

B. Sc. I Year (Theory)
Semester – II
Paper - V
(Diversity of Cryptogams - II)

45 L.

Unit- 1

Credit 1

1. Bryophytes:

1.1 General characters of bryophytes, classification as per G. M. Smith (02)

1.2 Systematic position, occurrence, thallus structure (external and internal), reproduction -vegetative, asexual, and sexual (excluding developmental stages), graphic life cycle and alternation of generations of the following types:

a) Hepaticopsida – *Marchantia* (07)

b) Bryopsida – *Funaria* (06)

Credits 2

2. Pteridophytes:

2.2 General characters of Pteridophytes, classification as per G. M. Smith (02)

Systematic position, occurrence, external and internal structure of sporophyte and gametophyte, reproduction (excluding developmental stages), graphic life cycle and alternation of generations of the following types:

a) Psilopsida – *Psilotum* (03)

b) Lycopsidea – *Lycopodium, Selaginella* (12)

c) Sphenopsida – *Equisetum* (06)

d) Pteropsida – *Marsilea* (07)

* Marchantia *

external
& Internal
features
of Marcha
ntia

PAGE:

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classification :

Kingdom - plantae - plants

Division - Hepaticopsida byta - Liverworts.

Subdivision - Hepaticae.

Class - Hepaticopsida.

Subclass - Marchantiae

Order - Marchantiales.

Family - Marchantiaceae.

Genus - Marchantia L.P.

↓ meaning

a small flowering
green plant with
leaflike stem or
lobed leaves
occurring in moist
habitats.

Marchantiales is an order of thallose liverworts that includes species like Marchantia polymorpha, a widespread plant often found beside Eivense and Lunularia cruciata, a common and often troublesome weed in moist, temperate gardens and greenhouses.

□ Five family.

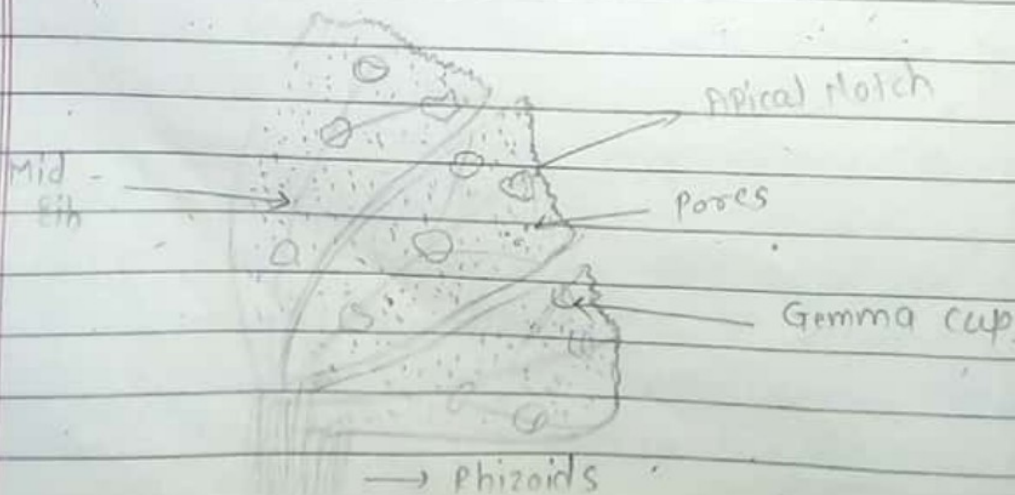
1) Ricciaceae.

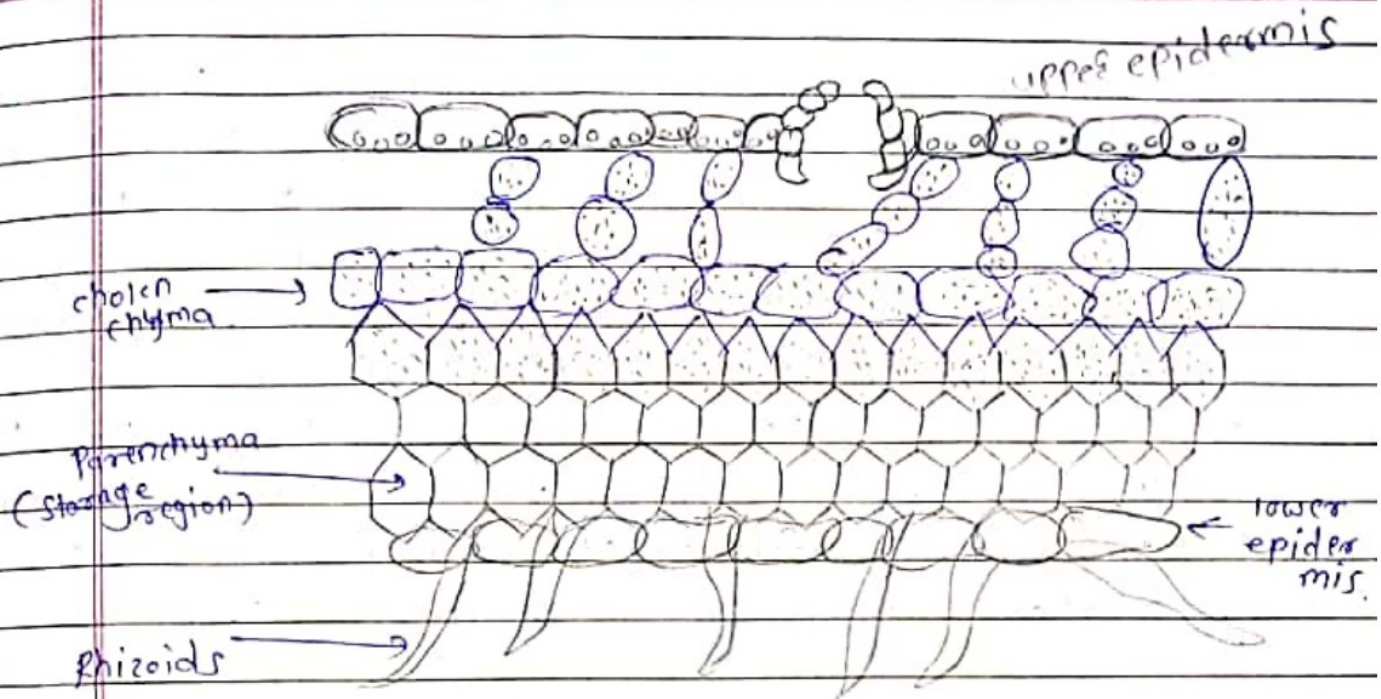
2) Corsiniaceae

3) Targionaceae

4) Marchantiaceae

5) Monocleaceae.





(fig: T.S of Marchantia)

Distribution of & Habitat of Marchantia.

Marchantia, the most important genus of family Marchantiaceae is represented by about 65 species. The name Marchantia was given honour of Nicolas Marchant, director of botanical garden of Gaston Orleans in Blois, France.

All species are terrestrial & com. cosmopolitan in distribution. The species prefer to grow in moist and shady place like wet open woodland, banks of streams, wood rocks or on shaded stub rocks. These grow best after the forest fire in the burnt soil. It is perhaps because of Nitrification of soil due to fire.

- 1) The species are commonly found growing in the Himalayan region at an altitude 4000-8000 feet.
- 2) Eastern Himalays Region particularly support the growth of the species.

- 3) Some species are also ^{found} growing in plains of Haryana, Punjab, Uttar Pradesh and hilly region of South India.
- 4) Some of the common Indian species are *M. palmata*, *M. polymorpha*, *M. simlana* etc. *M. polymorpha* is most widely distributed species. *M. polymorpha* var. *aquatic* grows submerged in swampy meadows.
- 5) The thalli with gemma cups are found throughout the year whereas the thalli with sex organs occur abundantly during February to March in Himalayas and October to November in hills of South India.

Gametophytic phase of Marchantia

• External features of gametophyte:

- 1) The plant body is gametophytic thalloid, flat, prostrate, plagiotrophic, 2-10 cm. long and dichotomously branched dorsal surface.
- 2) Dorsal surface is dark green.
- 3) It has a conspicuous midrib and a number of polygonal areas called areolae. The midrib is marked on the dorsal surface by a shallow groove and on the ventral surface by a low ridge.
- 4) Each polygonal area represents the wall that separates each air chamber from the next.
- 5) Each air chamber has central pore.
- 6) The midrib ends in a depression at the apical region forming an apical notch in which growing point is situated.
- 7) Dorsal surface also bears the vegetative and sexual reproductive structures. The vegetative reproductive structures are gemma cup and develop along midrib.

Thallus
↓
a plant body
without true
stem, roots or
leaves or vascular
system.

PAGE :

DATE : / /

- 8) These are crescent shaped with spiny or imbricate margins, and are about one-eighth of an inch in diameter.
- 9) Special sexual reproductive structures are borne on special stalked structures called gametophores or gametangiophores.
- 10) The gametophores bearing archegonia are called archegoniophores and those bearing antheridia are called antheridiophores.

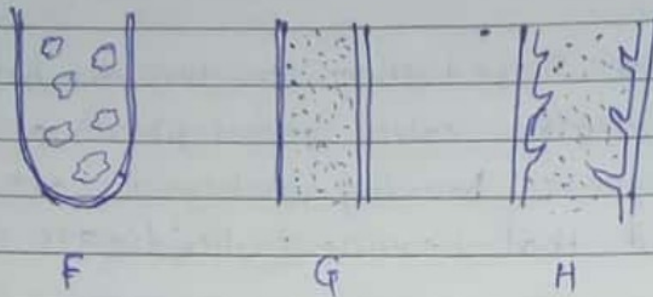
Ventral surface :-

- 1) The ventral surface of thallus bears scales and rhizoids along the midrib.
- 2) Scales are violet coloured, multicellular, one cell thick and arranged in 2-4 rows. Scales are of two types.
 - i) simple or ligulate
 - ii) Appendiculate
- 3) Appendiculate scales form the inner row of the scales close with midrib.
- 4) Ligulate scales form the outer and marginal row and are smaller than the appendiculate scale.

Rhizoid

- Rhizoids are unicellular, branched and develop as a prolongation of the lower epidermal cell, they are of 2 types.
- i) smooth walled rhizoids
 - ii) tuberculate rhizoids.
- 1) In smooth walled rhizoids both the inner & outer wall layers are fully stretched while in tuberculate rhizoids the inner wall layer appears like circular dots in surface view.
 - 2) The inner wall layer is modified into peg-like growth which projects into the cell lumen.
 - 3) The main functions of the rhizoids are to anchor the thallus on the substratum and to absorb water and minerals.

Nutrient from the soil.



F - smooth walled Rhizoid

G - tuberculate Rhizoid

H - Internal structure of tuberculate Rhizoid.

Reproduction in Marchantia :

Marchantia reproduces by vegetative and sexual methods.

Vegetative reproduction :

In Marchantia it is quite common and takes place by the following methods.

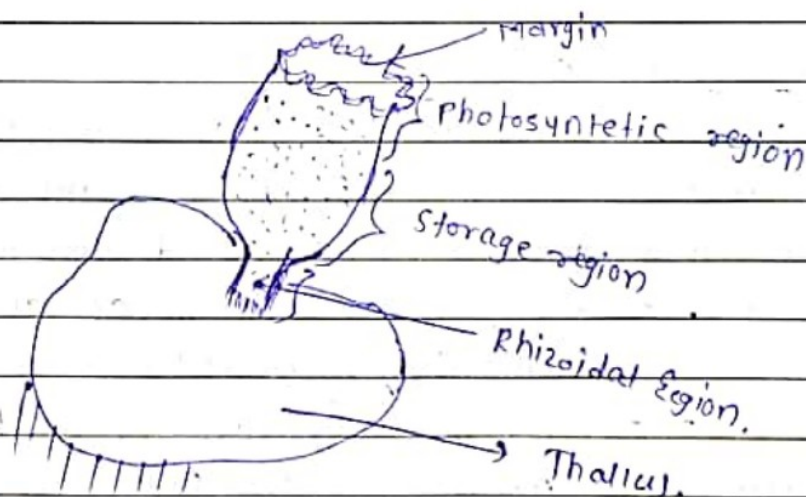
1. By Gemmae :

- i) Gemmae are produced in the gemma cups which are found on the dorsal surface of the thallus.
- 2) gemma cups are present shaped, 3 mm in diameter with smooth, spiny or fimbriate margins.

v.s passing through the gemma cup shows that it is well differentiated into two regions.

