# SEETHALAKSHMI RAMASWAMI COLLEGE (AUTONOMOUS)

**ACCREDITED AT 'A' GRADE (3rd CYCLE) BY NAAC**
**AFFILIATED TO BHARATHIDASAN UNIVERSITY**
**TIRUCHIRAPPALLI – 620 002**

**LAB MANUAL**
**I B.Sc., Botany**

# PRACTICAL PAPER – I

## THALLOPHYTA, BRYOPHYTA, PTERIDOPHYTA, GYMNOSPERMS AND PALEOBOTANY


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**Assistant Professor**

# PREFACE

This practical manual covers the portions prescribed for I B.Sc students of Seethalakshmi Ramaswami College, Tiruchirappalli including Thallophyta, Bryophyta, Pteridophyta, Gymnosperm and Paleobotany. This manual will be an elementary hand book describing in detail the selected genera which would supplement the classroom theoretical knowledge helping the students understand the subject easily. Special care is exercised in giving the exact images of organisms and parts of higher plants. Apart from the images, drawing is also given to serve as model of the sketches to the students to draw in the record. The hand drawn figures are given in black background to differentiate from the actual images. The manual is planned in seven chapters covering algae, fungi, lichen, bryophyte, pteridophyta, gymnosperms and paleobotany. To make the students learn the characters before understanding the genera, at every section, general characters of divisions are listed down. It is followed by model question paper for practical paper- I and the expected keys along with the brief notes, the students expected to write in the practical examination. Worksheet for each chapter has been incorporated to train the students in the genera prescribed. I do hope and wish this manual will be a good guide to the students.

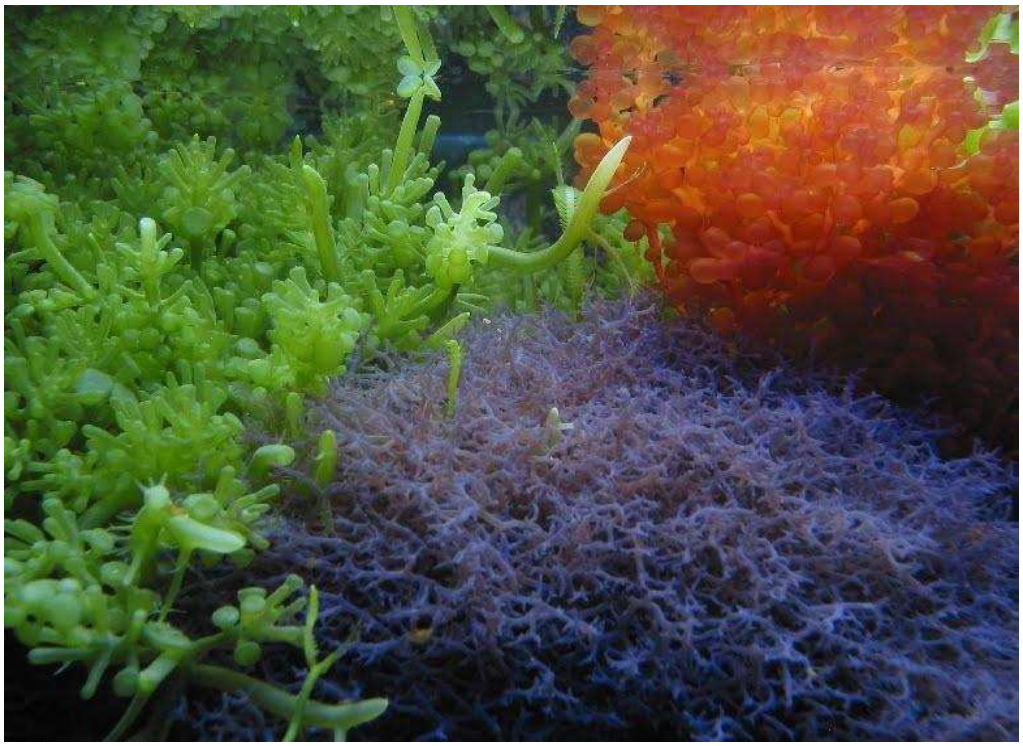
I profusely thank the management for the constant support. I offer my heartfelt thanks to Dr.(Mrs) Kanaka Bhashyam, the Principal for her best wishes. I acknowledge DBT for the Financial assistance under Star College Scheme.

***Dr. S. Kala***
**Assistant Professor**

# PRACTICAL PAPER-I

## (THALLOPHYTA, BRYOPHYTA, PTERIDOPHYTA, GYMNOSPERM AND PALEOBOTANY)

# ALGAE



# CHARACTERISTIC FEATURES OF ALGAE

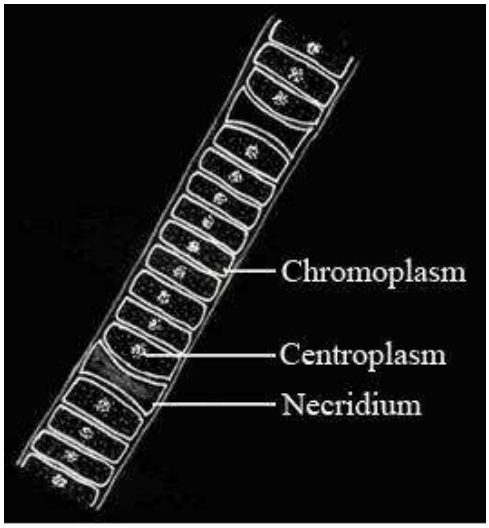
1. The Algae are **chlorophyll bearing-autotrophic**.
2. Cells contain **membrane bound organelles**.
3. Most algae are **unicellular** organisms, and there are a few multicellular groups.
4. Excepting a few all the algae are **aquatic.**
5. Most algae are **free-floating** and drift with water currents.
6. The color of the algal thallus which varies in different classes of algae is due to the presence of various **pigments.**
7. Algae reproduce **asexually** by **cell division**, or **sexually** producing **spores**.
8. The food materials which accumulate as food reserves are in the form of **Polysaccharides**, however, vary from group to group.

**Class** : Cyanophyceae

**Order** : Nostocales

**Family** : Oscillatoriaceae

**Genus** : Oscillatoria

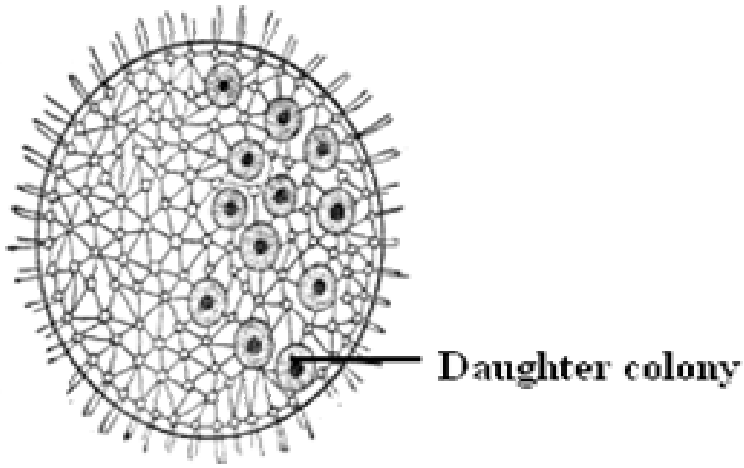

- Oscillatoria is a fresh water un-branched filamentous **blue green alga.**
- The cells are rectangular.
- Each cell has a cell wall and cytoplasm.
- Cytoplasm is differentiated into an outer coloured **chromoplasm** and central colourless dense **centroplasm** and **nucleus**.
- Biconcave dead cells called **necridia** are present in between the cells.

**Class** : Chlorophyceae

**Order** : Volvocales

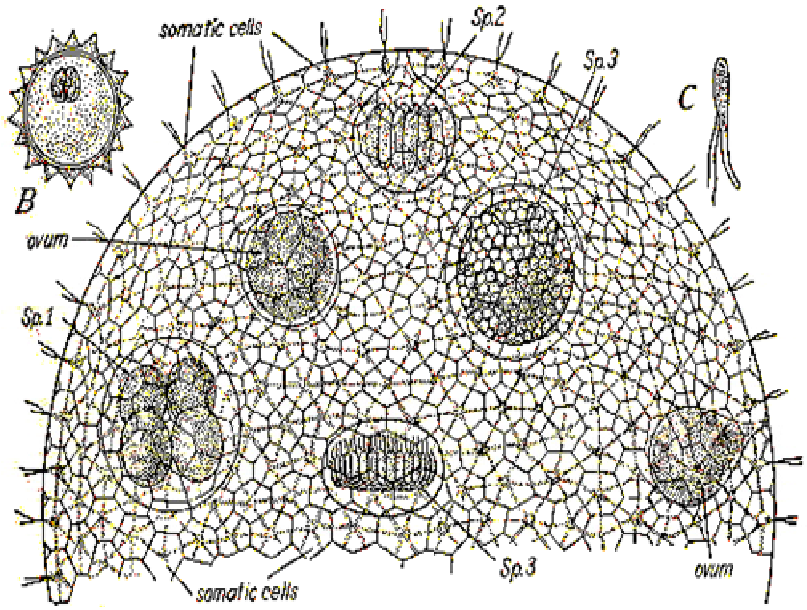
**Family** : Volvocaceae

**Genus** : Volvox




- Volvox is a small spherical motile **coenobium**.
- The colony is made up of hundreds of cells. It is enclosed within a common **mucilage substance**.
- Each cell has its own **mucilage envelope**.
- The cells are **uninucleate** with a large **cup shaped chloroplast**, a **stigma** and **flagella**.
- The cells are interconnected by **protoplasmic strand**.

## SEXUAL REPRODUCTION




B: zygote, with male and female nuclei uniting, and protective shell secreted after fertilization. C: microgamete or spermatozoon. Sp. 1, 2, and 3: developing sperm-spheres.

- Sexual reproduction is **oogamy**.
- The male sex organs named antheridia develop from reproductive cell called **gonidia** in the **posterior part** of the colony.
- Each antheridium consists of about 64 to 128 **biflagellate sperms** which are arranged in the form of a hollow sphere.
- Oogonia develop from gonidia in the posterior part of the colony.
- Oogonium is round with **non-motile** haploid uninucleate **egg** or ovum.

**Class** : Chlorophyceae

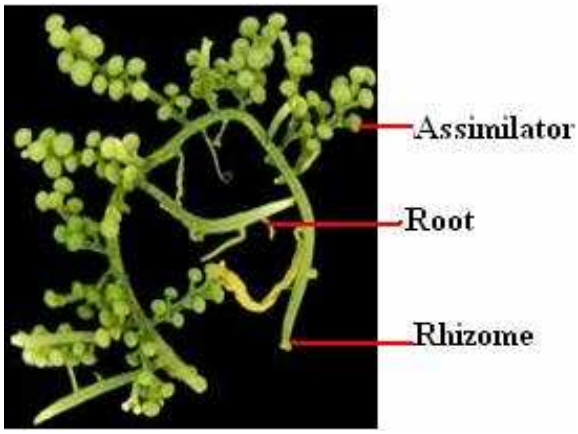
**Order** : Siphonales

**Family** : Caulerpaceae

**Genus** : Caulerpa

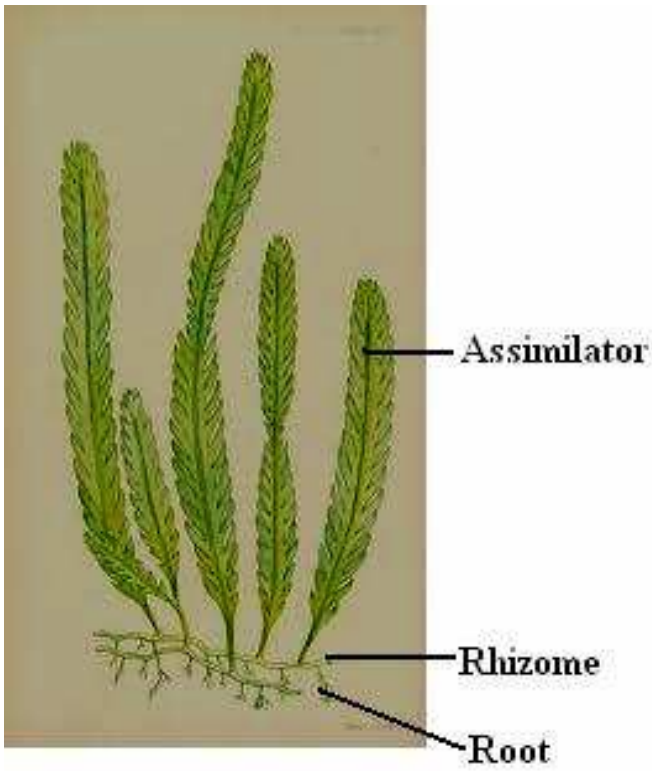
**ASSIMILATORS**

**Caulerpa racemosa**



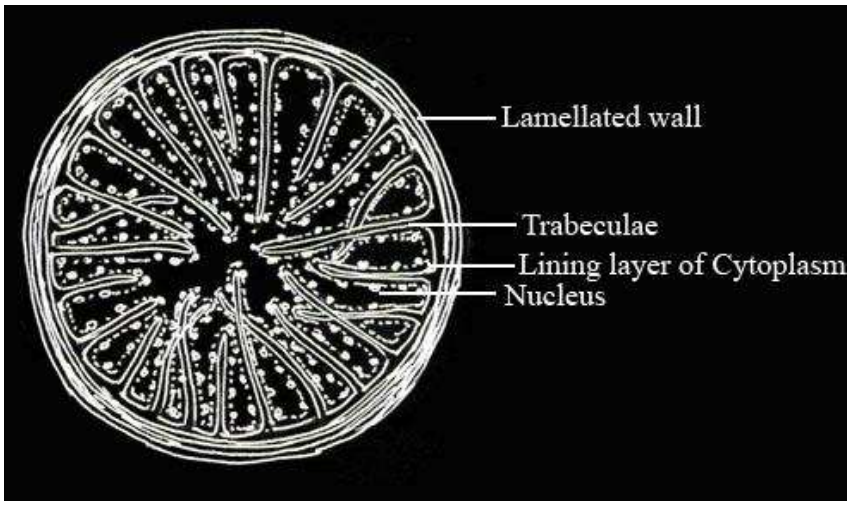

- It is differentiated into a cylindrical **rhizome-like creeping portion**.
- The rhizome bears a number of erect branches on its upperside and are called **assimilatory shoots**.
- They are **grape-like** in appearence.
- From the lower side of the rhizome arise numerous branched thread-like colourless **rhizoids**.

## Caulerpa scalpelliformis




- It is differentiated into a cylindrical rhizome-like **creeping portion**.
- The rhizome bears a number of erect branches on its upper side and are called as **assimilatory shoots**.
- They possess **flattened bright branches** that arise pinnately and numerous thread-like branched colourless **rhizoids**

## T.S. of Rhizome



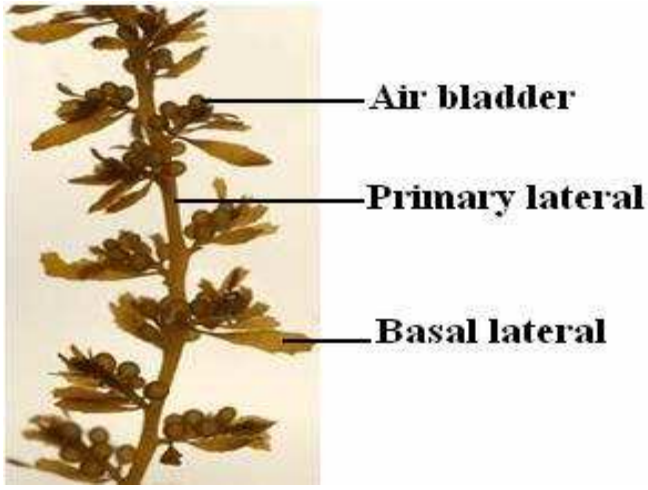

- The cross section of rhizome has numerous transverse and longitudinal cylindrical strands running across the cavity in all parts.
- These skeletal rods are made up of cellulose and pectin material and are called **trabeculae**.
- They are arranged perpendicular to the surface.
- The cell wall gradually increases in thickness by deposition of material in successive stratum.

**Class** : Phaeophyceae

**Order** : Cyclosphorae

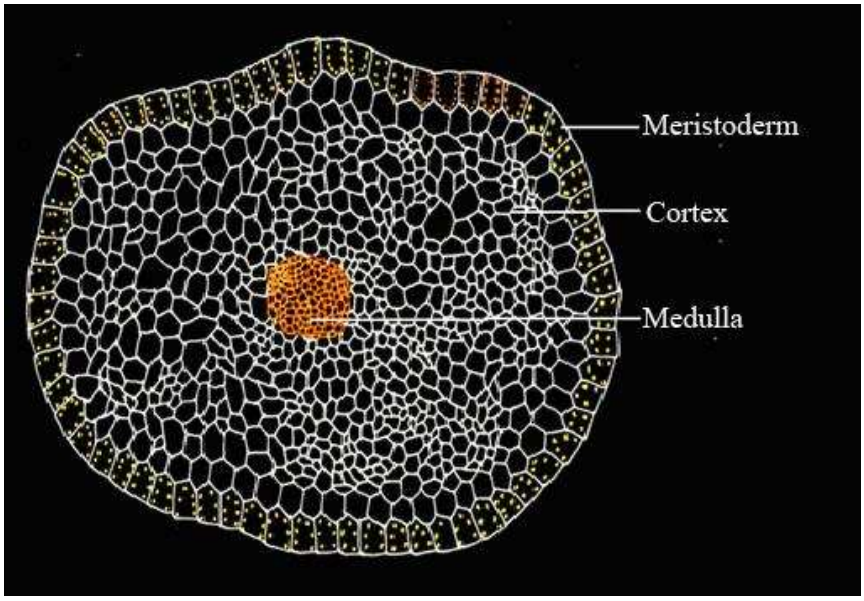
**Family** : Sargassaceae

**Genus** : Sargassum



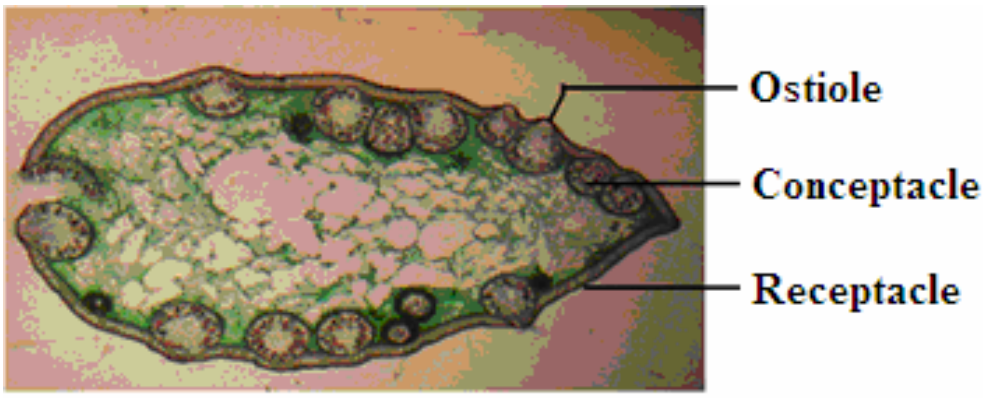

- The thallus of Sargassum is **erect** and **branched**.
- It is attached to the substratum by a **discoid hold fast**.
- Main axis bears a number of **primary laterals** and **secondary laterals**.
- The secondary laterals are much branched to form the **receptacle**.
- From the base of the primary laterals arise leaf-like structures called **basal lateral**.
- **Air bladders** are present in the lower part of the secondary lateral.
- The receptacle bears **reproductive structures** called **conceptacle**.

**Sargassum stem T.S.**



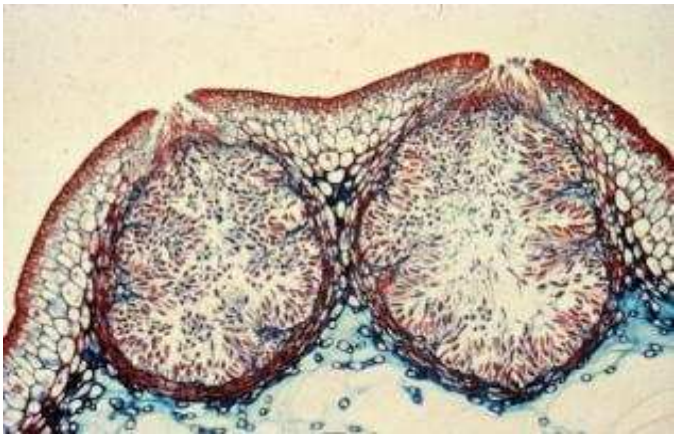

- The section of stem is almost circular in outline.
- It is differentiated into three regions: **(i) Meristoderm, (ii) Cortex and (iii) Medulla**.
- Meristoderm is the outermost **single layered**.
- It consists of many **compactly arranged** cells.
- It is covered by **mucilage** and rich in chromatophores.
- The cells remain **meristematic**.
- The cortex constitutes the **assimilatory region**, forms most of the axis.
- The cells are narrow and elongated with **intercellular spaces**.
- This acts as region of **conduction**, transporting water and essential nutrient from one part of the thallus to the another.

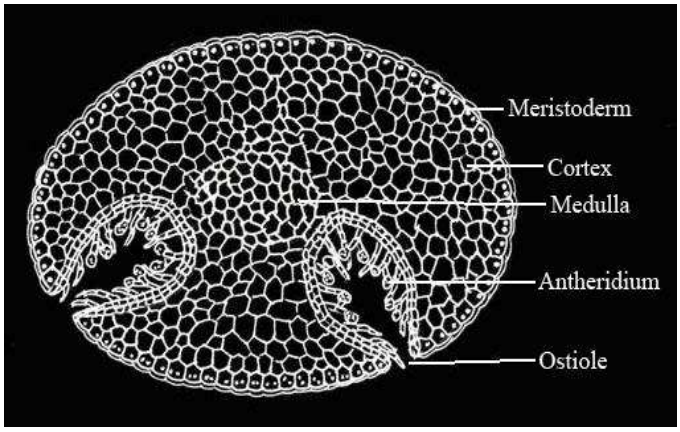
**Leaf T.S.**




- The cross section of leaf shows an outer **epidermis,** an **inner medulla** and **middle cortex**.
- The epidermis is single-layered and consists of closely arranged **thin-walled** cells.
- The epidermal cells contain **chromatophores.**
- The epidermis is followed by **cortex**.
- The cortex is made up of thin-walled polygonal cells. It is storage in function.
- Many flask shaped cavities lie embedded in the cortex. These cavities are called **cryptoblast.**
- The medulla occurs at the middle of the cortex. It consists of thick-walled cells. It serves as **conducting tissue.**

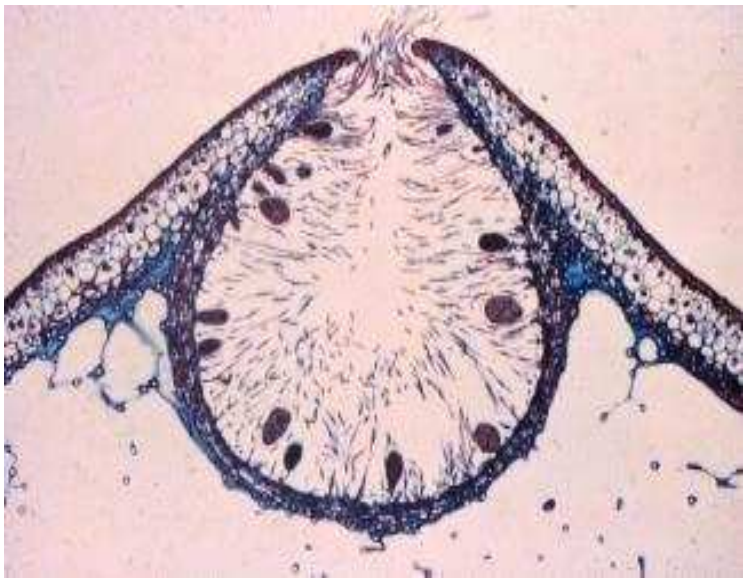
## Male conceptacle

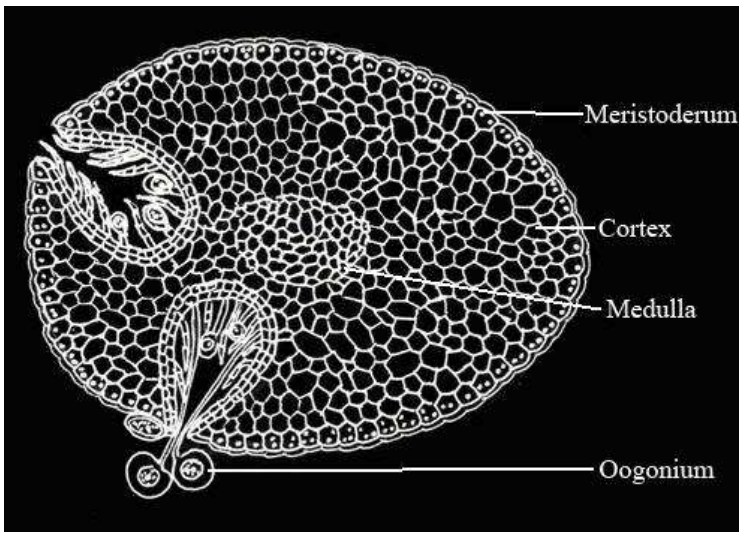





- Conceptacle is a **depression** or cavities **embedded in the cortex** composed of small flat cells.
- Numerous **flask-shaped** cavities arise from the wall of the conceptacle.
- It opens outside by small pore called **ostiole**.
- Larger number of **antheridia arise** from the **lower branches** of paraphysis.
- The **wall** of the anthridia is **two layered** and contains **64 antherozoids**.

