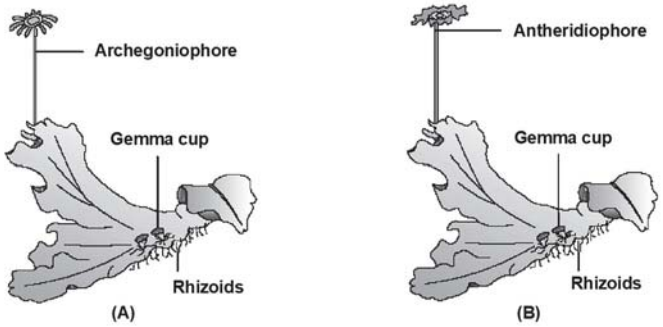
BRYOPHYTES

- The term ''Bryophyta'' was proposed by ''Robert Braun''.
- The study of Bryophytes is known as Bryology.
- Hedwig is considered to be the father of Bryology. But according to some scientist it is believed that Cavers is the father of Bryology.
- Father of Indian Bryology is Prof. Shiv Ram Kashyap.

General Features

- Bryophytes are the first land plant.
- It is believed that, they originated from aquatic plant and they come on land through water. Because some bryophytes have features similar to aquatic plants (eg. presence of air canals)
- Bryophytes are known as amphibians of the plant kingdom, because they live in soil but need water to complete their life cycle during sexual reproduction.
- Bryophytes are not considered as the successful land plants because vascular tissue is absent and they need water for fertilization.
- Due to the absence of vascular tissue bryophytes cannot grow very tall.
- The process of water conduction in bryophytes takes place with the help of parenchyma or Hardom tissue (Sphagnum)
- Parenchyma is a living tissue, while Hadrom is dead
- The plant body is dominantly haploid, more differentiated than algae i.e. Multicellular, thalloid, parenchymatous.
- Lower bryophytes thalloid, higher are branched (prostate or erect) with stem or leaf like structure.
- Roots are absent in bryophytes (Rhizoids Unicelled / multicelled present).
- Stem and leaves of higher bryophytes are functionally similar to the stem and leaves of higher plants.
- Bryophytes are sciophytes, i.e., bryophytes prefer to grow in moist (wet) and shady places.
- Vegetative reproduction is quite common through fragmentation, tubers, gemmae (inside gemma cup), buds, adventitious branches etc.



Body form:

- The plant body of bryophytes is more differentiated than that of algae.
- It is thallus-like (liverworts) and prostrate or erect (Mosses) and attached to the substratum by unicellular and unbranched rhizoids (Liverworts) or multicellular and branched rhizoids (Mosses).
- They lack true roots, stem or leaves. They may possess root-like (rhizoids), leaf-like (Phylloid) or stem-like (cauloid) structures.
- Thallus is multicellular, thick and dichotomously branched.
- The main plant body of the bryophyte is haploid. It produces gametes, hence is called a gametophyte.

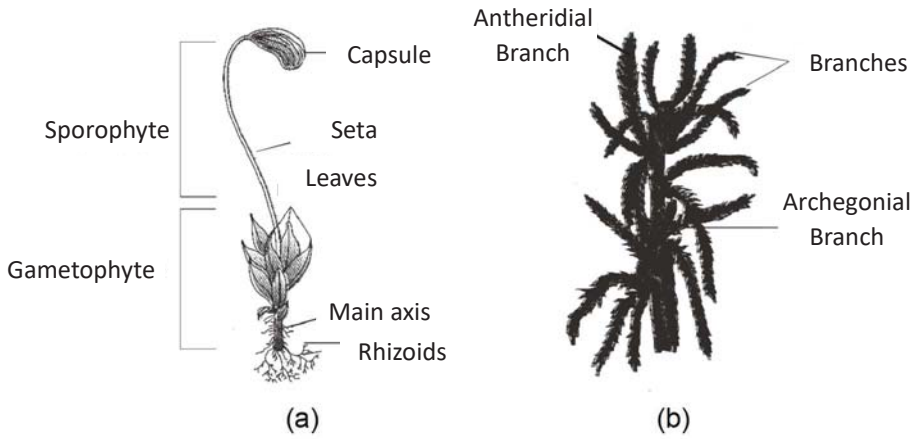


Fig. (a) Funaria (b) Sphagnum (TB)

Vascular tissues (xylem and phloem) are absent in both gametophytic and sporophytic phases. The conduction takes place through specialized parenchyma.