- i) upper photosynthetic region and inner storage region
- ii) The structure of both the zones is similar to that of the thallus.
- iii) mature gemmae are found to be attached at the base of the gemma cup by a single celled stalk.

- 4) Intermingled with gemmae are many mucilage hairs.
- 5) Each gemma is autotrophic, multicellular, bilaterally symmetrical, thick in the centre and thin at the apex. It consists of parenchymatous cells, oil cells and rhizoidal cells.
- 6) It is notched on two sides in which lies the growing point.
- 7) All cells of gemmae contain chloroplast except rhizoidal cell and oil cells.
- 8) Rhizoidal cells are colourless and large in size, oil cells are present just within the margins and contain oil bodies of chloroplast.



Dissemination of Gemmae :-

- i) Mucilage hairs secrete mucilage on absorption of water; it swells up and presses the gemmae to get detached from the stalk in the gemma cup. They may also be detached from the stalk due to the pressure exerted by the growth of the young gemmae. The gemmae are ~~produced~~ dispersed over long distance by water currents.

Germination of Gemmae:

After falling on suitable substratum gemmae germinate. The surface which comes in contact with the soil becomes ventral surface.

The Rhizoidal cell develops into rhizoids, meanwhile the growing points in which lies the two lateral notches form thalli in opposite direction. Thus, from a single gemmae two thalli are formed, Gemmae which develop on the male thalli form the male plants and those on the female thalli form the female plant.

Development of Gemmae:

The gemma develops from a single superficial cell. It develops on the floor of the gammarcup. It is papillate and gemma initial. It divides by a transverse division, to form a lower stalk cell and upper cell. The lower cell forms the single celled stalk.

The upper cell further divides by transverse division to form two cells. Both cell undergo by similar division to form four cells. These cells divide by vertical and horizontal division to form a plate like structure with two marginal notches. It is called gemma.

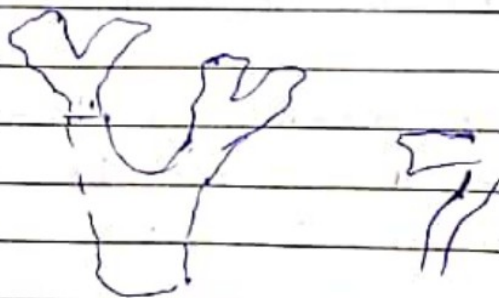
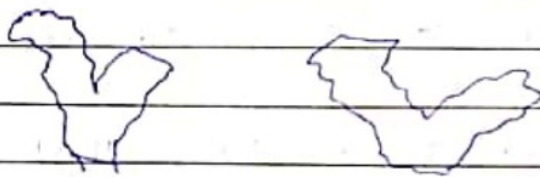
Death and Decay of the older portion of the thallus for fragmentation:

The thallus is dichotomously branched. The basal part of the thallus rots and disintegrates due to ageing.

when this process reaches up to the place of dichotomy the lobes of the thallus get separated. the detached lobes or fragments develop into independent thalli by apical growth.

3. by Adventitious branches:-

The adventitious branches develop from any part of the thallus or ventral surface of the thallus or rarely from the stalk and disc of the archegoniophore in species like *M. palmata*, on being detached these branches develop into new thalli.



Structure
Development
of
Sporophyte
↓
20 marks.

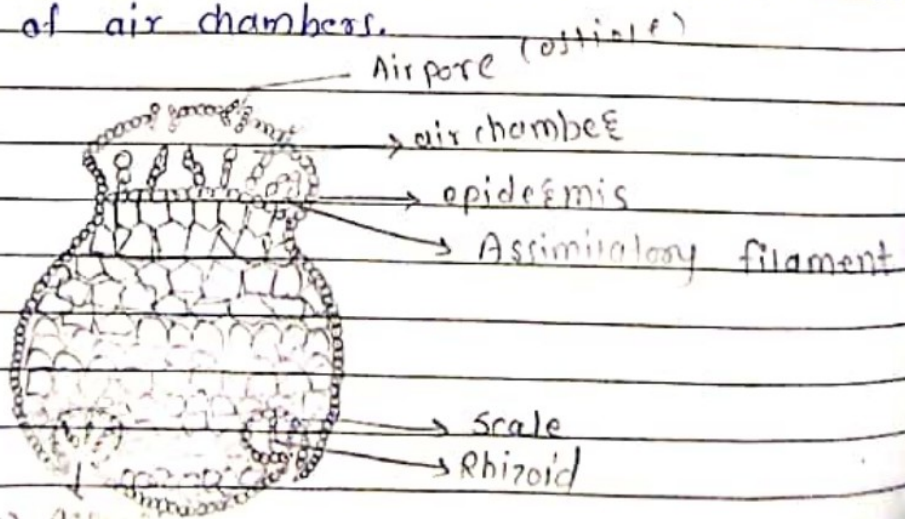
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Sexual Repⁿ:-

- 1) Sexual Repⁿ in Marchantia is oogamous. All species are * dioecious. Male reproductive bodies are known as anthridia & female archegonia.
- 2) Anthridia & Archegonia are produced on special, erect modified lateral branches of thallus called anthridiophore and Archegoniophore. Arpöcephalum.
- 3) Further growth of thallus is checked because growing point of the thallus is utilised in the form of these branches. In some all thalli of *M. palmata* & *M. polymorpha* abnormal receptacle bearing both Anthridia & Archegonia have also been reported. Such bisexual receptacles are called as and rogynous receptacles.

Internal structure of Anthridiophore or Archegoniophore:

- 1) its transverse section shows that can be differentiated into two sides ventral side & dorsal side.
- 2) ventral side has two longitudinal grooves with scales & shizoids.
- 3) These grooves, run longitudinally through the entire length of the stalk; dorsal side shows an internal differentiation of air chambers.



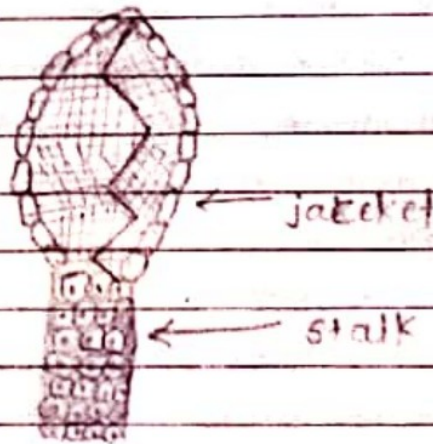
Acropetal
↓
older near
the centre &
youngest at
the margin

~~is~~ through Antheridiospore :-

- 1) It consist of 1-3 cm long stalk & a lobed disc at the apex
- 2) the disc is usually eight lobed but in *M. germinata* is it four lobed disc is a result of crossed dichotomies.

1.5 through disc of Antheridiospore.

The disc consists of air chambers alternating with horizontal cavities. Air chambers are more or less triangular & open on upper surface by n. pore called ostiole. Antheridia arise in acropetal succession i.e. the older near the centre & youngest at the margin.



(Mature Antheridia)

Mature Antheridium :-

- 1) A mature antheridium is globose in space and can be differentiated into two parts stalk and body.
- 2) stalk is short multicellular and attaches the body to the base of the antheridial chamber.
- 3) A single layered steriled jacket encloses the mass of androcyte mother cells which metamorphose into antherozoids.

4) The Antherozoid is minute rod like biflagellate structure.

Development of Antheridium :-

- 1) the development of the antheridium start by a single superficial cell which is situated on the so dorsal surface of the disc.
- 2) 2-3 cells behind the growing point. this cell is called antheridial initial.
- 3) The antheridial initial increases in size and divides by a transverse division to form an outer upper cell and a lower basal cell.

- Jacket initial divides by several anticlinal divisions to form a single layer of sterile antheridial jacket.
- primary androgonial cells divide by several repeated transverse and vertical division resulting in the formation of large no. of small androgonial cells.
- The last generation of the androgonial cell is known as androcyte mother cell.
- Each androcyte mother cell divides by a diagonal mitotic division to form two triangular cells called androcytes.
- Each androcyte cell metamorphosis into an antherozoid.

Spermatogenesis :-

The process of metamorphosis of androcyte mother cells into antherozoid is called spermatogenesis.

Metamorphosis :- a complete change of form.



(Antherozoids)

Archegoniophore OR Carpoccephalum ♂:

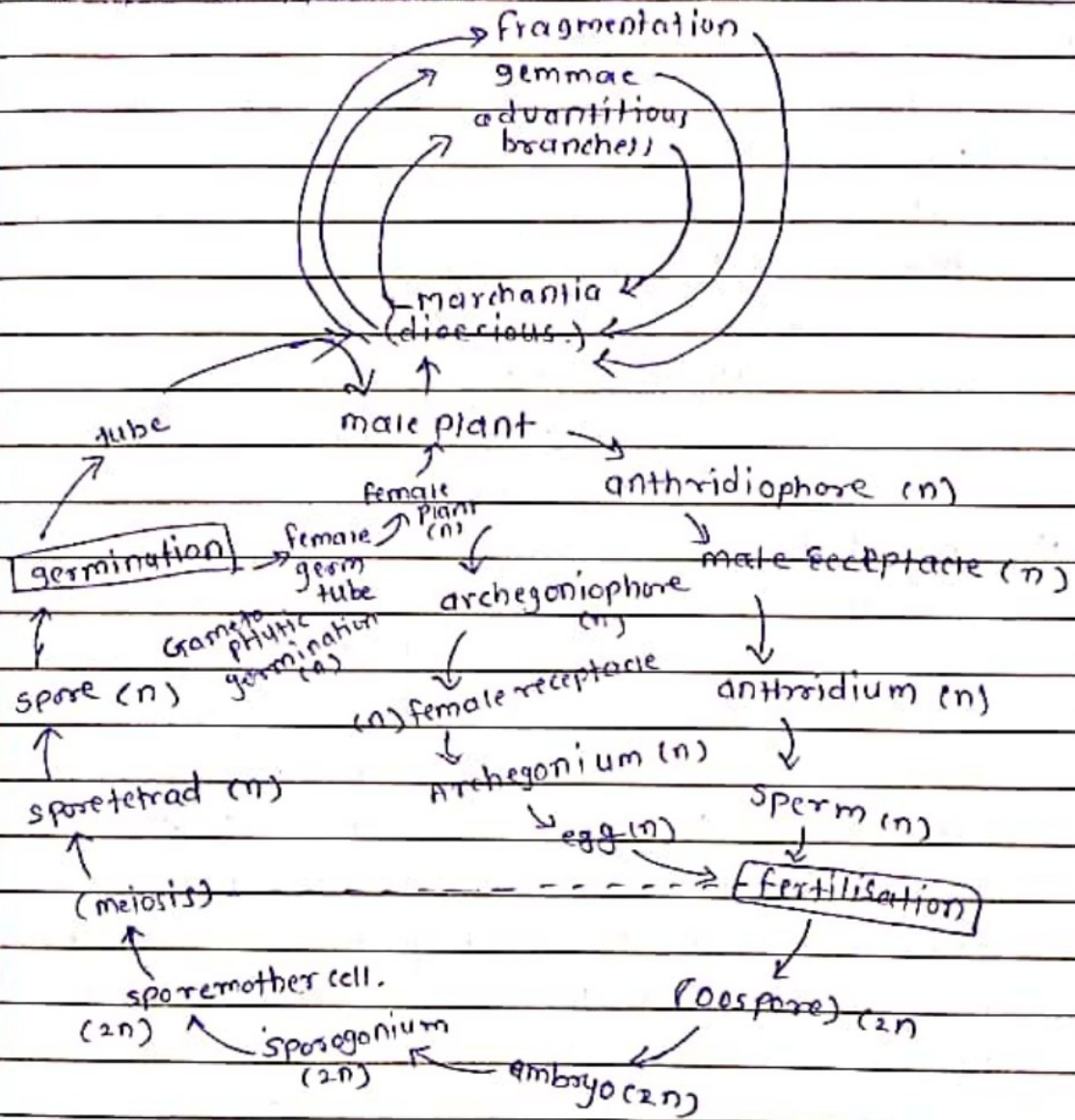
- it arises at the apical notch & consist stalk and terminal disc.
- it is slightly longer than the antheridiophore. - it may be 5-7 cm long. The young apex of the archegoniophore divides by three successive dichotomus to form eight lobed rosette like disc.
- each lobe of the disc contains a growing point. The archegonia begin to develop in each lobe in acropetal succession. i.e the oldest archegonium near the centre and the young archegonium near the apex of the disc.
- Thus, eight groups of archegonia develop on the upper surface of the disc.
- There are twelve to 14 archegonia in a single row in each lobe of the disc.

