FUNARIA

SYSTEMATIC POSITION

Division — Bryophyta
Class — Bryopsida
Order — Funariales
Family — Funariaceae
Genus — Funaria
Species — **Funaria hygrometrica**

Note : Common name : Green moss or **cord moss** or **rope moss**

DISTRIBUTION & HABITAT

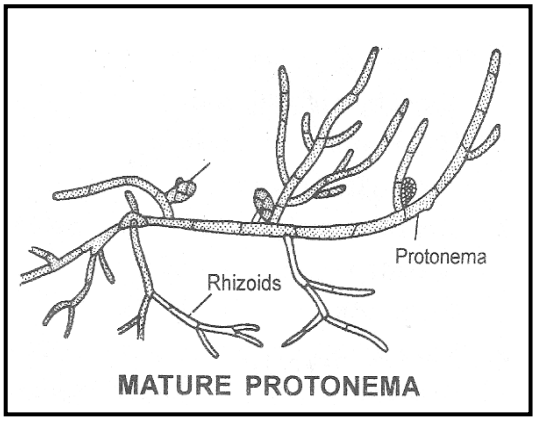
- **Funaria hygrometrica** is a comoolitan speices.
- the plants (mosses) are found in **damp** and **shady** localities.
- **Talelst moss** is **Dawsonia.**
  The adult plant body of mosses represents **Gametophytic pahse.**
  (a) **Protonem : (Prostrate, creeping filament & ephemeral)** - [Juvenile stage]
  (b) **Gametophre : (Erect & foliose)**

GAMETOPHYTIC PHASE :-

The gametophyte of moss is found in two forms :

(a) Protonema

- The **spore,** which is unit of gametophyte, on its germination, produces a filament like structure called as Protonema.
- It is prostrate, multicellular, filamentous algal like. its cells have humerous chloroplat. It is branched and bering **rhizoids** and **bunds.**



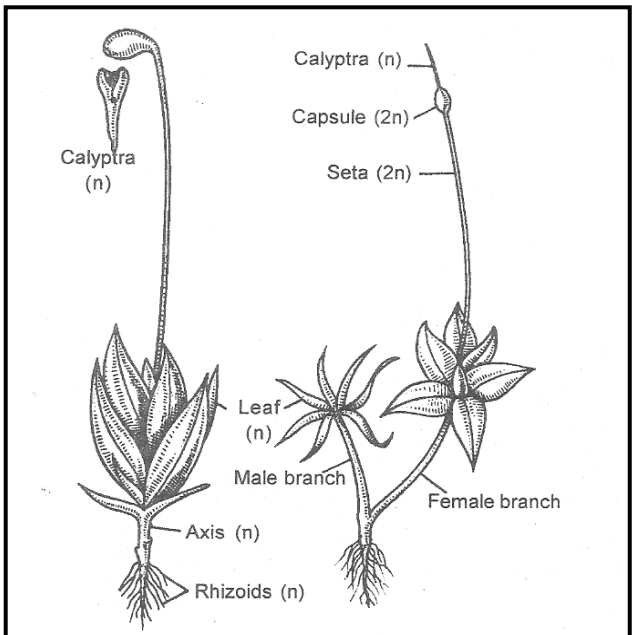
MATURE PROTONEMA

(b) Gametophore

- Gametophores arises from the bud of **protonema** which give rise to **leafy shoot.**
- Gametophore is an actual gametophytic plant which measures 1-3 cm and distinguished into three parts
  (i) **Rhizoids** (ii) **Axis** (iii)**Leaves.**

Rhizoids :
Rhizoids are brownish in colour, **branched, cylindrical, multicellular** and **oblique septate** structure.
Function :
They help to fix the plant and in absorption of water and minerals.
Axis :
It is green in colour, erect, soft and branched

- their branches are **extra axillary** in origin. It means branches are developed from below the leaves, not form their axis. Stem (axis) and branches bears bright green leaves.