Reproduction:

Asexual reproduction –

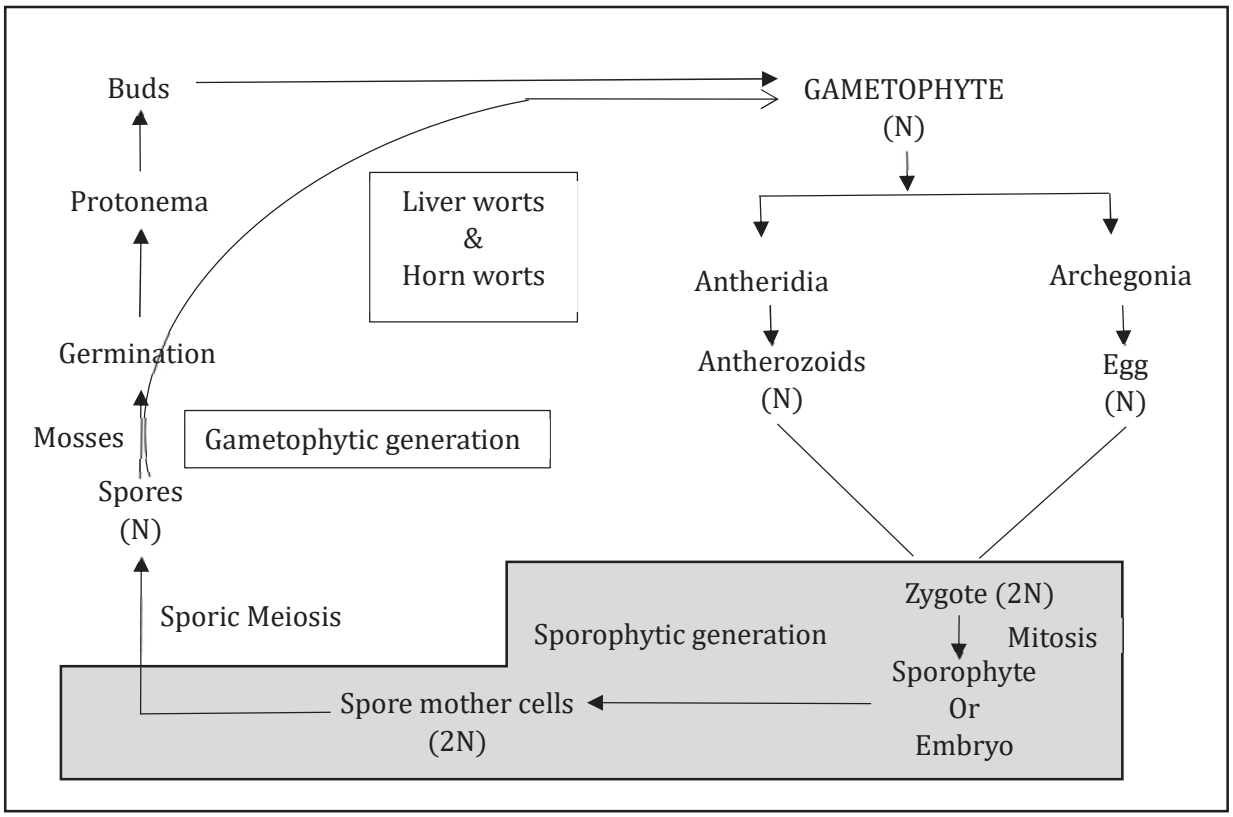
- Vegetative propagation takes place in liverworts by fragmentation, and gemmae while in mosses by fragmentation and budding in secondary protonema.