## Female conceptacle






- Female conceptacle possess the female reproductive organs called **oogonia**.
- Oogonium is **oval** or sub-spherical and its wall is **three layered**.
- Each oogonium is **uninucleate.**

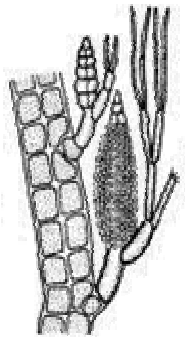
**Class** : Rhodophyceae

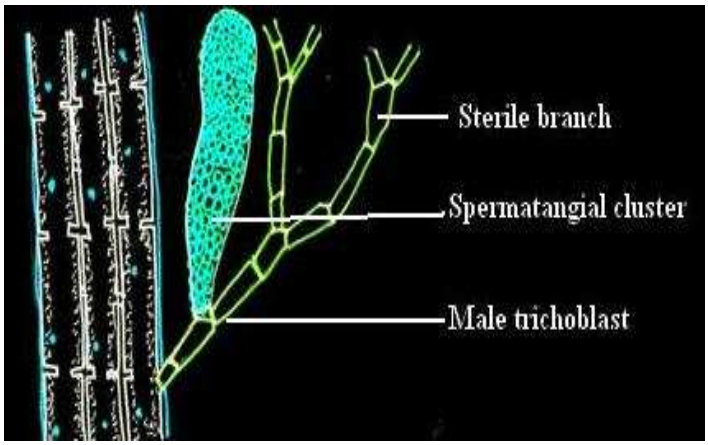
**Order** : Ceramiales

**Family** : Rhodomelaceae

**Genus** : Polysiphonia

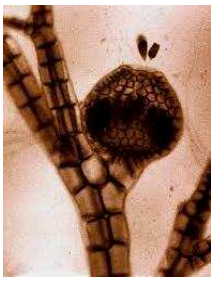
**Filament with spermatangial cluster**

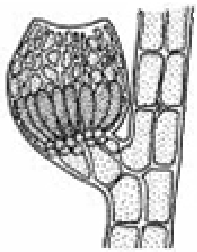


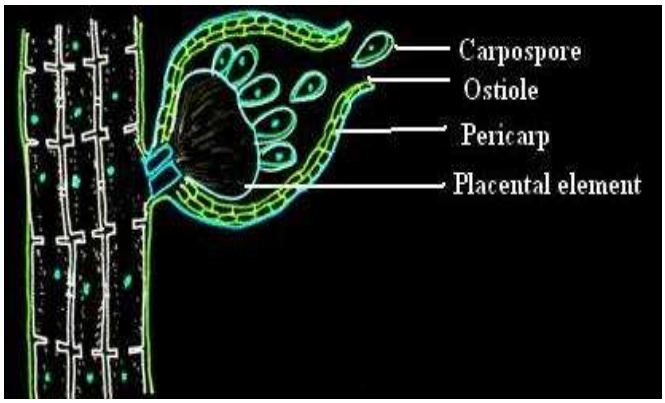



- Filaments of polysiphonia are **multicellular, branched, polysiphonous** with a central siphon surrounded by peripherial siphons.
- Fertile **trichoblasts** produces antheridial cluster near the apex.
- **Spermatia** are directly liberated through the surface of spermatangium.
- Spermatia are small **oval or spherical**, **uninucleate** and being **non-motile** is trapped by water currents.

**Filament with cystocarp**

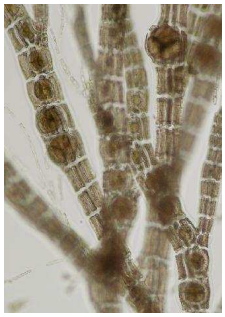


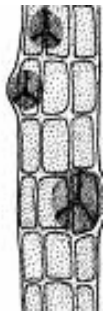


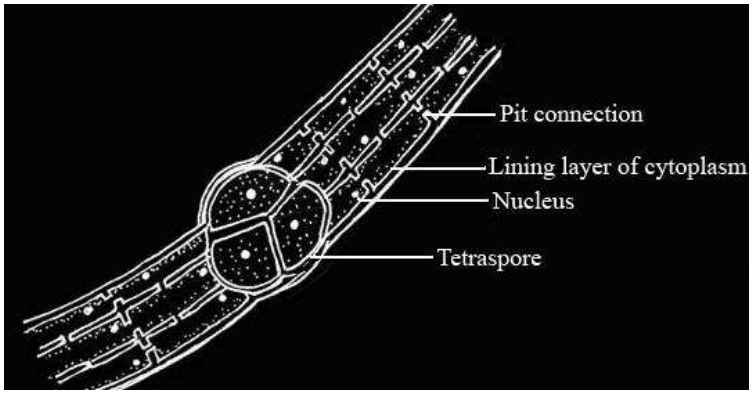



- The pericarp forms a **cystocarp** after fertilization and this plant is called as **carposporophyte**.
- It is oval, **urn-shaped** structure attached lateral to the filament.
- It opens to the exterior by **ostiole**.
- The wall of the cystocarp is **single layered.**
- At the base of the cystocarp is **placenta** from which arise several gonimoblast initials.
- The terminal cell of this filament acts as **carposporangium** producing carpospore.
- Carpospores are **oval**, **uninucleate** and **diploid**, develop into tetrasporophyte.

## Filament with tetrasporophyte








- The plant bears the **tetrasporangium** which is diploid.
- They are usually in longitudinal sori produced mostly by pericental cell.
- The tetrasporangia possess four tetrahedrally arranged **uninucleate** and **haploid tetraspores**.
- They develop into gametophyte.

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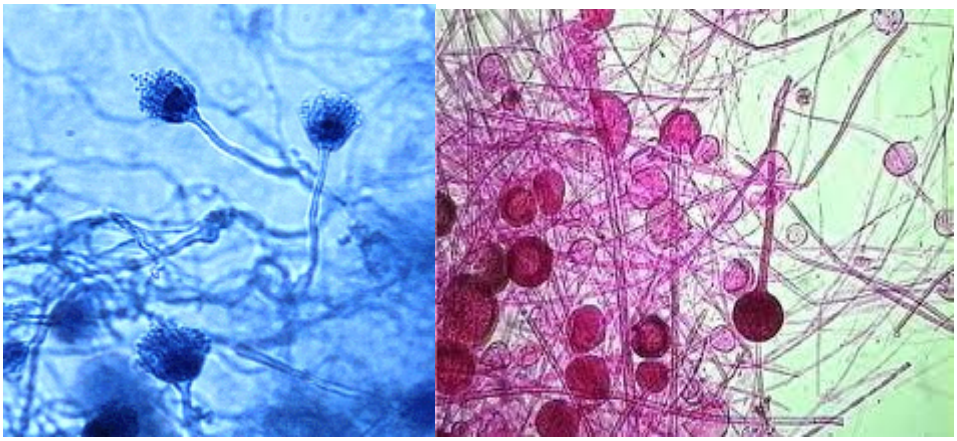
# FUNGI



# CHARACTERISTIC FEATURES OF FUNGI

- The fungi lack **chlorophyll.**
- They are **heterotropic** and live as **parasites (or) saprophytes.**
- Thallus is **mycelium,** an interwoven mass of fine, tubular structure called **hyphae.**
- The cell wall is made up of fungal cellulose called **chitin.**
- Reserve food material is **glycogen.**
- Fungi grow in a wide variety of habitats.
- There is gradual and progressive simplification and ultimate elimination of the sexual apparatus from the lower to higher forms.
- Fungi reproduce by **asexual** and **sexual** methods.
- They are involved in two types of symbiotic relationships. In the mycorrhizae form, fungi derive energy from the roots of vascular plants. The other form involves the production of lichens with algae and cyanobacteria.

**Class** : Oomycetes

**Order** : Peronosporales

**Family** : Albuginaceae

**Genus** : Albugo

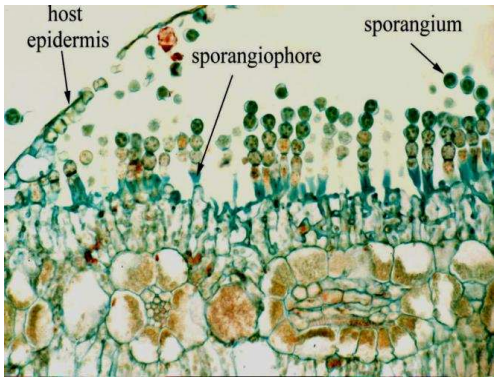
**Infected leaf**

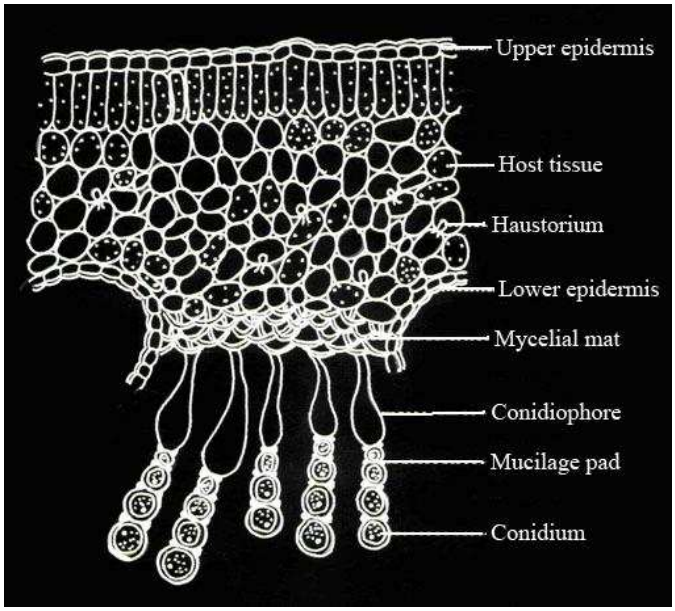

- Albugo causes **white rust** or **blister rust disease** on the leaves of **Amaranthaceae**.
- The disease is in the form **of shiny white smooth raised irregular blister**.

**Control Measures**

- Rotation of crops
- Removal and destruction of infected plants.
- Spraying fungicides

## Infected leaf T.S




- The mycelium produces pads of hyphae below the epidermis.
- Short upright club-shaped structures arise from this mycelium forming **sporangiophore**.
- These produce chain of conidia in **basipetal** succession.
- A **gelatinous pad** is formed in between the successive sporangia.
- These are conidia which are the **asexual reproductive** unit.

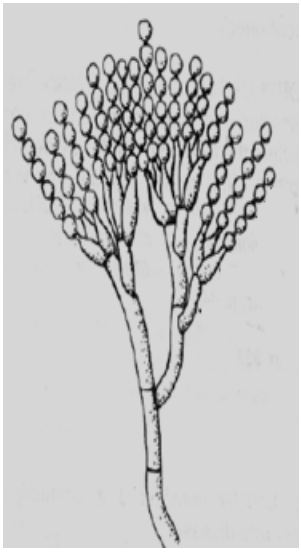
**Class** : Ascomycetes

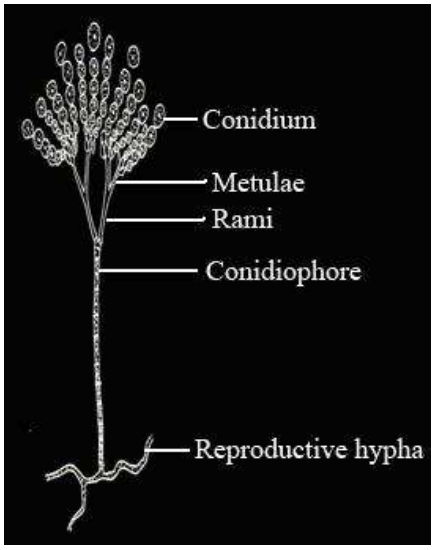
**Order** : Aspergillales

**Family** : Aspergillaceae

**Genus** : Penicillium

**Mycelium bearing conidiophore**

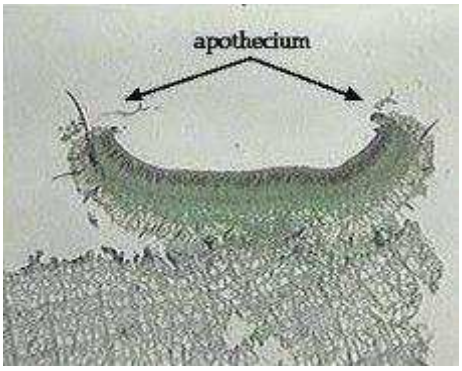




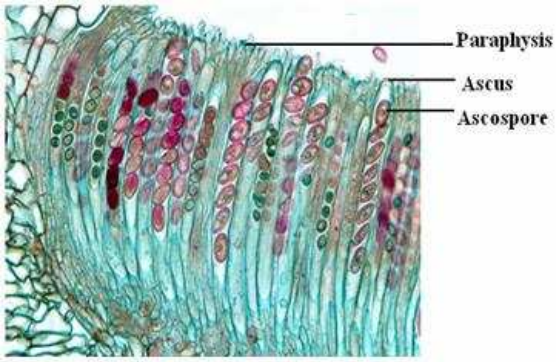

- Penicillium is a **saprophytic** fungus.
- The mycelium is **branched** and **septate**.
- From the mycelium arises short tubular structure called **conidiophore**.
- It divides into primary, secondary and tertiary branches.
- The tip of the conidiophores bears bottle shaped structure called **sterigmata**.
- They cut off **conidia** in **basipetalous** succession.
- Each conidium is a **globular** structure with single nucleus and the branch which bears **metulae** is called **rami.**

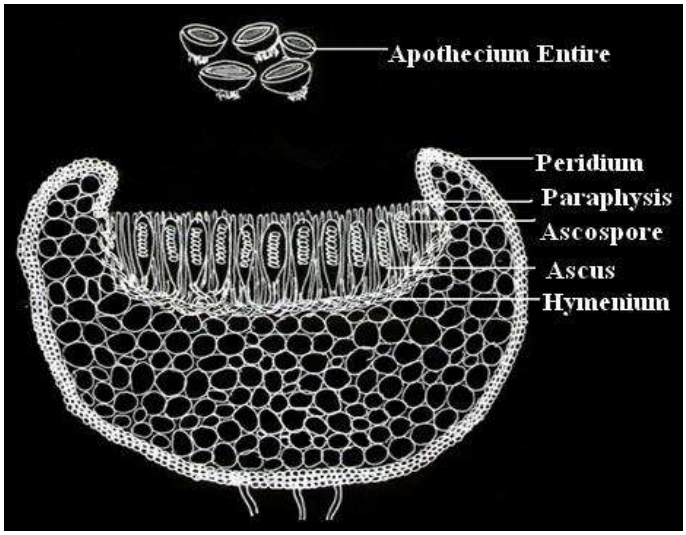
**Class** : Ascomycetes
**Order** : Pezizales
**Family** : Pezizaceae
**Genus** : Peziza

**Apothecium - Entire**




**A portion enlarged**




- It is a saprophytic **coprophilous** fungus.
- The fruit body is an **apothecium** and they are seen above ground.
- It has the following structures:

  (i) The base of apothecium is formed of **mycelium**; (ii) **Hymenium** consists of many fertile **ascus** and sterile **paraphysis**; (iii) **sub-hymenium** is made up of **pseudoparenchymatous** hyphae; (iv) in each ascus there are **eight uninucleate ascospores**.

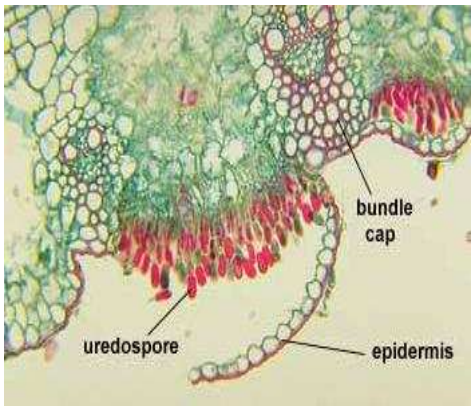
**Class** : Basidomycetes

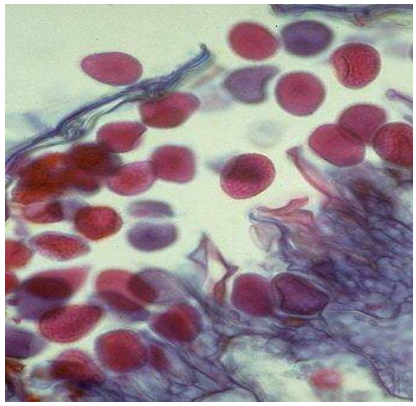
**Order** : Uredinales

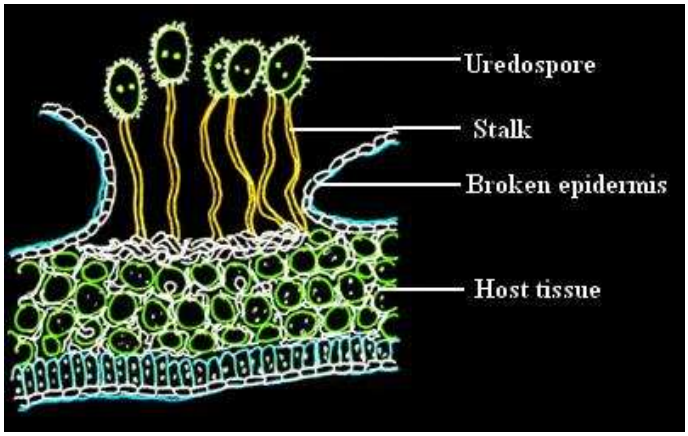
**Family** : Pucciniaceae

**Genus** : Puccinia

**T.S of Puccinia infected leaf passing through uredosorus**

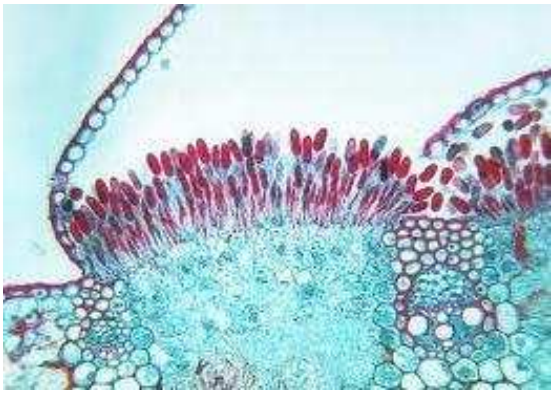


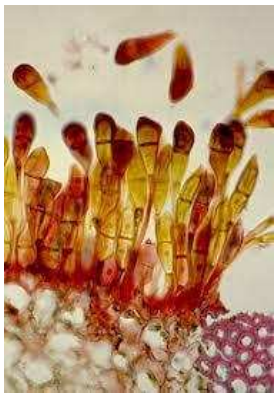



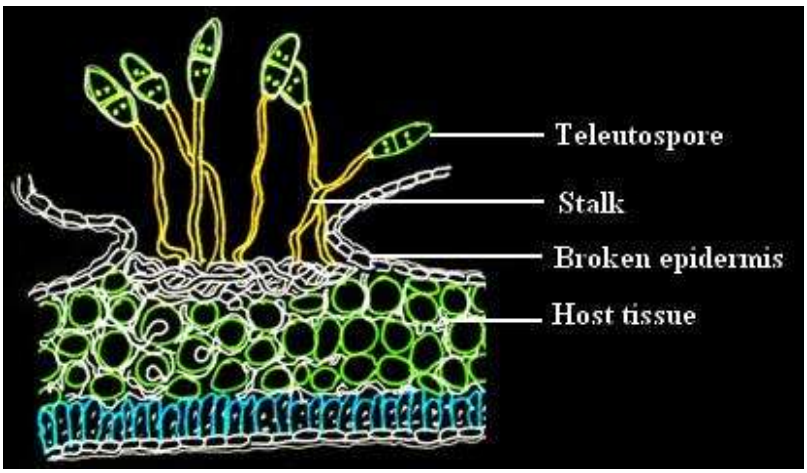



- This stage is found in **primary host, wheat.**
- The mycelium produces a number of **reddish brown pustules** on the **upper surface** of leaf.
- Each pustule is a uredosorus, consisting of number of uredodospores.
- The uredospores are **stalked, unicellular, rounded, bi-nucleate spores**.
- Uredospore is a **repeating spore**.

## T.S of Puccinia infected leaf passing through teleutosorus

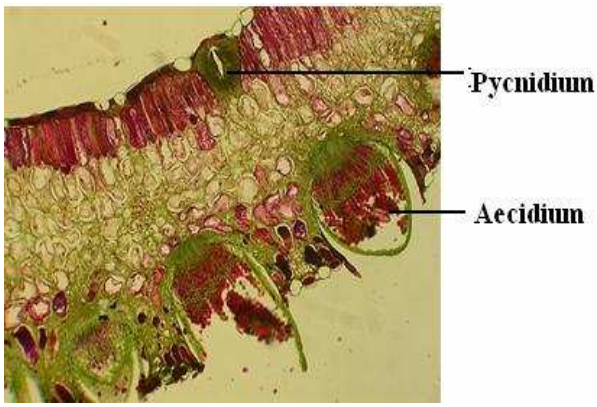




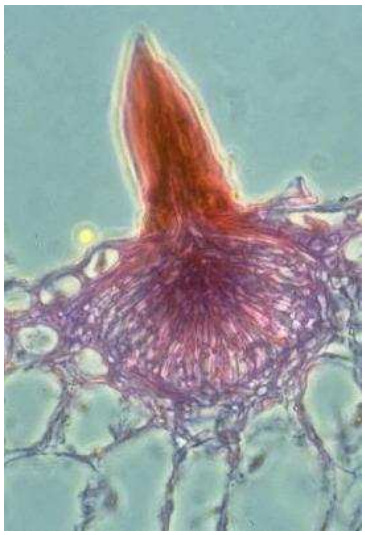


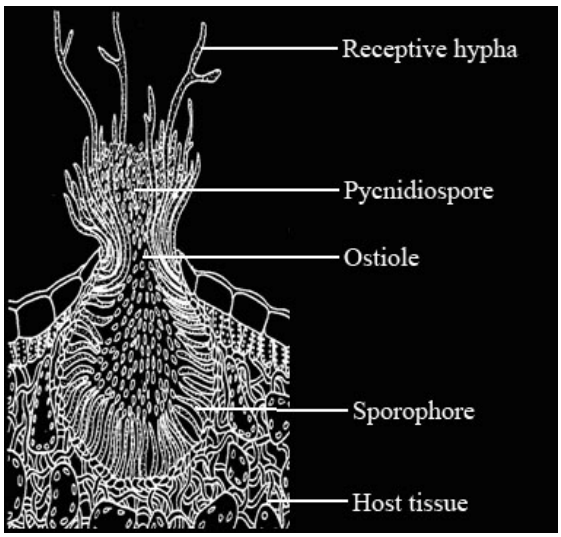

- This stage is found in **primary host, wheat**.
- They are called **winter spores** as they are produced in the beginning of winter.
- They produce **black streaks** in leaf and stem.
- The teleutospores are **stalked, bicelled and binucleate**.