FUNARIA HYGROMETRICA
A. A female branch of leafy gametophore with sporophyte
B. A leafy gametophore with a male branch and a female branch with young sporophyte.

Leaves : Leaves are small, membranous, sessile and oval shaped and a distinct mid-rib is present.

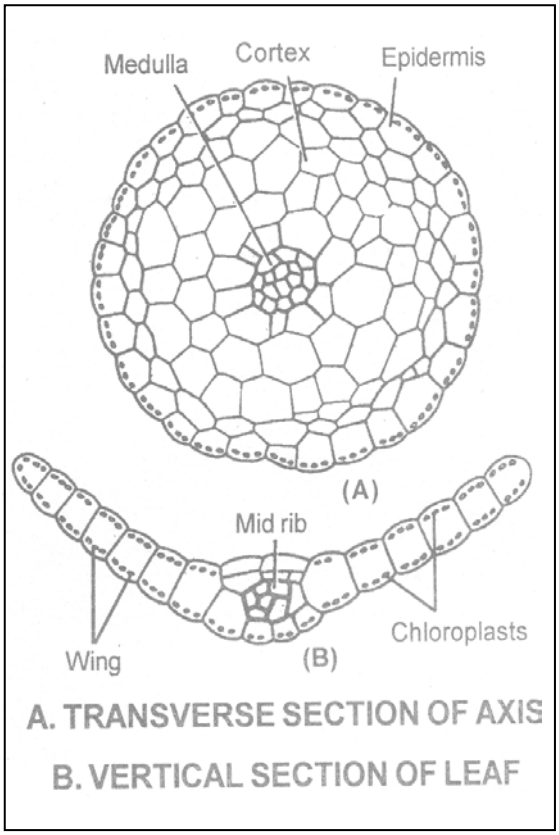
- They are arranged **(3/8 phyllotaxy)** spirally on the axis. In leaves **lateral vien are absent.**

3/8 phyllotaxy ie., in three complete spirals there are eight leaves

Note : A pyramidal shape apical cell is responsible for growth of apex of axis.

INTERNAL STRUCTURE

1. **Axis or stem :** A transverse section of the mature axis shows three distinct regioins.
   (a) Epidermis : it is the outermost layer, composed of tnagentitally elongated chlorophyllous cells. It has no stomata and cuticle.
   (b) Cortex : It is multilayered parenchymatous region. The cells of outer layers are thick walled and the cells of inner layers are thin welled.
   (c) Central Cylinder : it is composed of long. colourless and thin walled cells. These cells are dead and lack protoplasm. They help in the conduction of **water and nutrietns.**
2. **Leaf :** In the V.S. of leaf lamina one multilayered median vein is found and its both side having singel layered wings. The multilayered median vein the main part. The central part of median vein formed by narrow parenchymatous cells. Away form this area thick layered cells are found. Wing region of leaf lamina made up of thin layered cells in which many cloroplasts are present. **Stomata are absent in the leaf.**



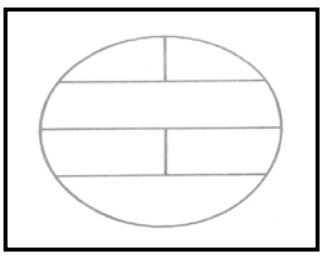
REPRODUCTION :

Reproduction in gametophyte of Funaria is of two types :
(1) Vegetative (2) Sexual

(1) Vegetative Reproduction : It is responsible for **gregraious habit.** Vegetavie propagation in Funaria takes place by the following methods :

1. Fragmentation of primary protonema : On germination the spore gives rise to a branched filamentous structure, knows as **primary protonema.** Sometimes it breaks into small fragments. The fragments **bear bunds** and each bud develops into an **erect gametophore.**

2. Secondary protonema : Under favourable conditions, secondary protonema may be formed by the cells of injuted **rhizoids, stems leaves** or **reproductive** structures. Like primary protenema, it bears buds which are capable of growing into erect gametophores.