Sexual reproduction – Oogamous type

- Sex organs are multicellular and surrounded by single layered sterile jacket.
- Male sex organ is called antheridium which is globular or club shaped and forms biflagellated antherozoids or sperms (motile male gamete).
- Flask shaped female sex organ is called archegonium that consists of a swollen venter and a tubular neck.
- Neck is composed of 6 vertical rows of cells and encloses 4–10 neck canal cells while venter has venter canal cell and a single egg cell or oosphere (nonmotile female gamete).
- Water is essential for fertilization. Archegonia secretes mucilage rich in potassium salts proteins/sucrose for attracting antherozoids in water.
- Fertilization is internal and takes place by zoodiogamy. Diploid zygote formed in the venter by the fusion of one antherozoid with egg cell.
- After fertilization zygote immediately divides mitotically and form multicellular embryo.
- Embryo gives rise to multicellular sporogonium or sporophyte. The latter differentiates into foot, seta and capsule. Sporophyte is completely (e.g.Riccia) or partially (e.g. Funaria) parasite on gametophyte.
- Some cells of the sporophyte capsule called as Spore mother cells or sporocytes undergo sporic meiosis and form haploid meiospores which are alike or homosporous.
- On germination, spore forms new gametophytic plant either directly (e.g. liverworts and hornworts) or indirect by juvenile filamentous, green, multicellular protonema stage (e.g. moss).

Life Cycle of Bryophytes

- The plant in bryophytes is gametophyte. It is haploid.
- Sex organs are formed on gametophyte.
- Sex organs are multicellular and jacketed in bryophytes.
- Male sex organs are called as antheridium and female sex organs are called as archegonium (Ist Archegoniate plant)
- The male gametes of bryophytes are motile. These motile male gametes are called as antherozoids. Antherozoids are comma shaped and biflagellate. Female gamete is called egg.



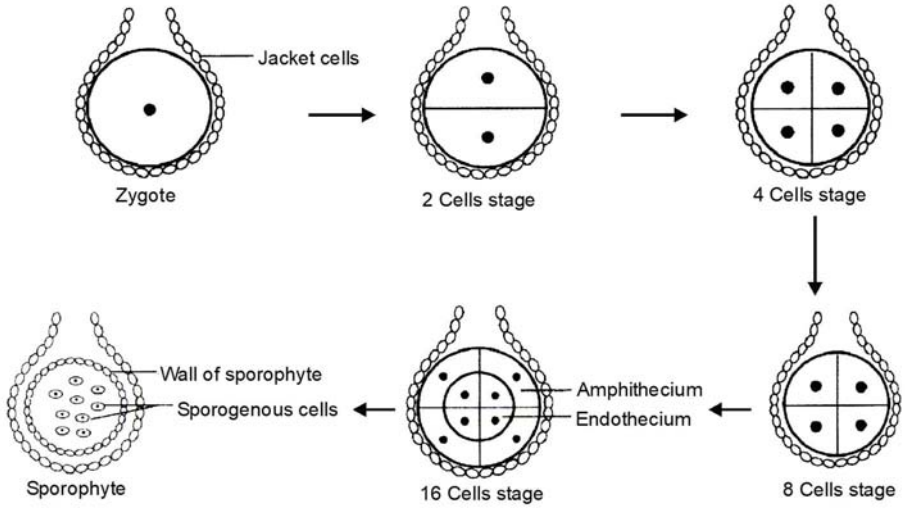
In Bryophyta, fertilization is done by zoodiogamy i.e. male gamete reaches the female gametes (for which water is essential) and fertilizes it.

- As a result of fertilization, a diploid zygote is formed.
- The zygote initiates the sporophytic generation. Sporophytic generation is a diploid stage.
- Zygote develops inside archegonia and divides by mitosis to produce embryo (so these are considered as first embryophytes).
- The embryo develops further into a sporophyte which is parasitic over the gametophyte (may be partial parasite as in mosses).
- The sprophyte of bryophytes is also called sporogonium, it is composed of three parts viz. capsule, seta and foot.
- It produces meiospores or haploid spores inside the capsule part (after meiosis in spore mother cells), while attached to the gametophyte.
- All bryophytes produce only one type of spores (Homosporous).

Development of Sporophyte

- During the development first division is transverse in zygote and second division is vertical.
- Third division is also vertical but at right angle to second division, therefore an eight celled embryo is formed.
- Now a periclinal division takes place in eight celled embryo. As a result of it a 16 celled embryo is formed.
- Now these sixteen cells are arranged in two layers.
  Outer 8 cells - Called Amphithecium
  Inner 8 cells - Called Endothecium
- Now cells of endothecium divided and form many cells which are known as sporogenous cells.
- Some sporogenous cells become sterile and called nurse cells (2n).
  Remaining sporogenous cells function as spore mother cells.
- Now meiosis takes place in spore mother cells, result of it haploid spores are formed.

