directly give rise to new gametophytes. A gemma (plural gemmae) is a single cell or a mass of cells, or a modified bud of tissue, that detaches from the parent and develops into a new individual. It is a means of asexual propagation in plants. They are dispersed from gemma cups by rainfall.

7. Violet colour of scales in Riccia is due to presence of which pigment.

Ans. Anthocyanin.

8. What is the significance of scales?

Ans. Scales protect the growing point by covering their delicate cells and secreting slime to keep them moist. The scales are absent in some aquatic members of order Marchantiales. e.g., *Riccia fluitans*.

9. Which bryophytes are called liverwort?

Ans. The gametophytic thallus (body) of some bryophytes resembles a liver lobed. Hence, such bryophytes are common name liverwort ("liver plant"). Ex. Riccia and Marchantia.

10. In which bryophyte are nurse cells found?

Ans. Funaria.

11. Which bryophyte is known as 'hornwort'?

Ans. Anthoceros is a hornwort. Hornworts are a group of non-vascular plants comprising the division Anthocerotophyta.

The common name refers to the elongated horn-like structure, which is the sporophyte.Its name means 'flower horn'.

12. What is the role of peristome teeth?

Ans. Peristome (exposed) plays an important role in the dispersal of spores. The peristome teeth by their hygroscopic movements help in the discharge of the spores. The inner peristome simply functions as a sieve. The spores are liberated in the dry weather and are carried out by air.

13. How many perstome teeth are found in capsule of funaria?

Ans. 16 + 16 = 32

14. Pyrenoids are found in which bryophyte?

Ans. The chloroplast of Anthoceros contains a unique feature 'pyrenoid' made up of 25-30 discoid or spindle shaped bodies.

15. How many types of scales are found in marchantia?

Ans. In Marchantia the scales are of two types- (1) Ligulate and (2) Appendiculate.

Scales protect the growing point by covering their delicate cells and secreting slime to keep them moist.

16. What is the dominant phase of the life cycle in Bryophytes?

Ans. **Gametophyte** is the dominant phase of the life cycle in Bryophytes.

17. The number of venter canal cell in bryophytes is?

Ans. Always One.

18. The number of Neck canal cell in bryophytes is?

Ans. 4 – 6 Neck canal cells present in bryophytes.

19. What is the name of the protective multicellular envelope formed from Venter wall around the embryo?

Ans. Calyptra.

20. In marchantia specialized branches bearing male and female sex organ is called?

Ans. Antheridiophore (male) and Archegoniophore (female)

21. Define pseudoelators.

Ans. The elaters are without thickening bands and therefore, called pseudo elaters.

22. Difference between Pseudoelators and Elators.

Ans. Pseudoelaters are cellular structures that help in spore dispersal in bryophytes. Elaters shows double spiral thickening with tapered ends and are unicellular whereas pseudo-elaters are without any thickening, with blunt ends and are multicelllular. Pseudoelaters are present in the species of hornworts

23. Write the function of pseudo elaters in bryophyte.

Ans. Pseudoelaters are cellular structures that help in spore dispersal in bryophytes.

24. Name the central sterile tissue present in some capsules of bryophyte.

Ans. Collumella.

25. Name a liverwort in which all endothecial tissue is fertile and give rise to sporogenous cells.

Ans. Marchantia.

26. What is the common name of Sphagnum?

Ans. Sphagnum commonly known as peat moss, also bog moss and quacker moss.

27. Give any four general characteristics of fungi.

Ans. The general characteristics of fungi are following:

1. Fungi are eukaryotic, non-vascular, non-motile and heterotrophic organisms.
2. Fungi lack chlorophyll and hence cannot perform photosynthesis.
3. The mode of reproduction is sexual or asexual. They reproduce by means of spores.
4. Fungi exhibit the phenomenon of alternation of generation.
5. Some fungi are parasitic and can infect the host.
6. Examples include mushrooms, moulds and yeast.

28. Mention the thallus organisation of hypha fungi.

Ans. The thallus of filamentous fungi typically consists of microscopic filaments, which branch out in all directions, thus colonizing the substrate that serves as food. A mass of hyphae forms the thallus (vegetative body) of the fungus, composed of mycelium. They can grow over or into the substrate.

29. What is heterokaryosis? Give its significance.

Ans. The presence of genetically-different nuclei in an individual is called heterokaryosis, and the organism heterokaryon.

Heterokaryosis is the main source of variation in the anamorphic (imperfect) fungi, which lack sexual reproduction. The term Heterokaryosis was proposed by Hansen and Smith in 1932.

30. What do you understand by parasexuality? List their importance.

Ans. A similar alternative to sexual reproduction was discovered by **Pontecorvo in 1952** in *Aspergillus nidulans fungus* that genetic recombination occurs in somatic cells by the mechanism of mitotic crossing over, which brings the same result as is achieved by the meiotic crossing over. He called this parasexual cycle.

31. What is nutrition? Write the modes of nutrition in fungus.

Ans. Fungi (singular fungus) are a scientific kingdom of organisms that are heterotrophs and play essential roles in how nutrients move through an ecosystem.

To be heterotrophic means fungus lack of chlorophylls so, cannot make their own food (carbohydrate) like plants; instead, they absorb nutrients from their environment. These heteromorphs according to their method of obtaining food are divided into two categories, namely the Parasites, the Saprophytes and the Symbiotic

- The Parasitic fungi - The fungal members that obtain their organic nutrition from the living tissues of various living body of a plants or animals.

- The Saprophytic fungi - The fungal members have the special ability to obtain their food from dead organic matter. The saprophytes cannot ingest solid food; they feed off decaying organic matter like wood, plants, and even dead animals.
- The Symbiotic fungi - Some fungal members obtain nutrition by living in mutually beneficial associations with other plants or their member species. The two best known examples of mutualisitc associations of fungi with other plants are lichens and mycorrhiza etc.

32. Write the vegetative reproduction in fungi.

Ans. Fission, budding and fragmentation are most common methods of vegetative reproduction in a number of fungi.

33. Give any four economic importances of fungi.

Ans. **1. Role of Fungi in Medicine:**

Some fungi produce the antibiotics help to cure diseases caused by the pathogenic microorganisms. The great antibiotic drug Penicillin from Penicillium notatum and Some antibiotics such as chloromycetin, aureomycin, terramycin, etc.

2. Role of Fungi in Industry: There are a number of industrial processes in which the biochemical activities of certain fungi are harnessed to good account.

(i) Alcoholic fermentation: the fermentation of sugar solutions by yeasts produces ethyl alcohol and carbon dioxide.

(ii) Enzyme preparations: Takamine the enzymes produced by Aspergillus flavus-oryzae. These are Digestin, Polyzime, Taka diastase, etc. They are used for dextrinization of starch and desiring of textiles.

(iii) Preparation of organic acids: The important organic acids produced commercially as the result of the biochemical activities of moulds are oxalic acid, citric acid, gluconic acid, gallic acid, fumaric acid, etc.

(vii) Vitamins: The yeasts, are the best source of vitamin B complex.

3. Role of Fungi in Agriculture: The fungi play both a negative and a positive role in agriculture.

- Some soil fungi are beneficial to agriculture because they maintain the fertility of the soil. Some saprophytic fungi particularly in acid soils where bacterial activity is at its minimum cause decay and decomposition of dead bodies of plants and their wastes taking up the complex organic compounds (cellulose and lignin) by secreting enzymes.
- Many insect pests can be controlled by the growth of fungi such as Empusa sepulchrasis, Metarrhizium anisopliae, Cordyceps melothac etc.

4. Role of Fungi as Food and as Food Producers:

Many species of fungi are edible, The fructifications of some fungi such as the field mushroom Agaricus campestris (dhingri), Podaxon podaxis (Khumb), the honey coloured mushrooms, the fairy ring mushrooms, the puff balls (Lycoperdon and Clavatia), morels (Morchella, guchhi), and truffles are edible.

34. What do you understand by antheridium and oogonium?

Ans - For sexual reproduction, special types of sexual structures are formed in most fungal species. These special structures are often called gametangia. These produce special sex cells or gametes.

