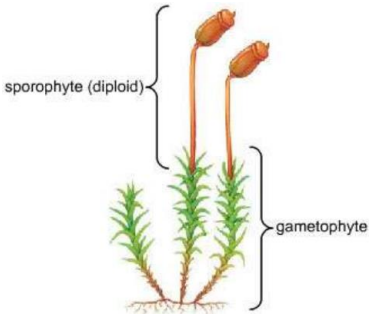
Division: Bryophyta - Class: Bryopsida (Mosses)

Mosses are differing from other bryophyte (liverworts and hornworts) in 3 main features:

a) **Vegetative features of gametophyte**.

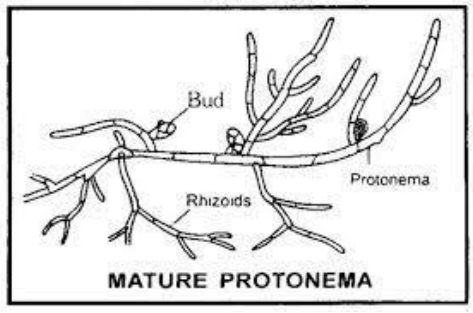
b) **Early ontogeny and mature structure of sex organs**.

c) **Early ontogeny and mature structure of sporophytes**.



The General characters of Bryophyta (Mosses)

1. Gametophytes of mosses are differentiated into two portions, a prostrate protonema and upright gametophores. The protonema is a transitory structure, and the adult plant consists only of persistent gametophores.



2. The mature gametophyte is differentiated into an upright axis and spirally arranged leaves.

3. The axis of gametophore may be unbranched or develop branches only at the apex of stem, or more or less regularly along the main axis. The architecture of branches is identical to that of the stem. They grow from an apical cell and building blocks formed by successive division of the derivative compose a new axis (fig. 2).

4. Branches typically bear leaves which arise from leaf initials, below each leaf-initial is a branch-initial, so that branches can also branch.

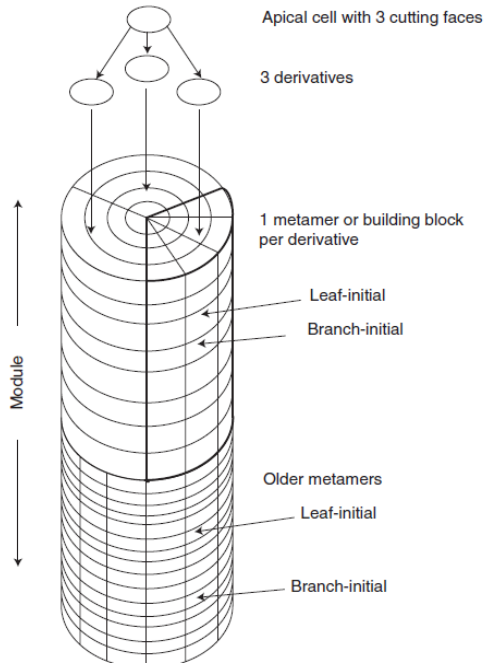


Figure (2): show Modular architecture of the moss shoot

5. The distribution of branches is determined by the dormancy of the initials. Some initials remain dormant throughout the life of the plant, others immediately develop into a branch. In mosses, wherein the formation of sex organs at the apex of the stem consumes the apical cell, vegetative growth may only resume through the activation of a branch-initial to form a new branch or innovation. This branching pattern is referred to as sympodial branching, and

characterizes many acrocarpous mosses. By contrast, pleurocarpous true mosses branch monopodially, maintaining apical growth of their main module (main axis) and developing branches independently of sexual maturation.

6. The leaves of mosses are always sessile: they lack a petiole and the lamina or is thus inserted directly on the stem at its base (Fig. 3) Leaves are normally only one layer thick except at the midrib (or costa) which is lacking in some genera.
7. Many pleurocarpous mosses have leaves with a double costa. The midrib may extend only part way to the apex of the leaf; in some genera it extends to the apex of the blade; in still other genera it continuous as an apical projection beyond the blade (Fig 4).
8. All leaves on a single plant may be identical. Most mosses display, however, heteroblastic leaf development, with the leaves at the base of the module often lacking the modifications characteristic of the mature leaves found higher up the axis. Plants branching monopodially often bear stem and branch leaves that are dissimilar in size and also shape.
9. The general shape of the leaf varies greatly among mosses, from nearly rounded, or tongue-shaped, to narrow and nearly linear (Fig. 3).