#

Development :

- The development of the archegonium starts on the dorsal surface of the young receptacle in acropetal succession.
- A single superficial cell which acts as archegonial initial enlarges and divides by transverse division to form a basal cell or primary stalk cell and an outer cell or primary archegonial cell.
- The primary stalk cell undergoes division and forms the stalk of archegonium.
- The primary archegonial cell divides by three successive intercalary walls or periclinal vertical walls resulting in the form of 3 peripheral initials and a fourth median cell, the primary axial cell.
- Each of the three peripheral initials divide by an anticlinal vertical division forming two cells.
- In this way primary axial cell gets surrounded by six cells.
- These are called jacket initials.
- Six jacket initials divide transversely into upper neck initial & lower venter initials.
- Neck initial divides by repeated transverse division in to form a tube like neck.

Lifecycle of Marchantia :-



(life cycle of Marchantia).

B) * Bryopsida *

PAGE :
DATE : 1 . 1

* Funaria *

General characters of Bryopsida :

- The Bryopsida constitute the largest class of mosses, containing 95% of all moss species.
- It consists of approximately 11,500 species, common throughout the whole world.

Kingdom - plantae

Division - Bryophyta

Class - Bryopsida.

1) All of the features of the gametophyte (protonema, gametophore, gametangia) and sporophyte (seta, sporogonium & peristome). described for the Bryophyte are applicable to the Bryopsida.

2) The group is distinguished by having spore capsules with teeth that are arthrodontous. The teeth are separate from each other & jointed at the base where they attach to the opening of the capsule. These teeth are exposed when the covering operculum falls off. In other groups of mosses, the capsule is either nematodontous with an attached operculum or else splits open without operculum or teeth.

characteristics of Funaria :

1) Funaria grows on moist, humid soil, trunks of trees during the rainy season.

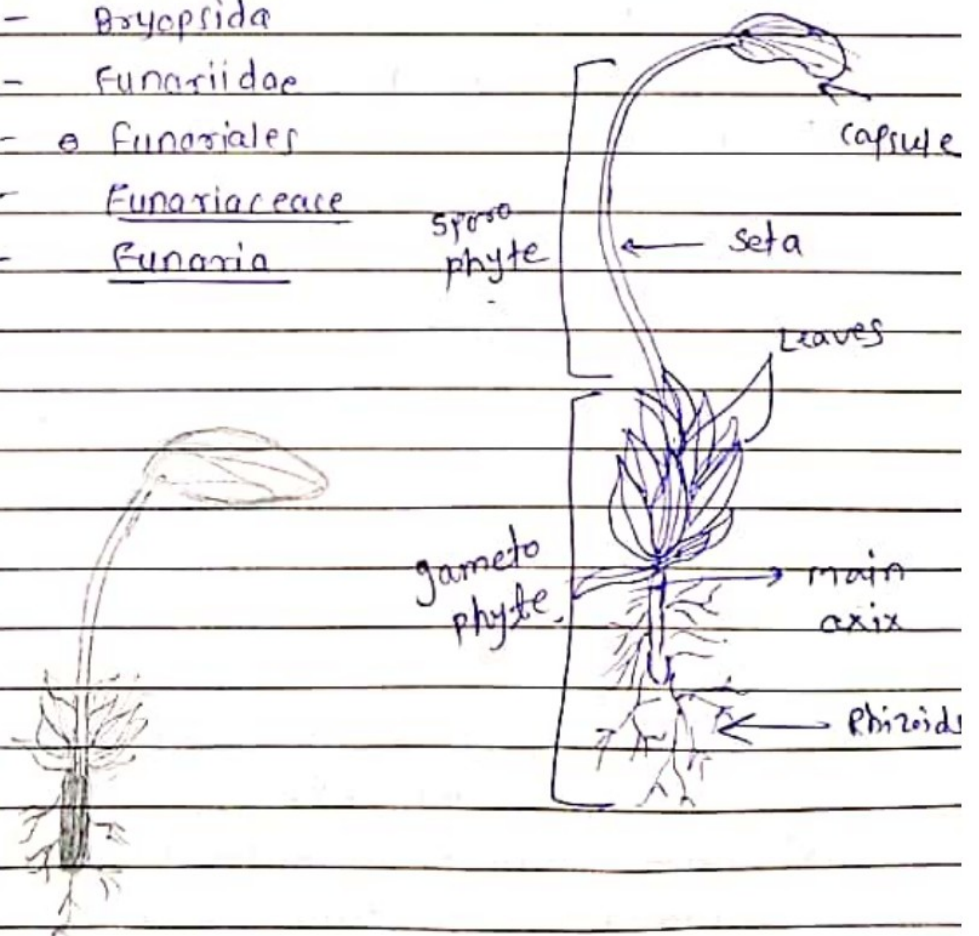
2) External structure :-

- The plant body is foliose. It is differentiated into rhizoids, stem and leaves.

- 1) Rhizoids : Rhizoids are multicellular & branched & slender structure. They fix the plant as well as absorb minerals & water.
- 2) Axis (stem) : the axis is slender, erect & branched, it is green in colour.
- 3) Leaves : leaves are arranged on the axis in spiral fashion. The leaves are sessile, simply green and distinct midrib.

Classification :

- Kingdom - plantae
- Division - Bryophyta
- class - Bryopsida
- subclass - Funariidae
- order - Funariales
- family - Funariaceae
- Genus - Funaria



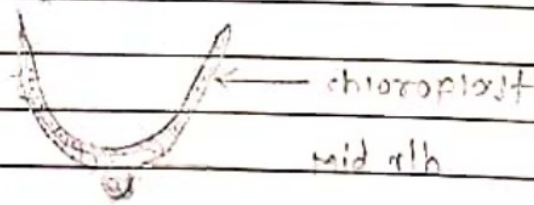
(Funaria)

Habit And Habitat :

- The genus Funaria includes about 117 species which are cosmopolitan in nature. They are the common moss.
- also known as green moss or cord moss.
- It forms velvety tuft on moist ground, rocks, tree trunks, under shade etc.
- About 15 species of Funarium have been reported from India.
- Funaria Hygrometrica it is common moss of Indian hills.

b) Leaf :

The leaf is single layered thick except for the mid-rib. The central part is similar to the central cylinder of the axis.



(x.s of leaf)

Internal Structure :

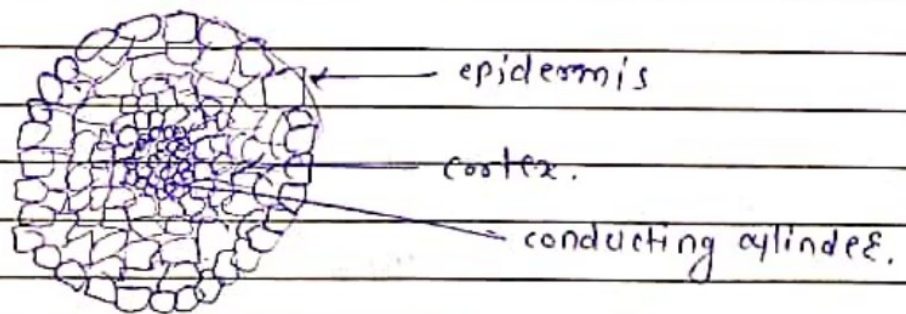
a. Stem :

- i) Epidermis :- it is outer most single layered. it is made up of thick walled cells.
- ii) cortex :- it is multilayered zone situated just below the epidermis and consists of parenchymatous cells.
- iii) central cylinder :- it forms the central core of the axis & consist of vertically elongated.

thin walled cells. The central cylinder provides mechanical strength to plant and help in conduction of water and mineral.

External Structure :-

- plant is a small about 1-3 cm long, stem is erect and branched, it is differentiated into rhizoids, axis & leaves.
- The rhizoids are multicellular & branched.
- The axis is aerial erect & branched.
- The leaves are simple small & spirally arranged.
- The upper leaves are large & lower leaves are crowded.



Life cycle in Funaria — vegetative & sexual repⁿ 20 mark

- In Funaria life cycle are two type i.e sexual & Vegetative :-

A.) Sexual life cycle :-

- The life cycle of Funaria is haplo-diplontic type.
- In the life cycle free living haploide gametophyte alternates with a semiparasitic diploid sporogonium.
- In this type alternation of generation is called heteromorphic or heterologous.

- In funaria the main plant body is free living gametophyte which exist 2 forms. i.e protonema (juvenile gametophyte) & leafy gametophyte (adult gametophyte.)

1. Spore germination and protonema :

- spore is the first cell of gametophytic generation.
- on a suitable damp habitat, a meispore of funaria germinates into a filamentous green algae like structure called protonema.
- protonema has green epitemean chloronemal branches (chloronema) and non-green subtemean Rhizoidal branches (caulonema)
- chloronemal branches produce several buds, each of which develop into a leafy gametophore.

2. Adult Gametophore : (gametophyte) ← no marks.

- It is long 1-3 cm in height and differentiated into Rhizoids, axis (stem) and leaves.

i) Rhizoids :

multicellular, colourless root-like structures with oblique septa. They help in anchorage and absorption.

ii) axis : It is 1-3 cm in height and branched.

- The axis and its branches covered with spirally arranged leaves.

= While the tip of the axis contain crowded young leaves forming a bud like structures.

- The growth of the axis is due to the activity of a pyramidal apical cell.

Paraphysis
small hair
like structure.

PAGE :
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iii) Leaves :

- Leaves are sessile, ovate and green.
- Each leaf has a midrib, on both side of which single layered wing present.

3) Sex organ :

- Adult gametophore is monoecious and auterocious i.e. male & female sex organs developes at the tips of separate shoots of the same gametophore Anthridia (male sex organ).
- The main axis is called male shoot or anthridiophore.
- The tip of male shoot has a convex disc or receptacle on which a cluster of club-shaped anthridia intermingle with like capitata paraphysis arils.
- The receptacle is surrounded by rosette of perigonal leaves.
- Each mature anthridium has a short stalk and a club shaped jacketed body.
- Inside the jacketed body a mass of androcyte mother cells present, each of which diagonally divides into two androcytes.
- Each androcyte develops into a biflagellate antherozoid.

4) Archegonia : female sex organ.

- The female shoot arise from the base of the male shoot & called as archegonial branch or archegoniophore.
- The apex of female shoot is called female receptacle from which cluster of Archegonia arise intermixed with non-capitata paraphysis.

- Further, the female receptacle is surrounded by perichaetial leaves (perichaetium).
- Each Archegonium has a stalk, flask-shaped venter and a neck. Venter encloses a basal egg cell (oosphere) and upper smaller venter canal cell.
- Neck consist of 6 or more neck canal cells.

