Biyani Girl's College

Concept Based Notes

DIVERSITY OF PLANT KINGDOM

BSC SEMESTER-I

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DEPARTMENT OF BOTANY

BIYANI GIRLS COLLEGE

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Preface

I am glad to present this book, especially designed to serve the needs of the students. The book has been written keeping in mind the general weakness in understanding the fundamental concepts of the topics. The book is self-explanatory and adopts the "Teach Yourself" style. It is based on question-answer pattern. The language of book is quite easy and understandable based on scientific approach.

Any further improvement in the contents of the book by making corrections, omission and inclusion is keen to be achieved based on suggestions from the readers for which the author shall be obliged.

I acknowledge special thanks to Mr. Rajeev Biyani,Chairman& Dr. Sanjay Biyani, Director (Acad.) Biyani Group of Colleges, who are the backbones and main concept provider and also have been constant source of motivation throughout this endeavour. They played an active role in coordinating the various stages of this endeavour and spearheaded the publishing work.

I look forward to receiving valuable suggestions from professors of various educational institutions, other faculty members and students for improvement of the quality of the book. The reader may feel free to send in their comments and suggestions to the under mentioned address.

Author

Syllabus

S.N.	Unit	Topic
1		**Algae**
	1.1	General Characters, Habitat
	1.2	Thallus structure, Reproduction
	1.3	Life cycle: Cyanophyaceae,Chlorophyaceae,Rhodophyaceae
		Fungi
	1.4	General characters, Thallus, Cell wall composition
	1.5	Heterokaryosis, parasexuality, Classification
	1.6	Reproduction, economic importance
		lichens: habitat, morphology and reproduction
2		**Bryophytes**
	2.1	General characters, habitat, thallus structure
	2.2	Classification, Reproduction
	2.3	Alternation of generation and economic importance
	2.4	Morphology, Anatomy, Reproduction and sporophytes of
	2.5	Marchantia, Anthoceros and Funaria.
3		**Pteridophytes**
	3.1	General characters, Classification, Economic importance
	3.2	Study of fossil pteridophytes: Rhynia
	3.3	Stelar system in pteridophytes
	3.4	Life histories of Selaginella, Marsilea
4		**Gymnosperms**
	4.1	General characters, Classification, Economic importance
	4.2	Life histories of Cycas and Ephedra
	4.3	Economic importance of gymnosperms

	 4.4 **4.5**	**Angiosperms** General Characters, Difference between monocot and dicot. Typical life cycle of Angiosperms.

Short Questions :

Ques.1 What is fungi?

Ans. Fungi are eukaryotic organisms that include microorganisms such as yeasts,moulds andmushrooms. These organisms are classified under kingdom fungi.

Ques.2 Write short notes on reverse food in algae?

Ans. The Reserve Food Material of Algae is starch. Algae reserves starch, laminarin, mannitol andFloridian starch as its food material.

Ques3. What is parasexuality in fungi?

Ans. Parasexuality is defined as a cycle in which Plasmogamy, Karyogamy and Meiosistake place in sequence but not at a specified time or at specified points in the lifecycle of an organism.Generally parasexual cycle occurs in fungi in which true sexual cycledoes not take place.

Ques4. Describe the pyrenoid present in algae?

Ans. The pyrenoid, a dense structure inside or beside chloroplasts of certain algae, consists largely ofribulose biphosphate carboxylase, one of the enzymes necessary in photosynthesis for carbonfixation and thus sugar formation. Starch, a storage form of glucose, is often found aroundpyrenoid**.**

Ques5. Describe types of lichens.

Ans. A lichen is a symbiosis of different organisms such as fungus and a cyanobacterium or algae.Cyanobacteria are also known as blue-green algae besides being distinct from algae.

Lichens are Classified into Three Types

- Crustose.
- Foliose.
- Fruticose.

Ques6. Write difference between gametophytic and sporophytic generation of bryophytes?

Ans. The generation of plants that formgametes is called gametophytes. Plants produce gametes with the help of their sex organs.

SPOROPHYTE

The generation of plants that produce spores is called sporophytes. Algae, bryophytes, angiosperms, and gymnosperms make spores.

Ques7. Write a short note on medicines obtained from bryophyte?

Ans. Sphagnum is used in surgical dressing due to its high absorptive power and someantiseptic property for filling absorptive bandages in place of cotton for the treatment ofboils and discharging wounds. Marchantia has been used to cure pulmonary tuberculosis and affliction of liverantibiotic substances can be extracted from certain bryophytes.

Ques.8 Write about structure of gemma in Marchantia?

The production of gemmae is a widespread means of asexual reproduction in both liverworts andmosses. In liverworts such as Marchantia, the flattened plant body or thallus isa haploid gametophyte with Gemma cups scattered about its upper surface. The Gemma cups arecup-like structures containing Gemmae.

Ques.9 Write about protonema of Funaria?

Ans. Protonema can be seen in Funaria as it is a type of moss.

Funaria are primitive multicellular, autotrophic, shade loving, amphibious moss. They reproduceby spore formation. The protonema stage takes part in the haploid phase of the moss.

Ques.10. Write the characteristic features of Anthoceros.

Ans. It is a club-shaped structure with a long stalk. The stalk is multicellular and arranged in 4 rows ofvertical elongated cells. The club-shaped antheridium has an outer sterile jacket inside which areenclosed androcytes. The androcytes then develop into biflagellated antherozoids.

Qes.11 Differentiate between Leptosporangiate and Eusporangiate?

Ans. Eusporangiate: The sporangium develops from a group of initial cells and such a development is called development.

Leptosporangiate: The sporangium develops from a single initialcell and such a development is called leptosporangiate development.

Qes.12 Explain stele?

Ans The stele constitutes the center part of a root or stems comprising vascular and other ground tissues. The stele's tissues are derived from the procambium, such as pericycle, pith, vascular tissue, etc.

Qes.13 Name two pteridophyte which has exosporic gametophyte?

Ans. Psilotum and Lycopodium.

Qes.14 Define homospory and heterospory pteridophytes?

Ans. The phenomenon of producing spores of similar shape and size is known as homospory. The phenomenon of producing different types of spores is known as heterospory. Bryophytes and ferns are considered as homosporous plants. Pteridophytes and seed plants are considered as heterosporous plants.

Qes15. Write about the role of ligule in Selaginella?

Ans.The ligule is specialized for the production and secretion of extracellular mucilage. The ligule is a structure on the adaxial surface of the microphylls and sporophylls of Selaginella and consists of apical, basal, glossopodial, and sheath cells.

. **Qes16.Explain the structure of Coralloid root in Cycas?**

Ans. They are specialized roots that are present in Cycas. Coralloid roots are associated with nitrogen-fixing cyanobacteria. These root tissues in conjunction with blue-green algae are also helpful in producing amino acids such as asparagine and citrulline.

Qes.17 Common name of Ephedra?

Ans. Jointed Fur

Qes.18 Which type of ovule present in Cycas?

Ans. Orthotropous type

Qes.19 Difference between monocot and dicots?

Ans. Monocots have only one cotyledon and dicots have two cotyledons.

Qes.20 Any two characters of angiosperms?

Ans. They are heterosporous and have well defined reproductive structures.

Answers Briefly

Qes.1. Describe the modes of reproduction in algae?

Ans. Algae are a group of Aquatic, photosynthetic, and nucleus-bearing organisms that lack the true roots, stems, leaves, and specialized multicellular reproductive structures of plants. Vegetative Reproduction in Algae:

1. Fragmentation in algae can occur by accident as a result of separation disc development, mechanical force, or injury.
2. Hormogonia is a type of vegetative reproduction used by blue-green algae.
3. Budding happens when vesicles that are separated from the parental body by a septum proliferate.
4. Various large thalloid algae produce adventitious branches, which grow into new individuals when separated from the plant's body. 5. 1. Describe the modes of reproduction in algae.
5. Amylum Stars are clumps of starch-containing cells that form a star shape. When they are removed from the plant body, they develop into new plants.

Asexual Reproduction in Algae:

1. Zoospores are motile exposed spores with two, four, or more flagella, and are called bi-quadri-or multi flagellated zoospores, respectively.
2. Aplanospores are non-mobile spores, such as Ulothrix and Microspora.
3. Autospores are cells that are genetically identical to their parents (for example, Scenedesmus,Chlorella, etc.).
4. Diploid algae, such as Polysiphonia, produce haploid aplanospores called tetraspores.
5. The vegetative cells of filamentous algae develop into akinetes, which are long, thick-walled spore-like forms with plenty of food reserves (for example Gloeotrichia).
6. Exospores are spores that have been sliced off at the protoplast's uncovered distal end.

7. Conidia and gonidia, for example, create endospores, which are small spores formed by the mother protoplast's divisions.

Sexual reproduction in algae:

1. **Autogamy** is the fusion of gametes formed from the very same mother cell throughout this process.
2. **Hologam**y: Vegetative cells of various strains (+ and -) act as gametes in certain unicellular members, and then after fusion, forms a zygote. It results in the creation of new genetic varieties such as Chlamydomonas.
3. **Isogamy** is the fusion of two gametes that are physiologically and morphologically identical such as Chlamydomonas Eugametos, Ulothrix, and others.
4. **Anisogamy** is the union of gametes that are physiologically and morphologically distinct during this phase such as Chlamydomonas braunii.
5. **Oogamy**is a complex process in which a small motile (non-motile in Rhodophyceae) male gamete (sperm or antherozoids) is fertilized by a large non-motile female gamete (egg or ovum).