3. Gemmae : During unfavourable period, the **terminal cells** of the protonema form **multicellular green** bodies, called **gammea.** Gemmae are body **vertically** and **transversely** septate and has **10-30** cells. On return of favourable conditions, it is detached from the parent plant and germinated to form an erect gametophore. Under certain conditions, gemmae may also develop on the leaf and on the axis of the gametophore.

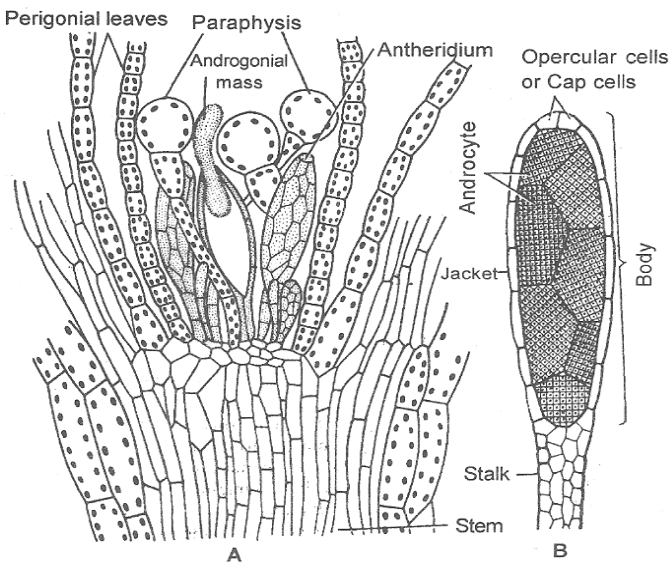
4. Bulbils : They develop on **rhizoid** and devoid of choloroplasts. The bulbil grows into a new plant when detached from the parent plant.

(2) Sexual Reproduction :

- Sexual reproduction in Funari is **oogamous** type.
- Funaria is **monoecious** and **autoicous plant.**
- Male and female sex organs are called **antheridia** and **archegonia** respectively and are borne in clusters at the tips of different branches. **Antheridia** develops at the apex of **main branch** of plant where as **archegoni** develops at the apex of **lateral branch.**
- These are covered by **involucral** leaves.
  [Note : Autoicous means when two different sex organs are borne of different head of the same plant**]**

Antheridium:

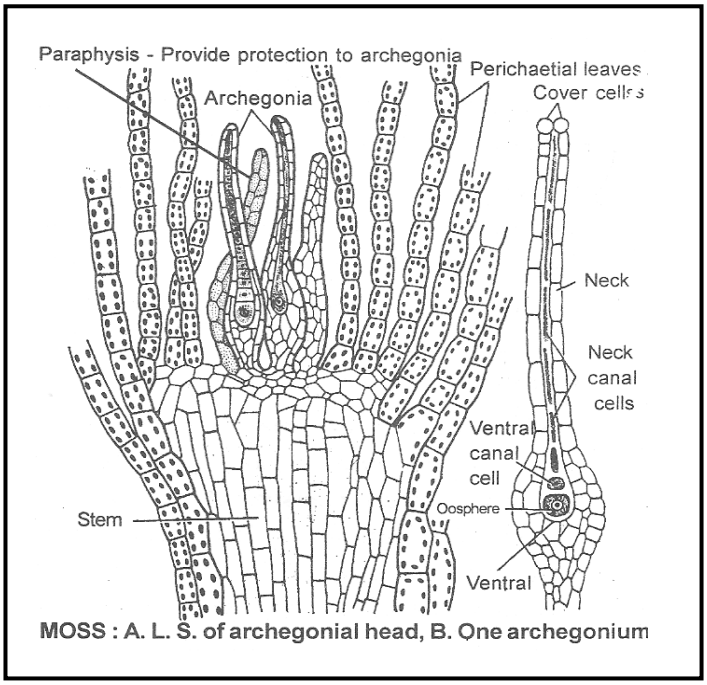
- Antheridium of Funaria is club shaped structure. Is has short multicellular stalk.
- It has single layer jacket. In Antheridium many androcytes are present. Each andocyte forms long, **spirally coiled or** $2\frac{1}{2}$ coiled, **biflagellated** antherozoids by **metamprphorsis.**
- Chloroplast is present in jacket cells of young antheridium due to which they are green but orange colour of jacket of mature antheridium is due to presence of **chromoplast.**
- At the apex of jacekt **one or two** (mostly) colourless cells are present called as **opercular cell** or **cap cells.**
- In between the antheridia, paraphysis are present which are green upright and multicellular **capitate** hairs. Antheridia and parahysis are surrounded by **perigonial leaves.** (**Red** in colour)
- **Function of paraphysis :** Provide protection to antheridia and water secretion.