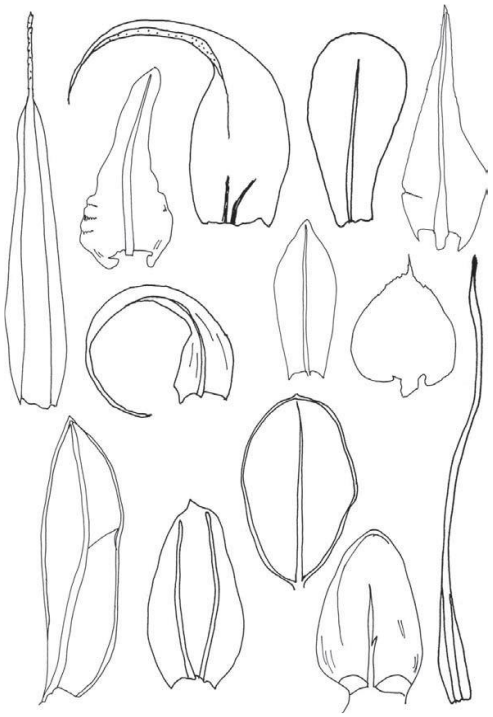


Figure (3): show Diversity in shape of vegetative leaves

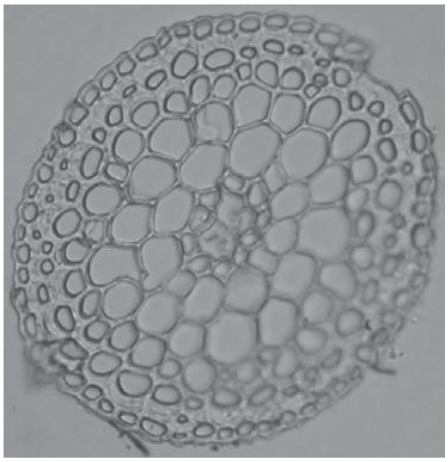
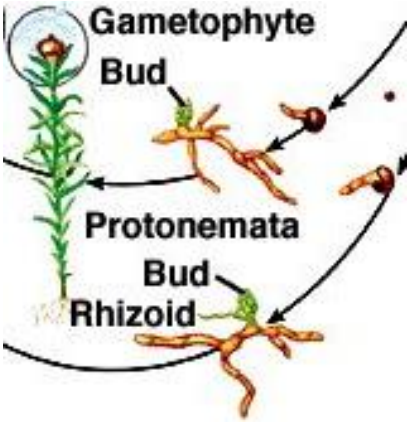


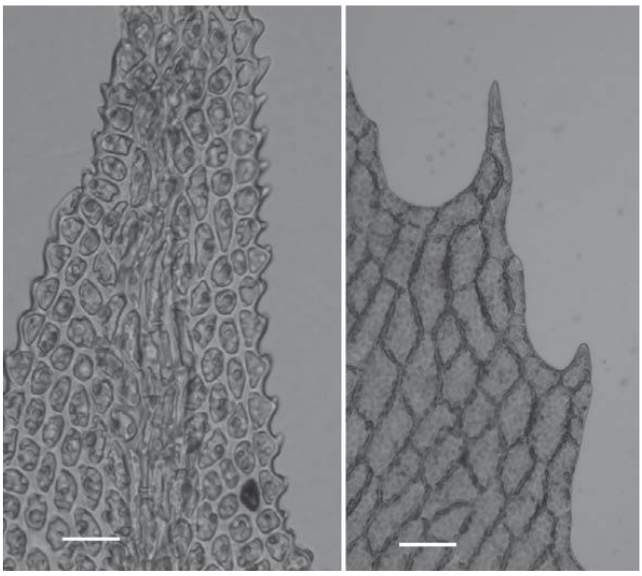
Figure (4): stem

10. The leaf is often entire, but lateral projections from either the apex or the sides of marginal cells confer dentations or serrations to the outline in many species (Fig. 5).
11. The anatomy of the stem or branch is typically simple, consisting of a mostly unistratose epidermis that always lacks stomata, a cortex of parenchymatous cells and, in some cases, a central strand of water-conducting cells known as Hydroids.