## T.S of Puccinia Infected leaf through pycnidia and aecidia



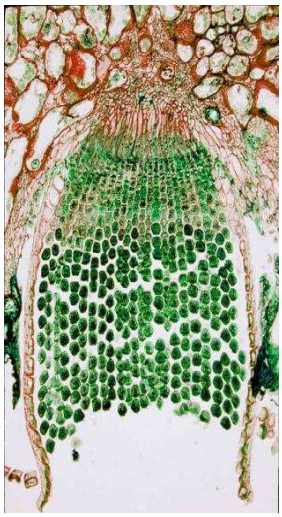

## Pycnidia

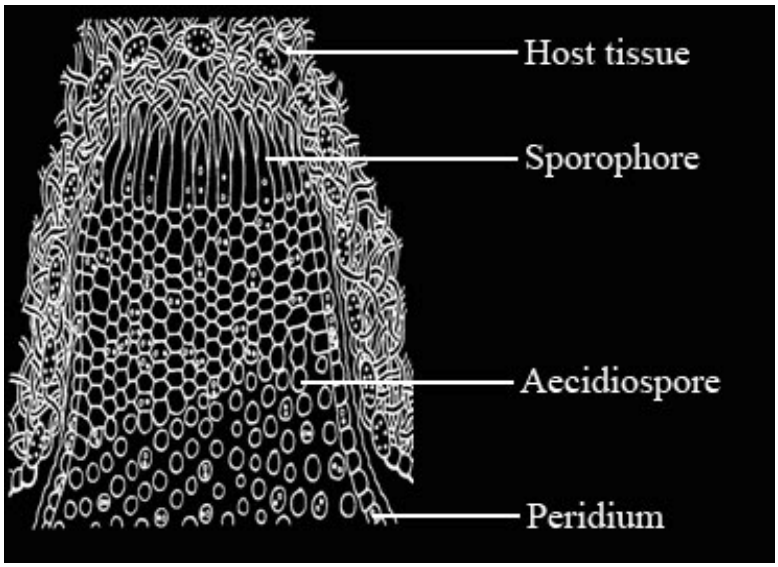





- ❖ This stage is found in **secondary host**, **Berberry plant**.
- ❖ They produce flask-shaped structures called the **pycnidium** or **spermogonium**.
- ❖ The pycnidium opens on the surface of the leaf by a minute pore called **ostiole**.
- ❖ The ostiole is guarded by a tuft of sterile hairs called **periphysis**.
- ❖ At the lower portion of the pycnidium there are uninucleate hyphae called **spermatophores** (Sporophore).
- ❖ The tip of the spermatophores produce **pycnidiospores or spermatia**.
- ❖ The pycnidiospores are of either **(+) or (-) strain**.

## Aecidia






- This stage is found in **secondary host**, **Berberry plant**.
- The aecidial cup is surrounded by sterile hyphae called **peridium.**
- From the middle of the cup, the dikaryotic mycelium forms a number of erect hyphae called **sporophores.**
- Each sporophore produces a number of **binucleate** spores called the **aecidiospores in chain.**
- In between the aecidispores small, sterile intercalary cells are present called **disjunctor cells**.

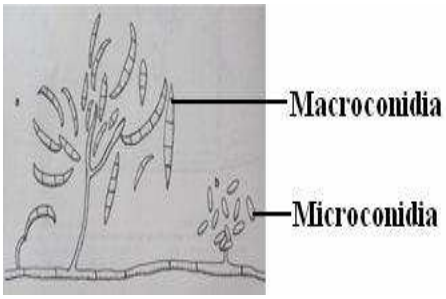
**Class** : Deutromycetes

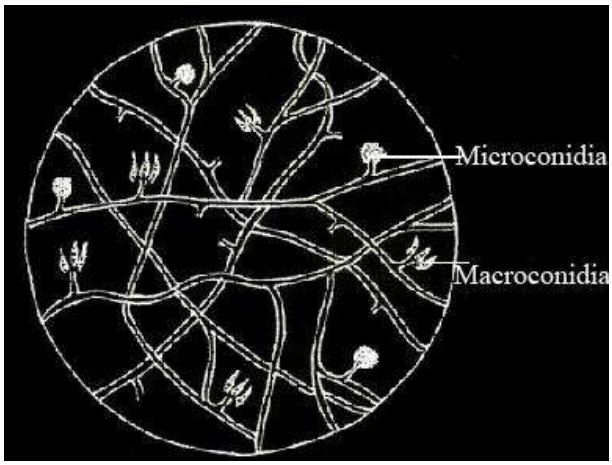
**Order** : Moniliales

**Family** : Tuberculeriaceae

**Genus** : Fusarium

**Microconidia and Macroconidia**




- Fusarium is a **saprophytic fungus**.
- The mycelium consists of **septate** and **branched** hyphae.
- They are both **intercellular** and **intracellular**.
- It reproduces asexually by **macrocomidia** and **microcoinidia.**
- The microconidia are **small** and **rounded.**
- The macroconidia are large **multicellular**, **elongated**, **sickle-shaped** produced at the tip of conidiophores.

# LICHENS

**Characteristic features of Lichen**

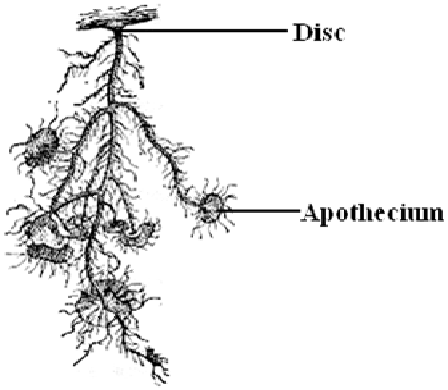
- Lichens are dual organisms formed by the **symbiotic association** of a **fungus** and an **algae.**
- Fungal partner is usually an **Ascomycete** (sometimes a Basidiomycete), called as **mycobiont.**
- Algal partner may be a **green** or **blue-green alga**, called as **phycobiont**.
- Fungus and alga together appear as a **single plant**.
- Lichens vary in their growth forms and mode of attachment to the substratum.
- Based on morphological features, three types of lichens are recognized- **Crustose lichen, Foliose lichen and Fruticose lichen.**
- Based on the internal structures, lichens are divided into two types – **Homoiomerous thalli and heteromerous thalli.**
- Reproduces by **vegetative reproduction – fragmentation, rejuvenation, isidia formation and soredia**
- **Spore** formation- pycnidia formation.
- **Sexual reproduction-** fungal partner is responsible for reproduction male reproductive organ is **spermagonium** and female reproductive organ is **carpogonium**.

# LICHEN

**Foliose lichen** eg. **Parmelia**

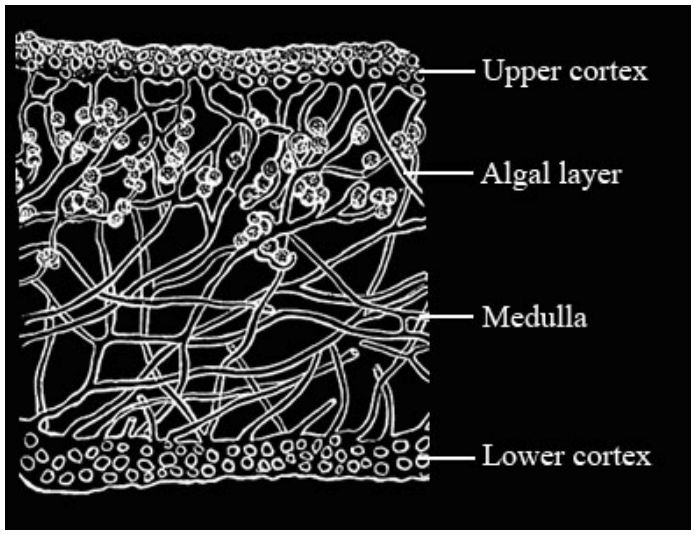
- The foliaceous lichen has a **flat leaf-like** lobed or deeply incised thallus.
- Thallus is attached to the substratum by **rhizine** which are rhizoid-like out growth that arise from the underside of the thallus.
- May be attached to the substratum by single rhizine or several rhizines.

**Fruticose lichen** eg. **Usnea**



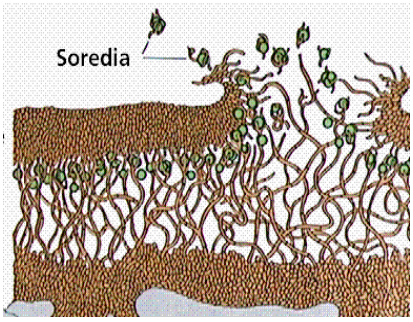

- The fruticose lichen has **much branched cylindrical ribbon-shaped** body.
- It remains attached by the narrow **basal flattened disc** and may be either **erect** or **drooping**.

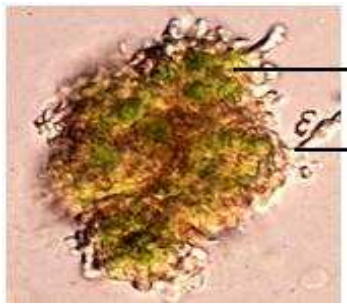
## T.S. of thallus

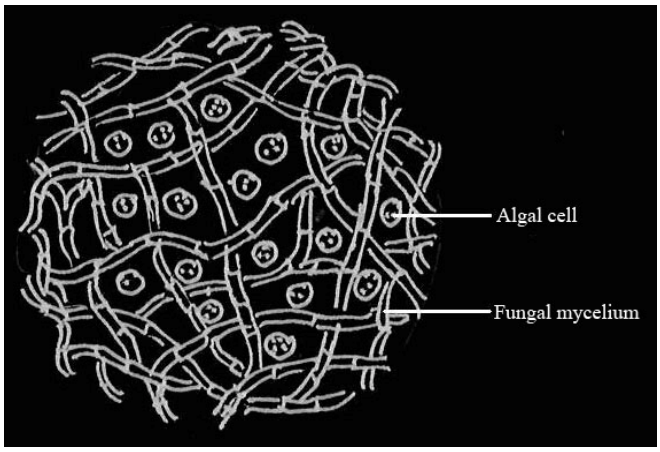



- The main frame work of the thallus is made up of an **interwoven mass of hyphae,** the fungus enclosing unicellular or filamentous algae.
- The thallus is differentiated into **four regions**.
- The upper region consists of vertical hyphae without intercellular spaces forming the **upper cortex**.
- Below the upper epidermis is **algal zone** containing many algal cells.
- Next zone consists of **loosely interwoven hyphae** helping in gaseous exchange.

## Soredium

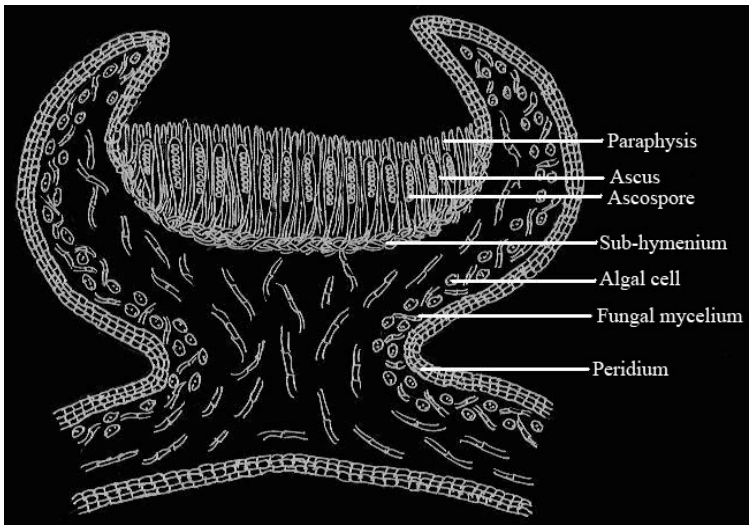



- Soredia formation is the **common method** of **vegetative propagation**.
- They develop as **bud-like** outgrowth either over the surface of the thallus or in local patches called **soredia**.
- They develop in the **gonidial layer** of the upper cortex.
- When detached from the thallus, they are blown away by wind and germinate falling on suitable substratum.

## Apothecium




- The apothecium of lichen is a **saucer-shaped** fruit body.
- It is lined with **palisade-like layer** known as **hymenium**.
- It consists of a series of elongated cells, the **asci** intermingled with sterile hyphae called **paraphysis.**
- Each ascus contains **8 ascospores**.
- Each ascospore when liberated comes in contact with suitable algae producing the lichen thallus.
- Below the hymenial layer is the **sub-hymenium** containing numerous interwovewn hyphae.
- Outer cortex with loosely interwoven hyphae and inner medulla with loosely arranged cells.

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# BRYOPHYTA

## Characteristic features of Bryophytes

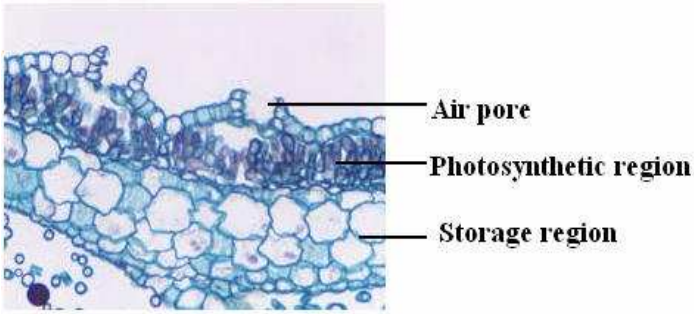
- The Plant body is a **gametophyte.** They grow in areas which arc in between the aquatic and terrestrial habitats i.e. **amphibious zone** and hence known as **amphibious plants**.
- They have **thalloid** or leafy multi cellular green plant body.
- The smallest form is microscopic (e.g. Zoopsis). The largest genus recorded so far is an Australian Dawsonia which is about 70 cms in length.
- The dominant plant body is gametophyte (n) which is **independent.**
- The plant body lacks true roots, stem or leaves.
- **Rhizoids** - (root like structure) serve the function of roots.
- The plants are green and possess **chloroplasts**.
- They show **autotrophic** mode of nutrition.
- **Vascular tissues** are completely **absent**.
- Sexual reproduction is **oogamous**.
- Sex organs are **multi cellular** and jacketed.
- Male reproductive organ is known as **antheridium**. It is a club shaped structure being borne by a narrow stalk. It produces **biflagellate** and **motile** male gametes or antherozoids.
- The female sex organ is known as **archegonium**. It is a **flask shaped** structure having a swollen base and a narrow neck.
- **Water** is essential for **fertilization**.
- The diploid zygote undergoes repeated divisions to form a multi cellular sporophyte.
- **Sporophyte is dependent** on the gametophyte for nutrition.
- Sporophyte generally consists of **foot, seta and capsule**. It produces haploid spores (homospores).
- Spores on germination give rise to gametophyte plant.
- Gametophyte and sporophyte differ in form which alternate with each other, thus heterologous alternation of generation is seen in Bryophytes.

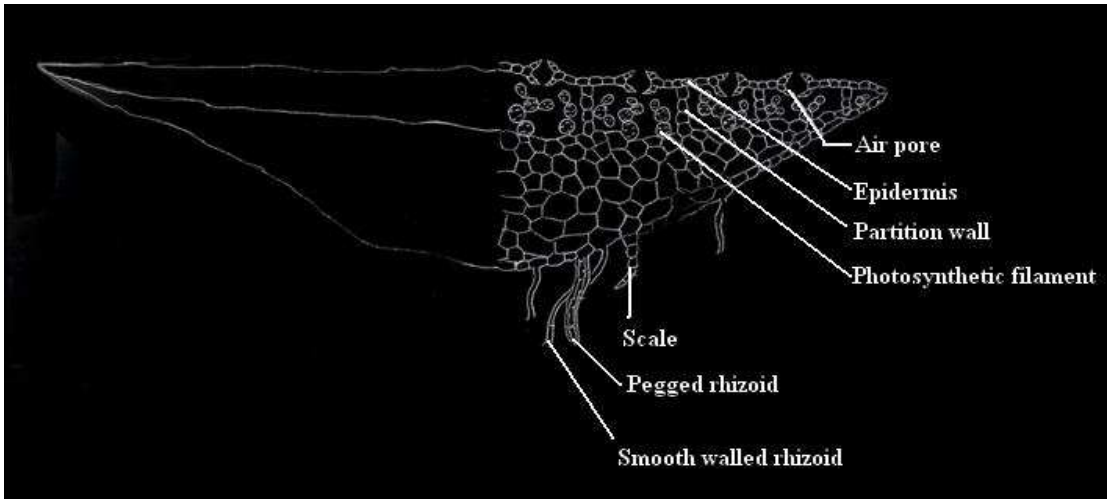
**Class** : Hepaticopsida
**Order** : Marchantiales
**Family** : Marchantiaceae
**Genus** : Marchantia

**Dorsal view**


- The plant is **haploid gametophyte**.
- The plant consists of **thallus, rhizoids &scales**.
- Fleshy, dark green, **prostrate, dorsiventral& dichotomously branched**.
- The dorsal surface is divided in to rhomboidal shaped **areolae**.
- It has single **air pore**.
- The thallus has a **midrib** on the dorsal surface ends in a **notch** at the apex, where the **growing point** is present.
- **Gamma cups** arise from midrib.
- These cups bear **asexual** reproductive bodies called **gemmae.**

## THALLUS T.S

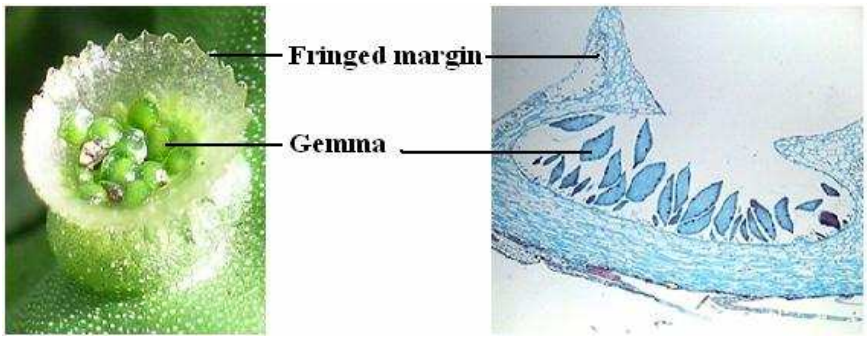


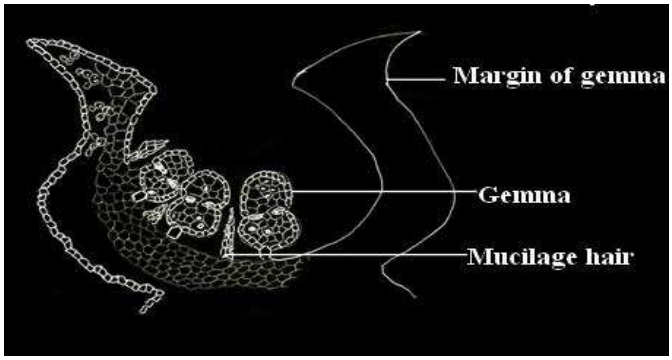




- It has two regions (i) **Dorsal photosynthetic region** (ii) **Ventral storage region**
- **Photosynthetic region** has upper epidermis with chimney like **air pores** which open in to lower air chambers.
- The air pore help in **gaseous exchange** for respiration & photosynthesis.
- The air chambers are separated by **partition layer**.
- From floor of each chamber arise short, simple or branched green filaments, called **photosynthetic or assimilatory filaments**.
- **Storage region** has thin walled **parenchymatous** cells.
- They contain **oil cells** and **mucilage cells**.
- The main function is **storage**.
- The lower most region of the storage region is single layer **lower epidermis** which bears **unicellular rhizoids** and **multicellular scales**.
- There are two types of rhizoids, **Smooth walled rhizoids & tuberculated or pegged rhizoids**.
- Smooth walled rhizoids are colourless and thin walled.
- The tuberculate rhizoids are thick walled with peg like in growths.
- **Function:** Fixation& absorption.

## Gemma cup

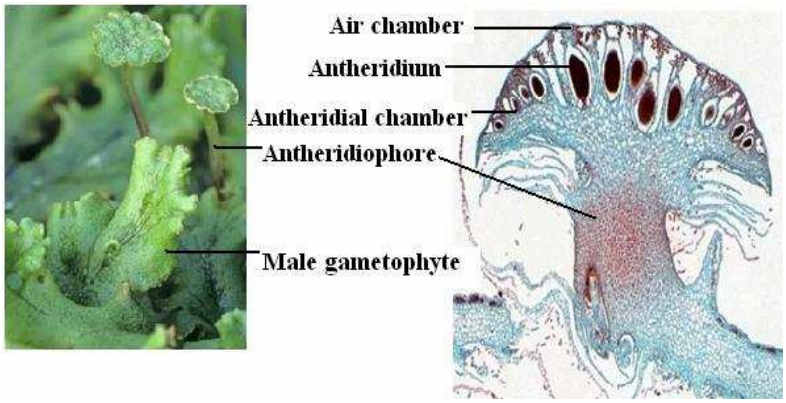
**Gemma Cup – A Closer View** **Section of a Gemma Cup**

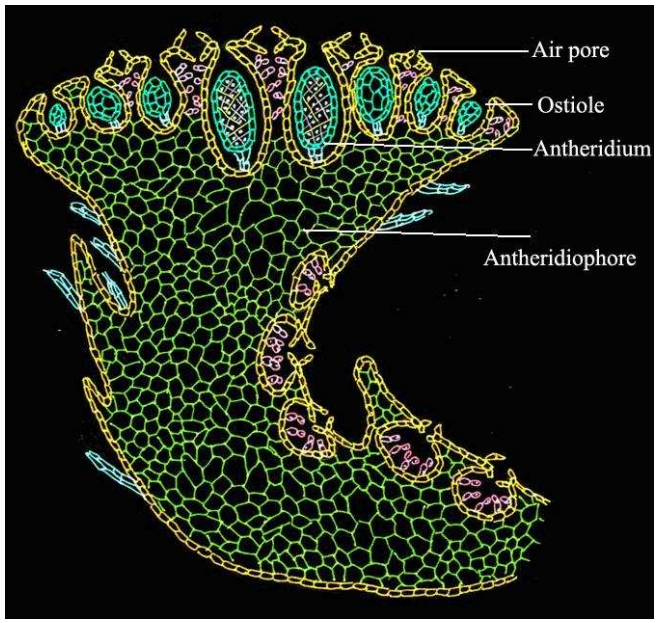



- Gemmae are **asexual reproductive bodies** produced in cup shaped structures called **gemma cups** on dorsal surface of the thallus.
- The margin of the gemma cup is toothed and membranous with many **gemmae.**
- Gemmae are attached to the bottom of the cup by **small, single celled stalk**.
- Many multicellular, **glandular hairs** are intermingled with gemmae.
- The mature gemma is **green, multicellular & lens shaped** structures.
- It has two deep **lateral notches** with **growing points**.
- The cells of gemma are **chlorenchymatous** with few oil cells and rhizoidal cells.
- The mature gemma separate from mother plant and develop in to **new plant**.