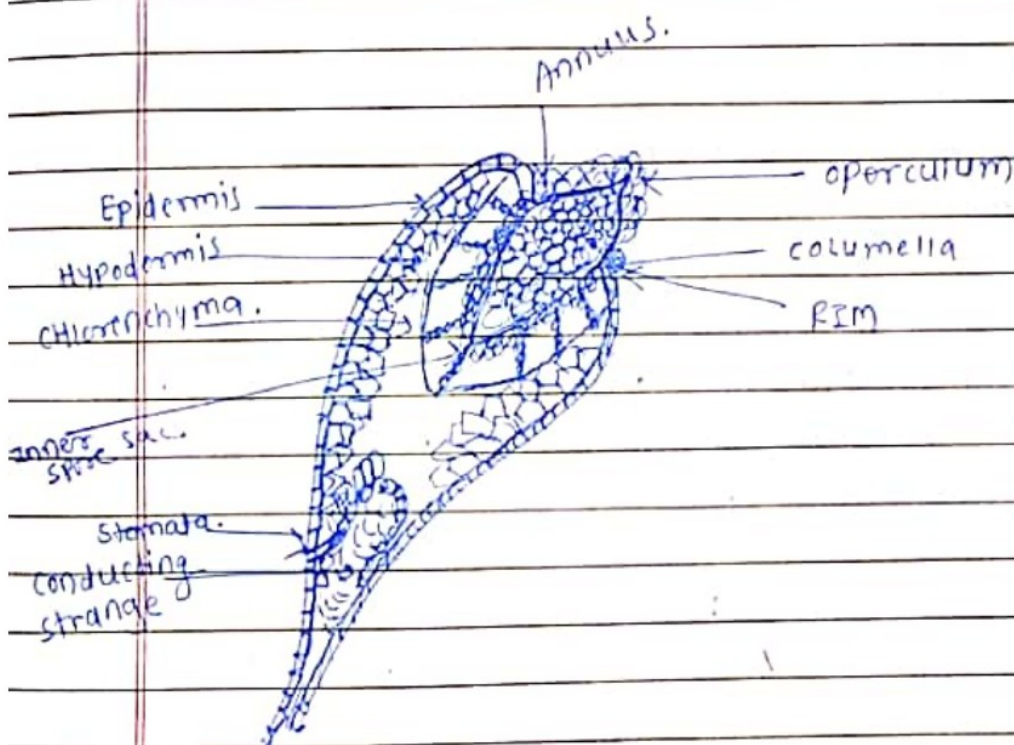
Fertilisation :-

- 1) Funaria is protandrous i.e male sex organs mature first. Hence cross fertilisation takes place.
- 2) Water is essential for fertilisation.
- 3) During heavy rains the antherozoids reach the vicinity of archegonial neck and swim down to venter.
- 4) Any one antherozoid fuses with egg to form zygote.
- 5) soon, the zygote secretes a cell wall and become the oospore.
- 6) The oospore divides and redivides to form embryo.
- 7) Later the embryo grows into a sporophyte or sporangium.
- 8) Thus, zygote or oospore is the first cell of sporophyte generation.

Sporogonium :-

- 1) The sporogonium of Funaria is photosynthetic, hence semi-parasitic on gametophore.
- 2) It differentiate into foot, seta and capsule.
- 3) The foot embedded in the female receptacle and absorb inorganic nutrients. seta is a long stalk with a pear-shaped capsule by its tip.
- 4) capsule has 3 parts - basal apophysis, central theca, terminal operculum.

- 5) Annulus is ring cell separate operculum and theca.
- 6) The middle fertile theca, from centre to outside consist of a sterile columella, surrounded by a barrel-shaped spore sac, a cylindrical air space with trabeculae, hypodermis and epidermis.
- 7) as the sporangium grows along with it in the form of protective covering called calyptra.
- 8) Later the calyptra ruptures and remains like a cup on the capsule.
- 9) Calyptra is haploid because it develops from venter wall.



Vegetative cycle :

- In funaria, the alternation of generation is not always obligatory.
- Frequently, the gametophyte undergoes vegetative propagation to form a succession of the gametophyte generation before the sporophyte generation develops.
- vegetative propagation is method by which part of the gametophyte separate or specialized to form a new individual.

The various methods of vegetative propagation in funaria:

a) By fragmentation of primary protonema :

Accidently, or death of intercalary, segment sometime, causes fragmentation of primary protonema, each fragment can give rise to leafy gametophore.

b) By secondary protonema :

- secondary protonema develops from any cell of injured part of gametophore, this develops lateral bud which grows into leafy gametophore.

c) by Bulbill (tubers) :

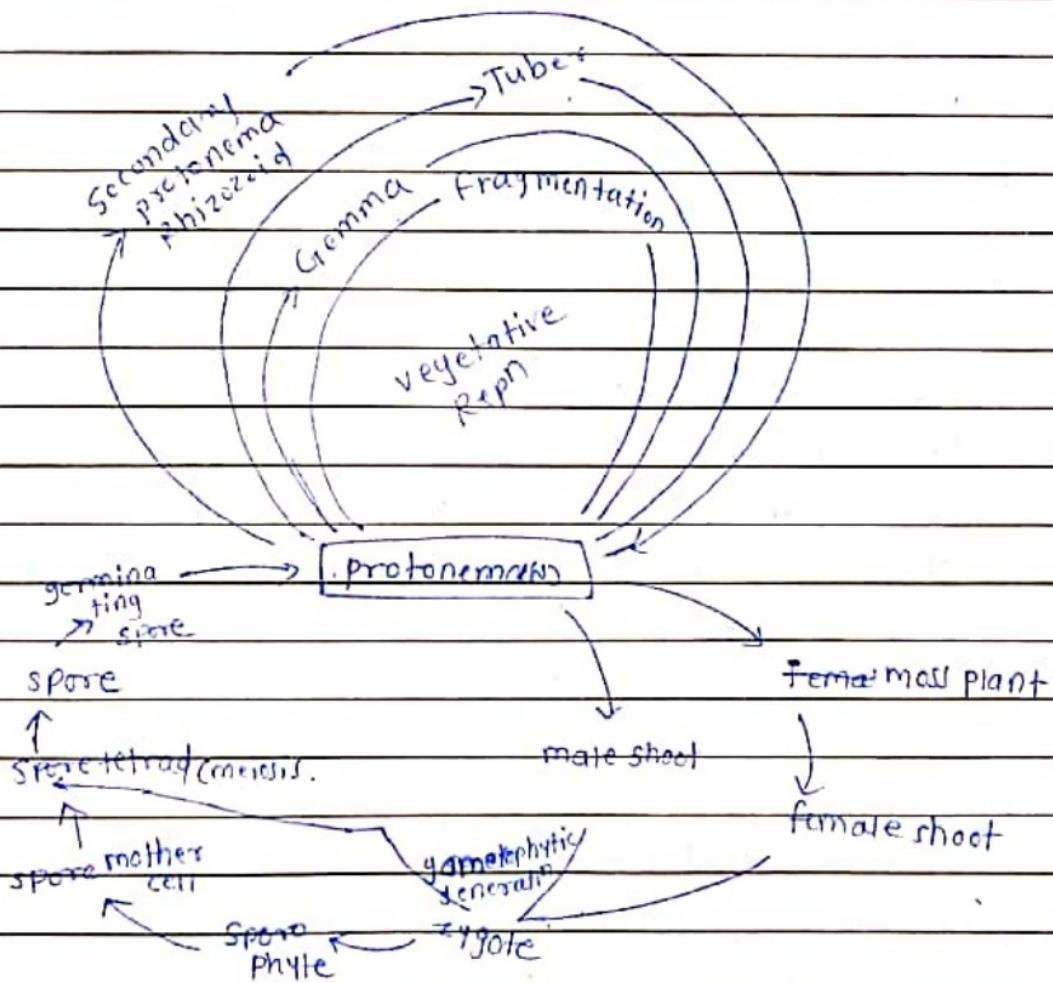
- These are perennating structures developed on rhizoids, on return of suitable condition, each of them produces a protonema.

d) By Gemmae :

- The apices of protonemal branches, leaves an axis develops gemmae. Detached gemmae gives rise to gametophore under favourable condition.

c) Apospory :

- This is the vegetative propagation of sporangia in which any somatic cell produce leafy gametophore without spore formⁿ. The aposporously produced gametes are exceptionally diploid (2n).



Pteridophytes

- 1) - The division pterophyta includes a group of primitive vascular plants.
- 2) pteridophyte and their relatives are considered as some of Earth's first land plants.
- 3) pteridophytes are mostly terrestrial or aquatic and some species are also epiphytes that grow on the branches of trees.
- 4) More than 12,000 diffⁿ species of ferns are distributed worldwide.
- 5) The adult plant body is known as sporophyte.

General characteristics :-

- 1) They are generally non-woody plants, but some giant ferns can be considered semi-wood.
- 2) The leaves are called fronds.
- 3) most are compound with a rachis and numerous pinnae almost all have divinate vernation i.e they are coiled tightly over the growing tips.
- 4) These unroll as they mature.
- 5) They also have specialised leaves that produce spores called sporophylls.
- 6) They are "vascular plants" with well-developed internal vein structure (with xylem & phloem) that allow the movement of water and nutrients.
- 7) Roots are simple and arise adventitiously along the rhizomes near the base of the stem.

Habitat :

- 1) Pteridophytes are delicate plants that only grow in areas where there are suitable moist conditions.
- 2) They favour sheltered areas under the forest canopy, along creeks and streams and other sources of permanent moisture.
- 3) They cannot grow readily in hot dry areas like flowering plants and conifers.

classification of pteridophyte :

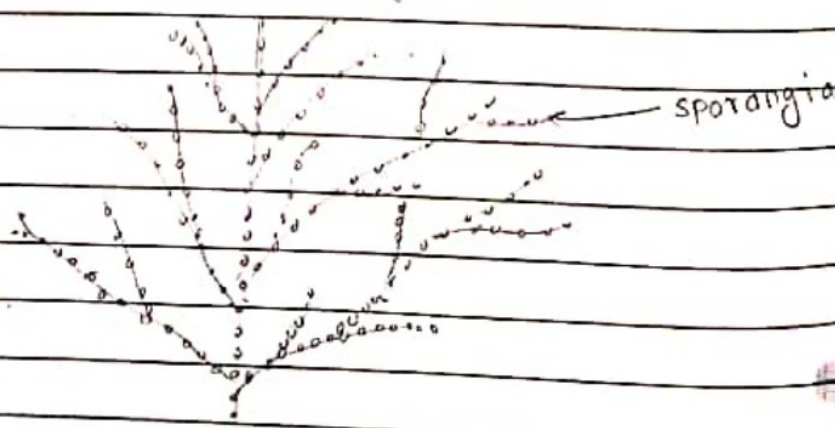
- 1) For a long time the division pteridophyta included the ferns, lycopods and horsetails.
- 2) on the basis of their anatomy Jeffrey in 1902 divided the vascular plants into two types or 'stocks'. He included i) ferns, gymnosperms and angiosperms in a stock known as pteropsida.
ii) Lycopods and horsetails in another 'stock' known as Lycepsida.
- 3) Scott in 1923 ranked them as divisions. He segregated the horsetails as a separate division, the sphenopsida.
- 4) accordⁿ to Fornet (1936), JIPPO (1942) and others there is a single division, the tracheophyta consisting of 4 divisions.
 1. psilopsida
 2. Lycepsida
 3. Sphenopsida.
 4. pteropsida.

5) classified into 4 divisions that have 40 families. they include about 10,000 living species (365 genera) distributed worldwide.

* Psilotum *

Kingdom - plantae
Division - pteridophyta
class - psilopsida
order - psilotales
family - psilotaceae
Genus - psilotum

- 1) psilotum (whisk fern) is a genus of fern-like vascular plants, one of two genera in the family psilotaceae, order psilotales, and class psilopsida (the other being (Tmesipteris).
- 2) The name of the genus is from greek psilos = bare referring to the lack of the usual plant organs, such as leaves.