A clear morphological differentiation between male and female gametangia, then such gametangia are called heterogametangia. In these heterogametangia, the male reproductive structure or gametangia is called **antheridium** and the female gametangia is called **oogonium.**

35. What is the systemic classification of Rhizopus?

Ans - Classification of Rhizopus:

Division : Mycota

Sub-division : Eumycotina

Class: Zygomycetes

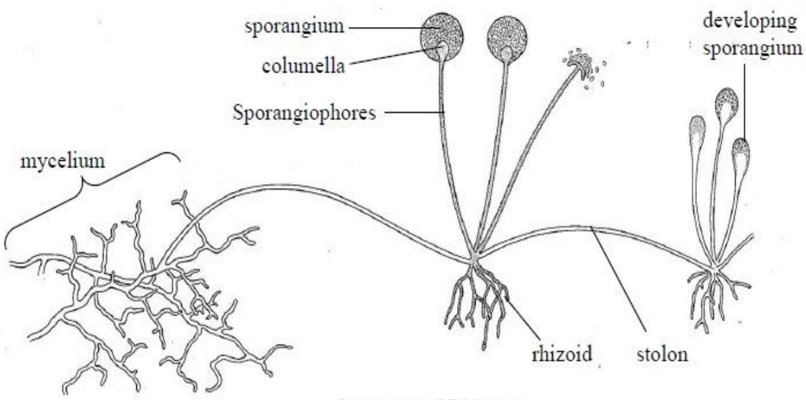
Order : Mucorales

Family : Mucoraceae

Genus : Rhizopus

36. Draw the structure of Rhizopus.

Ans - Rhizopus is a fungal genus that includes saprophytic and parasitic species. They prefer moist or humid environments. They can be found on organic foods, such as vegetables, fruits, bread, jellies, etc. Coenocytic (multi-nucleated) and branched hyphae make up the vegetative structure. They are utilised to make a variety of chemicals and alcoholic beverages.



Structure of Rhizopus

37. List the general characteristics of Rhizopus.

Ans - General Characteristics of Rhizopus

1) Rhizopus has saprobic and parasitic nutrition mode, with the majority of species being saprophytic and a few parasitic (R. artocarp and R. arrhizus).
2) Its mycelium is coenocytic, tubular, multi-nucleated, vacuolated, and contains Golgi bodies and mitochondria in the cytoplasm.
3) Glycogen and oil droplets make up the reserve food material.
4) Thallus has a non-cellulose cell wall, made up of chitin.

5) Its hyphae are divided into stolon (intermodal region), rhizoids (nodal region), and sporangiophores.
6) the most critical aspect in its growth is moisture or water availability.

38. What is the systemic classification of Agaricus?

Ans -

Division	:	Mycota
Sub-division	:	Eumycota
Class	:	Basidiomycetes
Order	:	Agaricales
Family	:	Agaricaceae
Genus	:	Agaricus

39. List any three general characteristics of Agaricus.

Ans. The characteristics of Agaricus are:

1. Agaricus is terrestrial saprobes and cosmo pollutant in distribution.
2. Agaricus is an edible gilled fungus. It is rich in cellulose and lignin materials.
3. The vegetative body of Agaricus is mycelium produced by Basidiospore.
4. It consists of uninucleate, septate hyphae called as primary mycelium and grows below the soil.
5. The two different (+strain & - strain) hyphae of primary mycelium fuse to form secondary mycelium.
6. The hyphae of the sec. mycelium are interwoven compactely to produce the basidiocarp or fruit body above the soil. It is edible.
7. Fruiting body consists of a stalk called as stipe and large circular umbrella like structure called as Pileus.
8. The basidiospore germinates to produce the primary mycelium.

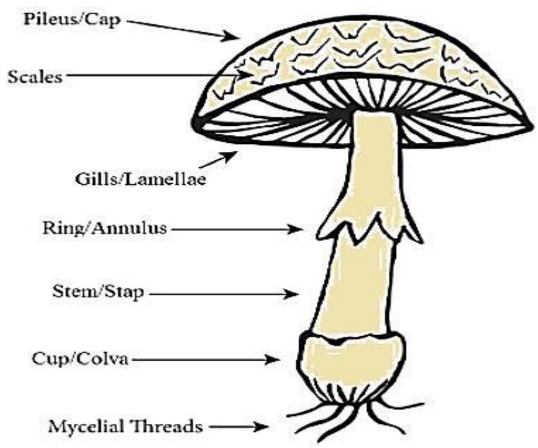
40. Draw a well labelled diagram of a mature basidiocarp of Agaricus.

Ans. The hyphae of the sec. mycelium are interwoven compactely to form rope like structure called as rhizomorph.

This rhizomorph produced the basidiocarp or fruit body above the soil. It is edible.

Fruiting body consists of a stalk called as stipe and large circular umbrella like structure called as Pileus.

The stipe is cylindrical and pinkish white in colure. Stipe has a ring like structure called as annulus.



Part – B

Long answer type questions :

1. Describe the general characters of Bryophytes.

Ans. Bryophyta is a Greek word (bryos = moss, phyton plant) which includes simple and primitive plants. In the plant world, they are placed between Thalophyta (algae) and Pteridophyta.

The word Bryophyta was first used by Bran (Braun) in 1864 and Shimper gave this plant group level in 1879.

These plants are found in both aquatic and terrestrial; hence they are also called plant amphibians.

Salient features / General Characters of Bryophytes: -

The following common characters are found in the plants of the Bryophyta group:

1. Bryophyta is a primitive terrestrial plant found in moist, damp and shady places.
2. The life cycle contains a clear gametophytic and sporophytic phases, which are heteromorphic.
3. The main plant body is Thalloid (gametophytic), is more clear, perineal, self -determined and green while the sporophytic are short -lived and dependent on a gametophytic.
4. Gametophytic Thallus are, prostrate and erect or upwards and differentiated into rhizoids, axis, and leaves.
5. Thallus lack of mechanical tissue and vascular system xylem, phloem and other lignin.
6. The gametophyte bears multicellular sex organs and is photosynthetic.
7. The reproduction is from the vegetative and sexual methods.
8. The vegetative reproduction occours by Decay and Death of Old Parts of Thallus, by Adventitious Branches, or special types of structures like tubers, gemma, etc.
9. Sexual reproduction is of advanced and oogamous type.
10. Sexual reproductive organ (Antheridium: Male gametangia, Archegonium: Female gametangia) are multicellular and jacketed.
11. The antheridium produces antherozoids (male gametes), which are flagellated.
12. The archegonium is a sort of a flask shape and produces one egg (Female gametes).
13. Fertilization is internal. Water is necessary for fertilization.
14. The zygote immediately develops into a multicellular Embryo (sporophyte).
15. The sporophytes are usually differentiated into the foot, seta and Capsule.
16. The sporophyte is semi-parasitic and dependent on the gametophyte for its nutrition.
17. In the capsule many sporogenous cells are formed haploid Meiospores undergoes meiosis division. All spores are the same in size and format.
18. The spores are released by the bursting of the capsule wall. The spores are non-motile and dispersal by air.
19. By germination of meiospores which form a new gametophyte thallus.

2. Discuss evolution of sporophyte in bryophyte. Give suitable diagrams.

Ans. **Evolution of Sporophyte in Bryophytes**

Bryophytes, including **mosses**, **liverworts**, and **hornworts**, are non-vascular plants that exhibit a distinct evolutionary pattern of the **sporophyte** generation in their life cycle. Bryophytes have a dominant **gametophyte generation** and a relatively small, dependent **sporophyte** generation.

Here's an explanation of the evolution of the **sporophyte** in bryophytes:

1. General Life Cycle of Bryophytes

Bryophytes have a **haplodiplontic life cycle** (alternation of generations), where both the **haploid gametophyte** and **diploid sporophyte** generations occur. However, in bryophytes, the **gametophyte** is the dominant, independent phase, and the **sporophyte** is short-lived and dependent on the gametophyte for nutrition.

1. **Gametophyte** (haploid, dominant phase): This is the photosynthetic, green, and free-living phase of the plant, where the **gametes** (sperm and egg) are produced.
2. **Sporophyte** (diploid, dependent phase): The sporophyte grows directly from the fertilized egg (zygote) of the gametophyte. It is not independent but relies on the gametophyte for nutrients.