Hydroids resemble the water conducting tracheary elements of vascular plants because both lack a living protoplast at maturity (fig. 4). While liverworts and hornworts totally lack this conducting strands of cells.

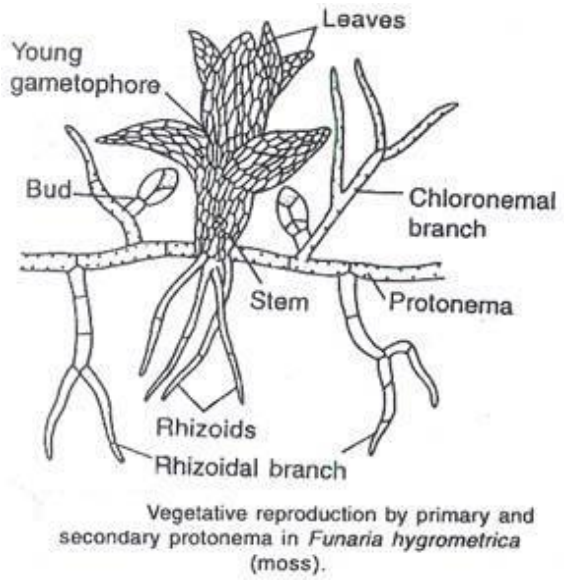


12. **The rhizoids** borne by both: protonema and gametophore, are multicellular and with diagonal cross wall branched and reddish-brown in colour. Rhizoid are absent in *Takaya* and restricted to the protonemal stage in *Sphagnum*.



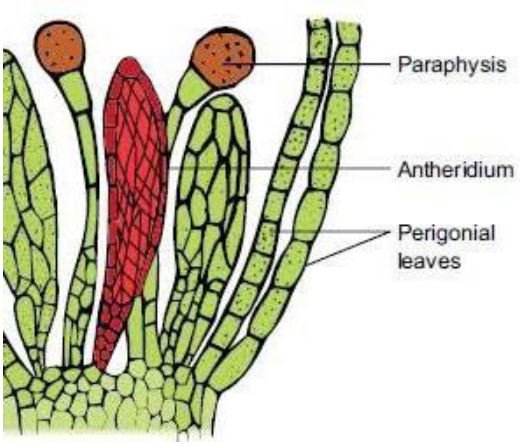
a b

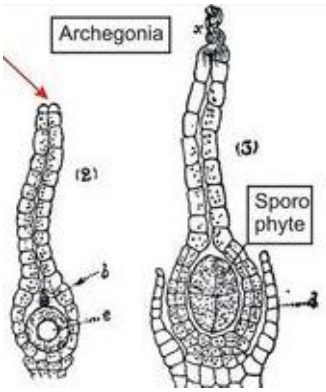
Figure (5): Leaf margin. (a) Dentate due to projecting papillae. (b) Toothed, with multiple cells composing each tooth.



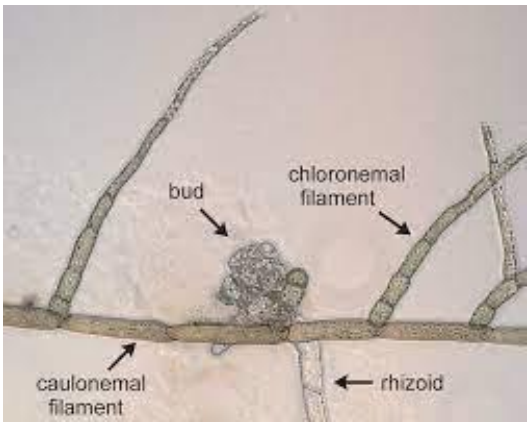
Vegetative reproduction by primary and secondary protonema in *Funaria hygrometrica* (moss).

13. Unlike liverworts and hornworts, a mature antheridium has a **multicellular long stalk** and a **club shaped body**.
14. Unlike those of liverworts and hornworts, a mature archegonium consists of a **long stalk**, a **basal swollen venter** and **an elongated neck.**
15. Sex organ are born terminally on gametophyte either at the **tip** of the main axis or at the end of the lateral branch.
16. The sporophyte is differentiated into **foot**, **seta** and **capsule**. In comparison with hornworts and liverworts capsules of mosses are with greater proportion of sterile tissue and frequently have the sterile portion differentiated in to a variety of tissues.