MOSS : A. L. S. of antheridial head, B. L. S. of one antheridium (young stage)

Archegonium :

- Archegonium of Funaria develop from and apical cell at the archegonial branch.
- A mature archegonium is **flask shaped** structure. Paraphysis are also present between archegonia which are **not captiate**. They are surrounded by **perichaetail leaves.**
  Archegonium by **perichaetial leaves.**
  Archegonium is distingushed inti **stalk, venter** and **neck.** A swollen **double layered** venter contain an **egg** and a **venter canal** cell.
- Neck contan **six** or **more** [6-10] neck canal cells. It is capped by two or four (mainly) **cover cells.**



MOSS : A. L. S. of archegonial head, B. One archegonium

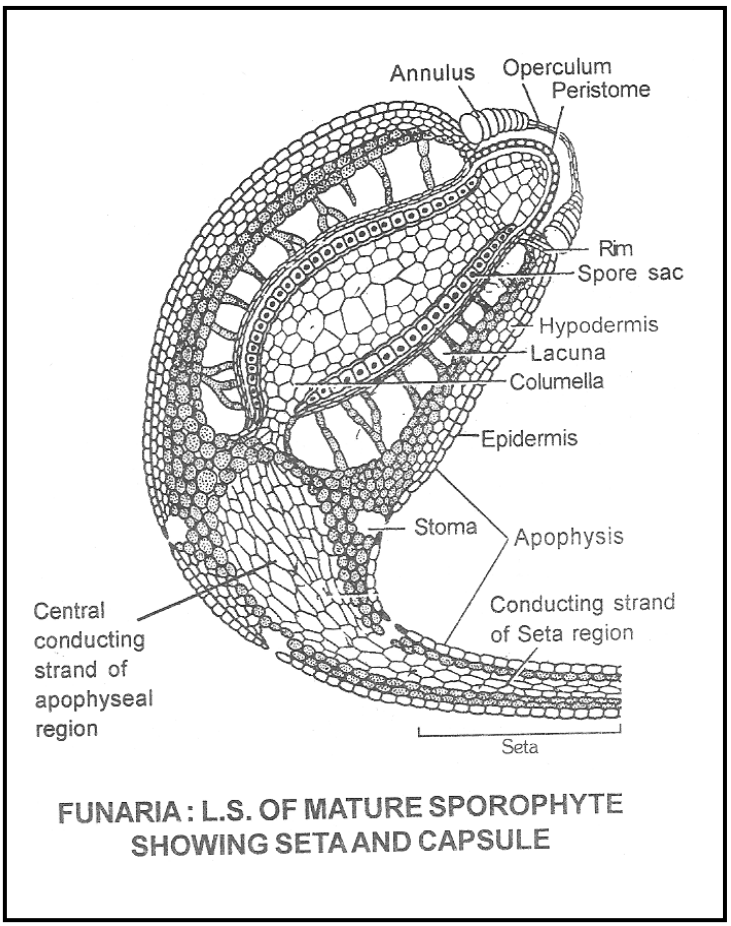
- Jacket of neck is single layered & made of six vertical rows of neck cells. In each vertical row 6 to 9 neck cells are present.