Ques.2 Describe the types of life cycle of algae with suitable diagrams?

Ans. The life cycle of algae varies depending on the species, and there are four basic life cycle patterns in algae. There is an alternation of generations in all four patterns, indicating different haploid and diploid stages. In all life cycles, the haploid stage indicates gametophyte, while the diploid stage indicates sporophyte.

Haploid refers to a cell or organism that contains a single set of chromosomes. Moreover, the organisms that reproduce asexually are called haploids. On the other hand, the organisms that reproduce sexually are called diploids, having two sets of chromosomes. Similarly, one such example can be seen in humans where only eggs and sperm cells are haploid cells, which produce diploid cell (zygote) after fertilization.

Types of Life Cycle in Algae Four major types of life cycles in Algae are described below:

1. **Haplontic Life Cycle**: In the Haplontic life cycle, the plant body is called gametophyte (haploid). In contrast, the sporophyte (diploid) stage is exclusively represented by the zygote. In the gametangium, the gametophytic plant produces haploid gametes. The fusion of gametes culminates in the development of the zygote, which is the sole diploid stage of this life cycle, i.e. the sporophytic phase. The zygote divides into four meiospores during meiosis. These meiospores become haploid plants as they mature. The number of chromosomes can be used to interpret the alternation of generations. The monogenic life cycle is another name for this life cycle. The majority of Chlorophyceae, such as Chlamydomonas, Ulothrix, Oedogonium, Spirogyra, Chara, and others, as well as all members of the Xanthophyceae, have this type (haplontic) of life cycle.
2. **Diplontic Life Cycle**: Diplontic is multicellular sporophyte stage. In this type of life cycle, the sporophyte develops sex organs. Mitosis is the process by which sex organs create gametes. The gamete represents only the gametophytic stage; the gametes are quickly fertilised and form a zygote. The zygote does not go through meiosis and produces sporophytic plant bodies. The majority of Bacillariophyceae members and some Chlorophyceae members like Cladophora glomerata show this type of life cycle. Furthermore, the diplontic life cycle can also be found in Phaeophyceae plants such as Fucus and Sargassum. 3.
3. **Diplohaplontic Life Cycle**: The haploid and diploid phases are equally dominant in this life cycle, which two vegetative individuals represent. Only the number and function of their chromosomes differ. The haploid gametophytic plant reproduces sexually, whereas the diploid sporophytic plant reproduces asexually. The two different vegetative individuals alternate with each other or sporogenic meiosis alternates with gametes fusion in this life cycle.

   Types of Diplohaplontic Life cycle are as follows: 1. Isomorphic or Homologous: Both sporophytic and gametophytic plants are free-living and morphologically identical in this type of life cycle. The gametophytic plant (haploid) produces gametes, reproduces sexually, and produces zygote. The zygote germinates into a sporophytic (diploid) plant immediately. By meiosis, the sporophytic plant produces haploid zoospores. These zoospores have the ability to produce new gametophytic plants. For example, Clapdohora, Ulva, Draparnaldiopsis of the Chlorophyceae, and Ectocarpus of the Phaeophyceae all show this type of life cycle. 2. Heteromorphic or Heterologous: In this type of diplohaplontic life cycle, both sporophytic (diploid) and gametophytic (haploid) plants are morphologically different. The sporophyte is usually complex and sophisticated. On the other hand, as observed in Laminaria of the Phaeophyceae, the gametophyte is basic and small. In some species, such as Cutlaria, the gametophyte predominates over the sporophyte. The gametophytic plant body of Laminaria is made up of minute filaments that create gametes. After that, gametes fuse to form a zygote, which then germinates into a sporophytic plant. The macroscopic sporophytic plant body can be several meters long. The sporophytic plant bears zoosporangia and produces zoospores after meiotic division. The haploid zoospores on germination produce the haploid gametophytic plant.

4. **Triphasic life cycle**: Algae have a triphasic life cycle, as it has three distinct generations as described below:
   Algae have two different types of Triphasic life cycles: Haplobiontic Diplobiontic Both these triphasic life cycles are unique. In simple words, the haplobiontic life cycle consists of two haploid generations and one diploid generation as shown in the below image: On other hand, the diplobiontic life cycle consists of two diploid generations and one haploid generation as shown below: The haploid gametophyte phase is dominant in the haplobiontic life cycle. In contrast, diploid sporophytes are the dominant stage in the diplobiontic triphasic life cycle. An example of this life cycle is found in the red algae of the genus Polysyphonia. Thus, from the above discussion, it is clear that there are several alternations of generations in algae and they do not have any fixed life cycle patterns as found in higher plants.

Ques 3. Describe the nature, occurrence and structure of lichens?

Ans. Lichens are bizarre organisms and no two are alike. Lichens are a complex life form that is a symbiotic partnership of two separate organisms, a fungus and an alga. The dominant partner is the fungus, which gives the lichen the majority of its characteristics, from its thallus shape to its fruiting bodies. Occurrence Lichens need homes too! Every lichen lives on top of something else.

The surface of that "something else" is called a substrate. Just about anything that holds still long enough for a lichen to attach to and grow is a suitable substrate. Trees, rocks, soil, houses, tombstones, cars, old farm equipment and more can be substrates. The most common natural substrates are trees, rocks, and soil. Having lichens growing on your rocks, trees and ground around your property is a good thing. That means the air you breathe in is healthy and clean. Although lichens can cause some damage to buildings and man-made structures, it is a very slow process and does not endanger those substrates.

Soil is another important substrate for lichens. It provides moisture, nutrients, space to grow, and depending on the location, shelter as well. One unique habitat lichens can colonize is dune systems. If stable for a long enough time, shifting sands can be "held down" by soil crusts, allowing other communities to establish themselves over the top. Soil crusts consist of cyanobacteria, mosses, and lichens. Once these soil crusts are disturbed, they do not come back for many years and the process has to start over again. The shifting sands themselves pose a risk by blowing over the crust communities and covering them up, preventing light from getting to the organisms underneath and killing them.

Structure: Lichens do not have a waxy cuticle like plants have on their leaves, nor do they have vascular tissue such as xylem and phloem to move nutrients and water around their thalli as a plant does. Everything in the lichen’s environment is absorbed into the lichen's structure. Lichens get their water and nutrients from their surrounding environment via air and rain.

The general structure of a lichen is composed of layers of fungus and alga. Cortex The cortex is the outer layer of the lichen thallus. These cells are thicker and more closely packed than the other fungal cells in the lichen. This layer provides some small measure of protection, as well as provides color in some species. Algal Layer You can usually tell what kind of alga a lichen has just by color alone.

When a lichen is dry, its color is usually gray or colored like the fungal cells on the upper cortex. When a lichen is wet, those cells become transparent, and the algal cells underneath get a chance to show their vibrancy. Green algae generally give the lichen a bright green color when wet, although there are exceptions of pigmented lichens with green algae due to the fungal partner showing its colors.

Cyanobacteria can be a layer under the upper cortex or in tiny pockets on top of the upper cortex if there is a green algal layer already present. Cyanobacteria will give the lichen a dark green, brown, or black color. In some lichens, however, there are no layers of fungus and alga. The individual components are mixed together in one big uniform layer and the resulting growth form is gelatinous. These types of lichens are called jelly lichens.

Medulla

The majority of the lichen thallus is comprised of fungal filaments called the medulla. It is made of fungal cells that are loosely packed in the middle of the lichen thallus, have thin cell walls, and are threadlike. The result is a cotton-like substance underneath the outer cortex. Basal Attachment Lichens attach to their substrate by different means.

Rhizines are fungal filaments that extend from the medulla and attach the lichen to its substrate. Rhizines have no vascular capabilities like the roots in plants. They do not move water or nutrients to the lichen; they simply hold the lichen down to whatever it is sitting on. Holdfast is an extension of the lichen thallus. Instead of many rhizines, some lichens have a central peg or holdfast that attach to the substrate, generally a rock. These types of foliose lichens are called umbilicate lichens, since the central holdfast is like an umbilical cord.

Ques.4Describe thallus organization and methods of reproduction in fungi with example?

Ans. Thallus organization: Thallus organizations are found in algae and fungi. The thallus is an undifferentiated flat tissue. It ranges from simple filaments to complicated and unbranched tree-like filaments. It is a simple structure that lacks specialized tissue such as conducting tissues, stems, and leaves. They lack organized and distinguishable sections. Thallus mimics vascular parts of the plants. In algae the thallus is called mycelium.

A thallus is composed of filaments or plates of cells and ranges in size from a unicellular structure to a complex treelike form Reproduction in fungi can reproduce asexually by fragmentation, budding, or producing spores, or sexually with homothallic or heterothallic mycelia.