General characteristics of psilotum :-

- 1) The sporophytes are dichotomously branched with an underground rhizome and upright branches.
- 2) The upright branches are leafless.
- 3) Rhizoids present instead of roots.
- 4) Stem have a relatively simple vascular cylinder.
- 5) The sporangia are borne in group (trilocular) and form synangia.
- 6) spore produced are all alike (homosporous)
- 7) The development of gametophyte is exosporic and form monoecious subterranean gametophyte.
- 8) The development of embryo is exoscopic.

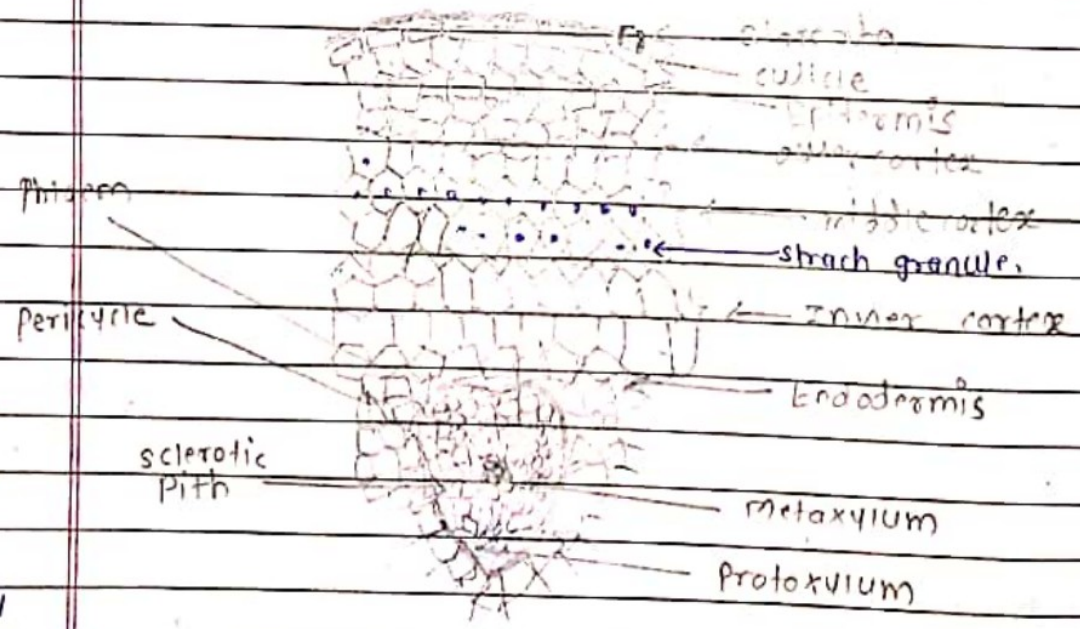
Sporophyte ^{*} ————— 20 marks

- The plant body of psilotum is sporophytic branched rhizome system and dichotomously branched, slender, upright green arial system that bears small appendages and syngia (syngium).

Arial stem :

- 1) Any one of the rhizome tips may turn upward and undergo several dichotomies to give rise to a green arial shoot.
- 2) The arial shoot are slender, generally erect but may be pendant in epiphytes (P. flaccidum).
- 3) They are perennial and become shrubby by repeated dichotomies and sometimes attain a height up to 1 meter.
- 4) The arial stems are photosynthetic and the general appearance is xerophytic although the plants grow in very moist environment.

- 5) In T.S the aerial system is covered by an epidermis followed by extensive cortical areas, single-layered endodermis & stele.
- 1) The stele is the siphonostelic in the basal part which becomes actinostelic in the younger branches.
- 2) The epidermis is single-layered, in which the outer tangential cell walls are heavily cutinized & covered by a layer of cuticle.
- 3) The epidermis is broken regularly by stomata.
- 4) The stomata of psilotum do not have subsidiary cells.
- 5) At base extreme, the stem is prokistelic (actinostelic).
- 6) In the middle portion of the stele is siphonostelic as the centre of the xylum is occupied by a patch of elongated sclerenchymatous cells (sclerotic pith).



Rhizome :-

- 1) The basal subterranean branched rhizome is generally hidden beneath the soil or humus.
- 2) It bears numerous rhizoids, instead of roots, which perform the functions of absorption.
- 3) In T.S the rhizome reveals an outermost epidermis, cortex, endodermis, pericycle and stele.
- 4) The epidermis is indistinct and gives rise to 2-celled rhizoids.
- 5) The cortex is extensive, parenchymatous and differentiated into outer, middle and inner layer.
- 6) The outer cortical is characterised by the presence of intracellular endophytic mycorrhiza.
- 7) The cells of middle cortex are large starch grains, while the cells of the inner cortex are often dark brown in colour because of the presence of phlobaphene (an oxidative product of tannin).

Appendages :-

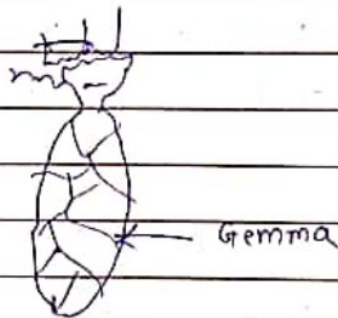
- 1) These are small scale-like structures helically arranged on the upper part of the aerial system.
- 2) Internally, the appendages is composed of parenchymatous photosynthetic cells, bounded by a single-layered cutinized epidermis.
- 3) There is no stomata in the appendages.

Reproduction in psilotum :

The psilotum reproduces vegetatively as well as by spores.

i. Vegetative Reproduction.

- 1) The sporophyte as well as gametophyte of *epi psilotum* propagate vegetatively through the production of Gemmae.
- 2) They are small, multicellular asexual structures developing of surface of rhizome. (in sporophytic plant body) or prothallus (in the gametophyte)
- 3) After detachment from the parent body, gemmae of sporophyte of may germinate to form a subterranean shoot, while the gemmae of prothallus, on germination, form a new prothallus.

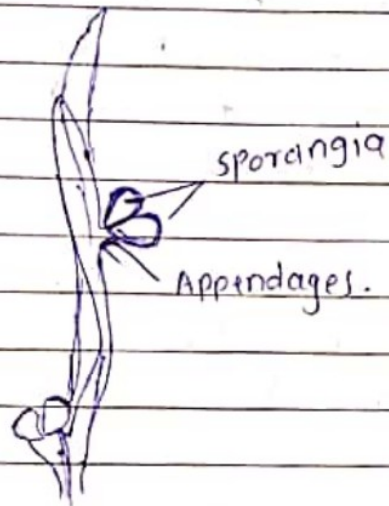


(gemma of psilotum);

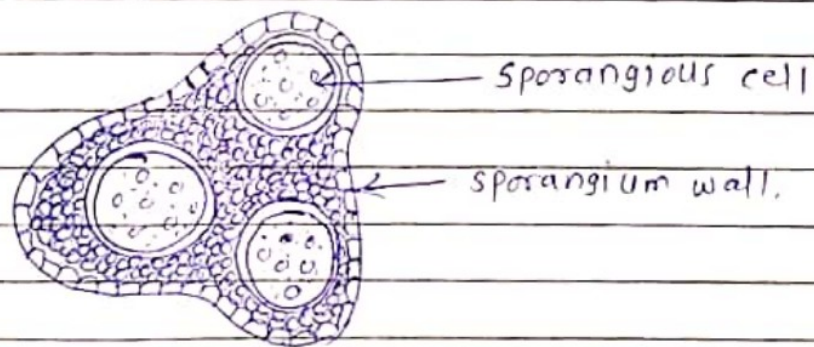
ii) Reproduction by spore.
spore producing structure :

- 1) At maturity, many of the dichotomously branched aerial shoots become fertile and produce trilocular sporangia known as synangia.
- 2) The mature synangium is generally a three lobed structure and each lobe of the synangium corresponds to a sporangium.

- 3) The synangia located at the tip of very short axis, measuring 1-2 mm in diameter.



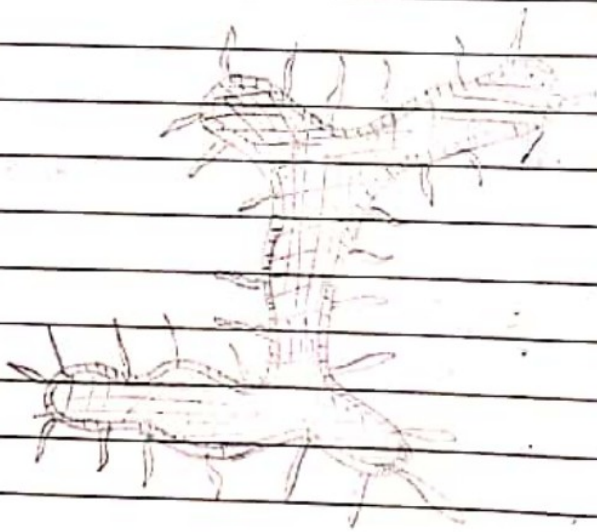
(Part of the fertile axis)



T.S of synangia.

Gametophyte :

- 1) The mature gametophyte shows a striking similarity with a piece of sporophyte rhizome.
- 2) It grows as saprophyte with an associated fungus.
- 3) Spores germinate exosporecally to form the gametophyte.
- 4) The mature gametophyte are brown, cylindrical and usually dichotomously branched, but may sometimes become irregular.
- 5) The surface of the gametophyte is covered by long unicellular, brownish Rhizoids.
- 6) The gametophyte grows by means of apical meristem.



Sex organs ♂-

- 1) The gametophytes of pteridium are monoecious (i.e. homothallic) sex organs i.e. antheridia & archegonia, are superficial & scattered over the surface of the gametophyte.
- 2) generally, antheridia are more in number than archegonia.

Antheridium

- 1) The antheridium develops from a single superficial cell (antheridial initial) of the prothallus.
- 2) The periclinal division of the superficial cell produces an outer jacket initial and an inner primary androgonial cell.
- 3) The outer jacket initial undergoes repeated anticlinal divisions and forms a single layered jacket.
- 4) The inner primary androgonial cell divides in various planes and produces a mass of developing androgonial cells, the last generation of which are the androcytes.

* Antheridium -



- 1) The antheridium develops from a single superficial cell (antheridial initial) of the prothallus.
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- 3) The outer jacket initial undergoes repeated anticlinal division & form a single layered jacket.
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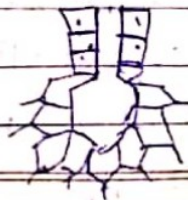
* Archegonia -

1) The arch. also develop from single superficial cell (archegonial initial) of the prothallus.

2) The cell under go periclinal division to form an outer primary covercell & inner central cell.

3) The anticlinal division followed by periclinal division of the outer cover cell produces a long projecting neck.