Fertilization :

- **Water** medium is essential for fertilization and the apical cells of the antheridium Jacket which form operculum absorbs water and bursts. The **spirally coiled** biflagellate antherozoids excape form the antheridium.
- The neck canal cells and venter canal cell also degenerate to form a mucilagenous substance which absorb water to exert a pressure so cover cells become separated from each other and to form a passage for antheroxoids.
  The antheroizoids are attracted towards the neck of the archegonium by some **chemotactic substance,** possible **sugar** produced by archegonium. An antherozoid fused with egg of archegonium to form a diploid **zygote.**

SPOROPHYTEIC PHASE :

- Diploid zygote divide to produce sprophyte of Funaria.
- The mature sporophyte distinuguished into three parts : **foot seta** and **capsule.**
  (1) Foot : Foot is very small and formed by **parenchymatous** cells. It absorbs water and other essential food material form the gametophyte.
  (2) Seta : Seta is a thick and thread like structure. Its upper end bears pear shaped capsule and lower end attached with foot. It is **hygroscopic** in nature.



FUNARIA : L.S. OF MATURE SPOROPHYTE SHOWING SETA AND CAPSULE

Function :

(1) Conducts after and nutrients
(2) Helps in dispersal of spores.
(3) Capsule : the capsul is distinguished into three regions. Development of capsule take place by upper apical cell of embryo.

(i) Upper → **Opercular region.**

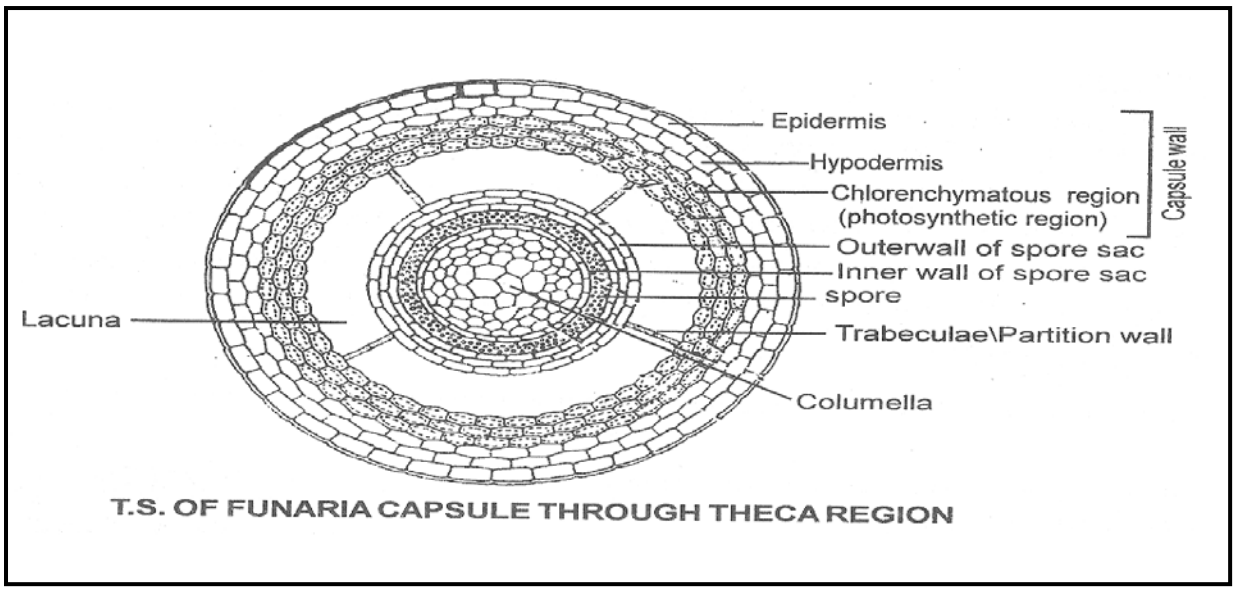
(ii) Middle → **Threca region** → Fertile