REPRODUCTION

Fungi reproduce sexually and/or asexually. Perfect fungi reproduce both sexually and asexually, while imperfect fungi reproduce only asexually (by mitosis). In both sexual and asexual reproduction, fungi produce spores that disperse from the parent organism by either floating on the wind or hitching a ride on an animal. Fungal spores are smaller and lighter than plant seeds. The giant puffball mushroom bursts open and releases trillions of spores. The huge number of spores released increases the likelihood of landing in an environment that will support growth. The release of fungal spores: The (a) giant puff ball mushroom releases (b) a cloud of spores when it reaches maturity.

ASEXUAL REPRODUCTION

Fungi reproduce asexually by fragmentation, budding, or producing spores. Fragments of hyphae can grow new colonies. Mycelial fragmentation occurs when a fungal mycelium separates into pieces with each component growing into a separate mycelium. Somatic cells in yeast form buds. During budding (a type of cytokinesis), a bulge forms on the side of the cell, the nucleus divides mitotically, and the bud ultimately detaches itself from the mother cell. The most common mode of asexual reproduction is through the formation of asexual spores, which are produced by one parent only (through mitosis) and are genetically identical to that parent. Spores allow fungi to expand their distribution and colonize new environments. They may be released from the parent thallus, either outside or within a special reproductive sac called a sporangium. Types of fungal reproduction: Fungi may utilize both asexual and sexual stages of reproduction; sexual reproduction often occurs in response to adverse environmental conditions. There are many types of asexual spores. Conidiospores are unicellular or multicellular spores that are released directly from the tip or side of the hypha. Other asexual spores originate in the fragmentation of a hypha to form single cells that are released as spores; some of these have a thick wall surrounding the fragment. Yet others bud off the vegetative parent cell. Sporangiospores are produced in a sporangium. Release of spores from a sporangium: This bright field light micrograph shows the release of spores from a sporangium at the end of a hypha called a sporangiophore. The organism depicted is a Mucor sp. fungus: a mold often found indoors.

SEXUAL REPRODUCTION

Sexual reproduction introduces genetic variation into a population of fungi. In fungi, sexual reproduction often occurs in response to adverse environmental conditions. Two mating types are produced. When both mating types are present in the same mycelium, it is called homothallic or self-fertile. Heterothallic mycelia require two differentbut compatible, mycelia to reproduce sexually. Although there are many variations in fungal sexual reproduction, all include the following three stages. First, during plasmogamy (literally, “marriage or union of cytoplasm”) two haploid cells fuse, leading to a dikaryotic stage where two haploid nuclei coexist in a single cell. During karyogamy (“nuclear marriage”), the haploid nuclei fuse to form a diploid zygote nucleus. Finally, meiosis takes place in the gametangia (singular, gametangium) organs in which gametes of different mating types are generated. At this stage spores are disseminated into the environment.

Ques5. Write short note on:

A) Pigment constitution in algae

Algae are found to have various pigmentation. The pigmentation in algae is present in plastids called chromophores.

The pigments are classified into three major categories • Chlorophyll - They are responsible for the green colour pigment and they are fat-soluble. • Carotenoids - They are responsible for the yellow pigment and are also fat-soluble. •Phycobilins - They are responsible for the blue or red pigment and are water-soluble. Algae show great diversity in pigmentation.

Type of pigment present in the algal thallus is an important criteria for their classification. Chlorophyll is found in all photosynthetic organisms, including green plants, cyanobacteria, and algae Chlorophyll is composed of a porphyrin-ring system that is very similar to that of hemoglobin but has a magnesium atom instead of an iron atom. The algae have four types of chlorophyll, a, b, c and d. Chlorophyll a is the primary photosynthetic pigment in all photosynthetic algae. Chl a has two main absorption bands in vitro, one band in the red light region at 663 nm and the other in violet region at 430 nm . chlorophyll a - found in all photosynthetic algae Chlorophyll b - Euglenophyta and Chlorophyta. Chlorophyll c- Dinophyta, Cryptophyta, Heterokontophyta (Xanthophyceae, Bacillariophyceae, Phaeophyceae). Chlorophyll d -occurs in some cyanobacteria, Rhodophyceae. Chlorophyll e- rare and found in some golden algae (chrysophyceae) Carotenoids are yellow, orange, or red pigments that usually occur inside the plastid but may occur outside in certain cases. carotenoids can be divided into two classes: (1) oxygen-free hydrocarbons, the carotenes; and (2) their oxygenated derivatives,the xanthophylls. The most widespread carotene in the algae is βcarotene. Fucoxanthin is the principal xanthophyll in the golden-brown algae and found in (Chrysophyceae, Bacillariophyceae, Prymnesiophyceae, and Phaeophyceae), giving these algae their characteristic brown color. Phycobilins/ Phycobiliproteins - The cyanobacteria and chloroplasts of the Rhodophyta contain phycobiliproteins Phycobiliproteins are water-soluble blue (phycocyanin) or red (phycoerythrin) pigments Phycobilins/ Phycobiliproteins – There are 3 types of phycoerythrin: 1. R-phycoerythrin - Rhodophyta 2. B-phycoerythrin - Rhodophyta 3. C-phycoerythrin - Cyanophyta There are also 3 types of phycocyanin - 1. R-phycocyanin - Rhodophyta 2. C-phycocyanin - Cyanophyta 3. Allophycocyanin - Cyanophyta

B) Economic importance of fungi.

Fungi are an important organism in human life. They play an important role in medicine by yielding antibiotics, in agriculture by maintaining soil fertility, are consumed as food, and forms the basis of many industries. Let us have a look at some of the fields where fungi are really important. Importance in Human Life Fungi are very important to humans at many levels. They are an important part of the nutrient cycle in the ecosystem. They also act as pesticides. Biological Insecticides Fungi are animal pathogens. Thus they help in controlling the population of pests. These fungi do not infect plants and animals. They attack specifically to some insects.

The fungus Beauveria bassiana is a pesticide that is being tested to control the spread of emerald ash borer. Reusing These microbes along with bacteria bring about recycling of matter by decomposing dead matter of plants and excreta of animals in the soil, hence the reuse enriches the soil to make it fertile. The absence of activities of fungi can have an adverse effect on this on-going process by continuous assembly and piling of debris. Importance in Medicine • Metabolites of fungi are of great commercial importance. • Antibiotics are the substances produced by fungi, useful for the treatment of diseases caused by pathogens. Antibiotics produced by actinomycetes and moulds inhibits the growth of other microbes. Apart from curing diseases, antibiotics are also used fed to animals for speedy growth and to improve meat quality. Antibiotics are used to preserve freshly produced meat for longer durations. Penicillin is a widely used antibiotic, lethal for the survival of microbes. The reason it is extensively used is since it has no effect on human cells but kills gram-positive bacteria. Streptomycin, another antibiotic is of great medicinal value. It is more powerful than Penicillin as it destroys gram-negative entities. Yield-soluble antibiotics are used to check the growth of yeasts and bacteria and in treating plant diseases. Administration of Griseofulvin results in the absorption by keratinized tissues and are used to treat fungal skin diseases(ringworms).Ergot is used in the medicine and the vet industry. It is also used to control bleeding post-childbirth. LSD – Lysergic acid, is a derivative of ergot and is used in the field of psychiatry. Consuming fungi called Clavatia prevents cancer of the stomach. Importance in Agriculture The fungi plant dynamic is essential in productivity of crops. Fungal activity in farmlands contributes to the growth of plants by about 70%.

Fungi are important in the process of humus formation as it brings about the degeneration of the plant and animal matter. They are successively used in biological control of pests. Plant pests are used as insecticides to control activities of insects. For example – Empausasepulchralis, Cordyceps melonhae. Use of fungal pesticides can reduce environmental hazards by a great extent. Fungi are also used in agricultural research. Some species of fungi are used in the detection of certain elements such as Copper and Arsenic in soil and in the production of enzymes. For instance, biological and genetic research on fungi named Neurospora led to the One Gene One Enzyme hypothesis. The fungi live in a symbiotic relationship with the plant roots known as mycorrhiza. These are essential to enhance the productivity of farmland. 80-90% of trees could not survive without the fungal partner in the root system. Importance in Food industry Some fungi are used in food processing while some are directly consumed.

Ques6. Describe the structure of sporophyte of Anthoceros with suitable diagram?

Ans. The zygote is the first cell that develop into sporophyte. The zygote inside the venter increases in size and divides repetitively by mitotic division to form a small embryo. Now the embryo contionue its division and finally form an elongated sporophyte. The sporophyte consists of a bulbous foot and a cylindrical, erect capsule (seta absent). In between foot and seta an intermediate meristematic tissue zone is present.

The sporophytic body of Anthoceros grows embedded in the gametophytic body. It is divided into three distinct regions: 1. Foot: The foot is a bulbous parenchymatous structure that is embedded in the gametophyte. It helps in absorbing water and nutrients from the gametophyte.

2. Intercalary Zone: It is a narrow zone of meristematic cells that is found between the foot and capsule. These cells keep the continuous growth of sporophyte.