- Nurse cells provide nutrition to spore mother cells and spore.
- The germination of spores is direct or indirect.
- In Liverworts & Hornworts the germination of spore is direct i.e. each spore forms a gametophyte after germination i.e. each spore forms one thallus.



The germination of spores in Mosses is indirect. I.e. a multicellular filament is formed after the germination of spore. This filament is known as protonema.

- Now buds are formed on every cells of protonema. Each bud develops into a gametophyte plant.
- Indirect germination is best for survival.
- Mosses are gregarious in nature because they appear in group.

Point to Be Remember

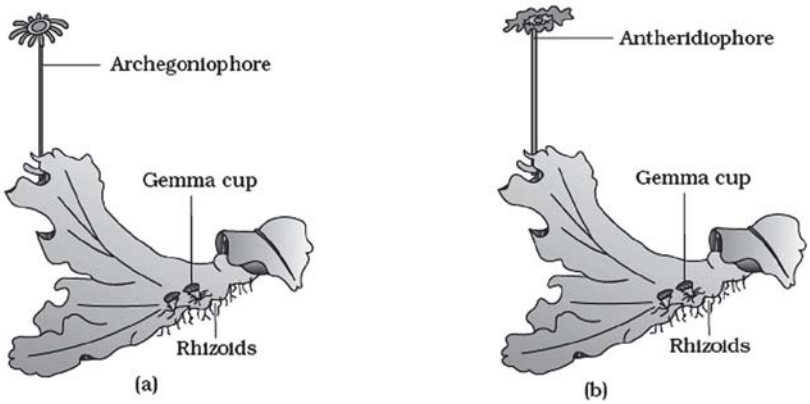
- Sexual reproduction in bryophytes is oogamous type and life cycle is haplodiplontic type.
- In Bryophyta the sporophyte is depend on gametophyte. (May be completely or partially) This is a unique character of broyphyta.

Classification of Bryophyta:

Bryophyte sis divided into three classes

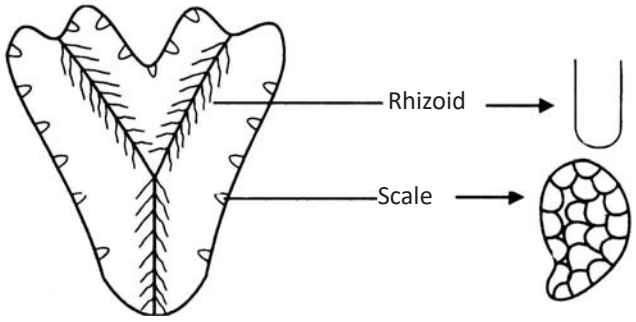
- Hepaticopsida
- Anthocerotopsida
- Bryopsida or Musci

Liverworts



A liverwort – *Marchantia* (a) Female thallus (b) Male thallus

- All the bryophytes includes in this class have shape like liver, so they are known as liverworts.
- Plant body of this group is thallus like.
- Rhizoids and scales are present on thallus.
- Rhizoids are unicellular, unbranched. Scales are multicellular.
- Rhizoids mostly on ventral surface while scales on margin and apical notch
- Thallus has two distinct zones i.e. photosynthetic and storage zone.
- Asexual reproduction occur by means of fragmentation, or by specialized structure called gemmae (e.g. Marchantia).
- Gemmae are '8' shaped, stalked, green and multicellular asexual buds developing in small receptacles (gemma cups) on dorsal surface of thallus.
- In marchantia specific structure found on which sex organs found in groups called Archegoniophore (archegonia) and Antheridiophore (Antheridium).
- The sporophyte of liverworts is completely depend on gametophyte i.e. it is depend on gametophyte for food, water and habitat.



The sporophyte of liverworts made up of foot, seta and capsule. [Except Riccia sporophyte is made up of only capsule).

- In this class formation of spores and nurse cells takes place by the cells of endothecium.
- Cells of amphithecium form only wall of sporophyte.
  Amphithecium = Wall of sporophyte
  Endothecium = sporogenous cells = spore mother cells + nurse cells
- Elaters are present in sporophyte of some members of liverworts. (E.g. Marchantia - In Marchantia nurse cells are modified in to elaters).
- Elaters are diploid, hygroscopic structures with spiral thickenings bands which help in spore dispersal.