(iii) Lower → **Apophyseal region.**

(i) Opercular region : The opercular region comparises operculum which covers peristome. The peristomial teeth are present in peristome. They are arranged in **two whorld-outer** and **inner** whorls. Outer whords bears **16 teeth** which are **thick large** and **well developed & red** through inner teeth are also 16 in number but they are **thin** and **delicate & colourless,** total 32 peristomial teeth are present. These teetch are help in dispersal of spores. The teeth are simply the strips of **cuticle** and they are **acellular.**
Opercular region is separated by theca region, by two rings

(i) **Rim** or **diaphragm** (lower)

(ii) **Annulus** (upper)
(ii) Theca region : The middle theca regino of distinguisable into **epidermis, hypodermis, chlorenchymatous** region (2-3 layered), filamentous **trabeculae** with large are spaces, two layered **spore sacs** and central **sterilie** region is **columella.** It is **conducting** tisse. **Elasters** are absent in **spore sac**



T.S. OF FUNARIA CAPSULE THROUGH THECA REGION

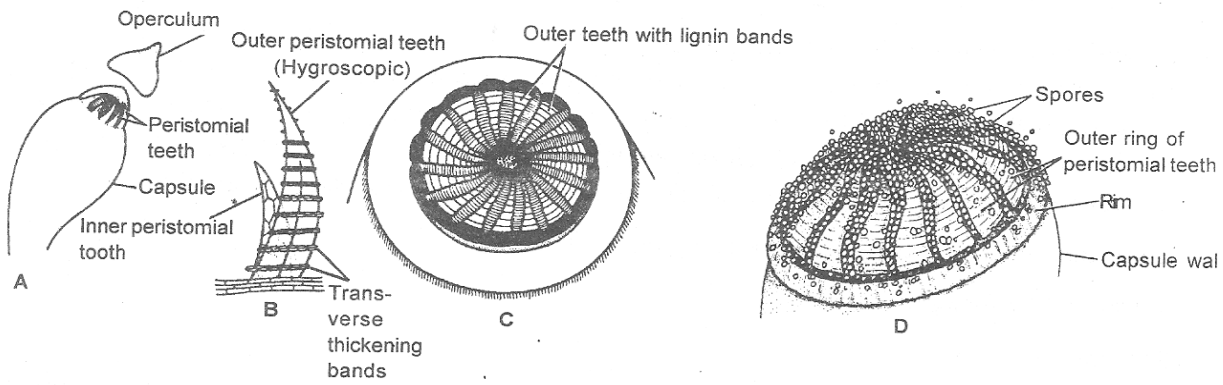
Function of columella : It provides water and food to devloping spores in spore sac.
Function of trabeculae : In connects the inner most layer of capsule wall to outer most layer of outer wall of spore sac.
(iii) Apophyseal region : The apophyseal region i s the lower most part of the capsule which has conducting strand and attached with seta. This is surrounded by chlorenchymtous cells with prominent **intercellular spaces.** The epidermis has **stomatal apertures** which is guarded by two **guard cells.** In mature stomata, stomatal aperture is surrounded by single ring like guard cells.
Note :

(1) the **endothecium** froms the **central parenchymatous** cells in the opercular region **columella, inner wall of sproe casca, archesporium** in the fertilize region, **central conducting** strand in the **apophyseal region** and central conducting strand in seta region. The **rest of the tissues** arises from the amphithecium.

(2) Archesporial cells divide and redivide of form a mass of **sporogenous tissue.** sporogenous cells behave lice **spore mother cells.** These cells are divided by meiosis and to form haploid **tetrahedral tetrad** of spores.