3. Capsule: It is a fertile, major and conspicuous part of the sporophyte. It is green, long and cylindrical when young, but turns brown or grey upon maturity. The erect capsule is an elongated, slender, cylindrical in structure. It may be of 2-3 cm, (in some species it may be up to more than 10 cm.) It looks like a horn or bristle, thats why the genus is known as hornwort. The capsule has 3 distinct zones, ie. a. The central columella. b. The middle archesporium or sporogenous tissue zone. c. The covering wall layers A) Columella: At the central portion of the capsule a cylindrical, supportive, pillar like tissue appearance is found, known as columella. It consists of 16 vertical rows of sterile cells. The main function of it is to provide mechanical support to the capsule. B) Archesporium or sporogenous tissue: The surrounding of the columella the next tissue zone is known as archesporium, it mainly consists of sporogenous tissue. From the base to apex of the cpsule different stages of development of spores from archesporium tissue are found. At the very bottom of the capsule only single layer of archesporim cells are found, next upwards the other successive stages like spore mother cells, spore tetrad, free spores and pseudoelaters are found. Pseudo-elaters are the multicellular elongated structures, help in spore dispersal. Here spore mother cells divide meiotically and form haploid spores. C) Wall layers: Surrounding the sporogenous tissue zone the next outer covering layer is known as wall layers or jacket layers. This zone is multi layered (4-6), the most outer cell layer is epidermis, this epidermis layer is cutinised and carries stomata in place to place. The next inner layer to the epidermis is chloroplast bearing photosynthetic green

tissue. The capsule wall is 4-6 layers thick, out of which the outermost layer is the epidermis that contains stomata. The inner cells are made up of chlorenchyma cells and are photosynthetic in nature.

Ques.7 Describe in detail the evolution of sporophyte in bryophyte with help of diagrams.

Ans.1. Bryophytes are non- vascular terrestrial plants. 2. They are known as the amphibians of the plant kingdom as they require water for their propagation. 3. They have two stages in their life cycle: sporophyte and gametophyte. Sporophyte:

1. Sporophyte is a diploid, multicellular plant structure in bryophtes. 2. It develops from the fertilized gamete formed by the gametophytic stage of the plant. 3. It produces spores through asexual, meiotic division. 4. These spores proliferate to become gametophytes.
2. Gametophyte: 1. Gametophyte is a haploid, multicellular plant structure in bryophytes. 2. It develops from spores formed by the sporophytic body. 3. it produces haploid gametes through mitotic division. 4. These gametes fuse to form a zygote that develops into a sporophyte.
3. **Evolution of sporophyte in bryophytes**: There are mainly two theories regarding the evolution of sporophytes: 1. Theory of progressive evolution. 2. Theory of regressive evolution. • Theory of progressive evolution: 1. According to this theory, the early sporophyte of bryophytes was uncomplicated and almost all of the sporogenous tissue was fertile (e.g., Riccia) and from this type of sporophyte, the more complex sporophytes (e.g., mosses) are said to have evolved by the process of progressive sterilisation of potential sporogenous tissue. 2. This theory is also known by the name of "theory of sterilisation". • Theory of regressive evolution: 1. According to this theory, the simplest sporophyte of Riccia (which is composed of a simple capsule) is the most advanced kind which is said to have evolved by the simplification or progressive reduction of the more complicated sporophytes (foliose with complex assimilatory tissue and functional stomata) of mosses (e.g. Funaria, Pogonatum, Polytrichum etc.). 2.

This theory is also known as “retrogressive theory” The life cycle of a dioicous bryophyte. The gametophyte (haploid) structures are shown in green, the sporophyte (diploid) in brown.

Ques.8Describe alternation of generation in bryophytes?

Bryophytes: 1. They grow in the amphibious zone, which is the transition between aquatic and terrestrial ecosystems, and are so known as amphibians of plant.

2. Their body is made up of leafy multicellular green plants.
3. True roots, stems, and leaves are absent from the plant body.
4. The plants are chloroplast-rich and green.
5. They show that they eat in an autotrophic manner.

Alteration of Generation: 1. Generational alternation involve two stages of life that alternate on a regular basis. 2. The first stage is the gametophytic phase, during which gametes with half chromosomes are produced. 3. Bryophytes reproduce sexually via egg and sperm at this phase of their lives. 4. The second phase begins when egg and the sperm unite to form a zygote. 5. The zygote germinates to give rise to sporophyte, which contain all of the chromosomes. 6. The spore-producing phase is the second stage, sporophytic phase. 7. The sporophyte can't exist on its own. It is made up of capsule, foot and stalk that connects the sporophyte and gametophyte bodies. Bryophytes are the non-vascular plants. In the life cycle, they are the only embryophytes(plants that produce an embryo) whose life history includes a dominant gametophyte (haploid) stage. Alternation of generations is a lifecycle involving two phases of life, which regularly alternate with each other. In Bryophytes, the first phase is the gametophytic phase, in which gametes are produced, that contain half the number of chromosomes. This is the dominant phase in the life of Bryophytes and reproduces sexually by egg and sperm. Once the egg and sperm fuse to produce a zygote, starts the second phase. The zygote germinates to produce the sporophyte, whose cells possess the complete number of chromosomes.

This second phase, the sporophytic phase, is the spore producing phase. The sporophyte cannot exist independently. It is composed of a capsule, a stalk, and a foot that attaches the sporophyte body to the gametophyte.

The sporophyte reproduces asexually by means of spores, which are produced by meiosis and are haploid. Each spore germinates to produce a gametophyte, which is the independent phase. This way, the life cycle is completed.

Ques.9 Write economic importance of bryophyte?

Ans. Economic Importance of Bryophytes:

A. Medicinal Uses: Bryophytes have many uses in medicine and there is a lot of evidence from ancient times.
B. Sphagnum has high absorptive power and antiseptic property due to this it was used for surgical dressing as well as for discharging wounds.
C. Marchantia has been used for the treatment of pulmonary tuberculosis and pain in the liver.
D. The extraction of dried sphagnum is used to treat acute haemorrhage and eye infections.
E. Sphagnum is the distillate form of peat-tar and was used to treatment of skin disease and peattar was also used as an antiseptic.
F. Polytrichum was used for kidney and gall bladder stones. B. In Research:
G. Bryophytes have many contributions to genetics like Mosses and Liverworts are used in research. C. Packing Material:
H. For packaging fragile materials like glassware dried mosses were an excellent choice.
I. The water retention property of bryophytes makes them a good choice for the trans-shipment of living materials.
J. As Food: Animals and birds use mosses as a good source of food. Mosses are consumed by the many like, Arctic Bison, and Alpine vertebrates reindeer, caribou, musk ox, arctic geese, lemmings, and rodents. One of the more interesting use is the feeding of mosses to baby pigs.

K. Bryophytes can indicate the acidity and basicity of the soil. Polytrichum indicates the acidity of the soil.

L. Tortella can indicate lime and bases of the soil. F. Potential Source for Antioxidants: Marchantia paleacea, Marchantia linearis, and Conocephalumconicum are potentially important sources of bioactive materials that can be effective in the prevention of cells from oxidative damage which leads to aging and carcinogenesis.

M. . Construction Materials: Nordic people used the aquatic moss Fontinalis antipyretica between the chimney and walls to prevent fires. Several mosses are used as chinking (chink – a crack or narrow fissure) materials. Similarly, in Alaska, the chinking of wooden and log cabins is done using bryophytes. The shepherds in the Himalayan highlands also use bryophytes C for chinking.

N. In Northern Europe, Sphagnum is stuffed between timber used in houses to deaden the sound. Mosses were also used in making huts by herdsmen in the Alps. Neckeracomplanata is used for plugging the seams and cracks of boats. H. Households Uses: As Absorbent: A layer of Sphagnum is used in hiking boots for cushioning the foot and absorbing moisture and odor. Dry Sphagnum is used in diapers and in cradles to keep babies clean and warm. It is also used to make beddings, mattresses, cushions, and pillows by stuffing mosses into coarse linen sacks.

O. Decorative Materials: Decorative materials are one of the most important economic use of bryophytes like Dicranumscoparium used for forming banks of green, in-shop window displays, Rhytidiadelphusloreus as green carpets, and Hylocomium splendens (dyed) for decorating women’s hats.

Ques.10 Explain general characters of Pteridophytes?.

Ans (i) Majority of the living Pteridophytes are terrestrial and prefer to grow in cool, moist and shady places e.g., ferns. Some members are aquatic (e.g., Marsilea, Azolla), xerophytic (e.g., Selaginella rupestris, Equisetum) or epiphytic (e.g., Lycopodium squarrosum).

(ii) Majority of the Pteridophytes are herbaceous but a few are perennial and tree like (e.g., Angiopteris). Smallest Pteridophyte is Azolla (an aquatic fern) and largest is Cyathea (tree fern).

(iii) Plant body is sporophytic and can be differentiated into root, stem and leaves.

(iv) Roots are adventitious in nature with monopodial or dichotomous branching. Internally usually they are diarch.

(v) Stem is usually branched. Branching is monopodial or dichotomous. Branches do not arise in the axil of the leaves. In many Pteridophytes stem is represented by rhizome.

(vi) Leaves may be small, thin, scaly (microphyllous e.g., Equisetum), simple and sessile (e.g., Selaginella) or large and pinnately compound (megaphyllous e.g., Dryopteris, Adiantum).