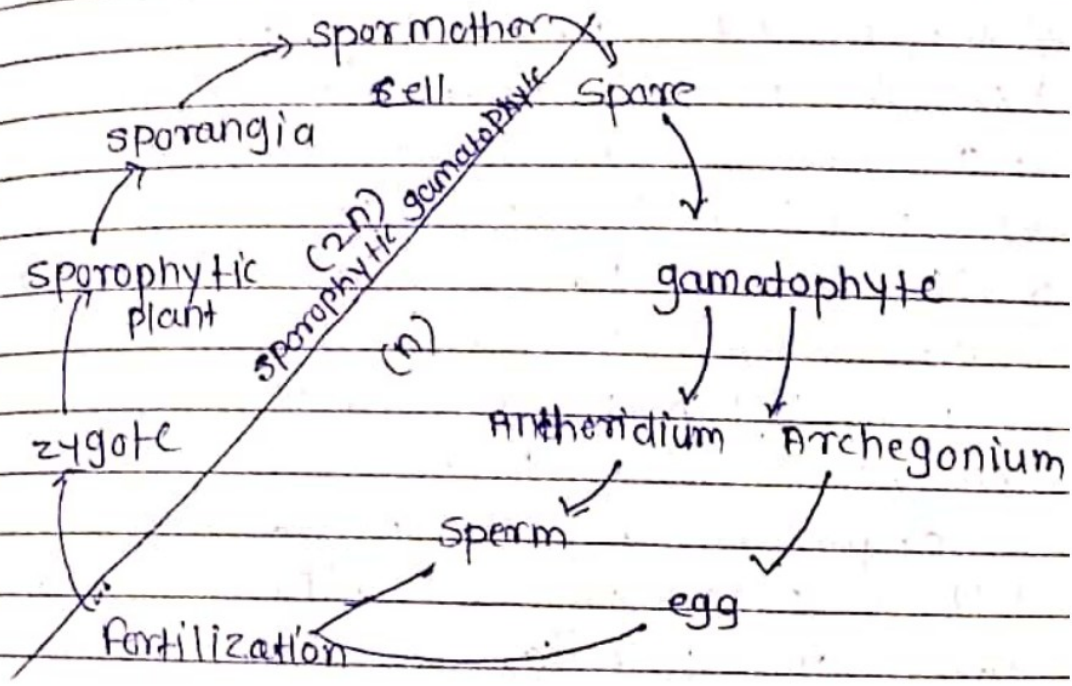
4) Arranged in 4 vertical cells with four or six cells in each row.



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* Fertilization -

- 1) At maturity cell wall of the lower tier, of neck cells becomes thick walled & cutinized.
- 2) The apical however, breaks away in presence of H_2O & the mucilaginous contents of the neck cell are released.
- 3) Thus the free passage is formed for the entry of antherozoids
- 4) The fertilization is accomplished by a union of multiflagelated sperm & egg resulting formation of diploid zygote.



mature archeg^m neck canal cell & venter canal disintegrate, the mouth of arche open & male antherozoid enter the archigonium & swim down the canal to reach venter fertill

* Lycopodium *

Kingdom → Plantae
Division → Pteridophyta
Class → Lycopodiopsida
Order → Lycopodiales
Family → Lycopodiaceae
Genus → Lycopodium

* Characters

- 1) The living lycopodials are the representatives of group which during the Carboniferous period formed the vegetation.
- 2) The modern representative are small & herbaceous sporophyte
- 3) The leaves are small & simple.
- 4) Each leaf passes unbranched midrib.
- 5) There are no leaf gap is state of the stem.
- 6) Sporophyll may or may not restricted to the terminal portion of branches & organized in definite strobili.
- 7) The sporophyte are simple vegetative leaves may similar or dissimilar
- 8) They pass homosporous sporangia
- 9) The antheridia remain embedded in the tissue of prothallus
- 10) Antherozoids are biflagellated.

* Habit & Habitat of Lycopodium -

1) It is commonly known as club moss due to their mosses like appearance. & club shaped strobili.

2) It has about 400 species which are cosmopolitan in distribution.

3) They are found colder arctic region as well as temperate, tropical & subtropical region but they are abundantly found in tropical zone.

4) Thirty three species of Lycopodium have been reported from India.

5) Mostly it is found growing in moist & shady places, which are rich in humus & other organic matter.

* It has 2 sub-generes -

1) Durastachya - branching dicotomous & root are originate from base of stem

2) Rhopalostachya -

stem prostrate with erect branching & root arises adventitiously from along stem.

* External Morphology of Lycopodium -

- 1) The herbaceous plant body is sporophyll.
- 2) usually they may have either prostrate
- 3) The stem with erect leafy branches or weak pendent (stem) (epiphytic)
- 4) The plant body is distinctly differentiated into
1) stem 2) Root 3) Leaves.

1) Stem -

In the sub-genus *Urostachya* stem is erect (terrestrial) or pendent (epiphytic) & may be branched (dicotomously) or unbranched in sub-genus *Rhopalostachya*. The stem is prostrate with erect branches.

2) Root -

Usually small, adventitious roots are present. In the sub-genus *Urostachya* roots originate only from the base of stem.

3) Leaves -

Leaves are simple, sessile, small in size. Elongate & possess a single unbranched midrib are known as microphylls. Usually the leaves are spirally arranged but may be arranged in whorls or pair.

Internal Structure of Lycopodium :-

a) Stem

A transverse section (T.S) of the stem of Lycopodium is somewhat circular in outline and can be differentiated into 3 regions:

1) Epidermis :-

- 1) It is the outermost covering layer comprising of single cell in thickness.
- 2) The epidermis is cutinised on the outer side and interrupted at places by the presence of stomata.

2) Cortex :-

- 1) Inner to epidermis is present a wide zone of cortex which shows a great variations in its structure in different species.

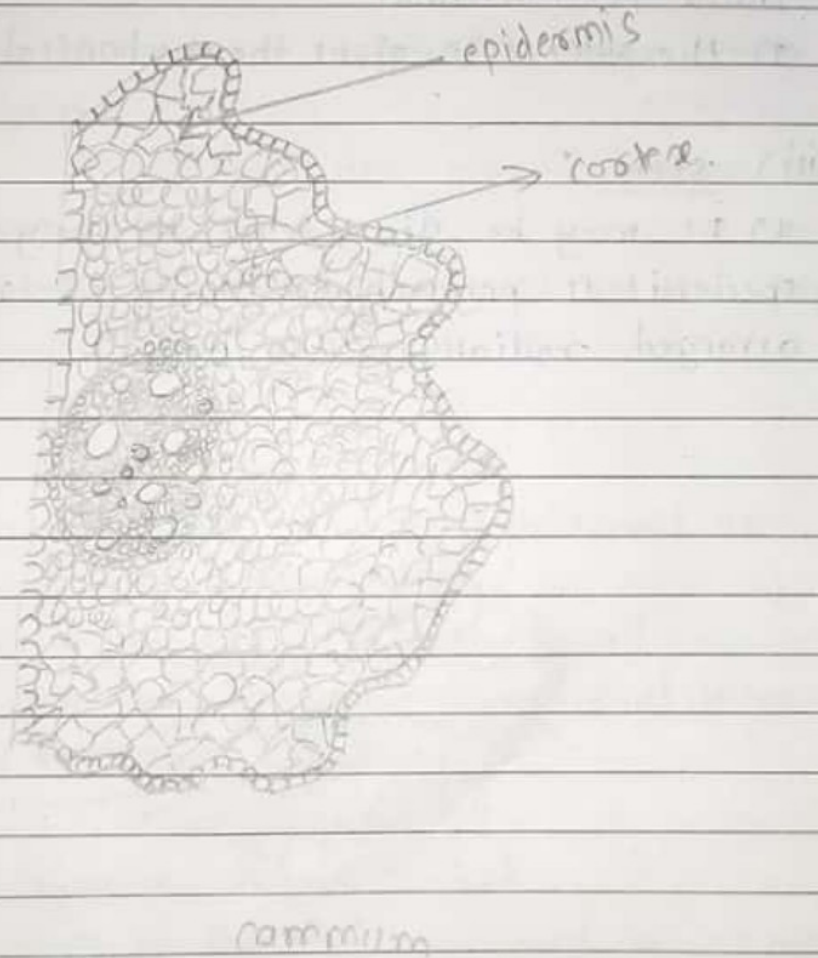
3) Endodermis :-

- 1) Next to the cortex is present a single layer of well defined cells known as endodermis with conspicuous casparian strips but at maturity the endodermis may or may not be a distinct structure.
- 2) Endodermis is followed by pericycle which is composed of one or more layers of compactly arranged parenchymatous cells.

4) Stele :-

- 1) It is made up of only primary xylem & primary phloem.
- 2) It is protosteleic pith is absent and the stele is situated in the centre.

- 3) The arrangement of xylem & phloem tissues is diffⁿ in different species and the steels also named differently.



b) Root :-

The roots are adventitious. : A T.S of arial root of Lycopodium is somewhat circular in outline and show the following internal structure.

1) Epidermis :-

i) It is the outermost covering layer and is only one cell thick.

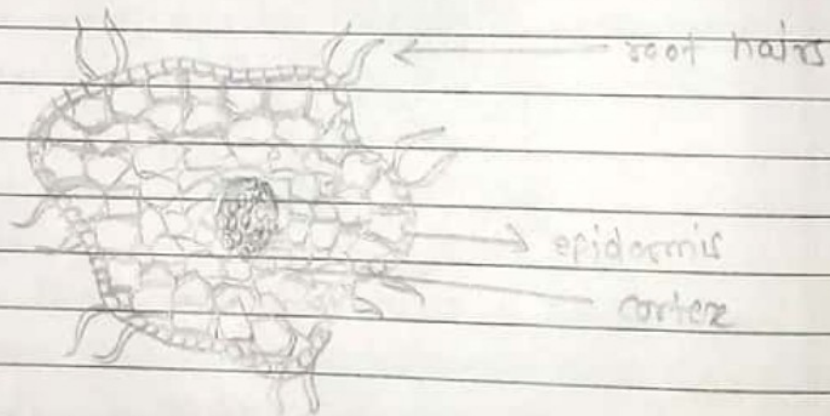
ii) The cells are thin walled. epidermis is provided with numerous root hairs present in a lot of characters of Lycopodi

ii) Cortex :-

- 1) just below the epidermis is present a wide zone of cortex.
- 2) it is differentiated into outer sclerenchyma and inner parenchyma.
- 3) the outer one gives the mechanical strength to the root.

iii) Stele :

- 1) It may be di-, tetra- or polyarch. In prostrate species it is polyarch i.e. having 6-10 plates of xylem arranged radially (star shaped)



Leaf :

T.S of leaf shows epidermis, mesophyll tissue & a single median vascular bundle.

1) Epidermis :-

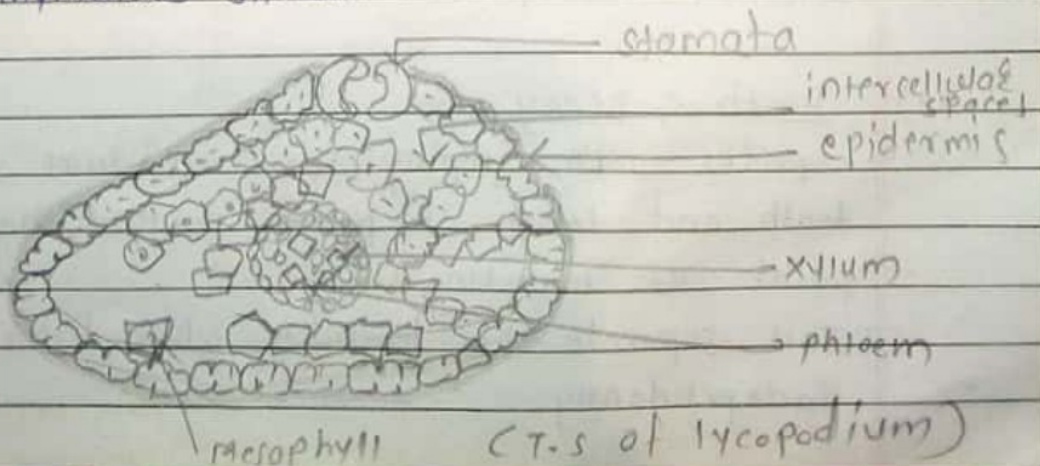
- 1) It is the outermost surrounding layer is only one cell in thickness.
- 2) the cells of epidermis are parenchymatous and cutinised on their outer side.
- 3) The epidermis is also interrupted by the presence of stomata.

2) Mesophyll :-

- 1) it occupies a wide zone betⁿ epidermis and vascular bundle.
- 2) it is usually made up of thin walled -chlorenchymatous cells which may be with or without intercellular spaces.

3) Vascular bundle :-

- 1) In the centre of the leaf is situated only a single concentric vascular bundle made up of only xylem & phloem.
- 2) The vascular bundle is surrounded on all sides by a sclerenchymatous sheath.