2. Evolution of the Sporophyte in Bryophytes

- **Early Bryophytes**: The earliest bryophytes had a simple, unicellular **sporophyte** that developed directly from the fertilized egg. The **sporophyte** was small, with very limited tissue differentiation. Early bryophytes likely had **haploid (n)** spores produced within a **sporangium** (spore-producing capsule).
- **Development of a Multicellular Sporophyte**: As evolution progressed, bryophytes developed a more complex **sporophyte**. The sporophyte became **multicellular**, with a more defined structure consisting of a **foot**, **seta**, and **capsule**. The **foot** is embedded in the gametophyte, absorbing nutrients. The **seta** is the stalk that supports the spore-producing capsule, which contains the **sporangium**.
- **Structure of the Sporophyte**:
  1. **Foot**: The foot anchors the sporophyte to the gametophyte and absorbs nutrients from it.
  2. **Seta**: The seta is the stalk that elevates the sporangium, allowing spores to disperse.
  3. **Capsule**: The capsule is where **meiosis** occurs, producing **haploid spores**. The capsule is the reproductive structure where **sporogenesis** takes place.
- **Sporophyte and Gametophyte Interdependence**: The sporophyte in bryophytes is not fully independent, unlike in higher plants. The sporophyte's development depends on the gametophyte for nutrition, and it cannot survive without the gametophyte.
- **Evolutionary Adaptations**:
  - As bryophytes evolved, their sporophytes became more specialized for **spore production** and **dispersal**.
  - The development of a **seta** and a more complex **capsule** allowed for efficient spore release, enhancing the plant's reproductive success.
  - The **sporophyte** evolved to become more specialized for its role in producing spores for reproduction and dispersal.

3. With the help of labelled diagrams, describe the external and internal structure of the thallus of Marchantia.

Ans. External structure of Gametophyte Thallus:

The plant body is haploid, gametophytic, thalloid, flat, dorsiventral, dichotomously branched.

1. Dorsal surface of thallus:

- Dorsal surface is bright dark green.
- A shallow groove marked by the presence of a distinct midrib in each branch.
- A number of polygonal areas called areolae which re-presents the underlying air chamber.
- The midrib ends in a depression at the apical notch in which growing point is situated.
- Dorsal surface also bears the vegetative (gemma cup) and sexual reproductive structures.

2. Ventral surface of thallus:

The ventral surface of the thallus bears scales and rhizoids along the midrib.

The scales are membranous, multicellular, one-cell thick, usually violet in colour due to the presence of anthocyanin pigments.

Morphologically, the scales are of two types — appendiculate and ligulate.

The main functions of the scales are to protect the growing point of the thallus from desiccation and provide mechanical support.

The Rhizoids are unicellular, colourless, branched and develop as prolongation of the lower epidermal cells. They are of two types: (i) Smooth-walled rhizoids and (ii) Tuberculate rhizoids.

The main functions of the rhizoids are to anchor the thallus on the substratum and to absorb water and mineral nutrients from the soil.

Internal structure of the Gametophyte Thallus:

A vertical cross section of the thallus can be differentiated into upper photosynthetic region and lower storage region.

I- Photosynthetic region:

- The outer most layer is called upper epidermis.
- Its cells are thin walled square, compactly arranged and contain few chloroplasts. Its continuity is broken by the presence of many barrel shaped air pores. Each pore is surrounded by four to eight superimposed tiers of concentric rings with three to four cells in each tier.
- The opening of the pore looks star like in the surface view.
- Just below the upper epidermis photosynthetic chambers are present in a horizontal layer.
- Each air pore opens inside the air chamber and helps in exchange of gases during photosynthesis.

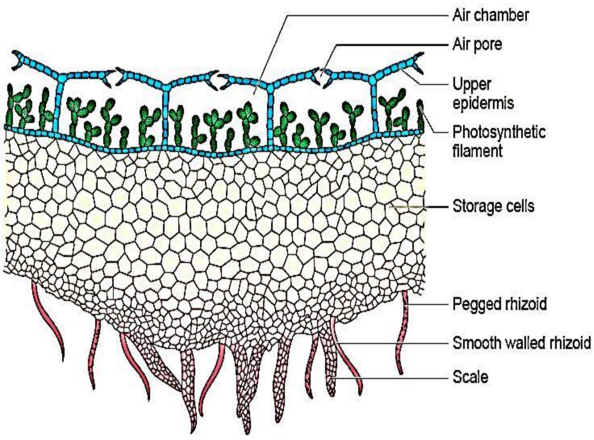


Figure 2.13: T.S. of Thallus

- These air chambers develop schizogenously and each are separated by single layered partition walls.
- The partition walls are two to four cells in height. Cells contain chloroplast.
- Many simple or branched photosynthetic filaments arise from the base of the air chambers.

II- Storage region:

- It lies below the air chambers.
- It consists of several layers of compactly arranged, thin walled polygonal parenchymatous, isodiametric cells. Intercellular spaces are absent.
- The cells of this zone contain starch. Some cells contain oil body or filled with mucilage.
- It is more thickened in the centre and gradually tapers towards the margins.
- The cells of the midrib region possess reticulate thickenings.
- The lower most cell layer of the zone forms the lower epidermis.
- Some cells of the middle layer of lower epidermis extend to form both types of scales and rhizoids.

4. Write detail notes on Marchantia Gemma cup.

Ans. Marchantia Gemma cup :

- The most common method of vegetative propagation is by specialised asexual multicellular bodies, known as gemmae.
- They are borne in large numbers in small receptacles called gemma cups present on the dorsal surface of the thallus in the midrib region.
- A gemma cup is about 2 mm in diameter and 3 mm in height, the margins of which are hyaline, lobed, spinuous or entire.
- **V. S. passing through the gemma cup shows that it is well differentiated into two regions:**

- Upper photosynthetic region and inner storage region.
- The structure of both the zones is similar to that of the thallus.
- Many small stalked gemmae develop on the floor of the gemma cup. Each gemma is vertically attached to the base of the gemma cup by a one-celled stalk.
- The gemmae are multicellular, biconvex, discoid bodies constricted at the middle. The two notches in the constriction possess a row of apical cells showing two growing points.

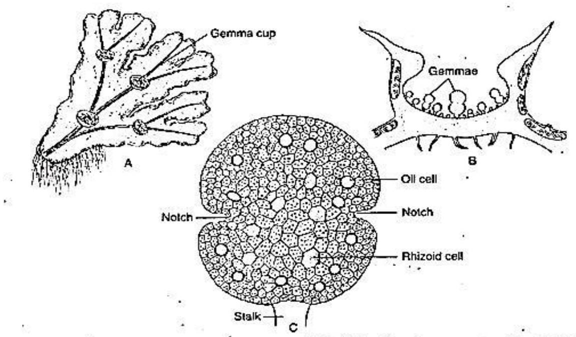


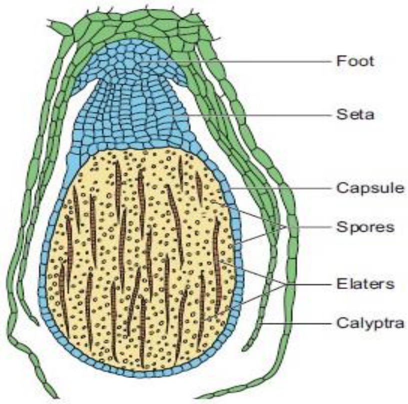
Fig. 6.11 : *Marchantia* : A. Thallus showing gemma cups. B. Vertical section of a gemma cup showing gemmae. C. A single gemma highly magnified

- Most of the cells of gemma contain chloroplastids but some superficial cells in either sides may be colourless, containing oil bodies. Some club- shaped mucilage hairs are present on the floor of the cupule. The mucilage secreted by these hairs imbibes water and the pressure thus generated causes the gemmae to disseminate from the stalks.
- The detached gemma germinates after falling on a suitable substratum. Some colourless superficial cells larger than the neighbouring cells having dense and granular cytoplasm are called rhizoidal cells. These cells on the lower face of the gemma develop rhizoids.
- Subsequently, the apical cells present in the two notches grow to develop two thalli of new independent plants in opposite direction. Usually, the gemmae present on the male thallus produce male plants and those on the female thallus form female plants.

5. Describe the structure of sporophyte in Marchntia with diagrams.

Ans. A mature sporogonium can be differentiated into three parts, viz., the foot, seta and capsule.

1. **Foot:** It is bulbous and multicellular. It is composed of parenchymatous cells. It acts as anchoring and absorbing organ. It absorbs the food from the adjoining gametophytic cells for the developing sporophyte.
2. **Seta:** It connects the foot and the capsule. At maturity, due to many transverse divisions it elongates and pushes the capsule through three protective layers viz., calyptra, perigynium and perichaetium.
3. **Capsule:** It is oval in shape and has a single layered wall which encloses spores and elaters.



❖ **Structure of Spore:**

Spores are very small, haploid, uninucleate, globose and surrounded by only two wall layers.
The outer well layer is thick, smooth or reticulate and is known as exospore or exine.
The inner wall layer is thin and is called endospore or intine. Spores are tetrahedrally arranged.