(vii) Vascular tissue is present in stem and root. It consists of xylem and phloem. Xylem consists of tracheids only and phloem has only sieve tubes.

(viii) The steel is protostele (e.g., Rhynia, Lycopodium), siphonostele (e.g., Equisetum), dictyostele Adiantum) or polycyclic (e.g., Angiopteris).

Qes.11 Explain life cycle of Pteridophytes?

P. **Ans.**Pteridophytes show heteromorphic alternation of generation. The main plant body is sporophytic and forms a dominant phase in the life cycle. Sporophytic plant body develops sporangia in which sporogenous tissue is formed. Sporogenous tissue divides meiotically to form haploid spores. Majority of the Pteridophytes are homosporous e.g., Lycopodium, Pteris etc. Spores on germination produce monoecious gametophyte. Some Pteridophytes are heterosporous and produce two types of spores: microspores and megaspores. Microspores on germination produce male gametophyte (prothallus) while megaspores on germination produce female gametophyte (prothallus). So, the prothalli are dioecious. Antheridia and archegonia develop on the same prothallus (monoecious) or on different prothalli (dioecious). The male and female gametes fuse to form zygote which develops into sporophyte. Thus, the life cycle of a Pteridophyte consists of an alternate succession of sporophytic and gametophytic generations.

Ques.12 Describe the life cycle of Selaginella?

Ans. The life cycle of selaginella is quite interesting, both similar yet distinct from that of flowering plants or angiosperms. Selaginella does have heterospory and sex allocation in its sporophyte generation. However, it does not have the protective, maternal features that occur after fertilization in angiosperms. There are no fruits or seeds. Fruit and seed development is considered a female-biased sex allocation. In selaginella, microspores and megaspores are instead produced by the paternal and maternal parts of the plant. The spore-bearing parts of selaginella are called microsporangia and megasporangia**.** The megasporangia can be found under the microsporangia. Microspores fall passively to the ground through cones called strobili.The sporophyte of selaginella releases and disperses those spores once they mature. They possess tiny, flagellated sperm that need water to swim to egg cells. The egg cells are produced by the megasporangia. Water therefore plays an essential role in the life cycle of selaginella, and in drought, it might be hard to find young plants Mating and game production do not happen near the parent. Selaginella is considered to have a with the microsporangia being far more abundant than megasporangia. However, there are a few species of selaginella that do have more megasporangia. As a selaginella plant grows older, its center dies and leaves living material around that center.

Qes.13 Distribution of Gymnosperms in India?

Ans. Indian Cycadales are represented by only 5 species of Cycas and occur mainly in South India. These are Cycas beddomei (Madras and dry hills of Cudapah in Andhra Pradesh), C. circinalis (Andaman and Nicobar Islands and some dry deciduous forests of South India), C. rumphii (Andaman and Nicobar Islands), C griffithi (Manipur and Nega Hills) and C. pectinata (Assam, Bihar, Sikkim and several parts or Eastern India).C. revoluta, a Japanese species, is cultivated commonly in Indian gardens. It does not occur in wild state. Indian Gnetales include species of Gnetum and Ephedra. Welwitschia, the third genus of the order, has not been reported from India. Five species of Gnetum (viz. G. ula, G. contractum, G. gnemon, G. montanum and G. latifolium) occur in various parts of the country.

Q. Ephedra, in India, is represented by only 6 species. These are Ephedra foliata, E. gerardiana, E. intermedia, E. nebrodensis, E. regeliana and E. saxatilis. These are distributed widely in dry parts of Haryana, Punjab, Rajasthan, and parts of Sikkim, Kashmir, and also at high altitudes in Himalayas.

Coniferales are the dominant forest-makers of the world. Out of 54 living genera of Coniferales in the world, ten have been reported from different parts of India. These are Abies, Cedrus, Cephalotaxus, Cupressus, Juniperus, Larix, Picea, Pinus, Podocarpus and Tsuga. The distribution of the majority of these members is restricted mainly in the Himalayas, and governed chiefly by altitudes.

Ques14. Explain development of ovule and Female gametophyte in Cycas?

The ovules are orthotropous, unitegmic and sessile or shortly stalked. The Cycas ovule is largest in plant kingdom with 6-7 cm in diameter. In young stage ovules are green covered with brown hairs but after fertilization hairs are lost and appear orange to red in colour. The body of ovule is called nucellus (megasporangium), covered by a thick integument in all sides except an opening called micropyle. The apex of the nucellus has a pollen chamber and a nucellar beak. The integument consists of three distinct layers: outer and inner fleshy layers and middle stony layer.

Development of female gametophyte (Endosperm):

Inside the nucellus, one cell differentiated into megaspore mother cell. It undergoes reduction division (meiosis) to form a linear tetrad of four haploid megaspores. Usually, the upper 3 megaspores towards micropyle degenerate while the lower most functional megaspore (embryo sac cell) undergoes free nuclear division followed by wall formation to form a cellular female gametophyte or endosperm.

Hence, the formation of female gametophyte is monosporic, i.e develops from a single megaspore. During formation of endosperm nucellus is utilized. It should be noted that in gymnosperms the endosperm develop before fertilization and is haploid (n) while in angiosperms it is triploid (3n) and formed after fertilization .

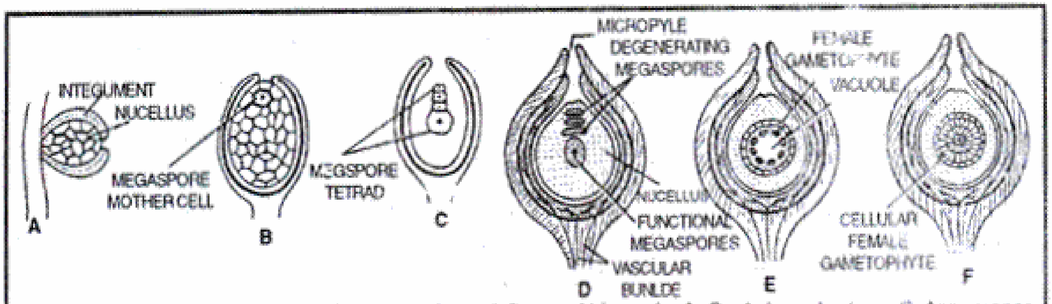
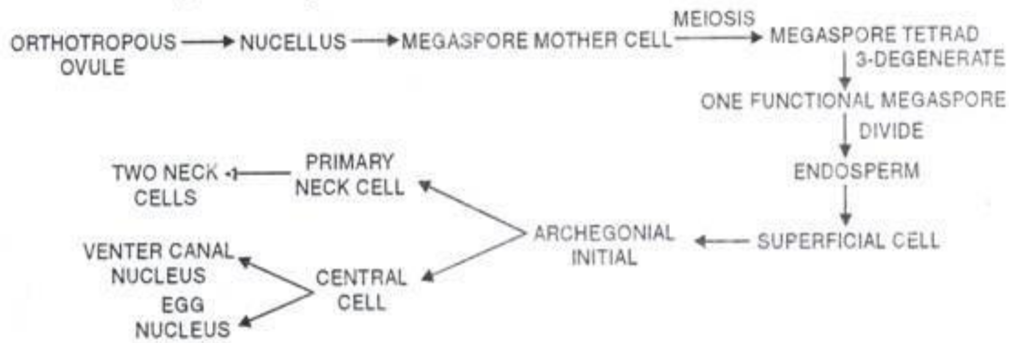


Figure 9.10 Development of female gametophyte of *Cycas* within ovule. **A.** Ovule in early stage, **B.** Appearance of megaspore mother cell, **C.** Megaspore mother cell divides reductionally to form four megaspores. **D.** Three megasporos degenerate, one remain functional, **E** to **J.** Development of female gametophyte and archegonia, **K.** Mature ovule.

R.

Summary of development of Female Gametophyte



(b) Development of archegonium:

At the micropylar end of female gametophyte 2-8 archegonia develop. All the necks of archegonia open into an archegonial chamber formed by a depression in female gametophyte. Each archegonium develops from single superficial cell called archegonial initial.

It gets enlarged and divides transversally into outer primary neck cell and inner central cell. The primary neck cell divides anticlinally to form two neck cells. The inner central cell enlarges and its nucleus divides into venter canal nucleus and egg nucleus. Soon the venter canal nucleus disorganizes. Thus, a mature archegonium has two neck cells and an egg. Neck canal cells are not formed. The egg cell in Cycas is largest in the plant kingdom.