#- Reproduction in Lycopodium :-

- Lycopodium reproduces by vegetatively & sexually.

1) Vegetative Reproduction :-

it takes place by following method

i) Gemma or bulbils

- certain bud like structure known as gemmae or bulbils are usually produced in large numbers on new stem tip annually.

- The morphological nature of gemmae is still not fully known.

- The gemmae on fall on ground, develop root primordia & soon form the root.

ii) Fragmentation :-

- In several epiphytic species fragments of the plant body are capable of giving rise to new plants.

iii) Resting Bud :-

- The whole of the plant body except the growing tip of rhizome is dead during winter.

- This tip portion of the rhizome acts as resting bud which in the coming spring resumes growth and develops into a new plant.

iv) Death & Decay :-

- species with creeping stem reproduces vegetatively by the death and decay of older parts of the stem up to the point of branching.

- This separate the branches which later on grow independantly.

2) sexual reproduction :

spore producing organ :

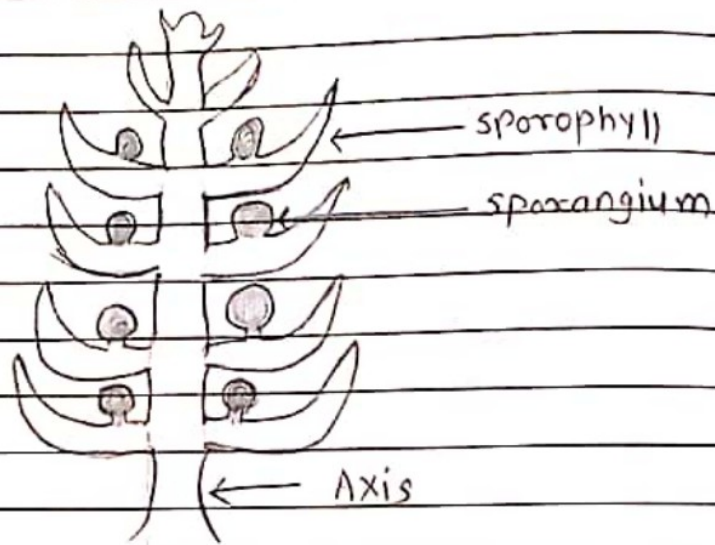
- 1) The plants are homosporous i.e. produce only one type of spore (without differentiation of mega & microspores).
- 2) These spores are produced in sporangia which, in turn are produced on fertile leaves known as sporophylls.
- 3) usually the sporophylls are grouped together to form a compact structure known as strobili (single-strobulus).

Strobilus (reproductive organ)

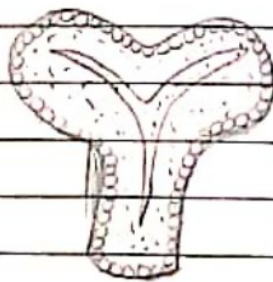
- 1) The sporophylls are loosely arranged.
- 2) The leaves of the apical portion of the branches only bear sporangia and are called sporophylls.
- 3) The rest behave as vegetative leaves.
- 4) The sporophylls may be of the same size or of different size from the foliage leaves in different species.
- 5) The arrangement of sporophylls is same on the central axis as that of the vegetative leaves.



(D - *L. leucodulum*) strobilus.



(Fig : sporophyll showing sporangia on the adaxial surface)



(Fig - spore)

Gametophytic Generation :

The development of the gametophyte (prothallus) takes place from the haploid spores which are the unit of gametophytic generation.

Development of sex organs :

Antheridium

- 1) A single superficial cell situated just away from the meristematic cells gives rise to an antheridium.
- 2) This superficial cell is known as antheridial initial.
- 3) This cell divides periclinally to form an outer cell known as jacket initial (primary wall cell) and an inner cell known as primary androgonial initial or cell.

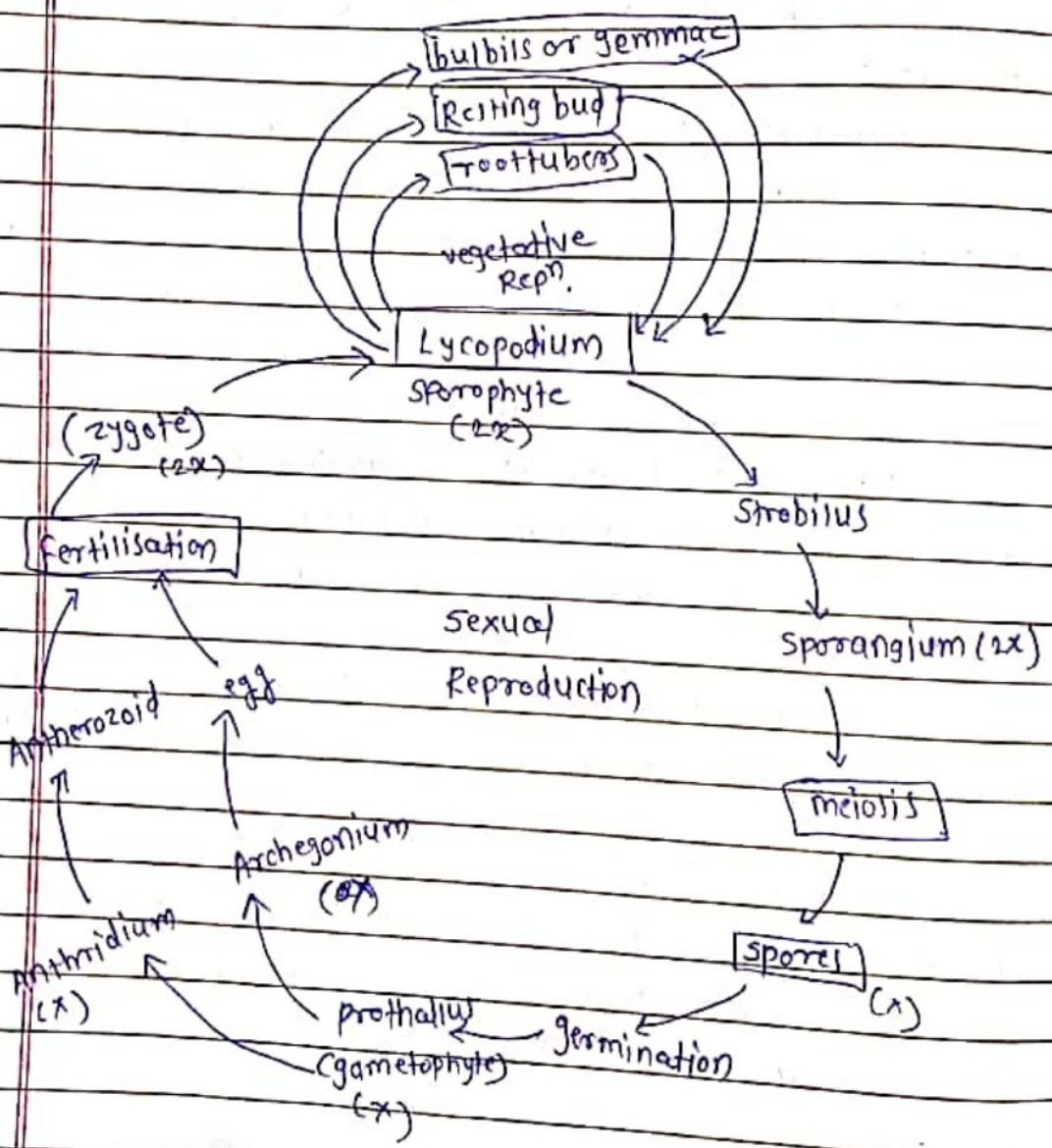
Archegonium

- 1) Just like antheridium, the androgonium also arises from a single superficial cell called archegonial initial, situated just away from the meristematic cells at the apex.
- 2) The archegonial initials divide by periclinal division into an upper primary cover cell & lower basal central cell.

Fertilisation :-

- 1) At the time of fertilisation the neck canal cells and the ventral canal cell disorganise and the cells of the upper-most tier of neck slightly separate apart forming a passage upto the egg.
- 2) Fertilisation is brought about in the presence of water.
- 3) The biflagellate antherozoids reach the archegonium by swimming in water on the surface of prothallus.

- 4) The antherozoids are perhaps attracted towards the neck by archegonium by a chemotactic movement.
- 5) They enter the archegonium through neck and reach the egg.
- 6) Only the nucleus of one antherozoid fuses with the egg nucleus thus forming a diploid structure known as zygote (2n).



SELAGINELLA

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Classification :

Kingdom - plantae

Division - Lycopodiophyta

Class - Isoetesida

Order - Selaginales

Family - Selaginellaceae

Genus - Selaginella

- Selaginella is the sole genus of vascular plants in the family Selaginellaceae; the spikemosses or letterclubmosses.

General characteristics.

1. The sporophyte is herbaceous and the shoot is dorsiventral and radial and creeping or erect.
2. The leaves are small (microphyllous) and a ligule is present at the base of each leaf and sporophyll.
- 3) Rhizomorph is (a leafless str. where from roots arise) present in some species.
4. Sporophylls are usually aggregated into strobili at the apices of the branch, heterospores.
5. Heterothallic (dioecious) gametophyte prothalli
6. Antherozoids are biciliate.

Habit & Habitat of Selaginella.

- 1) Selaginella shows considerable variation in size, symmetry & morphology.
- 2) mostly they are herbaceous perennials, however, a few are annuals (Selaginella pygmaea).
- 3) majority are dorsiventral, prostrate and creeping on the surface and few are scandent.

- 4) most of the species of selaginella grow on the ground humid, shady habitats.
- 5) A few species are xerophytic and grow in arid conditions or exposed.

structure of selaginella :

- 1) The plant body of selaginella is differentiated into well developed roots, stem and leaves. Besides, some species also have Rhizophore.



Stem :

- 1) The stem is generally erect and radially constructed in the subgenus Homoeophyllum.
- 2) The species belonging to the subgenus Heterophyllum are prostrate and dorsiventral.
- 3) The branching is dichotomous in the member of Homoeophyllum and somewhat lateral in Heterophyllum.
- 4) The anatomy of the mature stem is very distinct and is differentiated into an outer epidermis, middle cortex and centrally located stele.
- 5) The outer cell walls of the epidermis are cutinised, it is devoid of stomata and hairs.
- 6) In many species there are several layers of thick walled cells (hypodermis) beneath the epidermis, which merge gradually with thin walled chlorophyllous cells of the cortex.
- 7) The cortex is usually made up of compactly arranged angular parenchymatous cells without intercellular space.
- 8) The most part of the cortex of xerophytic species is comprised of thick walled sclerenchymatous cells. There is much variation in the vascular cylinder among the different species of Selaginella.
- 9) The number of steles varies from species to species and sometimes even in the same species.
- 10) This is due to the direction of the main stele.
- 11) Young plants invariably show monostelic configuration.

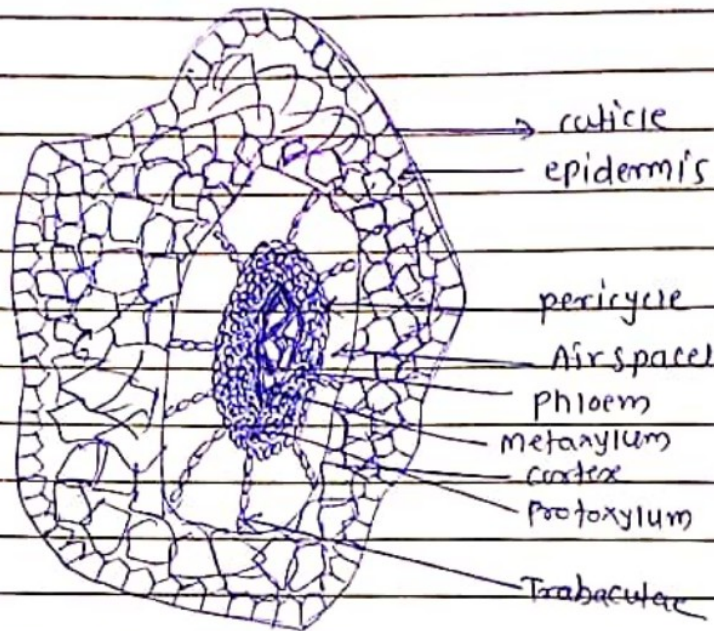


Fig: T.S of Selaginella stem.)