6. Wite detail notes on V.T.S of thallus of Anthoceros.

Ans. Morphology \External Features of the Gametophyte Thallus: -

- The gametophytic plant body is thalloid, dorsiventral, prostrate, dark green in colour with a tendency towards dichotomous branching.
- Such branching results into an orbicular or semi orbicular rosette like appearance of the thallus.
- The thallus is bilobed (A. Himalayensis or pinnately branched (A. hallii).

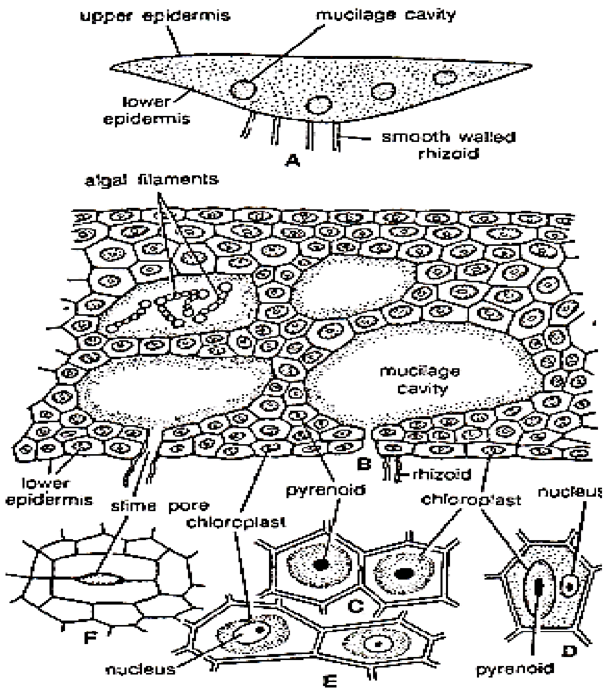
Dorsal Surface of thallus: -

- The dorsal surface of the thallus is dark green in colour with a tendency towards dichotomous branching.
- The dorsal surface of the thallus may be smooth or rough with spines and ridges.
- It is shining, thick in the middle and without a distinct mid rib.
- Dorsal surface also bears the vegetative (gemma cup) and sexual reproductive organs.
- The mature thalli have erect, elongated and cylindrical sporogonia. These are horn like structure and arise in clusters.

Ventral Surface of thallus: -

- The ventral surface bears many unicellular, colourless, smooth-walled rhizoids.
- Developed as prolongation of the lower epidermal cells.Their main function of the rhizoids are to anchor the thallus on the substratum and to absorb water and mineral nutrients from the soil.
- Tuberculated rhizoids, scales or mucilaginous hairs are absent.
- Many small, opaque, rounded, thickened dark bluish green spots can be seen on the ventral surface. These are the mucilage cavities filled with Nostoc colonies.

Anatomy / Internal feature of the Gametophyte:



- The vertical transverse section (V. T. S.) of the thallus shows a very simple structure.
- The upper most layer is composed of thin walled parenchymatous cells known as upper epidermis.
- The epidermal cells are regularly arranged, smaller in size and have large lens shaped chloroplasts.
- Each cell of the thallus contains a single large discoid or oval shaped chloroplast.
- Each chloroplast encloses a single, large, conspicuous body called pyrenoid, a characteristic feature of class Anthocerotopsida.
- The nucleus lies in the close vicinity of the chloroplast near the pyrenoid.
- The air chambers and air pores are absent in Anthoceros.
- In Anthocerosintercellular cavities are formed (schizogenous) on the lower surface of the thallus.
- The cavities are filled with mucilage and are called mucilage cavities.
- These cavities open on the ventral surface through stoma like slits or pores called slime pores.
- Each slime pore has two guard cells with thin walls, but are non-functional and the pore remains completely open.
- The blue green algae Nostoc invades these mucilagecavities through slime pores and forms a colony. It is a symbiotic association.
- The presence of Nostoc colonies in the thallus of Anthoceros is beneficial for the growth of gametophyte is not definitely known.
- The thallus supplies carbohydrates to the Nostoc and the latter, in turn, adds to nitrate nutrients by fixing atmospheric nitrogen.
- The lower most layers are composed of thin walled parenchymatous cells known as lower epidermis.
- Some cells of the lower epidermis extend to form the smooth-walled rhizoids.

7. Describe the structure of mature sporophyte of Anthoceros with suitable diagram.

Ans. Mature sporophyte of Anthoceros :

The mature sporophyte consist a bulbous foot and a smooth, slender, erect, cylindrical, structure called capsule.

- The sporogonium appears like a **'bristle'** or **'horn'**, hence; the species are called 'hornworts'.
- A mature sporogonium can be differentiated into three parts viz.,

(I) The Foot (II) The Meristematic Zone (III) The capsule.

(I) TheFoot: -

- It is bulbous, multicellular and made up of a mass of parenchymatous cells.
- It acts as ac haustorium and absorbs food and water from the adjoining gametophytic cells for the developing sporophyte.

(II) The Meristematic Zone: -

- This is present at the base of the capsule and consists meristematic cells. These cells constantly add new cells to the capsule at its base. The presence of meristem at the base enables the capsule to grow for a long period and form spores. *(It is a unique feature of Anthoceros in bryophyte*)

(III) The Capsule: -

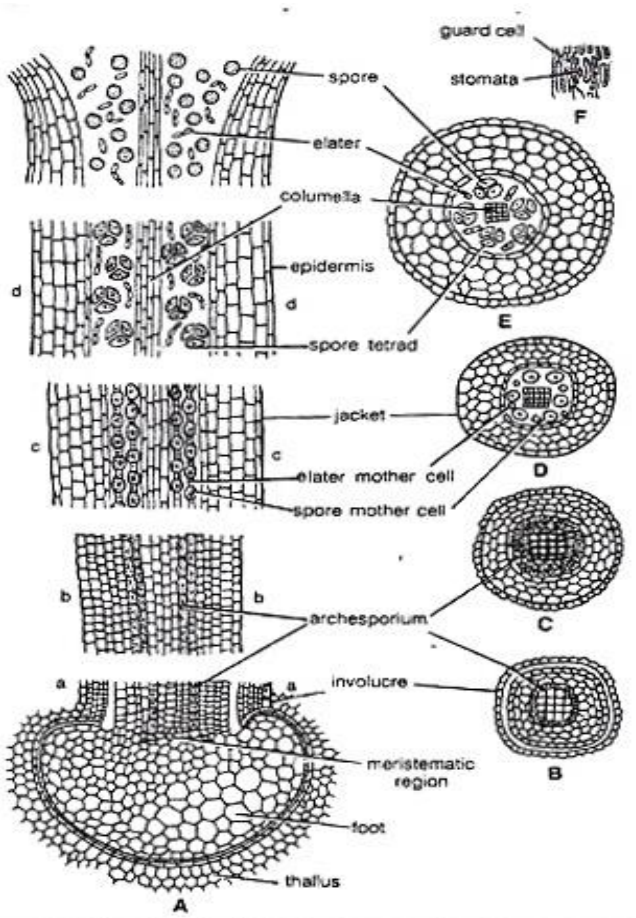
- Its internal structure can be differentiated into following parts:-

(i) Columella: -

- It is central sterile pan, extending nearly to its tip. In young sporophyte it consists of four vertical rows of cells but in mature sporophyte it is made up of 16 vertical rows of cells (4 x 4).
- It provides mechanical support, functions as water conducting tissue and also helps in dispersal of spores.

(ii) Archesporium: -

- It is present between the capsule wall and the columella.
- In upper part of the capsule it is differentiated into sporogenous tissue which produces spores and pseudo elaters.
- Pseudo elaters may be unicellular or multicellular, branched or un-branched and may consists more or less elongated cells. The spiral thickenings are absent (characteristic of Anthoceros).
- *(The elaters are without thickening bands and therefore, called pseudo elaters)*



(iii) Capsule wall: -

- It consists of four to six layers of cells, of which the outermost layer is epidermis.
- The cells of the epidermis are vertically elongated and have deposit of cutin on their walls.
- The continuity of epidermis is broken by the presence of stomata.
- The cells of the inner layers have intercellular spaces and contain chloroplast.

Dehiscence of the capsule: -

- As the capsule matures, its tip becomes brownish or black. Vertical lines of dehiscence appear in the jacket layer. The dehiscence of the capsule is usually by two longitudinal lines, occasionally it is by single line or rarely by four lines. The capsule wall dries and shrinks at maturity.