17. **Sporogenous** tissue of a capsule may arise in the endothecium or amphithecium of an embryo.
18. Unlike other bryophytes, Mosses do not have a differentiation of **elaters** or **nurse cells** by the sporogenous tissue.
19. The spores can travel long distance on wind.
20. The spore germinates to form **protonema**.



Sexuality of Gametophores in Mosses

Sex organs are borne terminally on gametophores and almost always there is a development of more than one of them at the end of a branch. A gametophore may be:

1. **Acrocarpous** and with sex organs borne terminally on the main axis and its major branches
2. It may be **pleurocarpous** and with sex organs restricted to the apices of short lateral branches.

Perichaetial leaves adjoining sex organs may differ somewhat from foliage leaves lower on the stem and they may lie close together in a distinct "floral envelope," called perichaetium. **Gametophores of mosses (true mosses)** may be homothallic or heterothallic. Homothallic species bear their sex organs in a variety of ways. Most conspicuous among these are:

1. The ***autoicous*** mosses in which antheridia and archegonia are borne on separate branches;
2. The ***paroicous*** mosses in which antheridia and archegonia are borne in the same head but in separate groups that are sometimes segregated from one another by perichaetial leaves; and
3. The ***synoicous*** mosses in which antheridia and archegonia are intermingled in the same head.

Sporophyte of Mosses (True mosses)

The mature sporophyte is differentiated into a foot, a long seta and a pear-shaped capsule at the tip. The capsule internally divided into three distinct parts:

1- The apical region

2- Theca

3- The apotheosis

The apical region of majority of mosses (true mosses) has the upper part of a capsule maturing into operculum and peristome. They join the theca of capsule through a notch. An annular rim or diaphragm of 2-3 radially elongated cells is present at this notch. The operculum is doming shaped lid that closes the mouth of the capsule. It's composed of 2-3 layers of thin-walled parenchymatous cells. The lower parts of the operculum form a ring of slightly large thin-walled epidermal cell. Epidermal cells at the base of an operculum in large radially to form an annulus whose lowermost cells are thin walled at maturity.

The peristome teeth lie just below the operculum, the number of segments (teeth) comprising the peristome is always four or a multiple there of and may be 4-8-16-32 or 64.

Teeth may be composed of entire cells or composed of thickened portion of cell walls. In the later type of peristom there may be a single set of teeth or 2 sets of teeth, one external to the other (fig. 6)

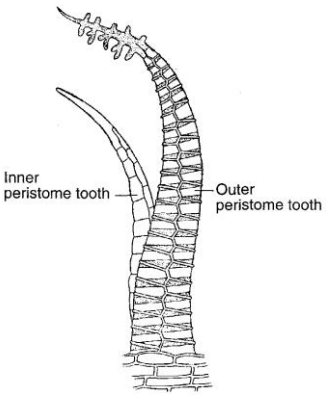


Figure (6): inner and outer peristome.

The theca is fertile in nature and has 4 distinct regions (fig.7):

a) Capsule wall, normally present in the epidermal cells of capsule wall

b) Spore sac

c) Air chamber (air cavity) Columella

Dehiscence of the capsule and the dispersal of spores

At maturity, the operculum begins to dry up due to the non-availability of water supply capsule to the capsule. Consequently, the thin-walled cells of the operculum, including the annulus, which hold the operculum in place, shrink and shrivel. Ultimately, the annulus breaks and the loosened operculum is thrown away leaving the peristome teeth exposed (Fig. 7B).