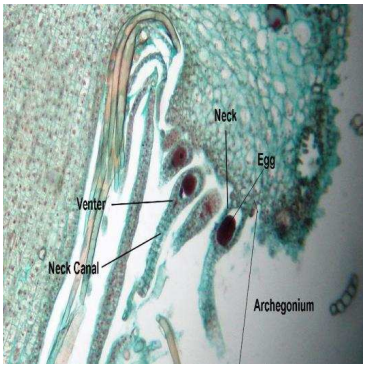
## Thallus with antheridiophore

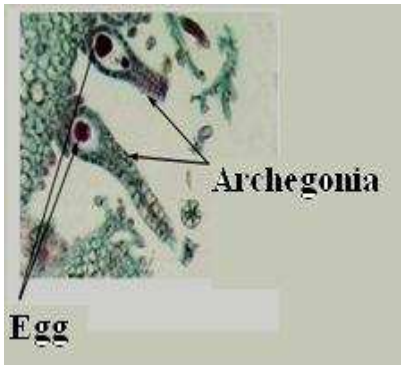


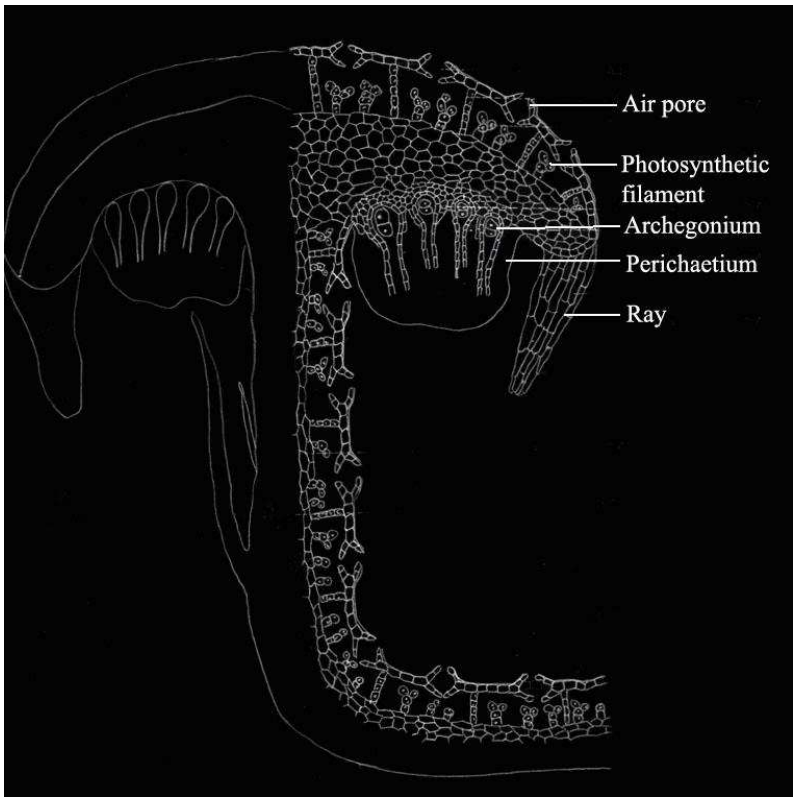




- Each antheridiophore has **stalk and receptacle**.
- The stalk is a **cylindrical** structure with a layer of air chambers on posterior side and two **vertical grooves** on the anterior side.
- The disc of the receptacle is made up of **assimilatory region** and **storage region.**
- The assimilatory chambers alternate with the flask-shaped cavities called **antheridial chambers.**
- Each antheridial chamber has **single antheridium** and it opens outside through **ostiole.**
- The mature antheridium consists of a **short stalk** and a rounded **body** called the **capsule.**
- The antheridium is surrounded by a single layered **jacket** or **antheridial wall.**
- The jacket encloses **androcyte mother cells.**

## Thallus with archegoniophore

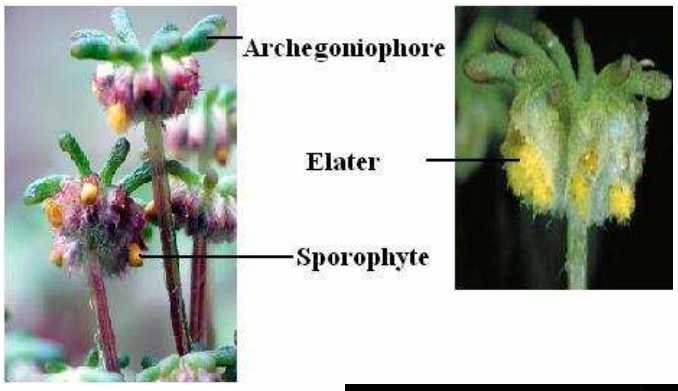


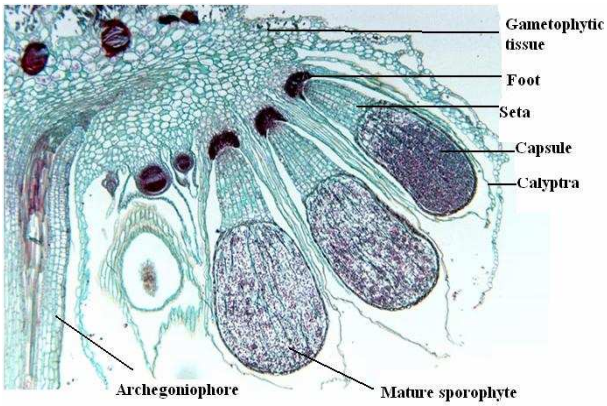



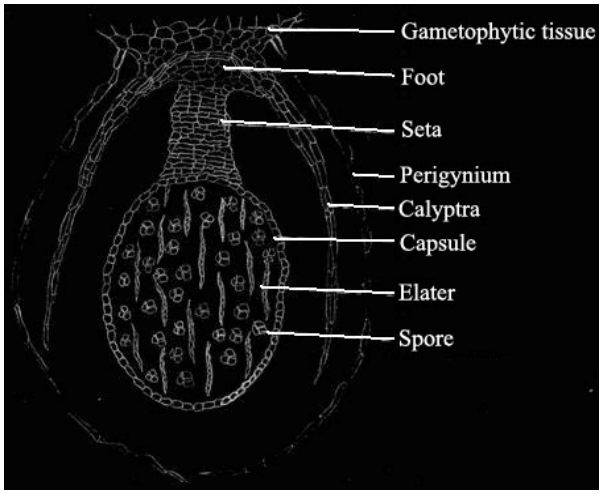




- Archegoniophore has **stalk and disc** shaped **receptacle**.
- The receptacle bears **8 lobes**.
- Each lobe has **12-14 archegonia** arranged in **acropetal** order.
- The mature archegonium is **flask shaped**.
- It has basal **stalk, venter &neck**.
- The venter has **egg** and **a venter canal cell.**
- The neck has **4-8 neck canal cells** and **4 lid cells**.
- In mature archegonium the neck canals and venter canal cell disorganize forming **mucilaginous fluid**.
- This mucilage **absorbs water** and help in **opening of lid cells**.

## Sporophyte




- The sporophyte of Marchantia is produced in the **female gametophyte.**
- The sporangium has three parts: **(i) Foot, (ii) Seta and (iii) Capsule.**
- Foot is the **basal portion**, **anchorage** and **absorptive** organ of the sporophyte.
- **Seta** is the middle portion and it connects foot with the capsule.
- The **fertile region** is the **capsule.** The outer layer of capsule is called **capsule wall**, encloses **fertile sporogenous** tissue.
- Sporogenous cells produce **spore mother cells & elater mother cells**.
- Elater mother cells produce elaters.
- Elaters are **hygroscopic diploid, sterile** and elongated with pointed ends. It has spiral bands of thickening on the inner surface. **It helps in dehiscence of capsule.**
- Each spore mother cell undergoes meiotic division to form **spore tetrads**.
- The spores are **haploid & develop in to gametophyte.**

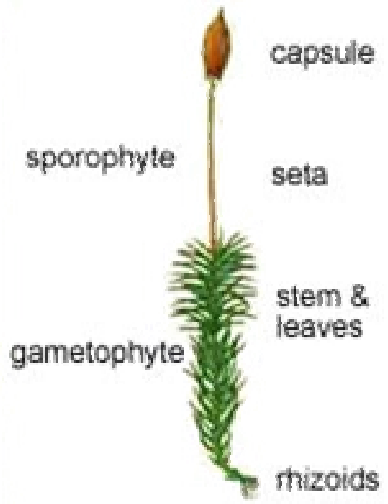
**Class** : Bryopsida

**Order** : Polytrichales

**Family** : Polytrichales

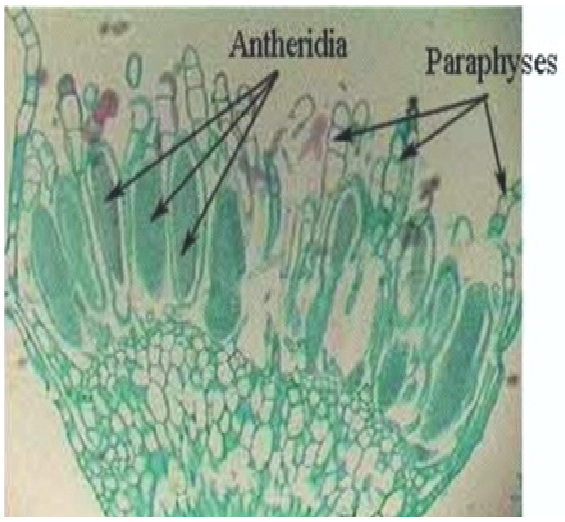
**Genus** : Pogonatum

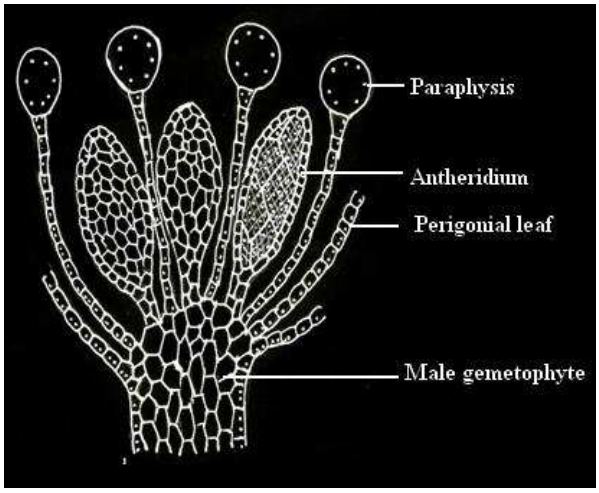
**Gametophyte with sporophyte**




- The sporophyte is differentiated into **underground rhizome, erect leaf** and **stem**.
- Rhizoids are borne on the rhizome and long **thick walled** with **oblique septa.**
- The leaves are in **3 vertical rows**, brown coloured.
- The leaves on aerial shoots are large and **spirally arranged**.
- Each leaf has a broad colourless membraneous one celled **sheathing leaf base**.
- **Midrib** is seen in the leaves.
- During diploid phase **sporophyte** is developed in the gametophyte.

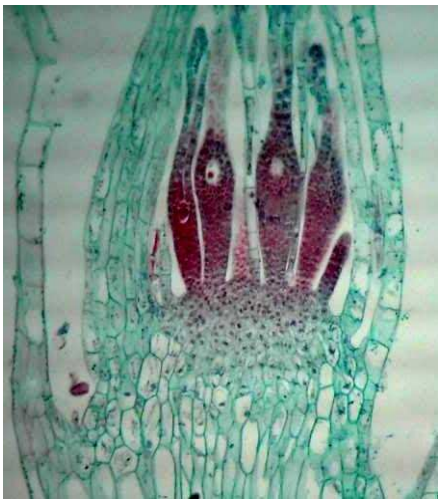
## Antheridial head

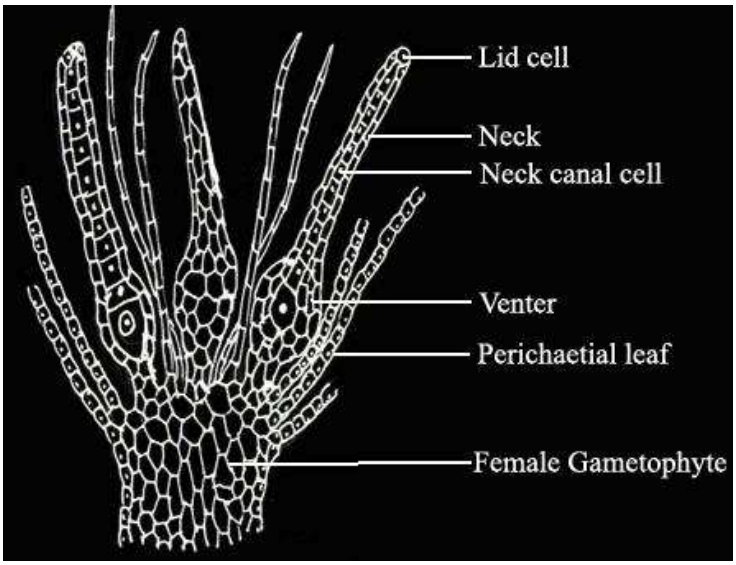



- Antheridial head consists of numerous **elongated antheridia**.
- Antheridia intermingle with **uniseriate paraphysis** arising from the receptacle.
- Each antheridium has a short **multicellular stalk**, **sterile jacket** layer enclosing mass of **androcytes.**

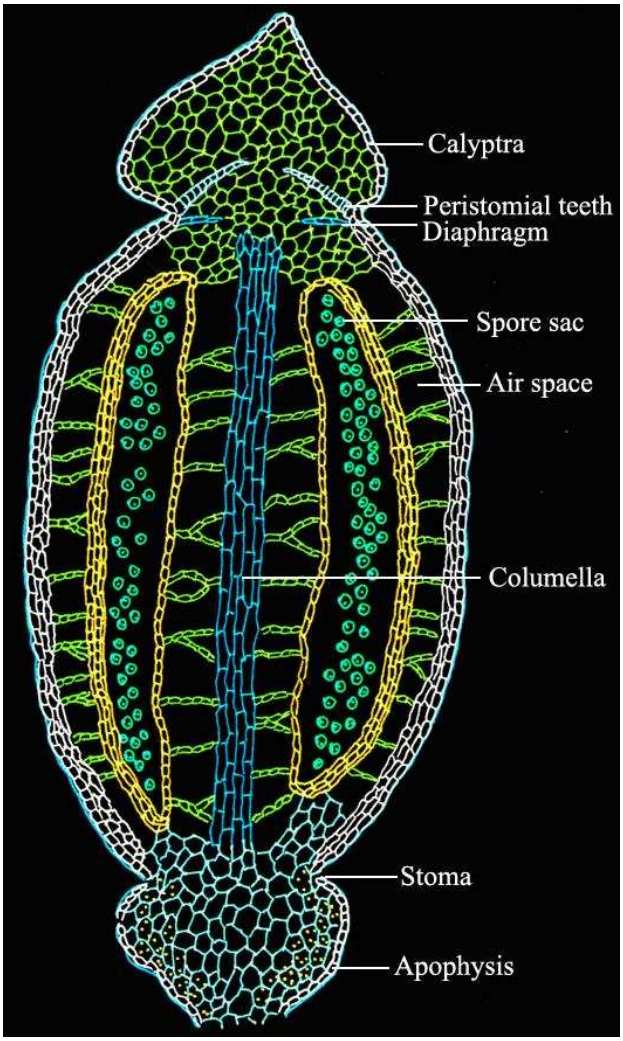
**Archegonial head**






- The female conceptacle terminates in cluster of **flask shaped archegonium**.
- Archegonia intermingle with **paraphysis**.
- Archegonium has a multicellular stalk, **swollen venter** and a long **tubular neck**.
- The venter encloses **ventral canal cell** and an **egg.**
- Neck encloses **eight neck canal cells.**
- The terminal cells of the neck are in the form of **cover cell**.

## Capsule




- Capsule is differentiated into **apophysis, operculum and theca**.
- Apophysis is continuous with seta.
- The epidermal cells are interrupted by **stomata.**
- Theca is the buldged space producing part of the capsule.
- Theca has central sterile tissue called **columella** surrounded by inner air space, middle **spore sac** and outer air space.
- The air spaces are traversed by **trabeculae**.
- This spore sac contains numerous **minute spores.** The outer wall of sac is singled layered and inner wall is multilayered.
- Outer air space is covered by **cell wall**.

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# PTERIDOPHYTA

## Characteristic features of Pteridophytes

- The plant body is **diploid sporophyte**.
- The sporophyte has distinct **roots, stem** and **leaves.** The leaves are **homophyllous** or **heterophyllous.**
- The **vascular tissues** are well-developed.
- Asexual spores are **haploid** and produced inside the sporangia. They may be identical (**homosporous)** or two different types **(heterosporous**).
- The sporangia are borne on **sporophylls**. The sporophylls are arranged in definite **cones**.
- The sporangial spores germinate into **haploid gametophytes**. The gametophytes produce **sex organs.** They may be **monoecious** or **diecious.**
- The male sex organ is called **antheridium**. It is a globular structure that produces motile flagellate male gametes called **spermatozoids.**
- The female sex organ is a flask-shaped structure called **archegonium.** It produces an egg.
- Fertilization takes place in the **presence of water.**
- The diploid zygote gives rise to a young sporophyte called **embryo.** The embryo grows into **sporophytic plant.**

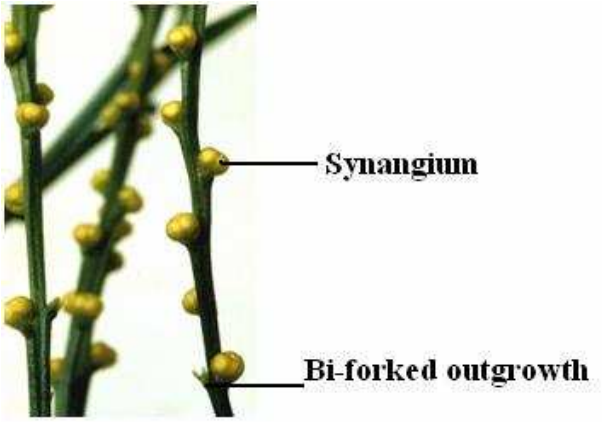
**Class** : Psilopsida

**Order** : Psilotales

**Family** : Psilotaceae

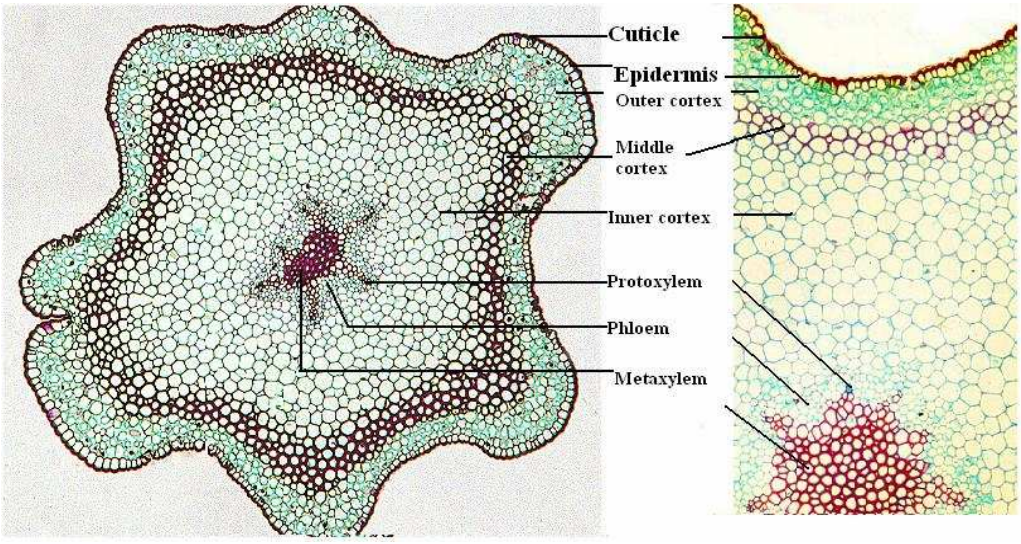
**Genus** : Psilotum

**Habit**



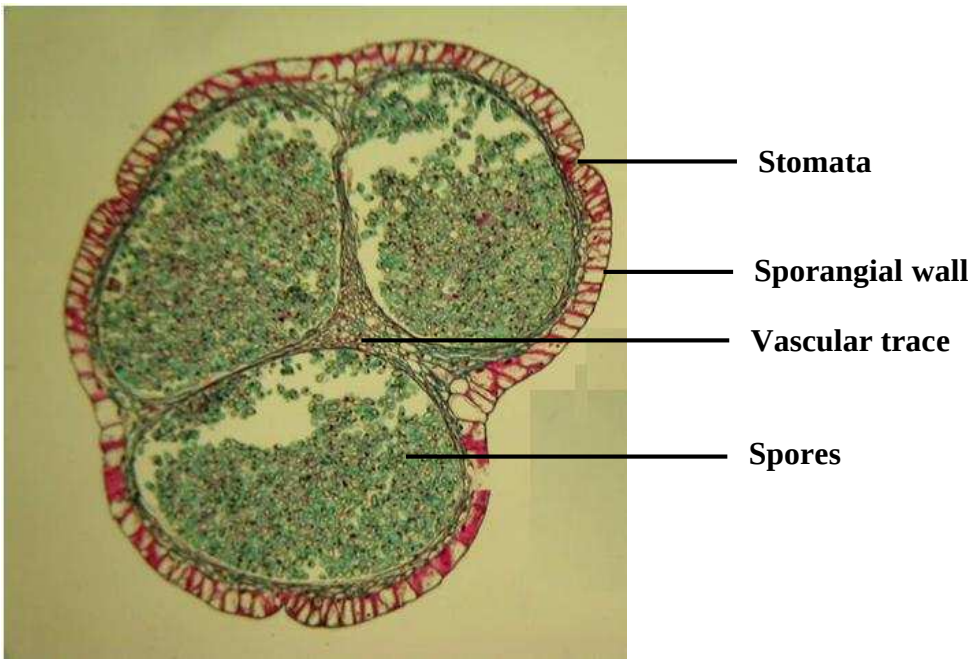

- The plant body is a **sporophyte**.
- The aerial branch is **green** and bear **small scale like leaves** which are devoid of any vascular system.
- The scale leaves are **spirally arranged.**
- The aerial branch is **dichotomously branched** and bear small scale like and biforked outgrowth which bear the **trilobed synangium**.

## Internal structure of aerial axis




- The T.S. of stem shows an outer **epidermis, a cortex, an endodermis** and an inner stele.
- **Epidermis** consists of thin-walled cells with many small pores called **stomata.**
- Epidermis is covered over by a layer of **cuticle.**
- Cortex - three layered **outer cortex, middle cortex and inner cortex**.
- The outer cortex is made-up of thin-walled, **chlorenchymatous cells.**
- The middle cortex consists of elongated, densely arranged, **thick – walled cells.**
- The inner cortex is multi-layered and it is composed of **thin-walled cells.**
- Endodermis is single-layered and is composed of elongated thin-walled cells; cells have **casparian thickening.**
- The stele is **actinostelic protostele.**
- Pericycle is always **single-layered.**
- Xylem is **stellate** (star-shaped) and exarch.
- **Phloem** occurs between the lobes and the surrounding regions.

## Synangium




- The synangia of psilotum are **trilobed** and associated with **trilobed appendage.**
- A section through the trilobed synangium reveals that it is **trilocular**.
- The synangial wall is made up of **3-4 layered wall.**
- The sporogenous tissue in the sporangial chamber forms the **spore mother cell**.
- The spore mother cell undergoes meiosis and form **tetrad of haploid spores**.

| | | |
|---|---|---|
| **Division** | **:** | Lycophyta |
| **Class** | **:** | Filicopsida |
| **Order** | **:** | Lycopodiales |
| **Family** | **:** | Lycopodiaceae |
| **Genus** | **:** | Lycopodium |

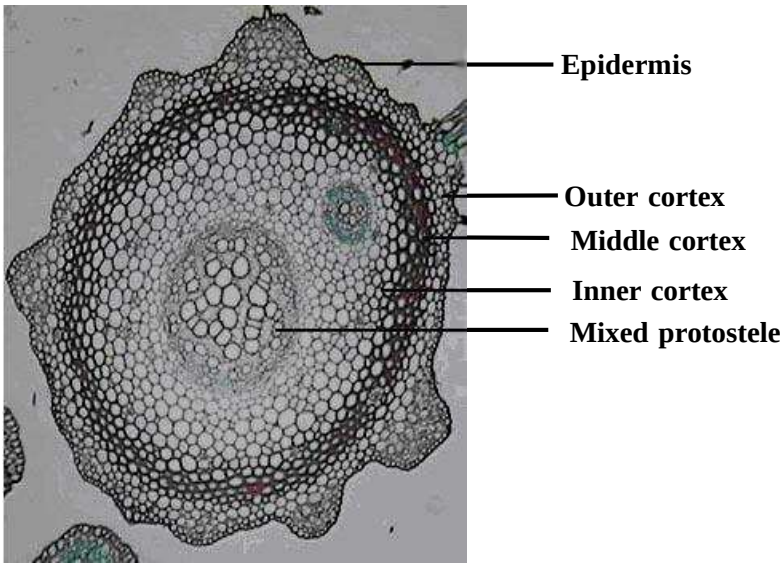
**Habit**
**Lycopodium cernnum**

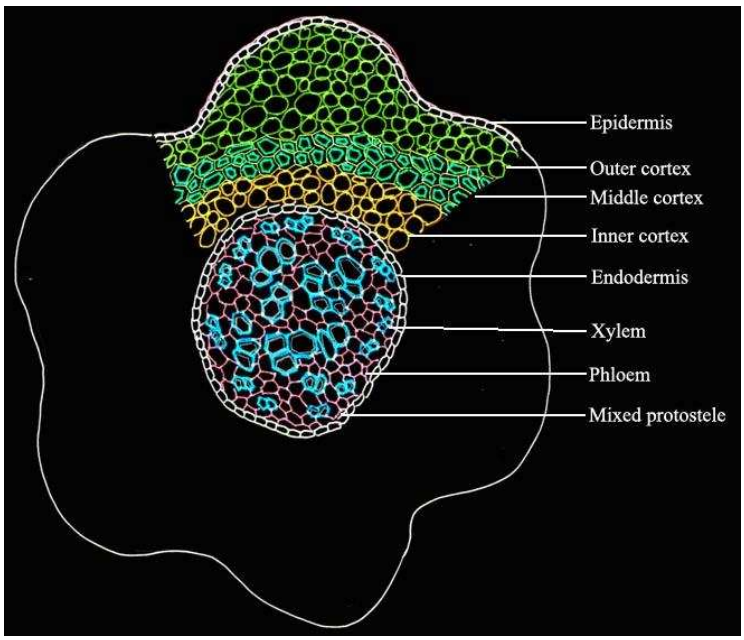
- The plant body is **terrestrial** consisting of a **creeping stem**, which give rise to erect aerial branches.
- The branching is **dichotomous** but looks like monopodial.
- All the foliage leaves are **alike** and are arranged in **whorls** on the stem.
- The strobili are comparatively small.
- They are sessile and borne on tips of **aerial branches**.
- Each sporophyll is provided with **abaxial flange**.

## L. phlegmaria

- L. phlegmaria is tropical **epiphytic species**.
- It grows **hanging** from the **tree trunks**.
- Stem covered with **sharp** and **pointed leaves**.
- The stem is **dichotomously branched**. The two branches of a dichotomy are almost equal.
- **Strobili** are produced at the **tips of branches**.