Structure of Spore: -

- The spores are haploid, uninucleate, semicircular with a conspicuous triradiate mark.
- Each spore remains surrounded by two wall layers.
- The outermost layer is thick ornamented and is known as exospore.
- The inner layer is thin and is known as endospore. Wall layers enclose colourless plastids, oil globules and food material.

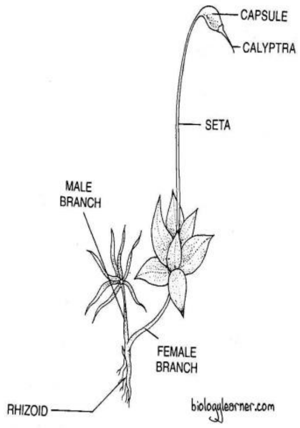
8. Write detail notes on L.S. of Funaria sporophyte / capsule.

Ans. Zygote is the first cell of the sporophytic phase. Development of sporophyte takes place within the venter of the archegonium.

The sporophyte is semi-parasitic in nature.

The mature sporophyte can be differentiated into three distinct parts—

Foot, Seta and **Capsule**.



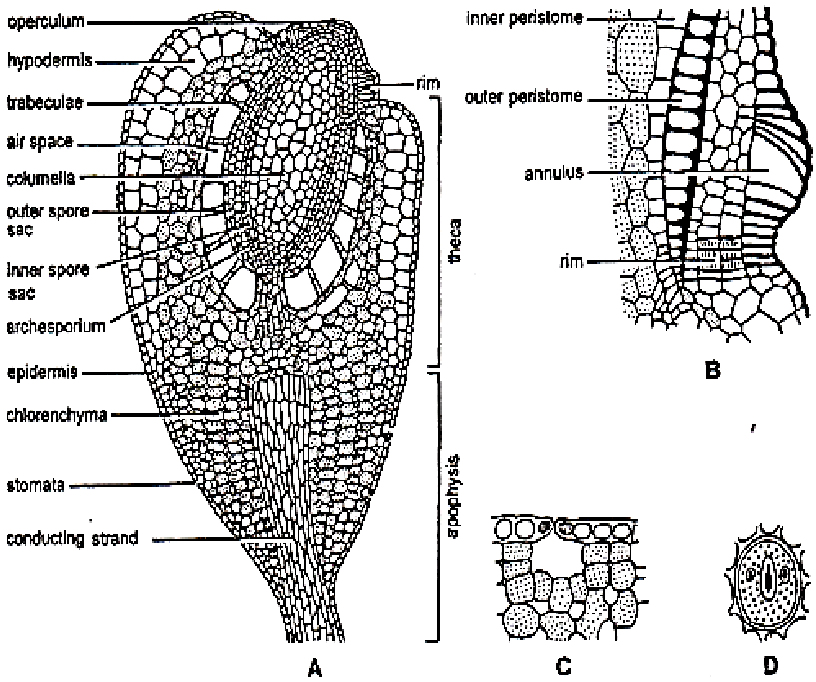
(i) Foot:- It is the basal portion of the sporogonium. It is small dagger like c onical structure embedded in the apex of female branch. It functions as anchoring and absorbing organ.

(ii) Seta:- It is long, slender, stalk like hygroscopic structure. It bears the capsule at its tip.

- It is mechanical in function and also conducts the water and nutrients to the developing capsule.

(iii) Capsule:

- It is the terminal part of the sporophyte and is developed at the apex of the seta.
- It is green in colour when young but on maturity it becomes bright orange coloured.
- It is covered by a cap like structure called calyptra.
-



Internal Structure of the Capsule:

- Longitudinal Section (L.S.) of the capsule shows that it can be differentiated into three distinct regions- **Apophysis, Theca** and **Operculum.**

1. **Apophysis:**
   - It is the basal sterile part of the capsule.
   - It is bounded by the single layered epidermis which is interrupted by stomata.
   - The sotmata have single ring like guard cells.

- Below the epidermis is spongy parenchyma. The central part of the apophysis is made up of elongated thin walled cells forming a conducting strand.
- It is called neck of the capsule. It is the photosynthetic region and connects seta with capsule.

2. **Theca:**
   - It is the middle, slightly bent spore bearing region of the capsule.
   - It lies between the apophysis and operculum.

Longitudinal section passing through the theca shows the following regions:

(i) Epidermis: It is the outer most layer. It is single layered with or without stomata.

(ii) Hypodermis: It is present below the epidermis. It consists two to three layers of compactly arranged colourless cells.

(iii) Spongy parenchyma: It is present inner to hypodermis and consists of two to three layers of loosely arranged chlorophyllous cells.

(iv) Air spaces: These are present just below the spongy parenchyma and outside the spore sacs. Air spaces are traversed by green cells (chlorenchymatous cells) called trabecular (elongated parenchymatous cells).

(v) Spore sac: These are present below the air spaces on either side of the columella.

- It is 'U' shaped and broken at the base. It has an outer wall (3-4 cells thick) and an inner wall (single cell in thickness). Between the outer wall and inner wall is the cavity of the spore sac.
- When young, the cavity of the spore sac is filled with many spore mother cells.
- At maturity the spore mother cells divide by meiotic divisions and form many haploid spores.

(vi) Columella: It is the central part of the theca region.

- It is made up of compactly arranged colourless parenchymatous cells.
- It is wide above and narrow below, connecting the central strand of apophysis.
- It helps in conduction of water and mineral nutrients.

3. **Operculum:**
   - It is the upper region of the capsule. It is dome shaped and consists four to five layers of cells.
   - Operculum is differentiated from theca by a well-marked constriction.
   - Just below the constriction there is a diaphragm (rim).
   - It is composed of two to three layers of radially elongated pitted cells.
   - Immediately above the rim is annulus which consists of 5-6 superimposed layers of cells.
   - Annulus separates the theca from the operculum. Below the operculum lies the peristome.
   - It is attached below to the edge of the diaphragm.
   - The peristome consists of two rings of radially arranged peristomial teeth.
   - In each ring there are sixteen teeth. The teeth are not cellular but they are simply the strips of the cuticle. The teeth of the outer ring are conspicuous, red with thick transverse bands while the teeth of the inner ring are small, delicate and colourless and without transverse bands.
   - Inner to peristome teeth lays a mass of thin walled parenchymatous cells.

9. Write detail notes on Economic importance of Bryophytes.

Ans. We can study their economic importance under the following heads:

1. Ecological Importance:

(a) Pioneer of the land plants- Bryophytes are pioneer of the land plants because they are the first plants to grow and colonize the barren rocks and lands.

(b) Soil erosion. Bryophytes prevent soil erosion- They usually grow densely and hence act as soil binders. Mosses grow in dense strands forming mat or carpet like structure.

They prevent soil erosion by:

(i) Bearing the impact of falling rain drops

(ii) Holding much of the falling water and reducing the amount of run-off water.

(c) Formation of soil- Mosses and lichens are slow but efficient soil formers. The acid secreted by the lichens and progressive death and decay of mosses help in the formation of soil.

(d) Bog succession- Peat mosses change the banks of lakes or shallow bodies of water into solid soil which supports vegetation e.g., Sphagnum.

(e) Rock builders- Some mosses in association with some green algae (e.g., Chara) grow in water of streams and lakes which contain large amount of calcium bicarbonate. These mosses bring about decomposition of bi-carbonic ions by abstracting free carbon dioxide. The insoluble calcium carbonate precipitates and on exposure hardens, forming calcareous (lime) rock like deposits.

2. Formation of Peat:

Peat is a brown or dark colour substance formed by the gradual compression and carbonization of the partially decomposed pieces of dead vegetative matter in the bogs. E.g. Sphagnum etc.

Various Uses of Peat are:

(a) Used as fuel in Ireland, Scotland and Northern Europe.

(b) In production of various products like ethyl alcohol, ammonium sulphate, peat, tar, ammonia, paraffin, dye, tannin materials etc.

(c) In horticulture to improve the soil texture.

3. As Packing Material:

Dried mosses and Bryophytes have great ability to hold water. Due to this ability the Bryophytes are used as packing material for shipment of cut flowers, vegetables, perishable fruits, bulbs, tubers etc.

4. As Bedding Stock:

Because of great ability of holding and absorbing water, in nurseries beds are covered with thalli of Bryophytes.