Eg. Riccia, Marchantia, Cryptothallus, Riella, Pellia
Porella (Leafy thallus have two rows of leafy appandages on stem like structure)
Note: In Bryophytes, sporophyte of Riccia is the simplest.

Hornworts and Mosses

Anthocerotopaida - Hornworts

- The plant body of this group is also thallus like. Scales are absent but rhizoids are present on thallus. Rhizoids are unicellular and unbranched.
- The sporophyte of Hornworts is divided into foot and capsule.
- The sporophyte of Hornworts is not completely dependent on its gametophyte i.e. it is partially depend because its sporophyte is photosynthetic therefore it can manufacture its own food. So it does not depend on gametophyte for food, it depends only for water and habitat.
- In hornworts at the basal part of capsule, a special, type of meristem is present. Due to the activeness of this, meristem, the capsule grows rapidly. It grows like the horn of animals.
  Eg. Notothylus, Anthoceros
  Note: Pseudo elaters are present in hornworts, which help in spore's dispersal.

Bryopsida or Musci - Mosses

- All the Mosses are included in this class. The plant body of mosses is made up of stem like, leaf like and rhizoids (roots like). The Rhizoids present in the plants of this class are multicellular, branched and obliquely septet.
  Note - The presence of leaf like structure in gametophyte is the unique character of Moss because in plant kingdom any gametophyte do not have leaf like structure. They consist of upright slender axis bearing spirally arranged leaves.
- Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema.
- During sexual reproduction, sex organs are produced at the apex of the leafy shoots.
- The saprophyte in mosses is more elaborated (developed) than that in liverworts. The saprophyte of moss is divided into foot, seta, and capsule.
- The saprophyte of mosses is also partially depend like, that of Hornworts, i.e. it is photosynthetic. The Moses have an elaborate mechanism of spore dispersal.
  Note: Prostomial teeth are present in moss saprophyte which help in spore's dispersal.

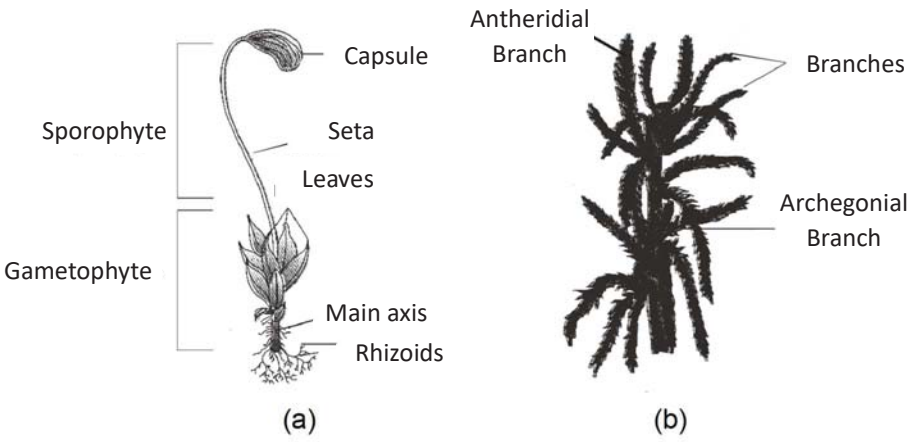


Fig.: Mosses: (a) Funaria, Gametophyte and Sporophyte, (b) Sphagnum Gametophyte

E.g. of Mosses:

Fun aria	-	Rope moss
Polytrichum	-	Hair cap moss
Buxbaumia	-	Saprophytic moss
Sphagnum		

- **Peat moss** – It is a fossil fuel that obtained from bog. The formation of peat takes place by the fossilization of sphagnum. Sphagnum grows in acidic bog. The number of bacteria are less in bog due to which the degradation of dead cell could not takes place. Hence it is present in the form of fossil.
- **Absorbent cotton -** Sphagnum can absorb water in very high amount, therefore it is used in the form of absorbent cotton in Europe.
- Bryophytes in general are of little economic importance but some mosses provide food for herbaceous mammals, birds and other animals. Species of sphagnum, a moss, provide peat that have long been used as fuel, and because of their capacity to hold water as packing material for trans-shipment of living material. Mosses along with lichens are the first organisms to colonies rocks and hence, are of great ecological importance. They decompose rocks making the substrate suitable for the growth of higher plants. Since mosses form dense mats on the soil, they reduce the impact of falling rain and prevent soil erosion.