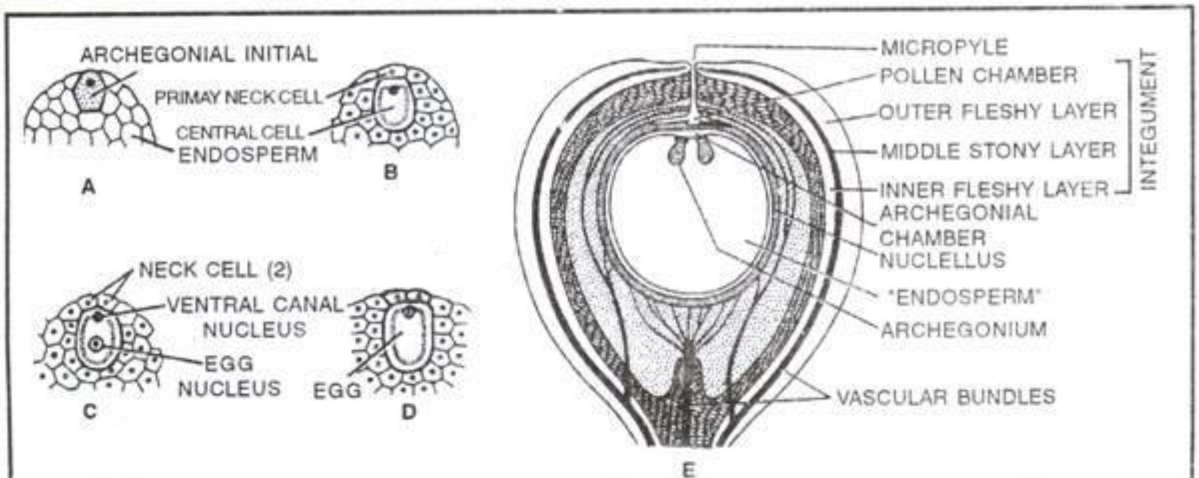


Figure 9.11 A-D. *Cycas.* Development of archegonium, **E.** V.S. of a mature *Cycas* ovule

Qes.15 Explain node and internode anatomy in Ephedra?

Ans.T.S. of stem at node shows the following structures

a. Epidermis:

It is the outermost layer of thick-walled cells, covered with a thick layer of cuticle. Sunken stomata are present on the slopes of the ridges in the circular pits.

b. Hypodermis:

It is present just below the ridges. It is made up of sclerenchymatous cells and provides mechanical strength to the plant.

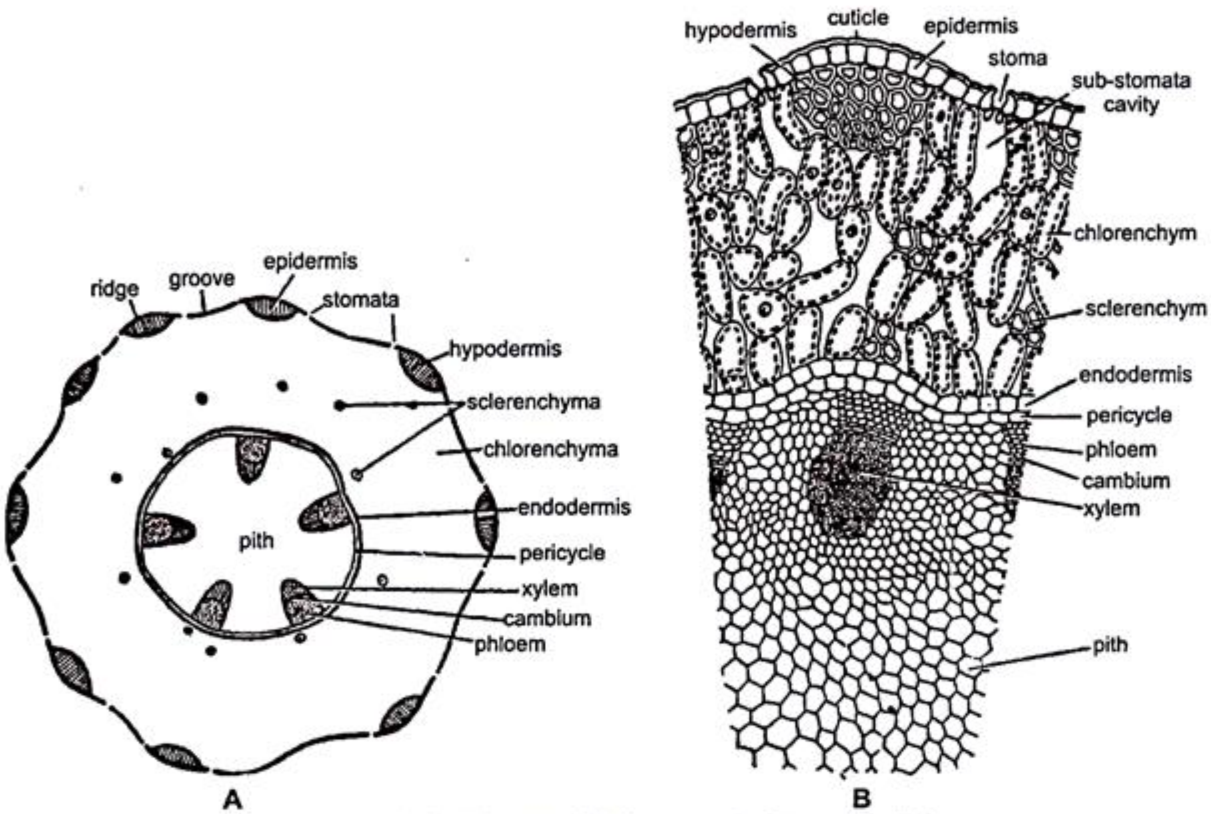


Fig. 2 (A, B) *Ephedra.* T.S. of stem, (A) diagrammatic; (B) a part of cellular.

c. Cortex:

In is present between the thick walled sclerenchyma and vascular cylinder. It can be differentiated into outer and inner cortex. The outer cortex contains 2-3 layers of radially elongated palisade tissue and inner cortex consists of 2-3 layers of spongy parenchyma.

The cells of outer and inner cortex are loosely arranged with large intercellular spaces and are provided with chlorophyll to perform the function of photosynthesis. A few patches of scleranchymatous cells may also occur in the cortex to provide mechanical support to the young axis.

d. Endodermis:

It is the innermost layer of cortex. It is not easily distinguishable from the cortical cells.

e. Pericycle:

It is present below the endodermis. It is single layered and ill defined.

f. Vascular Cylinder:
It is endarch, siphonostele and consists of many vascular bundles arranged in a ring. Vascular bundles are conjointed, collateral, open and endarch. The number of primary vascular strands is generally eight, out of which four small represent the foliar traces while the other large four are stem bundles.

Foliar traces run upto the node. Xylem consists of tracheids, vessels and xylem parenchyma. Due to the presence of the vessels the Ephedra resembles angiosperms. The phloem consists of sieve cells, phloem parenchyma and albuminous cells. Phloem and xylem are separated by a narrow strip of cambium.

g. Medullary rays:
Broad, parenchymatous medullary rays are present in between the vascular bundles. Medullary rays connect the pith with cortex.

It is present in the centre. It is made up off thin-walled parenchymatous cells. Near the node its cells become strongly lignified forming a peridermal diaphragm which accounts for the rapid separation of the branches in the region (Fig. 3).

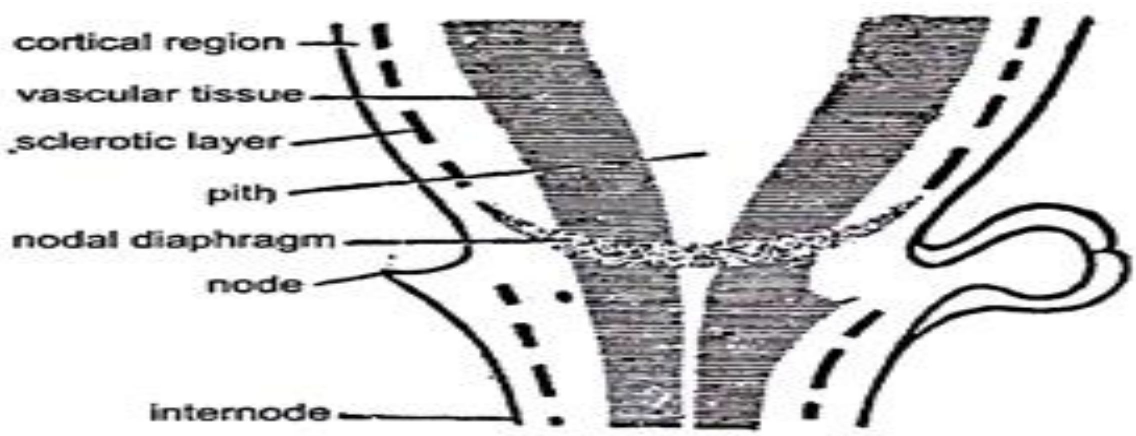


Fig. 3. ***Ephedra.*** **Longitudinal section of node (diagrammatic)**

Qes.16 Explain structure of male flower of Ephedra ?

Ans. Male Strobilus (Staminate Strobilus):

Male strobili arise in clusters from the nodes of the branches. Each strobilus is rounded, ovoid or spherical in shape and arises in the axis of a scale leaf. Their number at the node depends upon the number of scale leaves.

Each strobilus has a central axis which bears 2-12 pairs decussately arranged simple, broad and cupped bracts. Lower most 1-2 pairs of bracts are sterile. In the axil of each fertile bract arises a male flower or staminate flower. A male strobilus with several male flowers can be compared with an inflorescence.