5. In Medicines:

Some Bryophytes are used medicinally in various diseases for e.g.,

(a) Pulmonary tuberculosis and affliction of liver—***Marchantia polymorpha*** spp.

(c) Acute hemorrhage and diseases of eye—Decoction of Sphagnum.

(d) Stone of kidney and gall bladder—***Polytrichum commune***.

(e) Antiseptic properties and healing of wounds—Sphagnum leaves extracts of some Bryophytes for e.g., Conocephalum conicum, Dumortiera, Sphagnum protoricense, S. strictum show antiseptic properties.

6. In Experimental Botany:

The liverworts and mosses play an important role as research tools in various fields of Botany such as genetics. For the first time in a liverwort, Sphaerocarpos, the mechanism of sex determination in plants was discovered.

7. As Food:

Mosses are good source of animal food in rocky and snow-clad areas.

Some Bryophytes e.g., mosses are used as food by chicks, birds and Alaskan reindeer etc.

8. Other uses:

Some bryophytes act as indicator plants. For example, *Tortell tortusa* grow well on soil rich in lime.

10. Give the detailed characteristics of fungi.

Ans. Introduction –

- Fungi (singular fungus) (derived from the Greek word mushroom) are thallophytic plants that are heterophytes, i.e., they rely on others for food because they lack chlorophyll.
- They can be found in various environments and exhibit a wide range of anatomy, physiology, and reproduction.
- The fungi kingdom includes eukaryotic organisms, like yeasts, moulds, and mushrooms. These organisms are omnipresent, have a cell wall, and are categorised as heterotrophs.
- More than 5,000 genera and 50,000 species of fungi have been identified. Mycology (derived from ***mykes*** means mushroom and ***logos*** means to study) is the study of fungi, and the scientist who studies them is a mycologist.

General Characteristics of Fungi:

1) Fungi can grow at any place where life is possible, thus are cosmopolitan in distribution.
2) Due to the lack of chlorophyll, they are heterotrophic in nature. They can be parasites, saprophytes, or symbionts depending on their mode of nutrition.
3) Their plant body is unicellular (Synchytrium, Saccharomyces) or filamentous (Mucor, Aspergillus).
4) The filament is termed as hypha (plural - hyphae) and its entangled mass is mycelium. The hypha can be aseptate, i.e., coenocytic (lack's septa and is multinucleated) or septate. The septate mycelium in its cell might have only one (monokaryotic), two (dikaryotic), or more nuclei.
5) Various types of pores, such as micropore (Geotrichum), simple pore (most of the Ascomycotina and Deuteromycotina), or dolipote (Basidiomycotina, except rusts and smuts), can be found in the septa between the cells.
6) Cells are enclosed by a distinct cell wall (except slime moulds), composed of chitin (fungal cellulose); but the cell wall of some lower fungi (members of Oomycetes) is made up of cellulose or glucan.
7) Due to lack of chlorophyll, the cell protoplasm is colourless, contains nucleus, mitochondria, endoplasmic reticulum, microbodies, etc. nbosomes, vesicles,
8) Cells are haploid, dikaryotic, or diploid (short-lived).
9) Lower fungi (Mastigomycotina) have uni or biflagellate reproductive cells (zoospores and gametes) with whiplash or tinsel flagella.
10) Motile cells never form in higher fungi (Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina).
11) Due to the functional need, the fungal mycelia are transformed into different types, like plectenchyma, stroma, rhizomorph, sclerotium, hyphal trap. appressorium, haustorium, etc.
12) Holocarpic fungi (e.g., Synchytrium) are unicellular in which the entire plant body is turned into a reproductive unit. Eucarpic fungi (e.g.. Pythium, Phytophthora) are those in which only a part of the mycelial plant body is converted into reproductive unit.
13) They reproduce by vegetative, asexual and sexual methods.

11. Write detailed notes on Heterothallism in Fungi.

Ans. F. Blakeslee, an American Geneticist, in 1904 made an important observation with Mucor.

He observed, that while some isolates of Mucor formed sporangia as well as zygospores (e.g., M. tenuis), some others failed to form the zygospores and reproduced only by sporangiospores.

When he grew these non-sexually reproducing isolate with other similar isolates, zygospores appeared in the region where the hyphae of the different isolates came in contact with each other.

Blakeslee coined the terms homothallism and heterothallism to explain this phenomenon.

1. **Homothallic fungi** - Those which used to produce zygospores independently, in such fungal members each mycelium is self fertile in terms of sexuality, that is the fertile nuclei of both the strains are present on the same mycelium. Therefore, it does not require any other hyphae to carry out sexual reproduction.

2. **Heterothallic fungi** - In this type of fungal members, the presence of opposite mating type was required, that is each mycelium holds the fertile nucleus of only one variety, hence here another mycelium or hyphae was required for sexual reproduction. Therefore, such mycelium is called self sterile.

Since the two mating types were morphologically indistinguishable, Blakeslee designated them as the (+) and (-) mating types or strains (not male or female).Eg. Mucor, Rhizopus sps. etc.

On the basis of the distribution of sex organs, fungi can be put in the following categories:

1. **Monoecious / Hermaphrodite -**
   - In which both male and female sex organs occur on the same thallus. A hermaphroditic fungus having both the sex organs may be homothallic or heterothallic. When the two sex organs, present on the same mycelium, are unable to mate, this is because of self-sterility and is called physiological heterothallism.
   - Such fungi need genetically-different nuclei, which does not occur when the same thallus forms both the sex organs.
2. **Dioecious (sexually dimorphic) –**
   - The two sex organs are present on different thalli.
   - The dioecious fungi, in which the male and the female sex organs are borne on different thalli are, by necessity, heterothallic. This is called morphological heterothallism. In this case, heterothallism is made obligatory because the opposite and morphologically distinct sex organs are formed only on different thalli.
3. **Sexually undifferentiated –**
   - The male and female sex organs are morphologically similar and, therefore, indistinguishable e.g., Mucor, Rhizopus, and several members of Asco-and Basidiomycota, do not have morphologically distinguishable sex organs.
   - These can also be homo or heterothallic. The heterothallic forms provide another example of physiological heterothallism. The requirement for the other thallus does not lie in morphologically distinct sex organs, but in genetically-different nuclei which are not available in the same mycelium.

12. Write detailed notes on Heterokaryosis in Fungi.

Ans. Heterokaryosis is the main source of variation in the anamorphic (imperfect) fungi, which lack sexual reproduction. The term Heterokaryosis was proposed by Hansen and Smith in 1932, who reported it for the first time in Botrytis cinerea.

- The presence of genetically-different nuclei in an individual is called heterokaryosis, and the organism heterokaryon. Essentially, a heterokaryon possess two sets of chromosomes, just like a diploid organism, but instead of being contained in a single nucleus, the two sets of chromosomes lie in separate nuclei, sharing the same cytoplasm.
- Heterokaryons show dominance and, thus, resemble diploids in many respects. Heterokaryosis is a major factor in natural variability and sexuality.
- The heterokaryotic condition can arise in a fungus by three methods, viz.,
  - Mutation, (2) Anastomosis i.e., fusion between genetically-different hyphae
  - Diplodization-fusion between haploid nuclei to form diploid nuclei.
- Mutations occur frequently in fungi, and a homokaryotic mycelium is frequently converted into a heterokaryotic one. Anastomosis between spores and hyphae is a universal feature of higher fungi and certainly must be a potential source of heterokaryosis and, thus, of variability. Whether nuclei migrate

from one thallus to another is a debated point but the hyphae having nuclei of both parents arise at the point of fusion. Heterokaryosis is often accompanied by parasexual cycle.

13. Write detailed notes on Parasexuality in fungi.

Ans. Until 1944, the sexual cycle was the only means of exchange of genetic material. It is to the credit of microbial geneticists that a series of novel methods of genetic recombination are now known in bacteria, which do not involve karyogamy and meiosis.

These are transformation, conjugation, transduction, lysogeny, and sexduction which differ from the standard sexual cycle.

A similar alternative to sexual reproduction was discovered in the imperfect fungus, Aspergillus nidulans, in 1952 by Pontecorvo and Roper of Glasgow.

They called this parasexual cycle. In this, genetic recombination occurs in somatic cells by the mechanism of mitotic crossing over, which brings the same result as is achieved by the meiotic crossing over.

The parasexual cycle involves the following steps:

1. Formation of heterokaryotic mycelium.
2. Nuclear fusions and multiplication of the diploid nuclei.
3. Mitotic crossing over during division of the diploid cells.
4. Sorting out of the diploid strains.
5. Haplodization.