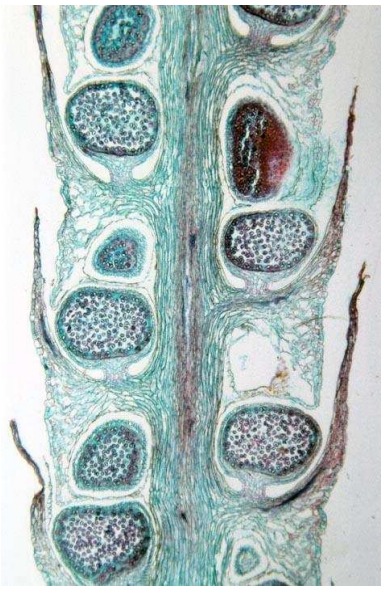
**Stem T.S.**

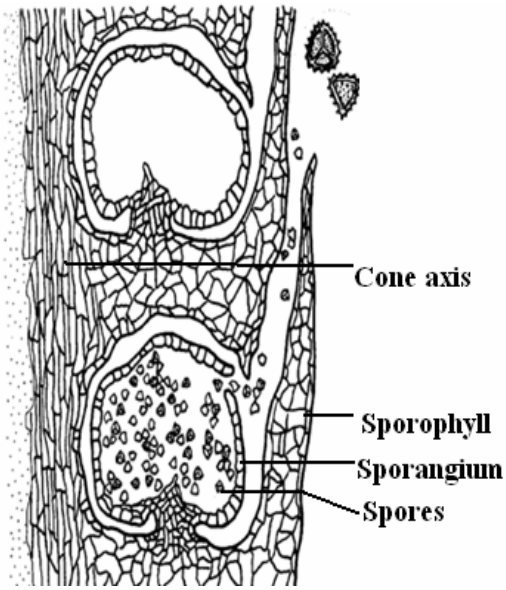



- The stem has got a **lobed appearance**.
- Epidermis is **cuticularised** and is followed by **three distinct zones of cortex**.
- The outer and inner portion of cortex are **parenchymatous** with the middle **sclerenchymatous** cortex - **heterogenous**.
- Endodermis and pericycle are **single layered**.
- The stele is a **mixed protostele**

**Cone. L.S.**






- The strobilus bears the spore producing organ namely, the **sporangium** which are arranged on the **adaxial surface** of sporophyll.
- The sporangia are **globular, stalked** with **many wall layers** enclosing numerous **spore tetrads**.
- The sporophylls are borne on the **central axis** of cones.
- It is a **homosporous** fern.

**Division** : Lycophyta

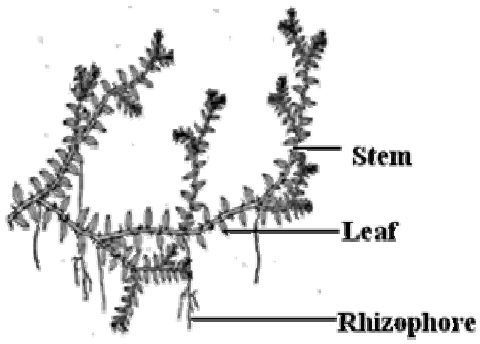
**Class** : Ligulopsida

**Order** : Selaginellales

**Family** : Selaginellaceae

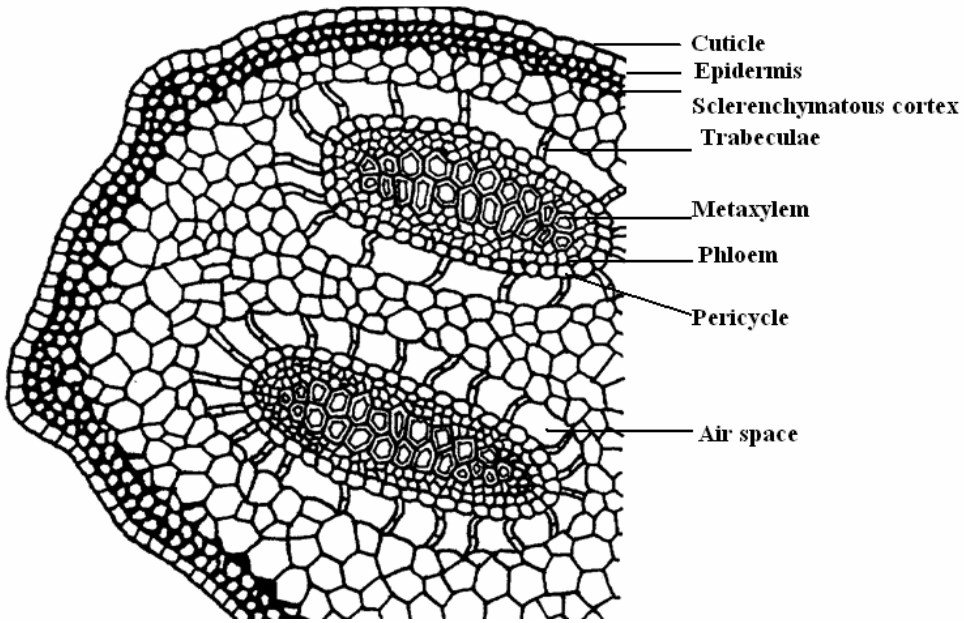
**Genus** : Selaginella

**Sporophyte**

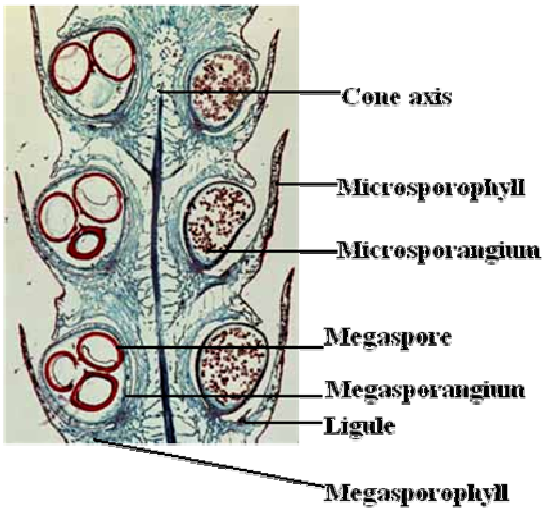

- The plant body of Selaginella is differentiated into **stem, root** and **leaf-like parts.**
- The leaf is **adventitious**.
- The stem is prostrate with erect branches bearing **dimorphic leaf** with larger leaves arranged at the sides of the stem and smaller leaves in the centre of the stem.
- The leaves are **sessile** and **ligulate**.
- The stem branches are **cylindrical**.
- Leafless structures grow downwards and are known as **rhizophore**, which give rise to clusters of roots at its tip.
- The rhizophore is **positively geotrophic** in nature.

## Stem T.S

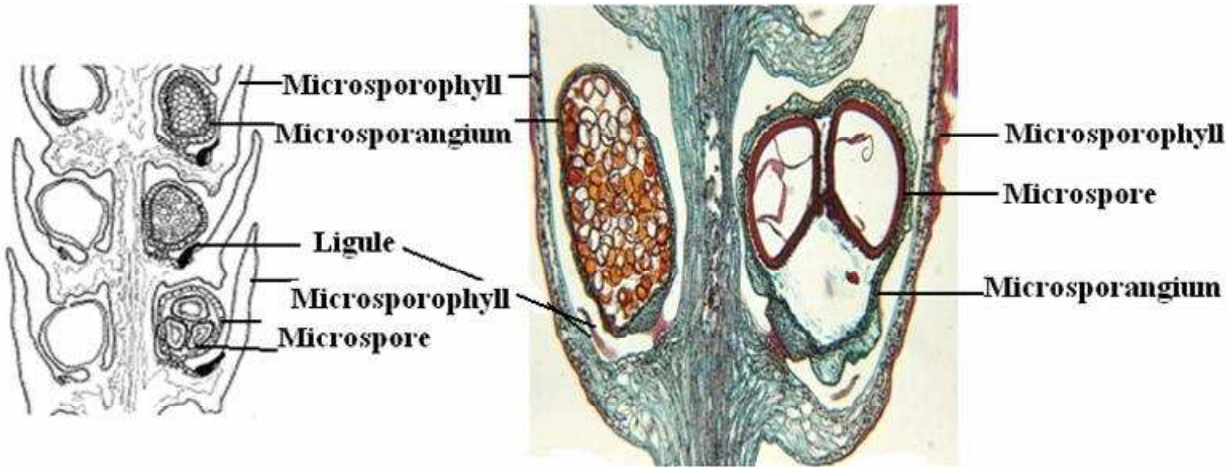



- Cross section of the stem shows an **epidermis, cortex, pericycle** and central **stele.**
- Outer layer is the epidermis covered by **cuticle**.
- Cortex is made up of an outer **sclerenchymatous hypodermis** and an **endodermis** and **airspace**.
- In the airspace **trabeculae** are present. They are the **modified endodermal** cells with casparian strips.
- The stele is a **protostele**.
- Xylem is **diarch** and **exarch.**

## Cone



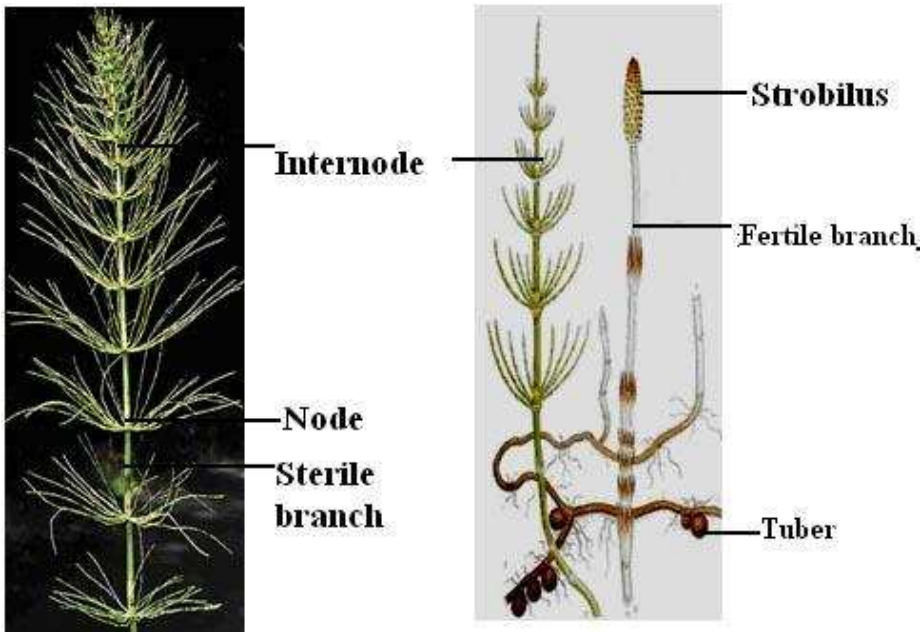

**A PORTION ENLARGED**




- The strobilus of Selaginella bears **many spores**.
- Selaginella is **heterosporous** producing **larger megaspores** and **smaller microspores** in the respective sporangia namely **megasporangia** and **microsporangia**.
- The sporophyll bears the sporangia in its axis and **ligulate**.
- The megasporangia are **stalked** and **four lobed** bearing four megaspores.
- Each megaspore has got a **triradiate** ridge.
- The microsporangia are **smaller** and contains **innumerable** spores.

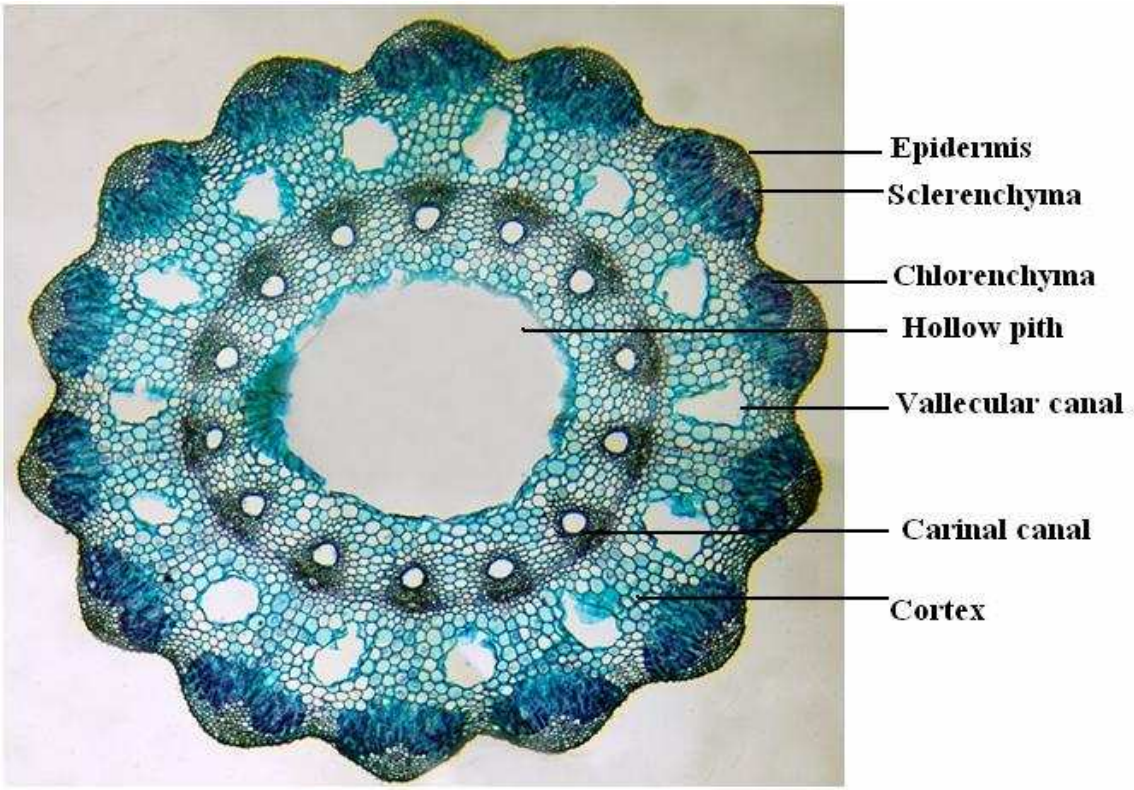
| | | |
|---|---|---|
| **Division** | **:** | Sphenophyta |
| **Class** | **:** | Calamopsida |
| **Order** | **:** | Equisetales |
| **Family** | **:** | Equisetales |
| **Genus** | **:** | Equisetum |

**Habit**




- The plant body has an underground stem known as the **rhizome** with **nodes** and **internodes.**
- **Roots** arise from the **lower side** of the rhizome.
- **Rhizome** also gives out on its upper side a number of **aerial branches** which are **long, slender** and differentiated into **nodes** and **internodes**.
- The internodes are with **ridges** and **furrows**.
- Leaves are very much reduced to **scaly** structures which fuse with one another to form a **sheath** around the node.
- The tips of some of the branches bear **cone**.
- Each sporangiophore has stalk and a **peltate disc**.

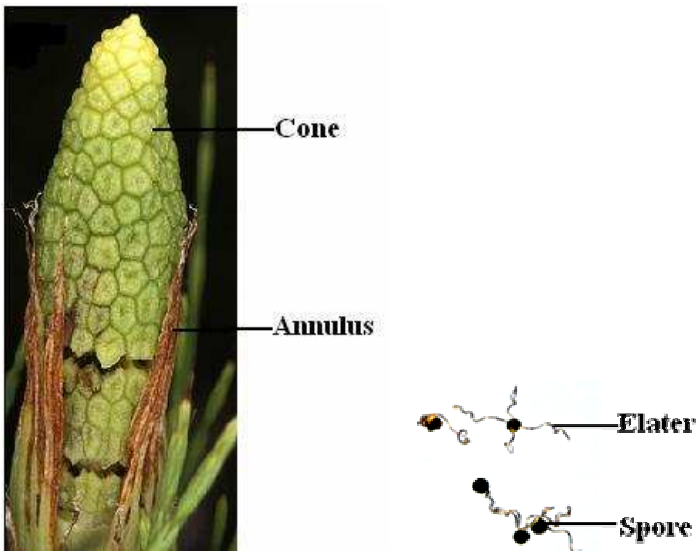
## Stem




- **Wavy** in outline due to the presence of **ridges and grooves.**
- It has **epidermis, cortex, vascular bundles** and a large **pith cavity.**
- Epidermis is **single layered** with deposition of **silica** on their outer and radial walls.
- Silica provides **mechanical strength.**
- Epidermis is interrupted by **stomata.**Stomata are confined to grooves- **sunken.**
- Cortex is differentiated into **outer and inner region.**
- The outer cortex consists of **sclerenchymatous and chlorenchymatous cells**, provides **mechanical strength.**

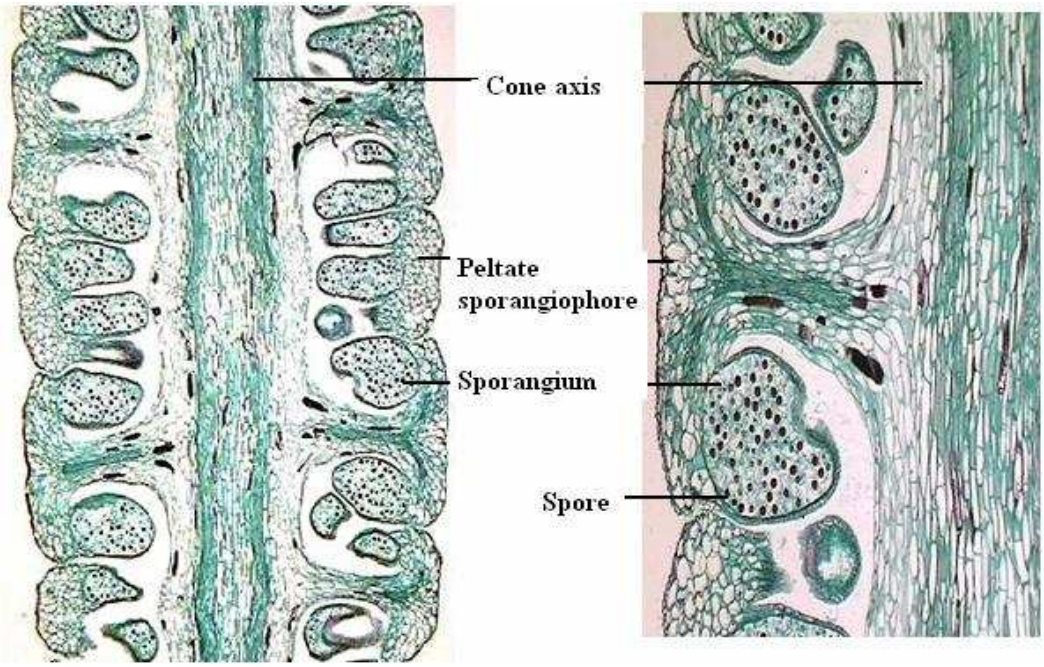
- Sclerenchyma lies below the epidermis. It is followed by a band of chlorenchyma- **photosynthetic** in function.
- The **inner cortex** is composed of thin walled **parenchymatous cells.** It has large **schizolysigenous canals** known as **vallecular canal** below the furrow- aerating system.
- **Cortex** is delimited from the stele by an **endodermis.**
- The endodermis is followed by a single layer of **parenchymatous pericycle**.
- The vascular bundle is a **siphonostele**. Vascular bundles are arranged in a **ring** around the large pith opposite to ridges alternating the vallecular canal.
- Vascular bundles are **conjoint, collateral and endarch.**
- Xylem of a bundle is in the form of **two lateral** and a **median group** of tracheids.
- In the young vascular bundle the protoxylem is represented by tracheids with **annular or spiral** thickening.
- In the mature bundle the protoxylem elements disintegrate to form a **protoxylem lacuna** called **carinal canal.**
- The metaxylem tracheids have **scalariform, reticulate or pitted** thickenings.
- The phloem lies outside the xylem.
- The **carinal canals** are filled with water and help in **conduction of water.**
- The central part of the internode of the aerial shoot has large **pith cavity.**

## Cone




- Equisetum is **homosporus**.
- Strobili are borne **terminally** on the vegetative shoots.
- Only the **peltate discs** are seen in the surface view of the strobilus.

## Cone L.S



- Strobilus has a **central strobilus axis** and a large number of **sporangiophores.**
- The sporangiophore is a **stalked** structure with a **hexagonal peltate disc** at its distal end.
- On the **underside** of the sporangiophore disc **5 – 10** sac like sporangia are borne near its periphery in a ring.
- In some species a whorl of scale-like outgrowths called **annulus** is present at the base of the strobilus.
- The development of sporangium is **eusporangiate.**
- The mature sporangia are sac-like structure attached to the underside of the peltate disc of the sporangiophore.
- The **wall** of mature sporangium is only **two layered**. All spores are alike. **(homosporous)**
- As the sporangia mature, the strobilus axis elongates, consequently, the compactly arranged sporangiophores separate from each other and the sporangia are exposed.
- As the sporangium dries the helicoid thickening bands present in the outer wall layer shrink and the sporangium ruptures.
- **Spores** are **spherical, uninucleate and green** (contain numerous chloroplasts)
- Spore wall is differentiated into **4 layers.**
  - The outermost **perispore / epispore.**
  - The second **middle layer.**
  - The third **expspore.**
  - The innermost **endospore.**
- The epispore splits into 4 strips which are separated from one another but attached to a common point on the spore. These bands are wrapped around the spherical spore but as the spore dries these bands are starched. These bands are called as **elaters.** They have expanded **spoon-like** tips.
- The elaters are **hygroscopic** and help in the **dehiscence** of the sporangium.

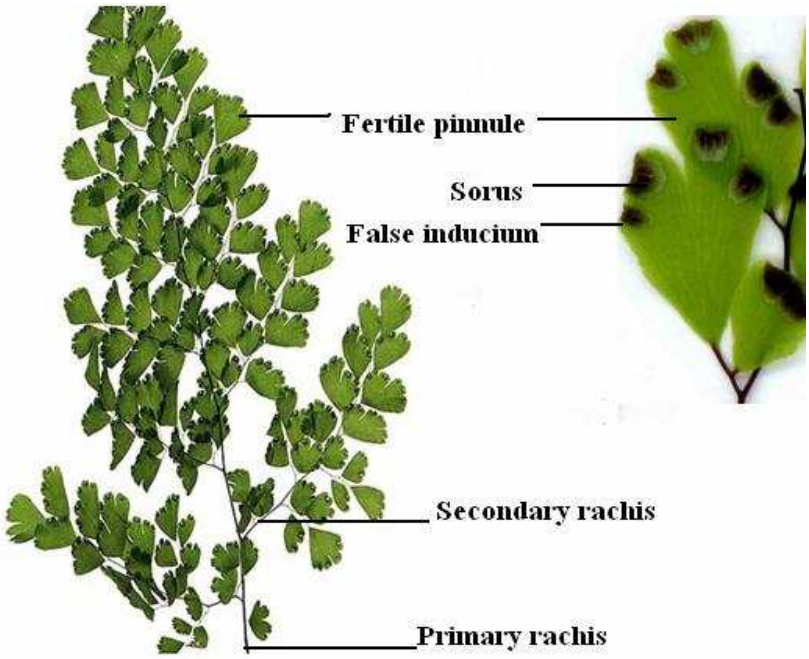
**Class** : Leptosporangiate

**Order** : Filicales

**Family** : Polypodiaceae

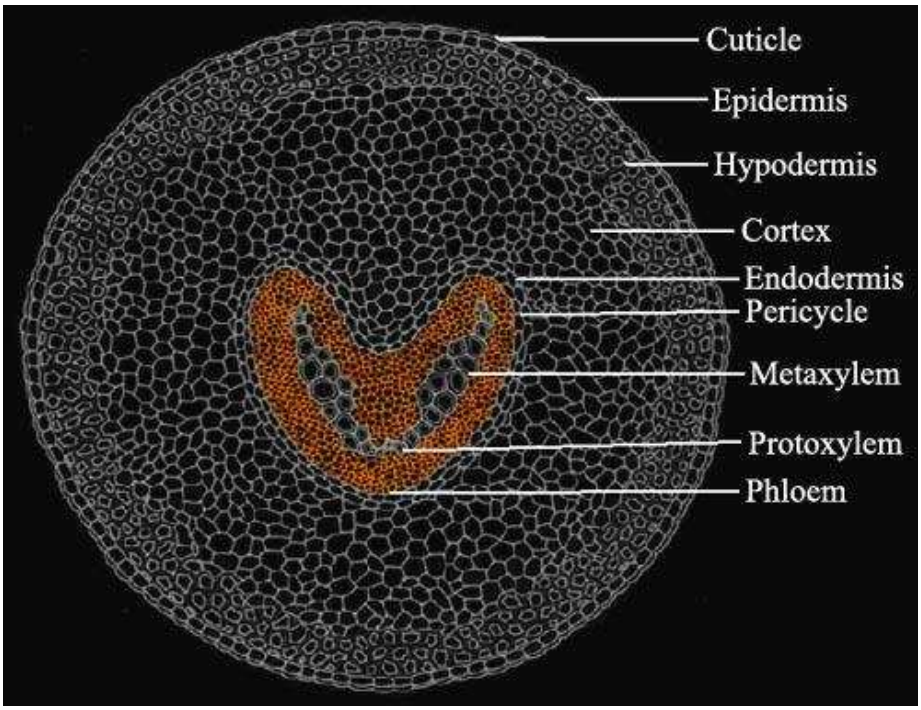
**Genus** : Adiantum

**Habit**



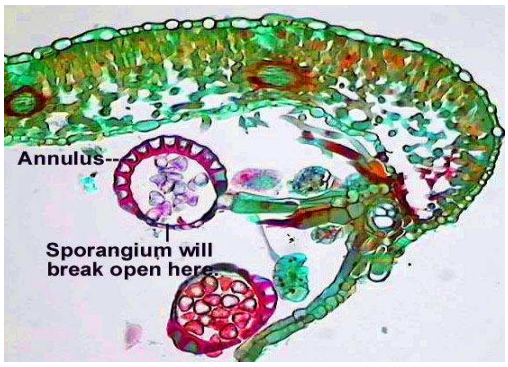

- The sporophyte of Adiantum is differentiated into **root, stem, leaf-like parts**.
- The underground stem is **rhizome** and it helps to **anchor** to soil with the help of **adventitious roots**.
- The young leaf shows **circinate vernation**.
- The leaf has **short petiole** and are compound bearing **pinnae** on either side of rachis.
- Venation is **open dichotomous** type.
- The veins spread in **fan-like manner** within the pinnae.
- **Sori** are formed on the **margin** of the pinnae.