DEHISCENCE OF CAPSULE & DISPERSAL OR SPORES :

- **Funaria** is a **stegocarpous moss. Stegocarpous** means the dehiscence of capsul always along a predetermined line, As the capsul matures, the thin walled cell including **columella** dries up.

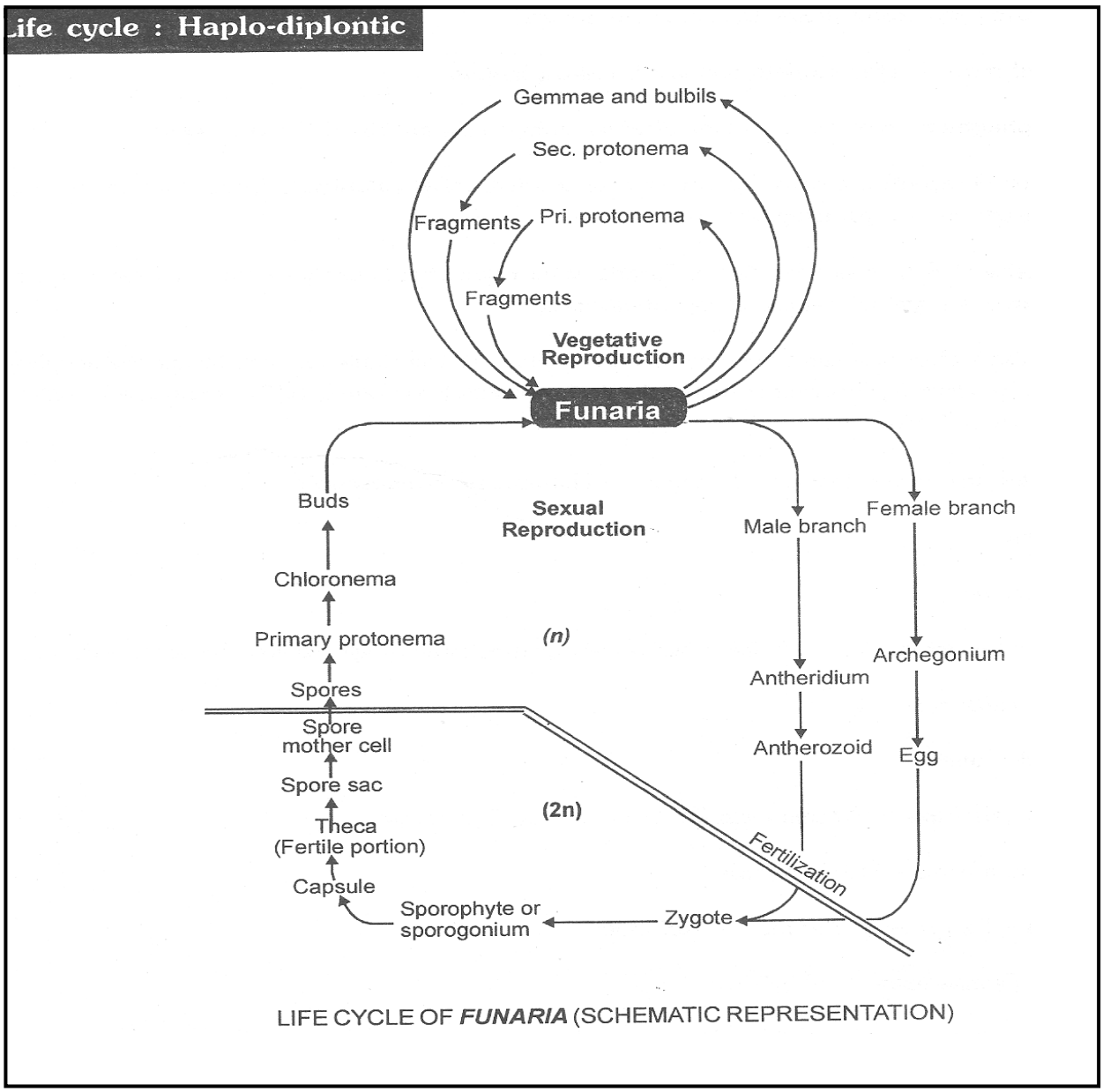


(A) CAPSULE WITH PERISTOMIAL TEETH, (B) OUTER & INNER PERISTOMIAL TOOTH,
(C) THE STRUCTURE OF CAPSULE AFTER THE SEPERATION OF OPERCULUM
(D) DISPERSAL OF SPORES

- The thin walled cells of annulus break away and thus operculum separated along the annulus and xposing the peristome.
- The **hygroscopic** nature of **outer peristomial teeth** helps in **dispersal of spores.** The inner peristome **acts as sieve** allowing only few spores escape a time. They reach at far places through the medium of **air**. In moss capsule, spore dispersal takes place by **censor mechanism.**
  Perisome teeth - They shows **xerochasy.**

Structure of spore and Germintion of spore :-

- **Spore** is the **first cell** of gametophytic generation. Spores of **Funaria** are spherical 12-20 μm in diameter and **double layered.** The outer **wall exosporium** is much thicker and inner wall **endosporium** is thin. Spores have **oil droplets** and **chloroplast.**
- The spore germinates to form the **primary protonema.** Protenam grows in **two directions.** The green prostrate branches growing on the surface called as **chloronema** or **chloronemal** branches and Colour less branches grow into soil are called **rhizoidsl branches.** The chloronemal branches give rise to many buds and each bud grows into an erect leafy gametophore,



LIFE CYCLE OF ***FUNARIA*** (SCHEMATIC REPRESENTATION)

SPECIAL POINTS

- **Funaria** is a **acrocarpous** & **protandrous** moss.