1. Formation of Heterokaryotic Mycelium:

The methods of formation of heterokaryotic mycelium are described earlier under ‘heterokaryosis.’

2. Nuclear Fusions and Multiplication of the Diploid Nuclei:

Nuclear fusion in somatic heterokaryotic hyphae was first noted by Roper (1952) in Aspergillus nidulans. Nuclear fusion may occur between genetically similar and dissimilar nuclei, resulting in the formation of homozygous and heterozygous diploid nuclei, respectively. Diploid heterozygous nuclei are formed very rarely (at a frequency of one in a million). In such hyphae, five types of nuclei are present- 2 types of haploid nuclei, their two types of homozygous diploids, and the one type of heterozygous diploids.

3. Mitotic Crossing Over:

Crossing over is a phenomenon which occurs during meiosis and gives rise to new linkage of genes, gene recombination. However, mitotic crossing over was discovered in 1936 by Stern in Drosophila. A similar mitotic crossing over occurs during the multiplication of the diploid heterozygous nuclei, though at a low frequency of 10^{-2} per nuclear division.

However, in some other fungi e.g., Penicillium chrysogenum and Aspergillus niger, the frequency of mitotic crossing over is as high as during meiosis in sexual reproduction. (Both species lack sexual reproduction.) Mitotic crossing over is the most important, or ‘key’ event in the parasexual cycle, as it is during this step that genetic recombination occurs.

4. Sorting Out of Diploid Strains:

The segregation of the diploid strains occurs when uninucleate diploid conidia are formed. The colonies that are formed by diploid conidia are recognized by various methods, e.g., higher DNA content and bigger (1.3 times) size of the conidia and certain phenotypic characters of the colony.

5. Haplodization:

The diploid colonies show appearance of sectors on the Petri plate, which produce haploid conidia. This indicates that some diploid nuclei must have undergone haplodization, forming haploid nuclei, which later get sorted out in haploid conidia. Some of these haploids are genetically different from the original haploid parental nuclei. This is because of the recombination that occurred during the mitotic crossing over.

Haplodization occurs at a constant frequency of 10^{-3} per nuclear division. The haplodization occurs not by a reduction division (meiosis), but by aneuploidy, a phenomenon in which chromosomes are lost during mitotic divisions. It happens in the following manner. During mitosis of the diploid nucleus, the chromatids fail to separate (non-disjunction) in the anaphase stage.

One daughter nucleus gets one chromosome more (2n + 1), while the other gets one chromosome less (2n – 1) than the normal 2 sets of chromosomes (2n). Both the daughter nuclei are called aneuploidy. The deficient aneuploid nucleus (2n – 1) may lose more chromosomes in the successive mitotic division and finally reduce to haploid state (n).

Mitotic crossing over and haplodization also occur with the diploid homozygous nuclei, but since the two nuclei are similar, crossing-over products or the haploid nuclei formed by haplodization, are genetically no different from the haploid parent nuclei.

The parasexual cycle, thus, like the sexual cycle, involves plasmogamy, karyogamy and haplodization, but not at a specified time or place. Every step differs drastically.

14. Write detailed notes on Nutrition in fungi.

Ans. The fungi utilise both organic compounds and inorganic materials as the source of their nutrient supply. Lacking chlorophyll the fungi are unable to photosynthesize or use carbon dioxide to build up organic food materials.

- They are, thus heterotrophic for carbon (organic) food compounds which they in their natural habitats obtain by living as saprophytes or parasites from dead or living plants, animals or micro-organisms or their wastes.
- Fungi store excess food in the form of glycogen or lipids.

❖ **Modes of Nutrition:**

- Fungi (singular fungus) are a scientific kingdom of organisms that are heterotrophs and play essential roles in how nutrients move through an ecosystem.
- To be heterotrophic means fungus lack of chlorophylls so, cannot make their own food (carbohydrate) like plants; instead, they absorb nutrients from their environment. These heteromorphs according to their method of obtaining food are divided into two categories, namely the parasites and the saprophytes.

(1) The Parasites fungus:–

- The fungal members that obtain their organic nutrition from the living tissues of various living body of a plants or animals (the host) are called parasitic fungi.
- Usually, due to the presence or infection of the parasite, the host becomes diseased, and is completely or partially destroyed.
- The fungal network of parasitic fungi is found on the outer surface of the host as an external parasite (ectoparasite), or in the intercellular or intracellularl parts of the host body as an endoparasite.
- Parasitic fungi absorb their food materials in the form of a solution by the help of special types of structures, which are called haustoria.

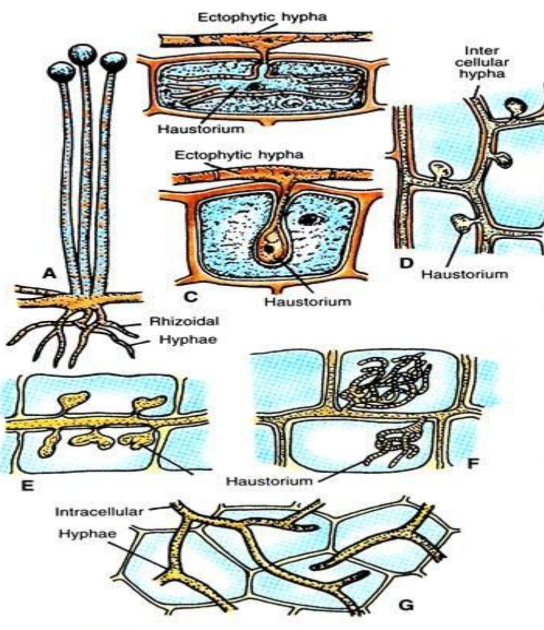


Fig. 1.15 (A–G). *Fungi*. Modes of Nutrition. Explanation in the text.

- Based on the nature of nutrition, mainly two types of parasitic fungi are found:-

A. Obligate parasites –

These parasitic fungi essentially use living protoplasm for their nutrition, and they cannot be grown on artificial saprophytic medium. If a suitable host is not available to them, their life cycle cannot be completed. Example - Sclerospora, Taplirina and Puccinia etc.

B. Facultative saprophytes –

Some fungal species normally live as parasites. But in some special circumstances, if a suitable host is not available, they can obtain their food as saprophytes from dead organic matter, such as Ustilago, Pythium and Rhizoctonia etc.

(2) Saprophytes Fungus:-

- The fungal members have the special ability to obtain their food from dead organic matter. The saprophytes cannot ingest solid food; they feed off decaying organic matter like wood, plants, and even dead animals.
- Saprophytic fungi are decomposers, feeding off decaying matter and helping break down the complex organic substances present in the medium into their simple and soluble form by exoenzymes secreted by the fungus are particularly active.
- Saprophytic fungi are found both in aquatic and terrestrial forms.
- like Mucor, Yeast, Chaetomium, Penicillium, Aspergillus, Pilobolus and Paziza.

On the basis of functioning of nutrition process, these saprophytic fungi can be divided into two categories –

(a) Obligate saprophytes –

These fungal species depend only on dead organic matter for their nutrition and are not capable of infecting plants or animals in their entire life cycle, i.e. they are not found as parasites in any situation. Examples - Mucor mucedo, Morchella, and Pilobolus etc.

(b) Facultative parasites –

Usually saprophytic fungi obtain their nutrition from dead organic matter. But under certain special circumstances, they also infect living plants and animals to make their living. For example - Rosellina, Rhizopus stolinifer and some species of Aspergillus and Penicillium.

(3) Symbiosis:–

Some fungal members obtain nutrition by living in mutually beneficial associations with other plants or their member species. This functional association is permanent and hence this type of alliance which is beneficial for both partners is called symbiosis.

The two best known examples of mutualisitc associations of fungi with other plants are lichens and Mycorrhiza etc.

❖ **In lichens association -**

symbiosis association of a fungus and an alga, the algae member (phycobiont) and the fungal member (mycobiont) live together as an alliance or represent a single model.

The fungus absorbs minerals in solution and water from the substratum and press on to the alga, the algae member synthesize food by photosynthesis and share it with its fungal partner. The lichen thallus provide shelter to the alga, in addition.

❖ **In mycorrhiza or mycorrhizae association** –

The symbiotic association between the hypha of certain fungi and roots of plants.

Exchange of water and nutrition is also observed between different trees or other vascular cryptogam's species, the roots of these plants form an association with fungal species.

Example, in Pinus and Orchids.