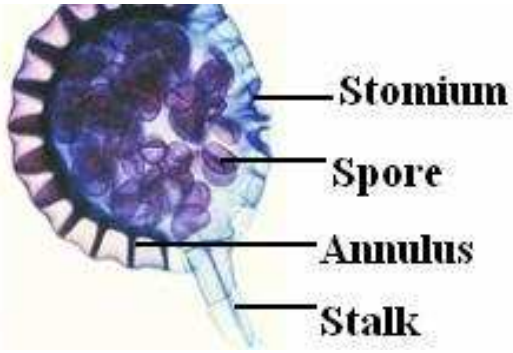
## Petiole T.S

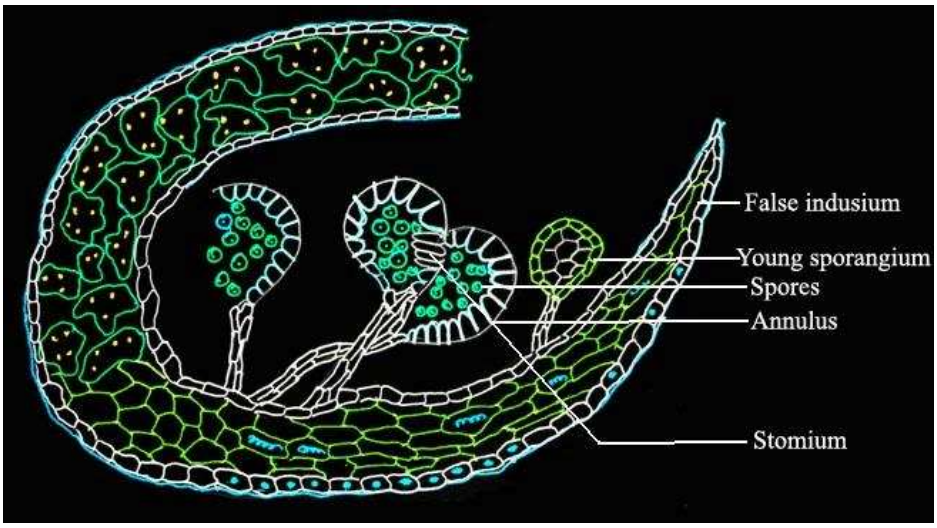



- Outermost layer of petiole is single layered **cuticularised epidermis**.
- **Sclerenchymatous hypodermis**.
- Inner cortex is **parenchymatous**.
- Presence of well developed **endodermis** and **pericycle**.
- Stele is **protostele**.
- Two vascular bundles are present.
- Xylem is **diarch** and **exarch**.

**Sorus V.S.**




- The sporangia arise on the **ventral surface** of the **fertile pinnule** and they are protected by the margins of the pinnule called **false indusium**.
- The sporangia develop from the **receptacle or placenta** of **fertile pinnule**.
- Each sporangium has got a **multicellular stalk** and spore bearing **capsule** with **single layered wall**.
- The wall of capsule has **annulus** with characteristic thickening consisting the major part of wall layer and thin walled **stomium** through which dehiscence takes place.

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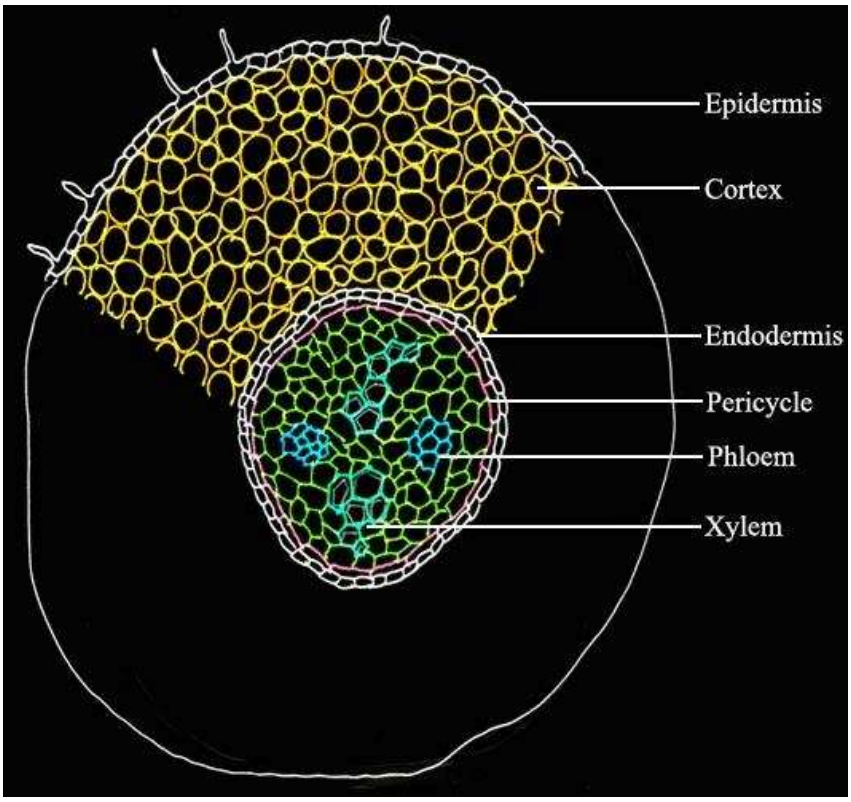
# GYMNOSPERM

## Characteristic features of Gymnosperms

- The adult plants are tall, woody, **evergreen, perennial trees** or shrubs. They show **xerophytic** characters. The plant is a **sporophyte.**
- The **stem** is branched but unbranched in Cycas. The vascular bundles are arranged in a **ring.** They are **conjoint, collateral, open and endarch**.
- The **xylem** is composed of **xylem parenchyma** and **tracheids** with bordered pits. **Xylem vessels** are absent, except in **Gnetales.**
- The **phloem** consists of **sieve tubes** and **phloem parenchyma,** but **companion cells** are absent.
- The **leaves** may be dimorphic, the **foliage leaves** and **scale leaves** or of one kind only.
- The reproductive parts are arranged in the form of **cones or strobili.** The cones are **unisexual.**
- In male cones, many **microsporophylls** are arranged on the **central axis.** The microsporophylls bear **microsporangia** with **microspores** or **pollen grains.**
- The **microspores** are **haploid,** and are formed from **microspore mother cells** after **meiosis.** The microspore germinates to form the **male gametophyte.**
- In the female cones, many **megasporophylls** are arranged on the **central axis**. The **megasporphylls** bear **megasporangia** or **ovules.**
- The **ovule** is **orthotropous.** It consists of **nucellus** surrounded by one or two **integuments.**
- The **ovules** are **naked** and are not enclose by the **ovary.**
- The **ovule** contains the **megaspore mother cell** which undergoes **meiosis** to produce a linear row of **four megaspores.** Of the four megaspores the lowest is **functional**. The **megaspore is haploid.**
- The megaspore gives rise to a **female gametophyte.**
- The female gametophyte bears **archegonia** the upper end.
- The endosperm is a **pre-fertilization** tissue. It is **haploid** in gymnosperms.
- Each archegonium consists of a **venter** and a **neck.** The **neck canal cells** are **absent.**
- The **pollination** is **direct**, i.e. the pollen grains come in contact with the ovule directly.
- **Embryo** development is **meroblastic,** i.e. develops from a small part of **zygote.**

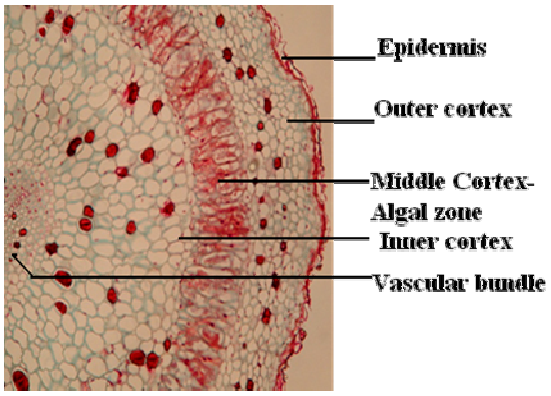
| | | |
|---|---|---|
| **Class** | : | Cycadopsida |
| **Order** | : | Cycadales |
| **Family** | **:** | Cycadaceae |
| **Genus** | **:** | Cycas |

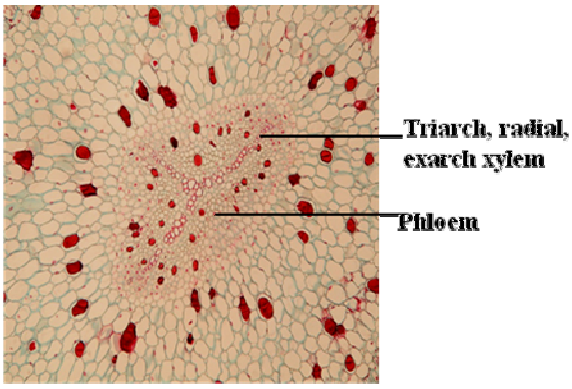
**Normal root**

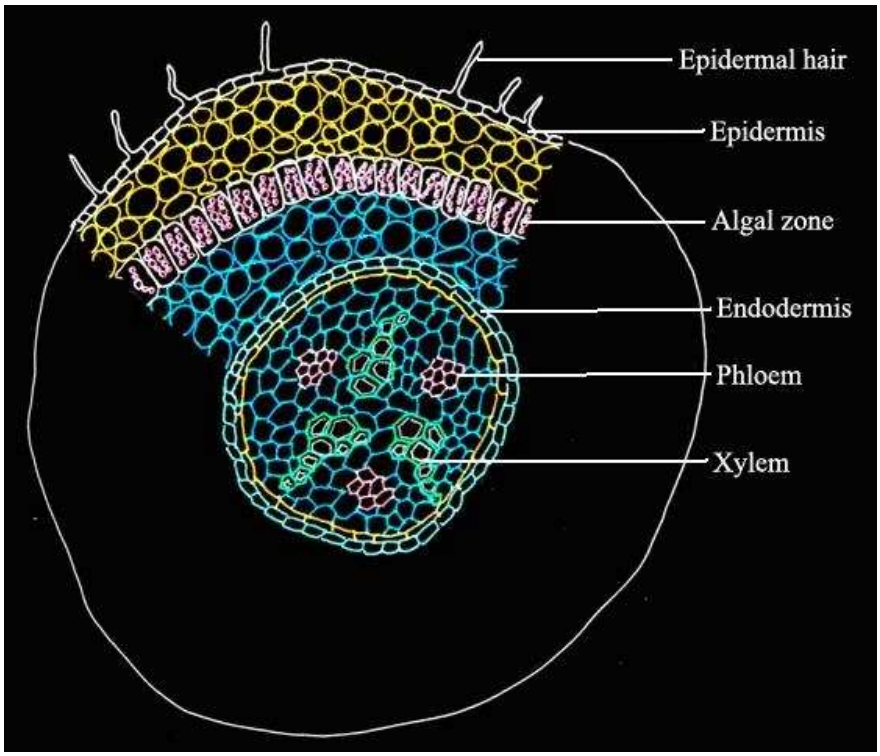



- The young root has got a **circular** outline.
- It is differentiated into outer **epiblema, cortex** and the **stele**.
- Epiblemma is **single layered** composed of thin walled cells, some of them with **root hairs.**
- Cortex is **broad parenchymatous** and multilayered.
- Stele is **radial, diarch, closed** with **endarch xylem**.

## Coralloid root

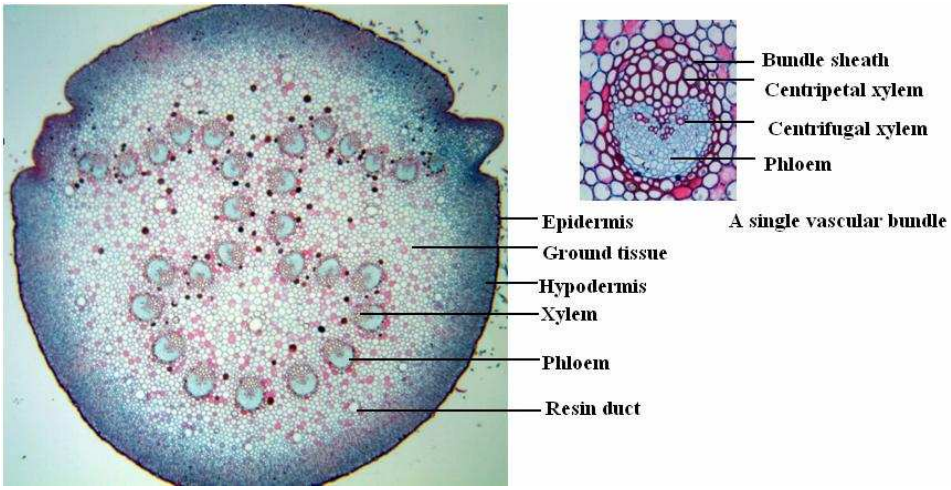


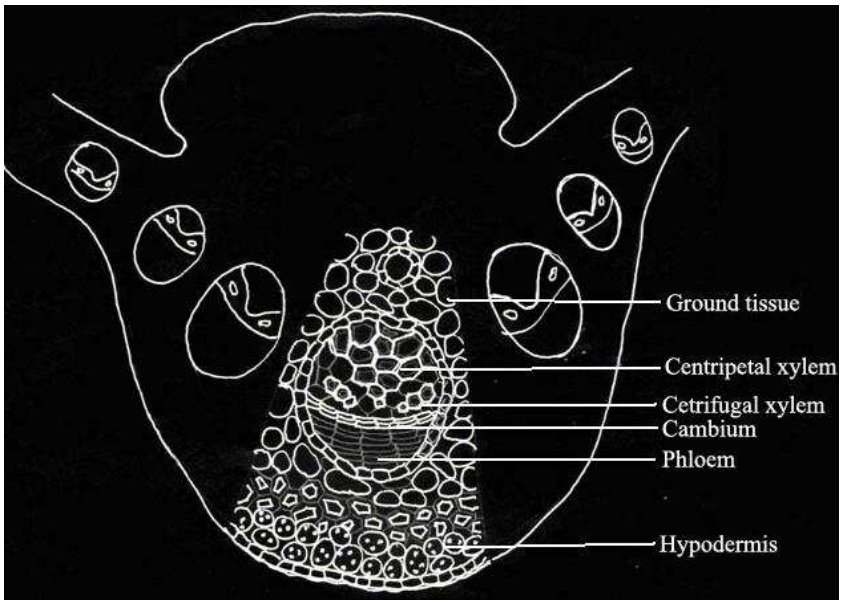




- The structure of coralloid root is very similar to that of normal root of cycas except the presence of **algal zone** made up of **radially elongated cell.**
- In the middle portion of the cortex **blue green algae** like **anabaena** and **nostoc** are present.
- Vascular bundles are **triarch, radial** and **closed**.

## T.S. of Rachis

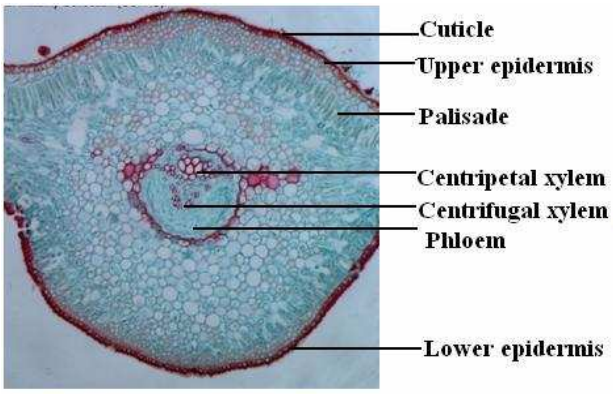



**Rachis- Omega shaped arrangement of vascular bundles**

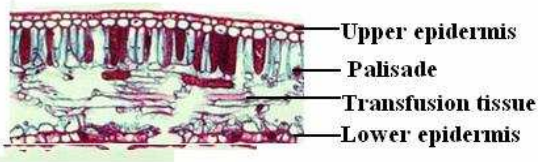



- **Epidermis** - single layered with **thick cuticle** & **sunken stomata** present on the lower epidermis.
- **Hypodermis - sclerenchymatous** followed by **chlorenchymatous** cells.
- Ground tissue is parenchymatous.
- **Vascular bundles** - bundles arranged in inverted **omega (Ω)** shaped. Each bundle is **collateral, open** and surrounded by **sclerenchymatous bundle sheath**.
- Xylem is **diploxylic** made up of **centripetal** & **centrifugal** xylem.

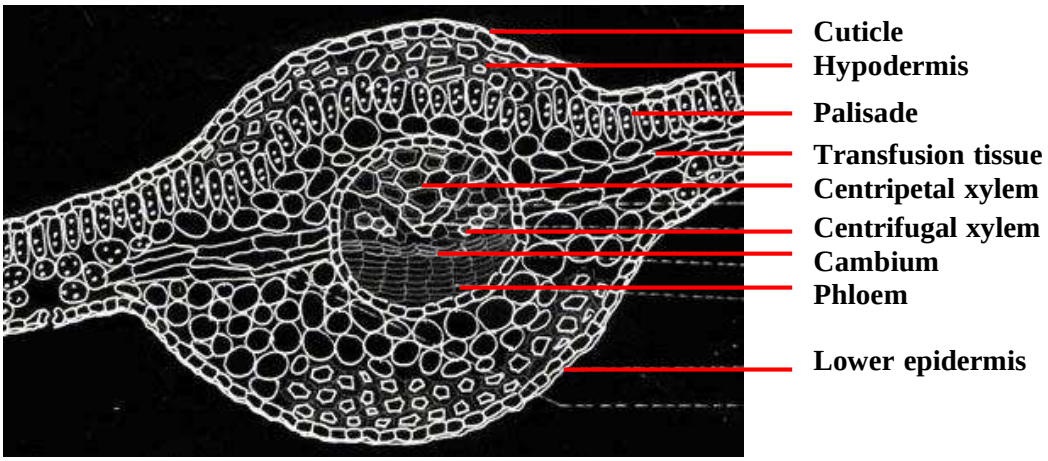
## T.S. of leaflet


Midrib region




Wing region



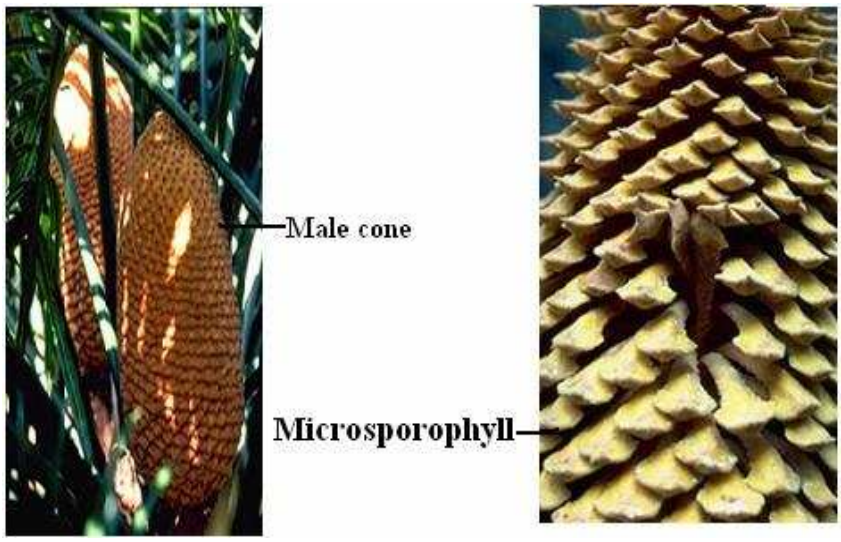

- Leaflet has **swollen midrib** and **narrow flat wings**.
- The outermost layer is **cuticularised epidermis**.
- **Sclerenchymatous hypodermis** is present on both sides.

- There is a centrally located **vascular bundle** in the midrib.
- The vascular bundle is **conjoint, collateral, open** and **pseudomesarch**.
- Xylem shows a large **V-shaped centripetal xylem** and two groups of **centrifugal xylem**.
- Mesophyll is differentiated into **spongy** and **palisade tissue**.
- Presence of **transfusion tissue** between palisade and spongy tissue helping in **lateral conduction.**

**Xerophytic adaptations**

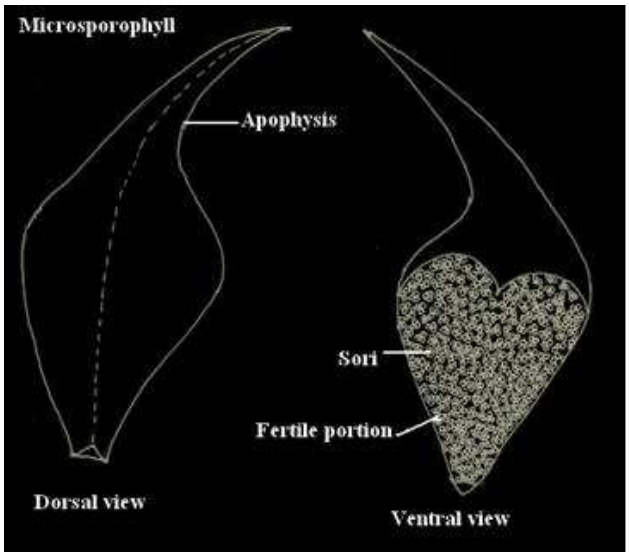
- Presence of **upper** and **lower epidermis** covered with **cuticle**.
- **Sunken stomata** restricted to the lower epidermis.
- Presence of **sclerenchymatous hypodermis**.
- **Diploxylic** nature of vascular bundles.
- Presence of **transfusion tissue.**

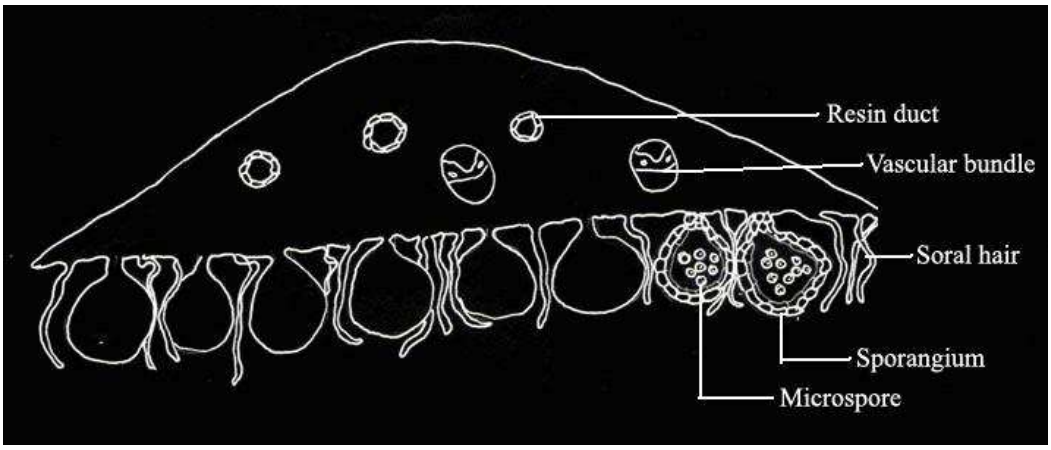
**CYCAS MALE CONE**




- Male cone is terminal, stalked, large and conical
- Consists of central cone axis and numerous micro sporophylls.
- Microsporophylls are spirally arranged around the cone axis.