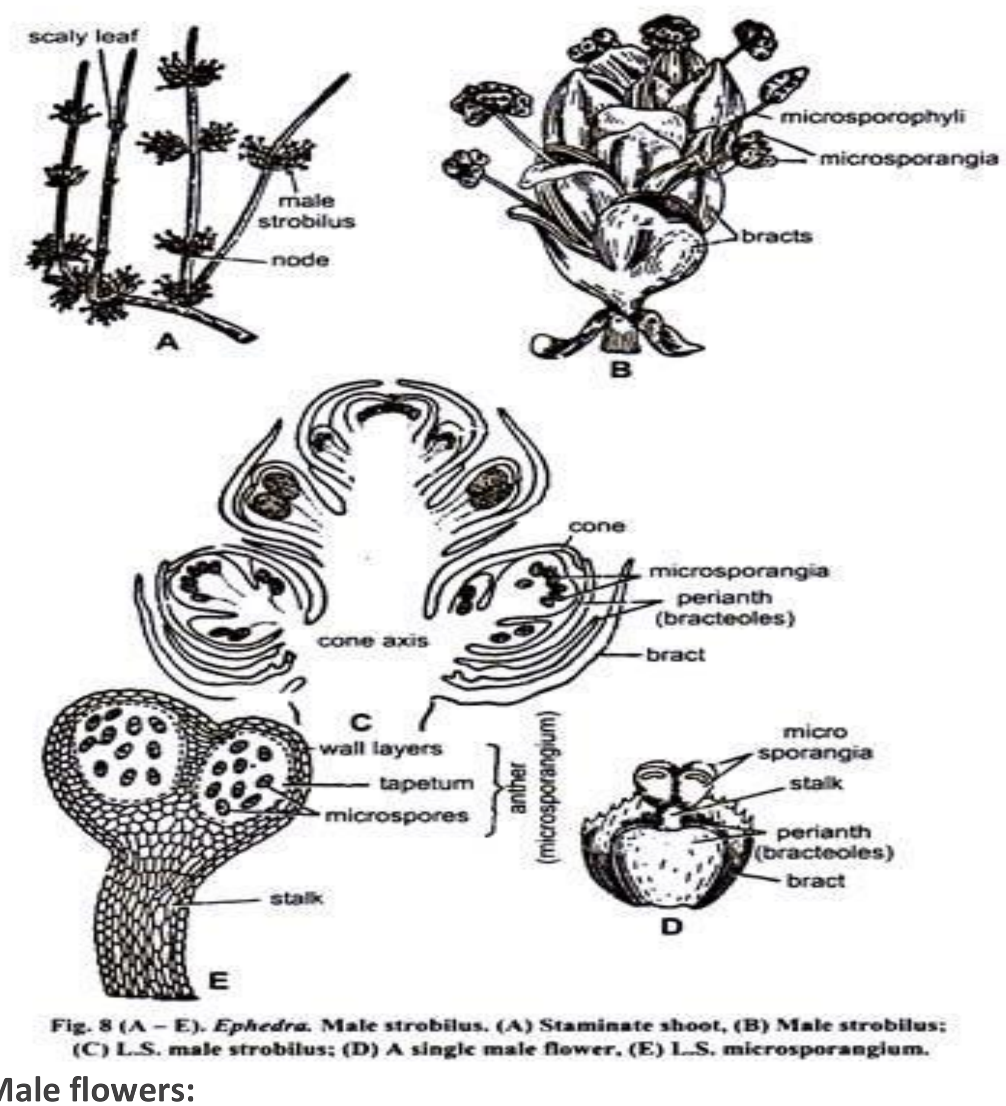


Fig. 8 (A – E). *Ephedra*. Male strobilus. (A) Staminate shoot, (B) Male strobilus; (C) L.S. male strobilus; (D) A single male flower, (E) L.S. microsporangium.

Male flowers:

Each male flower has two lipped thin bractioles (perianth) which encloses a stamen. Bracteoles are united at the base. The flower has a short stalk known as microsporangiophore and two, eight to twelve microsporangia at its tip.Microsporangia are sessile and dehisce terminally. Male flower is also called simple strobilus. A compound male strobilus, therefore, consists of many such strobili.

Ques.17 Describe general characters of Angiosperms?

Ans. Angiosperms are the most recent highly evolved group of plants.Prominent features of angiosperms are as follows:

HabitatThey range in size from tiny, almost microscopic **Wolfia** to tall trees of **Eucalyptus** (over 100 metres).

Vascular

They possess vascular tissues like xylem and phloem. It is used for the conduction of water and food respectively. They are arranged in the form of vascular bundles. Xylem possesses the vessels and phloem possess sieve tubes and companion cells.

Seed-bearing

It bears seed which contains the embryo.

Fruit-bearing

They bear fruits which are enclosed and protected by the fruit.

Flower-bearing

It bears flowers, which are the ornaments of the plant. It acts as the sexual organ too. Flowers attract insects which help in pollination.

Parts of a flower

The production of flowers is a unique feature of angiosperms. The sporophylls are aggregated to form the flowers. A typical flower has a short axis called thalamus and four whorls of floral leaves. Flowers have four major parts which are arranged in the form of four whorls as follows:

Calyx

It is the whorl of sepals. It is normally green in colour and protects the flower bud.

Corolla

It is the whorl of petals. It is coloured other than green and attracts pollinators like bees, butterflies etc.

Androecium

It is the whorl of stamens or microsporophylls. It is the male reproductive organ. Stamen is a modified leaf. It possesses anther and a filament. Anther is the bilobed portion present on the filament. It possesses pollen grains.

Gynoecium

It is the whorl of carpels or pistils or megasporophylls. It is the female reproductive organ. It possesses stigma, style and ovaries. Ovaries possess ovules. Ovule possesses nucellus, two integuments and a micropyle.

Details of floral parts

The details of floral parts are as follows:

Reproductive events of angiosperms

Reproductive events in angiosperms is divided into three types as follows:

- Pre-fertilisation events
- Fertilisation events
- Post-fertilisation events

Pre-fertilisation events

Events occurring before the process of fertilisation are described as pre-fertilisation events. These include the production of gametes and their transfer.

Formation of male gametophyte

The microsporophylls produce the male gametophytes called pollen grains. The stamens are composed of anther and filament. Transverse section of anther shows the presence of two lobes with four pollen sacs. They carry microspore mother cells which are diploid. Each microspore mother cell undergoes meiosis to form four haploid microspores or pollen grains. The generative cells of the pollen grains undergo mitotic divisions which result in the formation of two male gametes. Thus pollen grain is the male gametophyte.

Formation of female gametophyte

The megasporophylls bear the female gametophyte. The carpels composed of style, stigma and ovary constitute the megasporophylls. Inside the ovary, ovules are present. The ovule is the megasporangium of the angiosperms. Megasporangium consists of the megaspore mother cell (diploid) that undergoes meiosis to form four haploid megaspores. Three of them usually degenerate, and one divides mitotically thrice to form the embryo sac. This is called monosporic development.

Embryo sac

Each embryo sac has a seven-celled, eight-nucleated condition. It possesses the three-celled egg apparatus composed of one egg cell and two synergids, three antipodal cells, and one central cell having two polar nuclei. Two polar nuclei fuse together to form a diploid secondary nucleus in the central cell.

Pollination

Pollination is the process of transfer of pollen grains from anther (male reproductive part of a plant) to the stigma of pistil (female reproductive part of a plant). Pollination is essential for the event of reproduction in dioecious plants. The staminate (male) or pistillate (female) flowers do not have both the male and female gametes in the same flower. Hence, pollen bearing male gametes have to be transferred to the stigma of the flower bearing female reproductive parts. Thus, pollination is a very crucial event which ensures survival of generations in plants.

Ques.18 Explain stelar system in Pteridophytes?

Ans The term stele has been derived from a Greek word meaning pillar. Van Tieghem and Douliot (1886) recognized only three types of steles. They also thought that the monostelic shoot were rare in comparison of polystelic shoots.

It is an established fact that all shoots are monostelic and polystelic condition rarely occurs. The stele of the stem remains connected with that of leaf by a vascular connection known as the leaf supply.

Types of Steles:

1. Protostele:

Jeffrey (1898), for the first time pointed out the stelar theory from the point of view of the phylogeny. According to him, the primitive type of stele is protostele. In protostele, the vascular tissue is a solid mass and the central core of the xylem is completely surrounded by the strand of phloem. This is the most primitive and simplest type of stele.