15. Describe the classification, general characteristics, structure and life cycle of Albugo.

Ans. **Albugo** is a genus of obligate parasitic fungi belonging to the family **Albuginaceae** in the order **Peronosporales**. These fungi cause a disease known as **white rust** in various plants, affecting crops such as cabbage, mustard, and other cruciferous plants. Below is an overview of its classification, general characteristics, structure, and life cycle.1. Classification of Albugo :

- **Kingdom**: Fungi
- **Division**: Oomycota (Water molds)
- **Class**: Oomycetes
- **Order**: Peronosporales
- **Family**: Albuginaceae
- **Genus**: Albugo

2. **General Characteristics of Albugo :**

- **Parasitic Nature**: Albugo is an obligate biotrophic parasite, meaning it depends on living host tissues for survival and reproduction.
- **Host Range**: It infects members of the Cruciferae (mustard) family, particularly crops such as mustard, cabbage, turnips, and other related plants.
- **Symptoms**: The disease caused by Albugo is known as **white rust**. It leads to the formation of white, powdery pustules on leaves, stems, and flowers. These pustules contain sporangia, which release zoospores to infect new plant tissues.
- **Growth Form**: Albugo fungi grow in the intercellular spaces of the host tissues, often forming swollen, blighted areas.

3. **Structure of Albugo :**

- **Mycelium**: The fungal mycelium is intracellular, meaning it grows within the host plant cells, although it does not penetrate the host cell wall. The mycelium is composed of aseptate (non-septate) hyphae, and it is largely undifferentiated.
- **Sporangia**: The most notable structures in the life cycle are the sporangia, which are produced in the pustules on the host's surface. These sporangia release **zoospores** during wet conditions.
- **Spore Production**:
    - **Asexual Spores (Zoospores)**: Albugo produces motile zoospores that are released into the environment from the sporangium. These zoospores swim in water and infect new plant tissues.
    - **Sexual Spores (Oospores)**: Albugo also produces oospores as part of its sexual reproduction, which are thick-walled spores that can survive harsh environmental conditions.

4. Life Cycle of Albugo :

The life cycle of *Albugo* involves both sexual and asexual phases, with the asexual cycle being more prominent in the disease spread.

Asexual Phase (Sporangium and Zoospore Formation)

1. **Infection**: The fungus starts by infecting the host plant through stomata or wounded tissue.
2. **Hyphal Growth**: Once inside the host, the mycelium grows through the plant tissues, leading to the formation of **pustules** on the surface of leaves, stems, or flowers.
3. **Sporangium Formation**: The mycelium produces sporangia inside the pustules. These sporangia contain zoospores.

4. **Zoospore Release**: Under moist conditions, the sporangia rupture, releasing **motile zoospores**. These spores swim in water or moisture and can infect new parts of the same plant or other nearby plants.
5. **Reinfection**: The zoospores enter the host plant tissues and repeat the cycle of infection.

Sexual Phase (Oospore Formation)

1. **Gamete Fusion**: In the sexual phase, two types of gametes (antheridia and oogonia) fuse to form a zygote.
2. **Oospore Formation**: The zygote develops into a thick-walled **oospore** inside the oogonium.
3. **Overwintering**: Oospores can survive in the soil or plant debris during unfavorable environmental conditions, such as during the winter. These oospores are resistant to desiccation and can remain viable for extended periods.
4. **Germination**: When conditions become favorable (usually with moisture and warmth), the oospores germinate to release new sporangia, starting the asexual cycle again.

16. Write an elaborative note on structure and life cycle of Rhizopus.

Ans. **Rhizopus** is a genus of fungi in the family **Rhizopodaceae**, belonging to the class **Zygomycetes**. It is a common saprophytic fungus and is known for causing a variety of diseases, including **mucormycosis** in humans, but also plays an important role in the decomposition of organic material. Additionally, **Rhizopus** species are used industrially in the production of fermented foods and biotechnological processes, such as the fermentation of soy products and the production of alcohol. Below is an elaborate description of the structure and life cycle of **Rhizopus**.

Structure of Rhizopus

Rhizopus species have a characteristic structure suited to their life as saprophytes and parasites. The structures of Rhizopus can be classified into vegetative and reproductive parts.

1. Vegetative Structure

- **Mycelium**:
  - **Non-septate Hyphae**: Rhizopus has a **coenocytic** (non-septate) mycelium, meaning that its hyphae do not have cross-walls (septa). The hyphae are multinucleate, containing many nuclei in a shared cytoplasm.
  - **Rhizoids**: Rhizopus hyphae produce **rhizoids**, which are root-like structures that anchor the mycelium to the substrate (e.g., decaying organic material). They also help in nutrient absorption.
  - **Stolons**: These are horizontal, creeping hyphal structures that spread across the surface, helping the fungus to colonize new areas.
- **Sporangium**:
  - **Spore-producing structure**: The sporangium is the structure that produces and holds the asexual spores. It is typically spherical and contains many spores that are released when the sporangium ruptures.
  - **Sporangiophore**: A specialized hypha, known as a **sporangiophore**, supports the sporangium. It is often erect, and its tip bears the sporangium.

2. Reproductive Structures

- **Asexual Reproduction**:
  - **Sporangium and Sporangia**: The sporangium releases asexual spores called **sporangia** that are typically dispersed by wind, water, or other means to find new substrates to colonize.

  - **Conidiophores (rare)**: In some species of Rhizopus, conidiophores may be present, which are another type of structure that can produce conidia (asexual spores), but this is less common than sporangial reproduction.
- **Sexual Reproduction**:
  - **Gametes**: In sexual reproduction, specialized structures called **gametangia** are formed at the tips of the opposite mating strains of Rhizopus. These gametangia contain the gametes (haploid cells).
  - **Zygospore**: After fertilization of the gametes, a thick-walled, resting structure called a **zygosporangium** forms. Inside, the two gametes fuse to form a **zygospor**e, which is a diploid structure that can survive unfavorable conditions.

Life Cycle of Rhizopus

The life cycle of **Rhizopus** involves both **asexual** and **sexual** reproduction. The asexual cycle predominates in most cases and leads to rapid colonization of a substrate, while the sexual cycle is used for survival and genetic recombination.

Asexual Reproduction:

1. **Germination of Spores**: The life cycle begins with the germination of **sporangia**, which contain many haploid spores (sporangia). When these spores are dispersed (usually by air), they land on suitable substrates, such as decaying organic matter, where they can germinate.
2. **Hyphal Growth**: Upon germination, the spores produce hyphae that spread across the substrate. The hyphae form a dense network known as the **vegetative mycelium**.
3. **Formation of Sporangia**: As the mycelium matures, specialized structures called **sporangiophores** grow upward from the mycelium. The sporangium develops at the tip of these sporangiophores, and within the sporangium, new haploid spores (sporangia) are formed.
4. **Spore Release**: When the sporangium matures, it bursts open, releasing the spores into the environment. These spores are dispersed by air, water, or contact and can germinate when they find a suitable substrate.

Sexual Reproduction:

1. **Gamete Formation**: Sexual reproduction begins when two compatible mycelia (from different mating types) come into contact. Specialized hyphal structures called **gametangia** form at the tips of each mycelium. Each gametangium produces haploid nuclei (gametes).
2. **Plasmogamy (Fusion of Gametes)**: The two gametangia fuse, leading to the merging of their cytoplasm. This fusion is called **plasmogamy**.
3. **Karyogamy (Fusion of Nuclei)**: After plasmogamy, the haploid nuclei from the two gametangia fuse to form a diploid nucleus, a process known as **karyogamy**. This forms a **zygosporangium**.
4. **Zygospore Formation**: Inside the zygosporangium, the diploid zygospore develops. The zygospore is a thick-walled, resistant structure that can withstand harsh environmental conditions, such as dryness or lack of nutrients. It is typically dark-colored and can survive for long periods.
5. **Meiosis and Germination**: When conditions become favorable, the zygospore germinates. Inside the zygosporangium, meiosis occurs, producing haploid spores. These spores germinate into new mycelium, completing the cycle.

Summary of Life Cycle

1. **Asexual Phase**: Involves the production of sporangia, which release a large number of haploid spores. These spores germinate to form new mycelium and repeat the cycle.
2. **Sexual Phase**: Occurs when two compatible mycelia meet, leading to the formation of gametangia. After plasmogamy and karyogamy, a zygospore is formed, which can survive unfavorable conditions. Upon germination, the zygospore undergoes meiosis to produce new haploid spores.