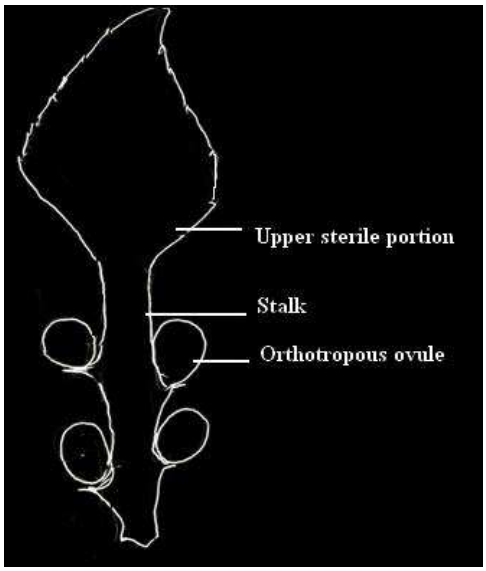
## Microsporophyll





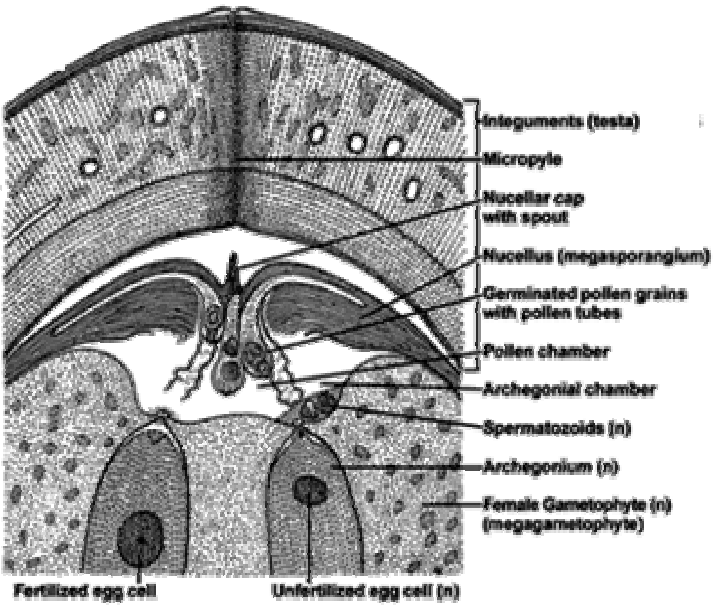

- **Microsporophyll**- leaf like, woody, **wedge shaped** & brown in colour.
- Lower expanded fertile region with **sori** & upper sterile region called **apophysis**.
- **Sorus** has 5 to 6 microsporangia with **soral hairs**.
- **Microsporangium** - **oval** in shape with sporangial wall. It encloses many **unicellular, uninucleate, haploid microspores** or pollen grains.
- Microspores has **inner intine, outer exine, cytoplasm & hapioid nucleus**.

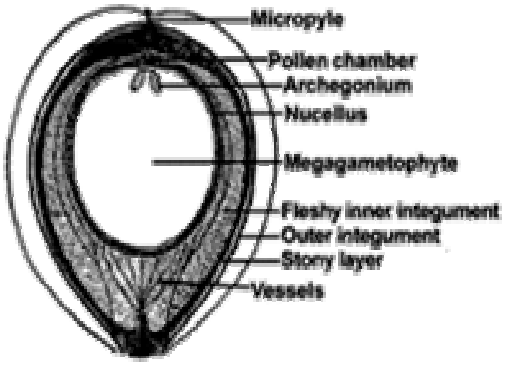
## Megasporophyll




- The megasporophyll **is large**, 6-8 inch long.
- Its upper portion is **broadly pinnate** and **tappers** to a point.
- The stalk like lower portion bears **orthotropous ovules** in two distichous, lateral rows.
- The whole sporophyll is covered with dense **brownish, woolly hairs.**

## Ovule L.S




- The ovule consists of a mass of cells, the **nucellus**.
- It is surrounded by a **single massive integument**.
- The integument is differentiated into **three layers**.
- The outer and inner layers are **fleshy** and the middle layer is **stony**.
- The integument fuses with nucellus all around except at the top where it leaves a pore leading to the nucellus called **micropyle**.

**Class** : Gnetopsida

**Order** : Gnetales

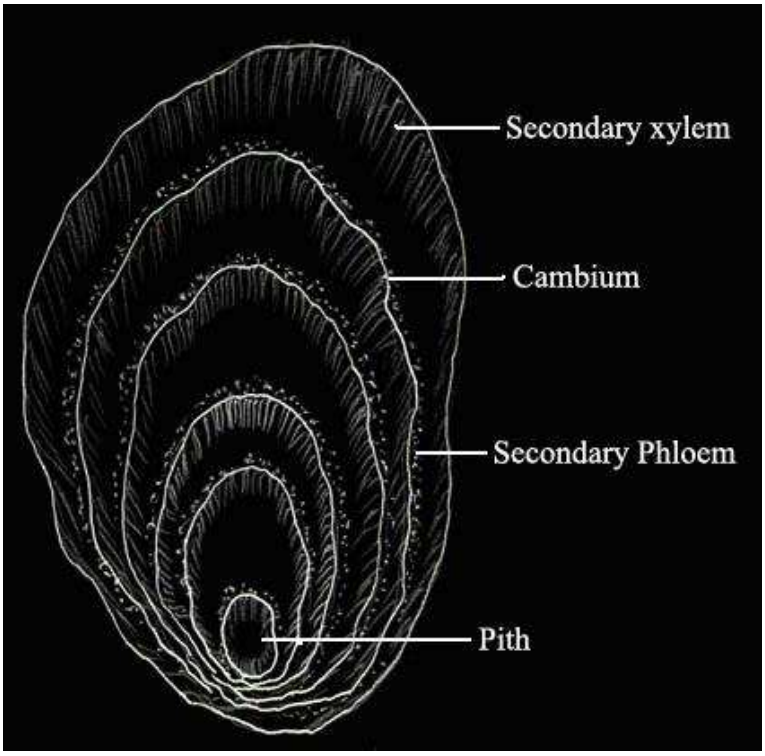
**Family** : Gnetaceae

**Genus** : Gnetum

**Habit**

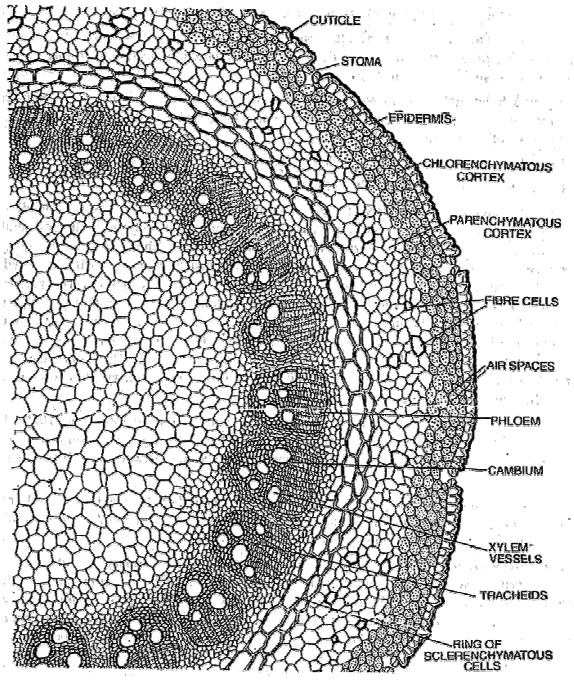
- Gnetum is a **sporophytic plant**.
- Consists of **stem, leaves** and **tap root** system.
- Stem is **woody** and **branched**.
- It has two types of branches- **long** or **branches of unlimited growth** and **dwarf shoot** or **branches of limited growth**.
- Long branches bear **scale-like leaves** at the nodes.
- There are two leaves at each node, **opposite decussate**.
- The dwarf branch arise from the axis of the scale leaves on the long branch.
- The stem is **articulated** with node and internode.
- Leaves show **reticulate venation**.

**Old stem**



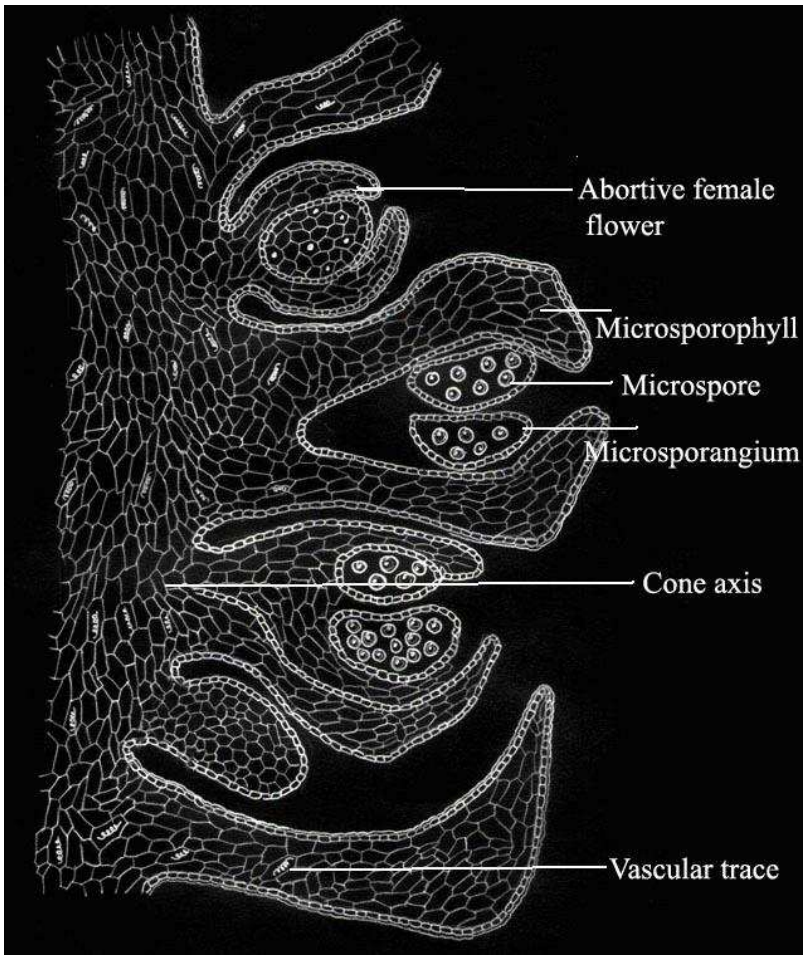

- In some climbing species of Gnetum, **accessory cambia** are formed at different levels of the cortex.
- These cambia are not equally active in nature and so they produce **incomplete vascular rings**.
- Hence the stem represents an **eccentric** appearance.
- The **pith** is also **eccentric**.

## Stem T.S



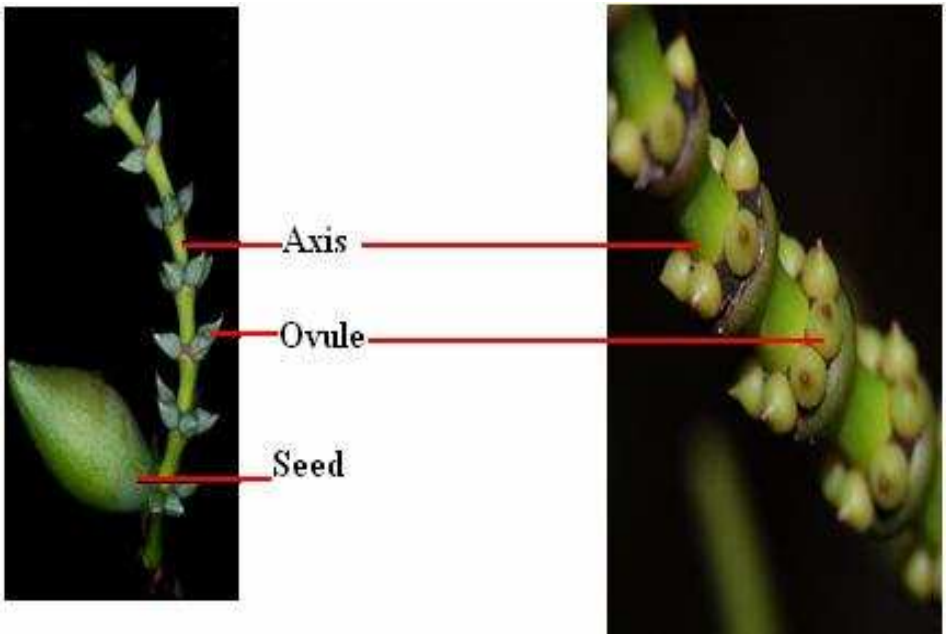

- The T.S of stem shows an **epidermis, cortex, endodermis** and a **stele**.
- Epideermis is the outer layer made up of **rectangular** cells covered with cuticle. It has **sunken stomata**.
- The cortex has **three distinct zones**. The outer cortex is **chlorenchymatous**, the middle cortex is **parenchymatous** and the inner cortex is **sclerenchymatous**.
- The endodermis and pericycle are not so distinct.
- The stele is an **ectophtoic eustele**. It consists of a ring of **many vascular bundles**.
- The vascular bundles are **conjoint**, **collateral**, **endarch** and **open**.
- Xylem occupies the centre. It consists of **tracheids** and **vessels**.
- The phloem consists of **sieve cells, phloem pacenchma** and **companim cells**.
- Vascular bundles are separated by a broad parenclyma.
- The **pith** is **parenchymatous**.

## Entire male cone

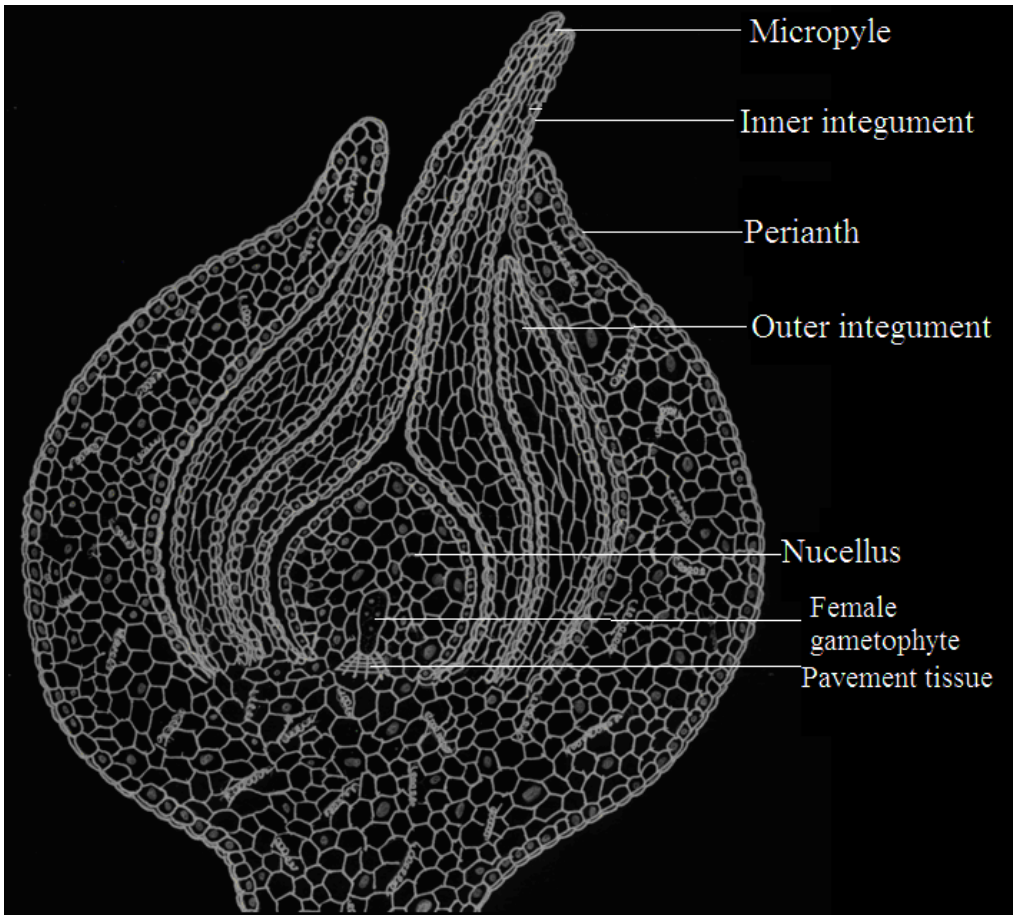

- The male flowers are arranged in many rows from 3-6 above each collar.
- Each male flower is stalked and enclosed with a sheath like perianth.

## Entire female cone




- Female flowers are arranged in a **single ring** on each collar.
- Each female flower consists of **sessile ovule**.
- The ovules are **naked** in nature.

## Ovule L.S.




- The ovule is **orthotropous.** The V.S. ovule shows a **spherical nucellus** and three envelops called **integuments.**
- The three integuments are called **outer integument, middle integument** and **inner integument.**
- The outer and inner integuments are **soft,** but the middle one is **stony.**

- The inner integument grows beyond the others and form a tube called **micropylar tube.** The opening of the tube is called **micropyle.**
- A **pollen chamber** lies below the micropylar tube.
- The nucellus consists of a mass of thin-walled cells. It is a **nutritive tissue.**
- A **female gametophyte** remains embedded in the nucellus.
- The female gametophyte consists of a **sac-like** structure consisting of cellular tissue at the **chalazal end** and free nuclei at the **micropylar end.**
- It has **one** or **two large nuclei** which act as female nuclei.
- The female nucleus fuses with the male gamete to form a diploid **zygote.**

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# PALEOBOTANY

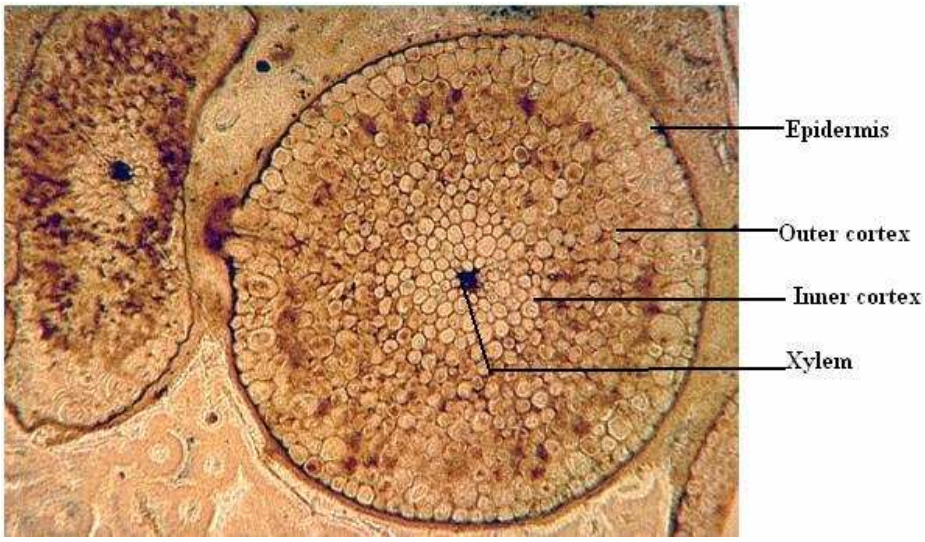
**Class** : Psilophytopsida

**Order** : Psilophytales

**Family** : Rhyniaceae

**Genus** : Rhynia

**Stem**

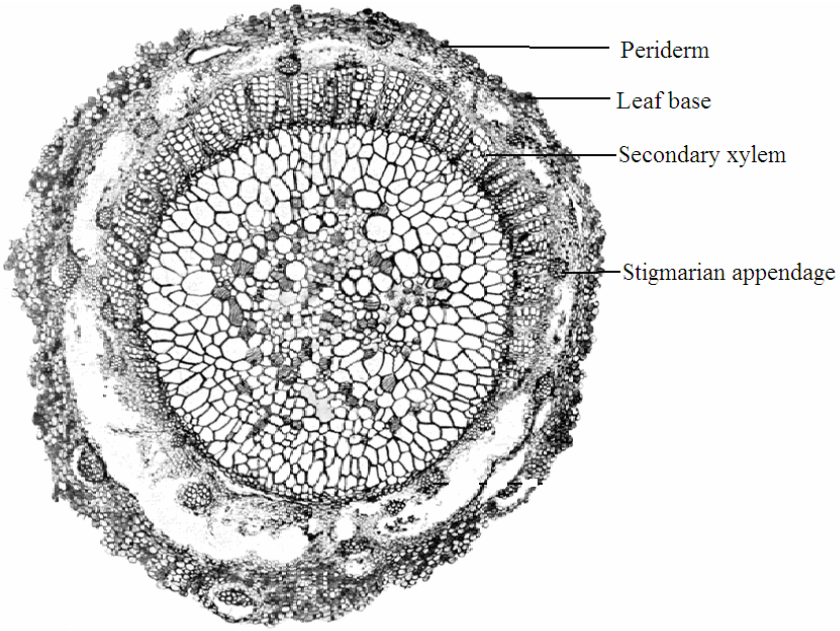



- Rhynia is a fossil fern.- **Psilotopsida**.
- Stem shows **epidermis,cortex and stele**.
- **Epidermis**- outermost, cuticularised with stomata.
- **Cortex** –parenchymatous and well preserved.
- **Stele- protostele-** xylem surrounded by phloem.

**Geological period:** Devonian of Paleozoic era.

**Class** : Lycopsida
**Order** : Lepidodendrales
**Family** : Lepidodendeaceae
**Genus** : Lepidodendron

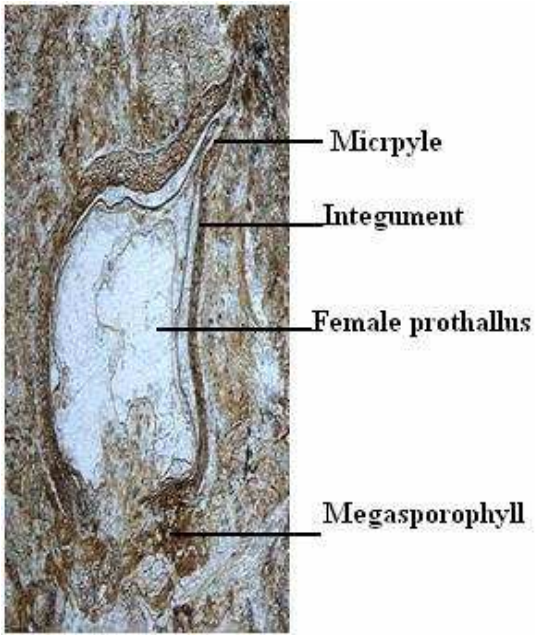
**Stem**




- The old stem of *Lepidodendron selaginoides* has got an irregular outline due to the presence of **persistant leaf bases**.
- There is well developed **periderm** followed by three layers of cortex.
- The outer wall is made up of alternately arranged thick walled cells.
- The cells of middle cortex have disappeared and the space is occupied by organic debris and **stigmarian rootets**.
- The inner cortex is parenchymatous.
- **Secondary phloem is not preserved.**
- Secondary xylem is **exarch** with tracheids intermingling with parenchyma.
- Stele is **protostele.**

**Geological period:** Carboniferous period of Paleozoic era.

## Lepidocarpon

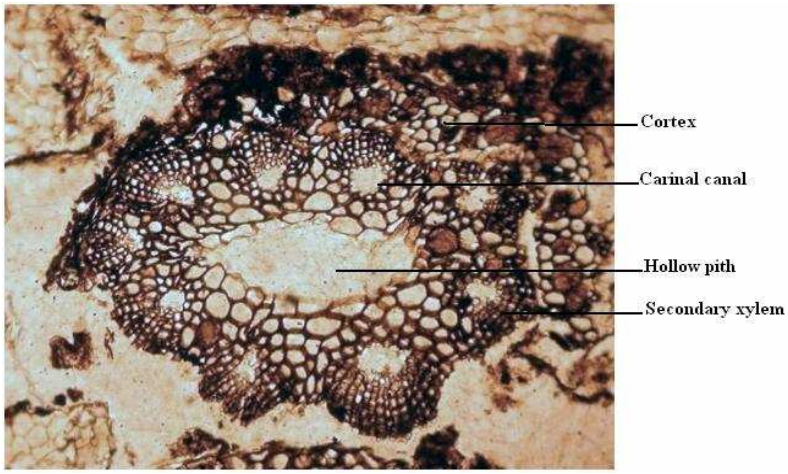


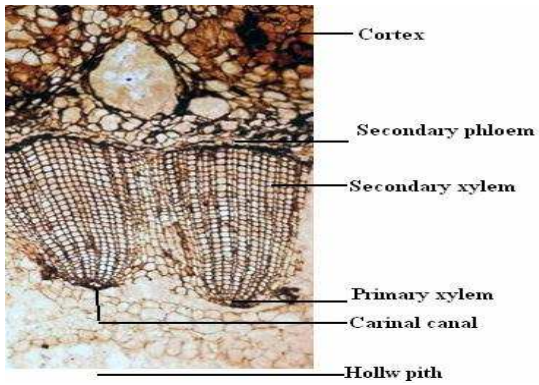

- **Female fruit body** of Lepidodendron- fossil fern.
- It consists of **single megasporangium** with a **megaspore**.
- Megasporangium enclosed by megasporophyll which forms integument like structure.
- Integument has a **false micropyle**.