- Internal structure of ***Sphagnum*** stem is differentiated into central medulla, cortex and epidermis. **Medulla** had **hadrome. Hadrome** is **water condicuting tssue** and it is made up of parenchyama.
- ***Sphagnum*** has two types of cell, ***hyaline*** and ***chlorophyllous*** in leaves.
- **Apogmy** in mose results into hapllid sprophyte and **apospory** results into diploid gametophyte.
- when the egg in as archegonium develops into a sprophyte without fertilization this phenomenon is called **parthenogenesis.**
- Formation of diploid gametophyte from diploid sprophyte in Funaria is termed **apospory.**
- In **Anthoceros** and **Notothyllus,** pyrenoids are present.
- The stem of moss is called **cauloid** and leaf is called **phylloid.**
- Stem of **Sphagnum** contain special type of water storage cells are called **"retort cells".**
- Upper region of capsule is covered by membranous structure called **calpytra.** Clapytra is formed by venter of archegonium. So it is gametophytic tissue.
- Bop and stehel (1957) concluded that in funaria water conduction is partly external and partly internal. thus **Funaria** is a typical example of **myxohydric** moss.
- The sterile tissue of capsule can be divided into four regions - (i) The sterile cells constituting the apophysis, (ii) the sterile cells forming thick capsule wall (iii) the sterile cells forming columelal (iv) The sterile cells contituting the operculum and peristome.
- In Bryophytes type of development of embryo $\rightarrow$ **Holoblastic & exoscopic.**
- **Polytrichum :**

  (i) **Dioecious**

  (ii) Vegetative reproduction - by bulbils (which develop on rhizoids) and fragmentation of underground rhizome.

  (iii) Neck canal cells - Ten

  (iv) Annulus absent

  (v) In **Polytrichum** peristome tecth (32 or 64) are not hygroscopic.

  (vi) Common name - Hair cap moss

- **Sphagnum** - Peat moss / Bog moss / Truf moss
- **Andraea -** Granite moss