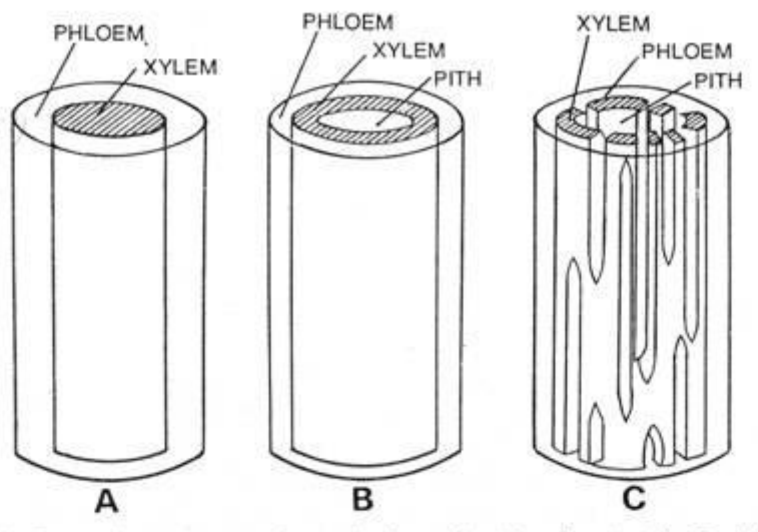


Fig. 37.42. Types of arrangements of vascular tissues in steles. A, protostele; B, siphonostele; C, dictyostele.

There are several forms of protostele:

(a) Haplostele:

This is the most primitive type of protostele. Here the central solid smooth core of xylem remains surrounded by phloem (e.g., in Selaginella spp.).

(b) Actinostele:

This is the modification of the haplostele and somewhat more advanced in having the central xylem core with radiating ribs (e.g., in Psilotum spp.).

(c) Plectostele:

This is the most advanced type of protostele. Here the central core of xylem is divided into number of plates arranged parallel to each other. The phloem alternates the xylem (e.g., in Lycopodium).

(d) Mixed-pith stele:

Here the xylem elements (i.e., tracheids) are mixed with the parenchymatous cells of the pith. This type is found in primitive fossils and living ferns. They are treated to be the transitional types in between true protosteles on the one hand and siphonosteles on the other (e.g., in Gleichenia spp. and Osmunda spp.).

2. Siphonostele:

This is the modification of protostele. A stele in which the protostele is medullated is known as siphonostele. Such stele contains a tubular vascular region and a parenchymatous central region. Jeffrey (1898) interpreted that the vascular portion of siphonostele possesses a parenchymatous area known as a gap immediately above the branch traces only or immediately above leaf and branch traces.

On the basis of these branch and leaf gaps Jeffrey (1910), distinguished two types of siphonosteles. In one type, however, the leaf gaps are not found and they are known as cladosiphonicsiphonosteles. In the other type both leaf and branch gaps are present and they are known as phyllosiphonicsiphonosteles.

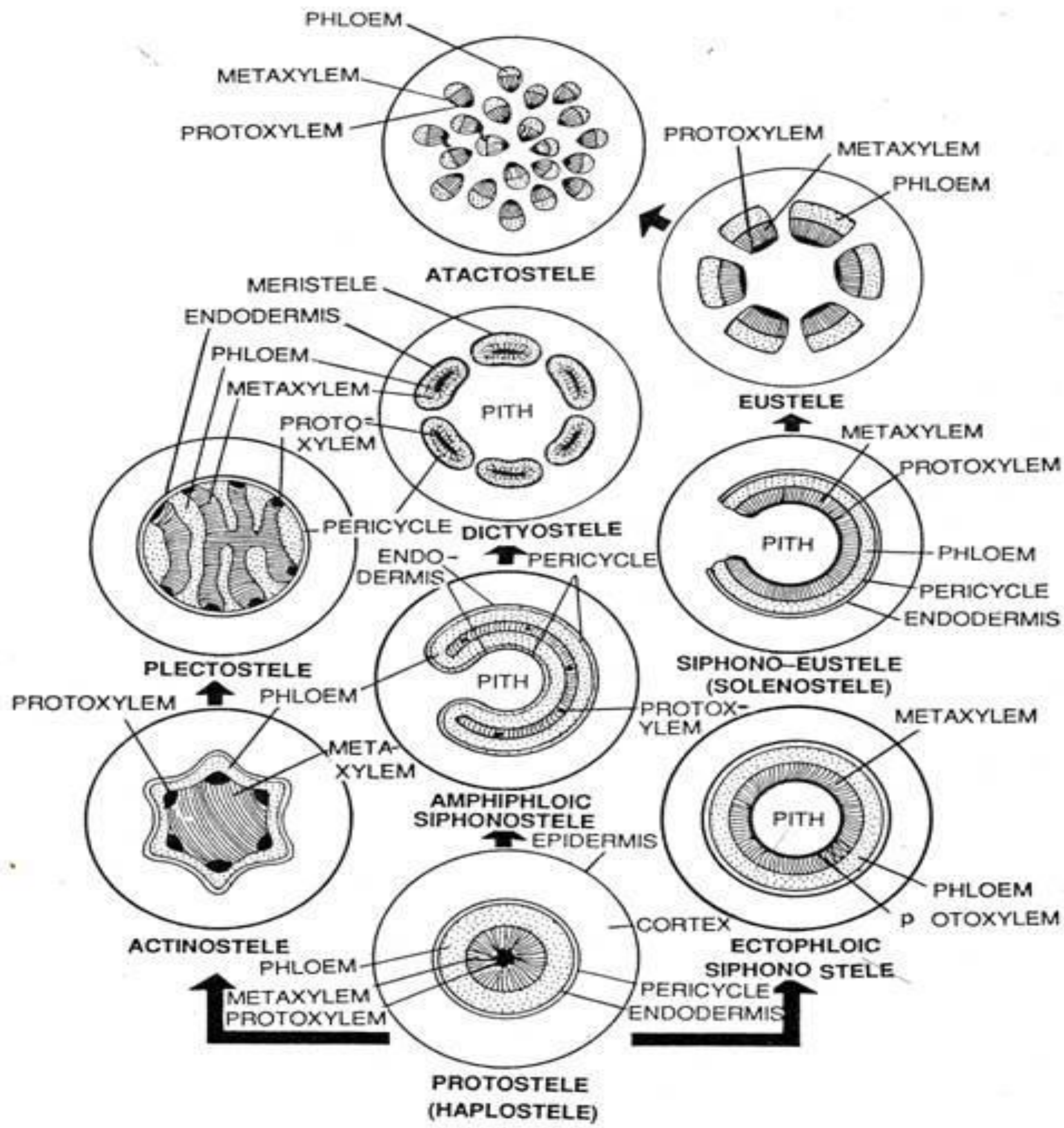


Fig. 37.43. The stelar system. Different types of steles arranged in evoluntionary sequence.

Jeffrey (1902, 1910, and 1917) interpreted the evolution of the siphonostele from the protostele as follows. He supported that the parenchyma found internal to the phloem and xylem has been originated from the cortex.

The supporters of this theory believe that the inner endodermis found to the inner face of the vascular tissue and the parenchyma encircled by this endodermis have been originated from the cortex. According to Jeffrey and other supporters of this theory the siphonosteles with internal endodermis are more primitive than those without an internal endodermis.

The siphonosteles which do not possess the inner endodermis are believed to have been originated by disintegration of inner endodermis during evolution.According to the theory proposed by Boodle (1901), and Gwynne Vaughan, the siphonostele has been evolved from the protostele by a transformation of the inner vascular tissue into parenchyma.

A siphonostele may be of the following types:
(a) Ectophloic:
In this type of siphonostele, the pith is surrounded by concentric xylem cylinder and next to xylem the concentric phloem cylinder.

(b) Amphiphloic:
In this type of siphonostele the pith is surrounded by the vascular tissue. The concentric inner phloem cylinaer surrounds the central pith. Next to the inner phloem is the concentric xylem cylinder which is immediately surrounded by outer phloem cylinder (e.g., in Marsilea).

3. Solenostele:

The vascular plants have been divided into two groups on the basis of the presence or absence of the leaf gaps. These groups are— Pteropsida and Lycopsida. The ferns, gymnosperms and angtosperms are included in Pteropsida, whereas the lycopods, horse-tails, etc., are included in Lycopsida.

The simplest form of siphonostele has no gaps, such as some species of Selaginella. However, among the simplest siphonostelic Pteropsida and siphonostelicLycopsida, the successive leaf gaps in the stele do not overlap each other and are considerably apart from each other.

According to Brebner (1902), Gwynne-Vaughan (1901) such siphonosteles which lack overlapping of gaps are known as solenosteles. They may be ectophloic or amphiphloic. Some authors (Bower, 1947; Wardlaw, 1952; Esau, 1953) however, interpret the solenostele as an amphiphloic siphonostele.

4. Dictyostele:

In the more advanced siphonosteles of Pteropsida, the successive gaps may overlap each other. Brebner (1902) called the siphonosteles with overlapping gaps as dictyosteles. In such cases the intervening portion of the vascular tissue between lateral to such leaf gaps is known as meristele. Each meristele is of protostelic type. The dictyostele with many meristeles looks like a cylindrical meshwork.

5. Polycylic Stele:

This type of stelar organization is the most complex one amongst all vascular cryptogams (pteridophytes). Such type of steles aresiphonostelic in structure. Each such stele possesses an internal vascular system connected with an outer siphonostele. Such connections are always found at the node.

6. Eustele

According to Brebner (1902), there is one more modification of the siphonostele known as eustele. Here the vascular system consists of a ring of collateral or bicollateral vascular bundles situated on the periphery of the pith. In such steles, the inter-fascicular areas and the leaf gaps are not distinguished from each other very clearly. The example of this type is Equisetum.