**Geological period:** Carboniferous period of Paleozoic era.

**Class** : Sphenopsida
**Order** : Calamitales
**Family** : Calamitaceae
**Genus** : Calamites

**Stem**




- It is a **fossil fern. - Calamopsida**.
- The stem shows **periderm, cortex, vascular bundles and pith**.
- Outermost **periderm**.
- Narrow **parenchymatous cortex**.
- Secondary xylem **wedge shaped**, radiating from the centre.
- Primary xylem **endarch** with **carinal canals**.
- Broad medullary rays between secondary xylem.
- Central **hollow pith**.

**Geological period:** Carboniferous period of Paleozoic era.

**Spot at sight the genus, group and morphology of the following.**

**The first one is done for you**

| Part | Genus | Group | Morphology |
|---|---|---|---|
|  | **Pogonatum** | **Gymnosperm** | **Gameophyte with sporophyte** |
|  | | | |
|  | | | |
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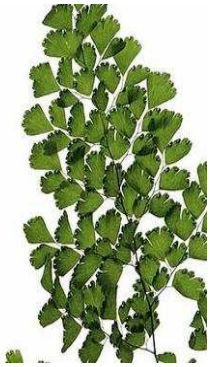
| | | | |
|---|---|---|---|
|  | | | |
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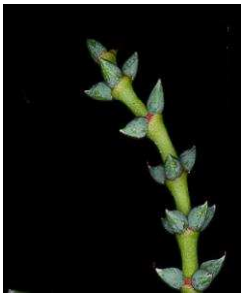
|  | | | |
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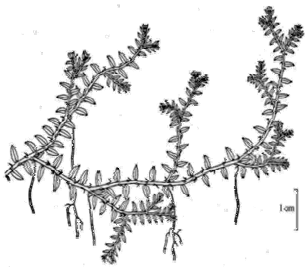
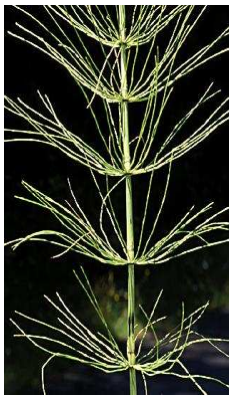
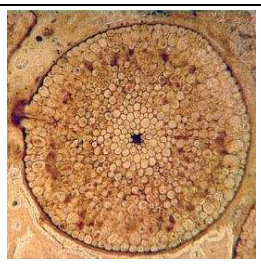
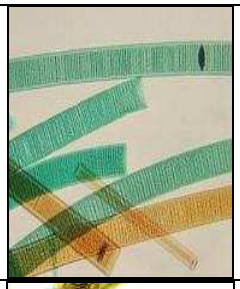
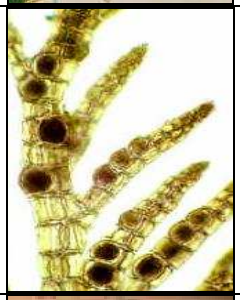
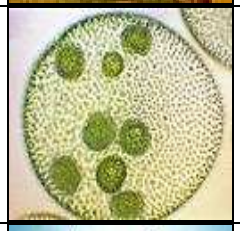
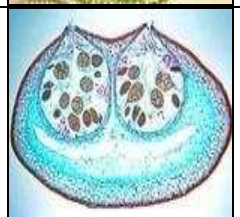
|  | | | |
|  | | | |

## Identify the following fossil, write the geological period.

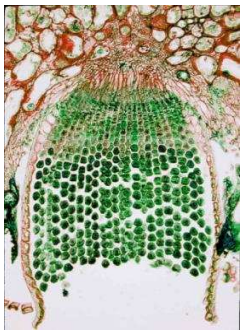
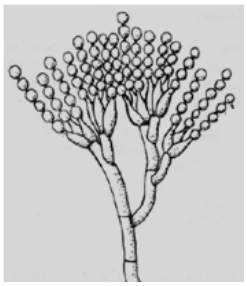
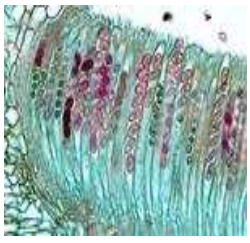
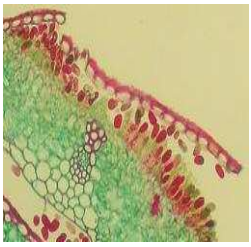
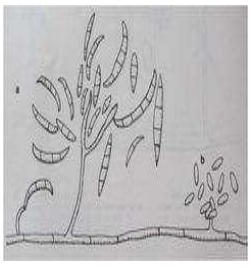
| | NAME | GEOLOGICAL PERIOD |
|---|---|---|
|  | | |
|  | | |
|  | | |

## Observe the images and answer the questions

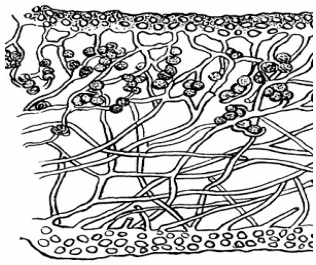
# ALGAE

| IMAGES | QUESTION | ANSWERS |
|---|---|---|
|  | Identify separation disc, trichome, hormogonia. Write down its systematic position. | |
|  | Name the plant and the type of spores present in it. Add a note on the next generation produced by these spores. | |
|  | Can you identify the plant from this cross section? Name the parts you can see in the cross section. | |
|  | What dose this picture represent? Label the parts and mention the plant in which it is present. | |
|  | Which alga can you see? Name the type of thallus and write down the systematic position. | |
|  | Which alga you have studied possesses this structure? Mention the parts and the function. | |
|  | Name the genus and species of this alga. To which division dose this alga belong? Write down the characters. | |

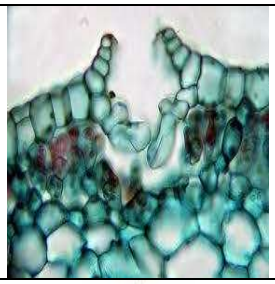
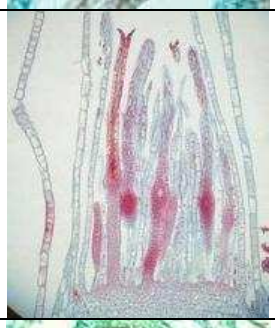
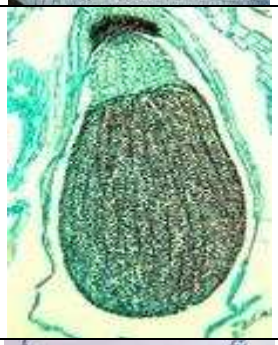
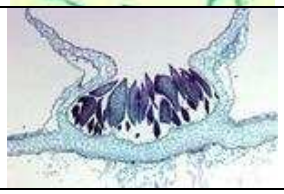
# FUNGI

| IMAGES | QUESTION | ANSWERS |
|---|---|---|
|  | Name the structure. Mention the fungus and the host in which it is produced? | |
|  | Label the different parts with the name of the fungus that produces this. Write down the important use of this fungus. | |
|  | Which fungus you have studied produces this type of fruit body? Name the different parts and the function. | |
|  | Identify the causal organism, symptoms and control measure of the disease. | |
|  | Name the spore and the fungus producing this type of spore. Mention the host in which it is produced. | |
|  | Mention the types of spores seen. Name the fungus and the disease caused by it. | |

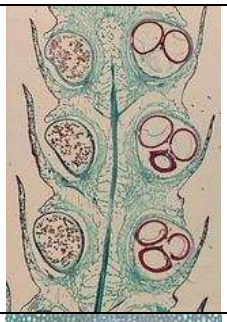
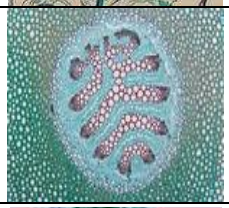
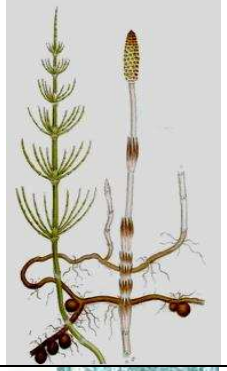
# LICHEN

| IMAGES | QUESTION | ANSWERS |
|---|---|---|
|  | Name the plant and describe the nature of association. | |
|  | Label the different parts and mention the type of thallus. | |
|  | What part of lichen is this? Mention the significance of it. | |

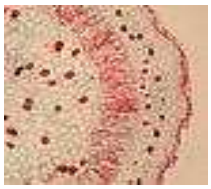
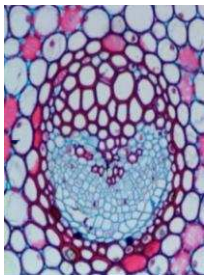
# BRYOPHYTA

| IMAGES | QUESTION | ANSWERS |
|---|---|---|
|  | Observe the image and write a note on it. | |
|  | Label and describe. | |
|  | Describe the structure you notice in the image. | |
|  | Can you identify the image? Mention the structure you see and describe the structure. | |
|  | What structure is seen? Name the different parts along with the function. | |
|  | To which plant dose this belong to? Write down the importance. | |

# PTERIDOPHYTA

| IMAGES | QUESTION | ANSWERS |
|---|---|---|
|  | Is it a homosporous or heteosporous cone? Give example and reason out. | |
|  | What type of stele is this? Describe with example. | |
|  | Name the different parts of the structure and mention the plant which possesses it. | |
|  | What is the image? Label and describe. | |
|  | Name the plant and differentiate the two structures given. | |
|  | Which Pteridophyte you have studied possesses this type of strobilus? Describe. | |

# GYMNOSPERM

| IMAGES | QUESTION | ANSWERS |
|---|---|---|
|  | Name the important part you can see. Mention the significance. | |
|  | Name the image. Which gymnosperm possesses this? | |
|  | What part of Gnetum is this? Describe the structure. | |
|  | What does this image show? Name the plant and write down the systematic position. | |
|  | Describe the stele. Where does this type of stele occur? | |

# PRACTICAL MODEL QUESTION PAPER

I. Make suitable preparations of ‘A’, ‘B’, ‘C’ and ‘D’. Draw labeled sketches and identify giving reasons. Submit the slides for valuation.
(Identification-1; Slide-3; Reason-3; Diagram-2) (4 × 9 = 36)

II. Separate the various types of algae in the given sample ‘E’. Identify them giving reasons and draw labeled sketches.
**(2 × 3 = 6)**

III. Identify, draw labeled sketches and write notes on ‘F’, ‘G’, ‘H’ ‘I’ and ‘J’. (Identification-1; Notes-1; Sketch-1.) **(5 × 6 = 30)**

IV. Identify the fossil ‘K’ with reasons. Draw diagram, give the geological period. (Identification-1; Reason-2; Diagram-2; geological period-1) **(1 × 6 = 6)**

V. Spot at sight genus, group and morphology of L, M, N and O
**(4 × 3 = 12)**

**TOTAL = 90**
**RECORD = 10**

# PRACTICAL NOTES

I. Make suitable preparation of 'A', 'B', 'C' and 'D'. Draw labeled sketches and identify giving reasons. Submit the slides for valuation. (Identification-1; Slide-3; Reason-3; Diagram-2)

**(4 × 9 = 36)**

**A. (Sargassum – stem, Caulerpa- rhizome, Albugo- infected leaf)**

**Sargassum - Stem:**

(i) Sargasssum is a marine brown alga.

(ii) Stem is differentiated into meristoderm, cortex and medulla.

(iii) Meristoderm - single layered, palisade like, meristematic.

(iv) Cortex - parenchymatous with reserve food, storage region.

(v) Medulla - thick walled, help in conduction of water and nutrients.

**Caulerpa - Rhizome:**

(i) Caulerpa is a marine, coenocytic, acellular green alga.

(ii) Rhizome has thick lamellated cell wall.

(iii) Lining layer of cytoplasm with many nuclei and many discoid chloroplasts.

(iv) Central cavity- traversed by trabeculae.

(v) Trabeculae – mechanical strength.

**Albugo - Infected leaf:**

(i) Albugo is an obligate parasitic fungus causing white rust disease in greens.

(ii) Mycelium - branched, aseptate, intercellular with haustoria.

(iii) Mycelial mat forms below the lower epidermis.

(iv) Conidiophore - thick walled, unbranched, club shaped, palisade like.

(v) Conidiophores bear chain of conidia basipetally.

(vi) Conidium - small, spherical and multinucleate and joined by mucilage pad.

**B. Marchantia – Thallus.**

(i) Marchantia is bryophyte belonging to Hepaticae.

(ii) Thallus is differentiated in to epidermis, photosynthetic region and storage tissue.

(iii) Epidermis: upper epidermis-single layered with airpores; lower epidermis with smooth walled and tuberculate rhizoids.

(iv) Upper photosynthetic region - air chambers with assimilatory filaments with partition wall.

(v) Storage region - thin walled, parenchymatous.

**C. (Lycopodium- Stem, Adiantum- Rachis)**

**Lycopodium cernuum - Stem**

(i) Lycopodium is a fern - Lycopsida.

(ii) Stem is wavy in outline.

(iii) It is differentiated in to epidermis, cortex and stele.

(iv) Epidermis is single layered with cuticle.

(v) Cortex - differentiated into outer and inner parenchymatous and middle sclerenchymatous.

(vi) Stele is mixed protostele - patches of xylem in phloem.

(vii) Pith is absent.

**Adiantum - Rachis:**

(i) It is a fern - Filicopsida.

(ii) Rachis is differentiated into epidermis, cortex and stele.

(iii) Cuticularised epidermis.

(iv) Hypodermis - 3-4 layers, sclerenchymatous.

(v) Cortrex- broad, parenchymatous.

(vi) Stele - protostele with single layered endodermis and pericycle.

(vii) Xylem – V - shaped, exarch, completely surrounded by phloem.

**D. (Cycas leaflet, Cycas rachis and Cycas microsporophyll)**

**Cycas - leaflet:**

(i) Cycas is a gymnosperm.

(ii) The leaflet has swollen midrib and narrow wings.

(iii) Outermost cuticularised epidermis.

(iv) Lower epidermis with sunken stomata.

(v) Sclerenchymatous hypodermis on both sides.

(vi) Midrib: centrally located vascular bundle- conjoint, collateral, open and pseudomesarch. Xylem – V shaped centripetal xylem and two groups of centrifugal xylem- diploxylic.

(vii) Wings: Mesophyll shows palisade and spongy. Transfusion tissue between palisade and spongy - lateral conduction.

**Cycas rachis:**

(i) Cycas is a gymnosperm.

(ii) Rachis is shield shaped.

(iii) It is differentiated into epidermis, hypodermis and vascular bundles in ground tissue.

(iv) Epidermis- single layered, cuticularised.

(v) Hypodermis- multilayered, outer chlorenchyma and inner sclerenchyma.

(vi) Ground tissue - parenchymatous.

(vii) Vascular bundle - arranged in an inverted omega shape.

(viii) Each bundle - conjoint, collateral, open and pseudomesarch, diploxylic with centripetal and centrifugal xylem.

**Cycas microsporophyll:**

(i) Cycas is a gymnosperm.

(ii) Microsporophylls are arranged spirally forming male cone.

(iii) T.S of microsporophyll is triangular in outline.

(iv) Microsporangia attached on the lower surface.

(v) Sporangia- oval, sac like with short stalk.

(vi) Sporangia enclose large number of microspores.

(vii) Soral hairs are seen among the sporangia.

II. Separate the various types of algae in the given sample 'E'. Identify them giving reasons and draw labeled sketches.
E- Algal mixture ( Oscillatoria and Polysiphonia).
(Identification-1; Notes-1; Sketch-1) **(2 × 3 = 36)**

**Oscillatoria:**

(i) Unbranched filamentous blue green alga.

(ii) Cell is rectangular - prokaryotic.

(iii) protoplasm - differentiated into outer chromoplasm and inner centroplasm.

(iv) Presence of necridia and hormogone.

**Polysiphonia:**

(i) It is a marine branched filamentous red alga.

(ii) Filaments show of many siphons.

(iii) Each cell has lining layer of cytoplasm with nucleus and many chromatophores.

(iv) Pit connection is present between the cells.

III. Identify, draw labeled sketches and write notes on 'F', 'G', 'H' 'I' and 'J'. (Identification-1; Notes-1; Sketch-1.) **(5 × 6 = 30)**

**SPOTTERS - (F, G, H, I, J)**

F - Algae or lichen. (Volvox, Lichen-apothecium)

G - Fungi. (Puccinia-uredosorus, Penicillium-conidia, Peziza-apothecium)

H - Bryophyte. (Marchantia-sporophyte, Pogonatum-antheridial head, Pogonatum-archegonial head)

I - Pteridophyte. (Lycopodium-cone, Selaginella-cone, Equisetum-cone)

J - Gymnosperm. (Cycas-coralloid root, Cycas-ovule, Gnetum-ovule)

**F - Volvox:**

(i) Volvox is a coenobial round planktonic green alga.

(ii) Coenobium has an outer mucilage sheath.

(iii) Cells are ovoid, biflagellate, uninucleate, interconnected by plamodesmata.

(iv) Each cell has large cup shaped chloroplast with a pyrenoid.

(v) Reproduction- by special large cells called gonidia.

**Lichen apothecium:**

(i) Lichen is a composite symbiotic form with phycobiont and mycobiont.

(ii) Apothecium is a saucer shaped fruit body.

(iii) Apothecium is differentiated into hymenium, sub-hymenium and peridium.

(iv) Hymenium consists of asci with 8 ascospores and paraphysis.

(v) Sub-hymenium-mycelial mat.

(vi) Peridium-fleshy wall layer differentiated into outer cortex and medulla.

(vii) Algal cells are seen only in the outer cortex.

G - **Puccinia-infected leaf with uredosorus**

(i) This stage is found in primary host, wheat.

(ii) The mycelium produces a number of reddish brown pustules on the upper surface of leaf.

(iii) Each pustule is a uredosorus, consisting of number of uredodospores.

(iv) The uredospores are stalked, unicellular, rounded, bi-nucleate spores.

(v) Uredospore is a repeating spore.

**Penicillium-conida:**

(i) Penicillium is saprophytic Ascomycetous fungus.

(ii) Mycelium-branched and septate.

(iii) Asexual reproduction by conidia.

(iv) Conidiophores-branched-primary, secondary and tertiary.

(v) Ultimate branch produce bottle shaped sterigmata with chain of conidia basipetally.

(vi) Conidium-globular with single nucleus.

**Peziza-apothecium:**

(i) Peziza is a coprophilous Ascomycetous fungus.

(ii) Apothecium-cup shaped fruit body.

(iii) It shows hymenium, subhymenium and peridium.

(iv) Peridium-thick fleshy wall - parenchymatous.

(v) Hymenium-fertile lining layer with number of asci, ascospores and paraphysis.

(vi) Below the hymenium is subhymenium.

H - Marchantia-sporophyte, Pogonatum-antheridial head, Pogonatum-archegonial head)

**Marchantia-sporophyte:**

(i) Marchantia is bryophyte belonging to Hepaticae.

(ii) Sporophyte has foot, seta and capsule.

(i) Foot-bulbous help in anchorage and absorption.

(ii) Seta-short and elongates at maturity.

(iii) Capsule-oval and encloses spores and elaters.

(iv) Sporophyte is enclosed by calyptra, perigynium and perichaetium.

**Pogonatum-antheridial head:**

(i) Pogonatumis a bryophyte-Bryopsida.

(ii) Antheridia arise in cluster at the tip of male branch.

(iii) Antheridium-elongated, club shaped, short-stalked with an outer jacket enclosing a number of biflagellate spermatozoids.

(iv) Sterile uniseriate paraphyses present in between.

**Pogonatum-archegonial head:**

(i) Pogonatumis a bryophyte-Bryopsida.

(ii) Archegonia arise in cluster at the apex of female shoot.

(iii) Sterile paraphysis seen among archegonia.

(iv) Each archegonium is flask shaped.

(v) It has a stalk, swollen venter and long tubular neck.

(vi) Venter has venter canal cell and egg.

(vii) Neck consists of six vertical rows of cells enclosing 4-10 neck canal cells.

I (Lycopodium-cone, Selaginella-cone, Equisetum-cone)

**Lycopodium-cone:**

(i) Lycopodium is a fern-Lycopsida.

(ii) Cone-strobili - reproductive part of sporophyte.

(iii) Sporophylls arranged spirally on the cone axis.

(iv) Stalked sporangia on the adaxial side of the sporophyll.

(v) Sporangia are homosporous with spores in tetrads.

**Selaginella-cone:**

(i) Selaginella is a heterosporous fern-Lycopsida.

(ii) Cone-strobili-reproductive part of the sporophyte.

(iii) Ligulate sporophylls are arranged spirally-two types.

(iv) Microsporophyll - bear microspoprangia with many small microspores- male.

(v) Megasporophyll - bear lobed megasporangia with four large megaspores - female.

**Equisetum-cone:**

(i) Equisetum is a homosporous fern-Calamopsida.

(ii) Cone-strobili - reproductive part of the sporophyte - borne at the tips of branches.

(iii) Each cone has a basal sterile sheath-annulus.

(iv) Sporangiophores with a stalk, peltate disc with pendent sporangia.

(v) Peltate disc bears sporangia on the underside.

(vi) Sporangia-sac-like with spores and pseudoelater

J (Cycas-coralloid root, Cycas-ovule, Gnetum-ovule)

**Cycas-coralloid root:**

(i) Cycas is a gymnosperm.

(ii) Coralloid roots-apogeotropic, coral like roots with symbiotic blue green alga.

(iii) It has epidermis, cotex and stele.

(iv) Epidermis- single layered.

(v) Cortex - outer cortex, middle algal zone and inner cortex.

(vi) Algal zone - radially elongated, loosely packed with blue green algae.

(vii) Endodermis followed by pericycle.

(viii) Vascular bundle - triarch, radial,closed with exarch xylem.

**Cycas-ovule:**

(i) Cycas is a gymnosperm.

(ii) Ovule-megasporangium - large, ovoid, borne on megasporophylls.

(iii) Ovule has nucellus covered by an integument.

(iv) Integument - differentiated in to outer and inner fleshy and middle stony layers with narrow tubular micropyle at the apex.

(v) Nucellus encloses female gametophyte.

**Gnetum-ovule:**

(i) Gnetum is a gymnosperm.

(ii) Ovule - megasporangium borne in whorls on female cone.

(iii) It has integument and nucellus.

(iv) Integument is three layered- outer and inner short, middle long tubular (style) forming micropyle.

(v) Nucellus encloses female gametophyte.

(vi) Fan shaped pavement tissue present below the prothallus-nutritive.

IV. Identify the fossil 'K' with reasons. Draw diagram, give the geological period. (Identification-1; Reason-2; Diagram-2; geological period-1) **(1 × 6 = 6)**
K- (Rhynia-stem, Lepidocarpon, Calamites-stem.)

**Rhynia-stem:**

(i) Rhynia is a fossil fern-Psilotopsida.

(ii) Stem shows epidermis, cortex and stele.

(iii) Epidermis-outermost, cuticularised with stomata.

(iv) Cortex-parenchymatous and well preserved.

(v) Stele-protostele-xylem surrounded by phloem.

**Geological period:** Devonian of Paleozoic era.

**Lepidocarpon:**

(i) Female fruit body of Lepidodendron-fossil fern.

(ii) It consists of single megasporangium with a megaspore.

(iii) Megasporangium is enclosed by megasporophyll which forms integument like structure.

(iv) Integument has a false micropyle.

**Geological period:** Carboniferous period of Paleozoic era.

**Calamites-stem:**

(i) It is a fossil fern-Calamopsida.

(ii) The stem shows periderm, cortex, vascular bundles and pith.

(iii) Outermost periderm.

(iv) Narrow parenchymatous cortex.

(v) Secondary xylem wedge shaped, radiating from the centre.

(vi) Primary xylem endarch with carinal canals.

(vii) Broad medullary rays between secondary xylem.

(viii) Central hollow pith.

**Geological period:** Carboniferous period of Paleozoic era.

V. Spot at sight genus, group and morphology of L, M, N and O

**(4 × 3 = 12)**

| GENUS | GROUP | MORPHOLOGY |
|---|---|---|
| Caulerpa | Algae | Thallus |
| Sargassum | Algae | Thallus |
| Peziza | Fungi | Apothecium |
| Usnea | Fruticose lichen | Thallus with apothecium |
| Psilotum | Pteridophyte | Sporophyte |
| Lycopodium | Pteridophyte | Sporophyte |
| Equisetum | Pteridophyte | Sporophyte |
| Adiantum | Pteridophyte | Sporophyte |
| Selaginella | Pteridophyte | Sporophyte |
| Cycas | Gymnosperm | Old stem |
| Cycas | Gymnosperm | Microsporophyll |
| Cycas | Gymnosperm | Megasporophyll |
| Gnetum | Gymnosperm | Male cone |
| Gnetum | Gymnosperm | Female cone |
| Gnetum | Gymnosperm | Wood |

**TOTAL = 90**

**RECORD = 10**