Rhizophora :-

- 1) In many species of Selaginella, peculiar leafless, prop-like cylindrical structures, originate from the stem at the point of branching.
- 2) These grow downwards into the surface and form many adventitious roots at their free ends. They are known as Rhizophores.
- 3) A T.S of the Rhizophore shows features very much similar to the root, however, with some mild variation.
- 4) The epidermis is singlelayered and highly cutinised.
- 5) The cortex is extensive and may be differentiated into an inner thin walled parenchymatous and outer-thick walled sclerenchymatous zone (hyphodermis).
- 6) The stele is protostelic and surrounded by layer of endodermis.

Morphological Nature of Selaginella.

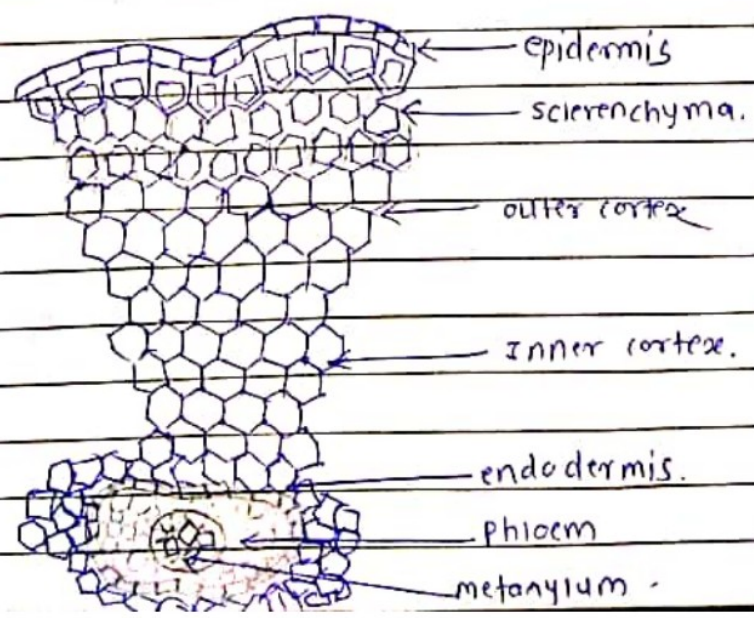
- 1) morphological nature of Rhizophora is controversial because of its unusual position and structure.
- 2) it has been interpreted by various plant scientists as root, stem or an organ sui generis (i.e. an organ, neither a stem nor a root).

1) Similarity with Root.

1. Rhizophores are positively geotropic in nature.
2. It does not bear leaves.
3. Monarch xylem like that of leaf.
4. presence of root cap in some species.
5. Transport of Auxin in Rhizophore is acropetal which is similar to root.

2) similarity with stem.

- 1) exogenous in origin like stem.
- 2) Absence of root caps & root hairs.
- 3) production of roots endogenously from the tip.
- 4) it is specialised stem behaves like root.



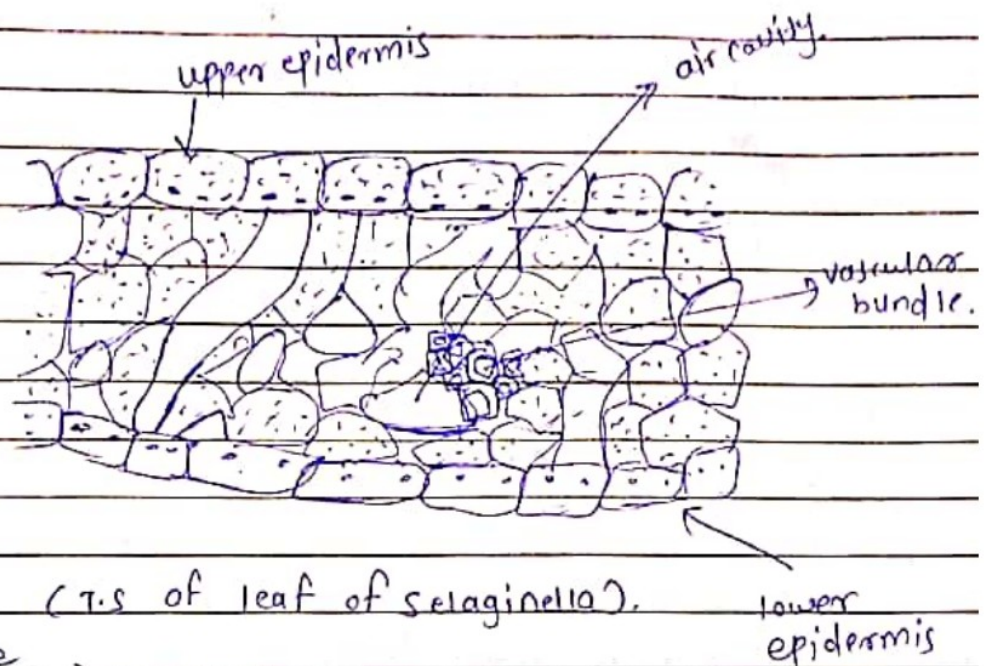
Leaf :-

- 1) The leaves of all species are microphyllus, sessile and simple attaining a length of a few millimetres.
- 2) The leaves may be ovate, lanceolate or trabecular ^{shape} with one vein running nearly the entire length of the leaf.
- 3) all the leaves are of same type and the arrangement is spiral in subgenus Homoeophyllum.
- 4) In the subgenus heterophyllum, the leaves are of two types small leaves and large leaves, that are arranged in four rows along the stem.
- 5) There are two rows of small leaves on the dorsal side of the stem and two rows of larger leaves on the ventral side or in a lateral position.
- 6) A small, membranous tongue like structure ligule (Latin (ligula - tongue: (small)). is located at the base of each vegetative, leaf and sporophyll.
- 7) The ligule is found on the ventral (upper) surface of the leaf.

- A T.S of leaf shows two epidermal layers, mesophyll tissue, stele and stomata.

- the cells of upper and lower epidermal layers may be similar in most of the species.

- However, they may be somewhat different in some species. where the upper epidermis consist of conical cells, but the cells of the lower epidermis are smaller.



Female & male gametophyte → L. march.

Reproduction In Selaginella:

1) The sporophyte of Selaginella reproduces by vegetative and sexual methods.

Vegetative method

- 1) The vegetative repⁿ in Selaginella takes place by dormant buds, tuber and fragmentation.
- 2) Bulbils and dormant buds are produced in aerial branches, while tubers may be aerial or underground.
- 3) In favourable conditions they germinate to produce new sporophyte plants.
- 4) In *S. rupestris* the trailing branches of the stem develop adventitious branches, that separate from the parent plant and grow into new sporophyte.

(i) Sexual method.

- 1) Numerous haploid spores are produced in the sporangium.
- 2) The sporangium are located in the sporophyllus and the sporophyllus are compactly arranged to form cones or strobili.

Strobilus :

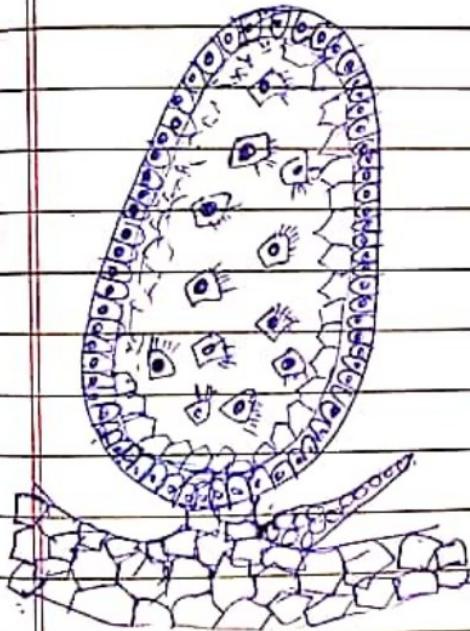
- 1) All the species of Selaginella forms strobili or cones. generally strobili occur terminally on side branches, the apical meristem of the cone may continue meristematic activity producing foliage (vegetative) leaves and, therefore, produces a leaf shoot with sporophyllus (sporangium bearing leaves) and foliage leaves in alternate segments along the axis.
- 2) Selaginella is heterosporous and therefore, sporangia are of two types. viz microsporangia and megasporangia.
- 3) The sporophyllus associated with these two type of sporangia are designated as microsporophyllus and megasporophyllus respectively.
- 4) There is variation in distribution of sporangia within the strobili of diffⁿ species.
- 5) strobili either consist entirely of microsporangia or of megasporangia. However, the mixed condition is more common.
- 6) The lower portion of a strobilus consist of megasporangia and the upper portion of microsporangia or the two types of sporangia may be mixed indiscriminately.

Sporangium

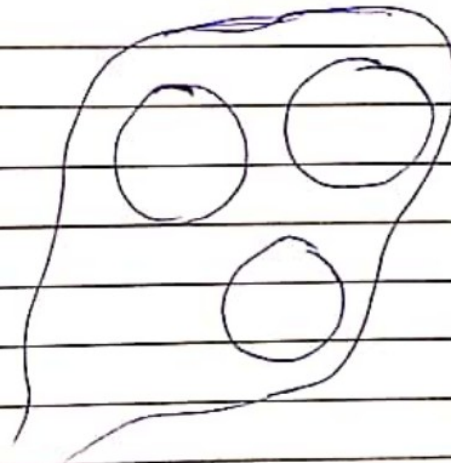
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- 1) The mature sporangia are stalked with two layered jacket.
- 2) The microsporangia are slightly elongated and reddish to bright orange in colour.
- 3) megasporangia are larger than microsporangia and are frequently lobed.
- 4) The megasporangia are whitish yellow or light orange in colour.



microsporangia



DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

AURANGABAD

Faculty of Science

Practical Examination

B. Sc. I YEAR (I & II Semester)

BOTANY

Paper III & VI

University of Cryptogams I, Morphology of Angiosperms, Diversity of
Cryptogams II and Histology, Anatomy and Embryology)

in 4 hours

Max. Marks: 100

Batch No. _____

Date _____
Name: S.M. Dnyandeo Mohekar Mahavidyalaya, Kalam.

1. Identify, classify and describe any two algae from the given mixture 10
2. Identify, classify and describe the given specimen of Fungi 10
3. Identify, classify and describe the given specimen (Bryophytes) on the basis of internal and external features 10
4. Prepare temporary slide of the given specimen (Pteridophytes) Draw well labeled diagram 10
5. Prepare a double stained permanent preparation of the given specimen. Identify and draw a well labeled diagram 20
6. Identify and describe the specimen A, B, C, D and E as per instructions 15

- A - Bacteria/ Lichen
B - Morphology
C - Morphology
D - Histology
E - Embryology

Submission

- a. Record book 10
b. Collection / Field notebook / Slides 10
c. Viva - voce 05

50
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01
- Record book
Collection / Field notebook / Slides
Viva - voce

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Batch No. _____

Date _____
Name: S.M. Dnyandeo Mohekar Mahavidyalaya, Kalam.

1. Identify, classify and describe any two algae from the given mixture 01
2. Identify, classify and describe the given specimen of Fungi 01
3. Identify, classify and describe the given specimen (Bryophytes) on the basis of internal and external features 01
4. Prepare temporary slide of the given specimen (Pteridophytes) Draw well labeled diagram 01
5. Prepare a double stained permanent preparation of the given specimen. Identify and draw a well labeled diagram 02
6. Identify and describe the specimen A, B, C, D and E as per instructions 51

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