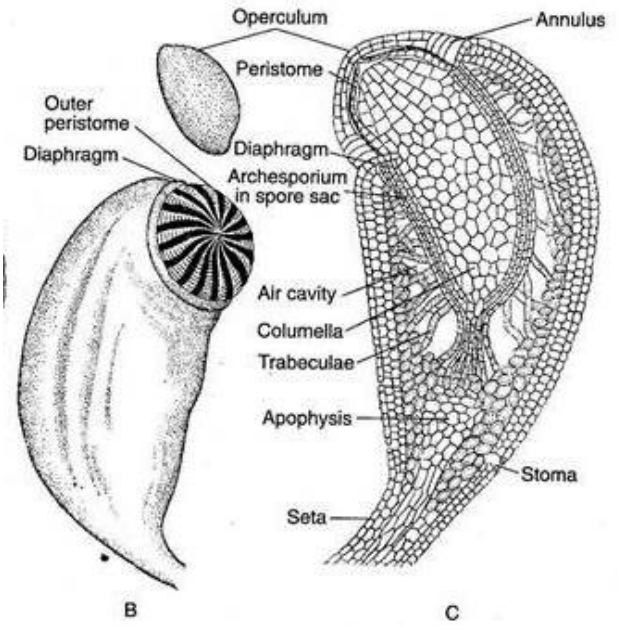
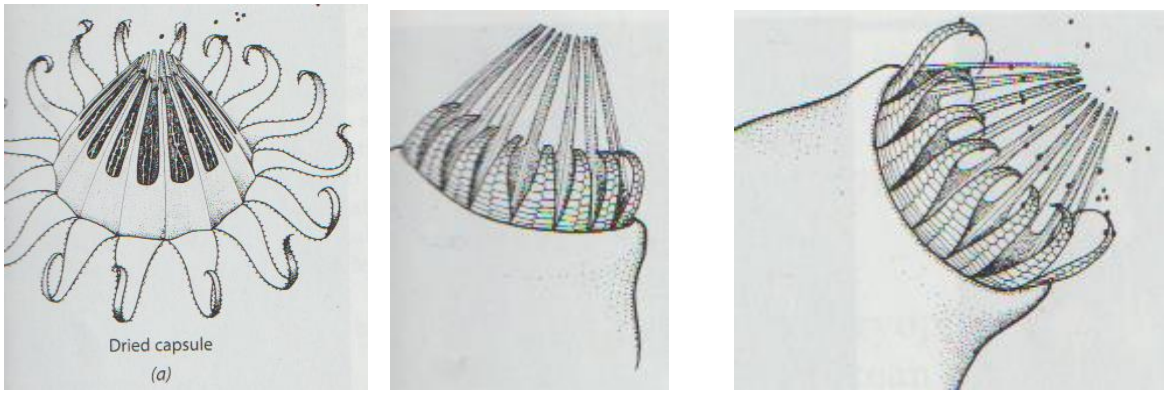


Figure 7: *Funaria* sp.: B) mature capsule with operculum removed, C) L.S. of capsule

The peristome teeth are twisted spirally appearing like an iris diaphragm (Fig. 7B).

The outer peristome teeth are hygroscopic which show inward or outward movements according to the presence or absence of moisture in the environment.

During dry atmosphere the outer perostome teeth bend outwards with jerky movements. The slits between the inner peristome teeth widens, due to the outward movements of the outer peristome teeth, thus allowing the spores to escape through these slits. In high humidity the hygroscopic teeth of the outer peristome absorb water and bend inwards and close the slits. This prevents the escape of spores in wet weather (Fig. 8).



Dried capsule **Moist capsule** **Drying capsule**

Figure (8): peristome teeth in mosses of the class Bryidae

The young sporophyte is covered by calyptra that develops from the old archegonial venter wall. It protects the capsule from drying and shades prior to its dehiscence.

Division Bryophyta (Mosses) includes approximately 660 genera and 14500 species, and it's classified into 3 classes: **Sphagnidae**, **Andreaeidae** and **Bryidae**.

Class Bryidae (True Mosses)

The true mosses (Bryidae) differ from other two classes in the following features:

1. The protonema is almost always filamentous composed of a single row of cell and gametophores produced by them usually have leaves with a midrib more than one cell in thickness.
2. Sporophytes never become elevated above the gametophore by means of a pseudopodium, but quite frequently the capsule becomes elevated by elongation of the seta.
3. The leaves of mosses are always sessile they lack a petiole and the lamina is thus inserted directly on the Sporogenous tissue of a capsule is derived from the endothecium and does not overarch the columella.
4. Mature capsules are generally internally differentiated into several tissues.
5. There is no uniformity in mode of opening of capsules but the great majority of genera have the spore cavity covered by a peristome (Fig. 9).

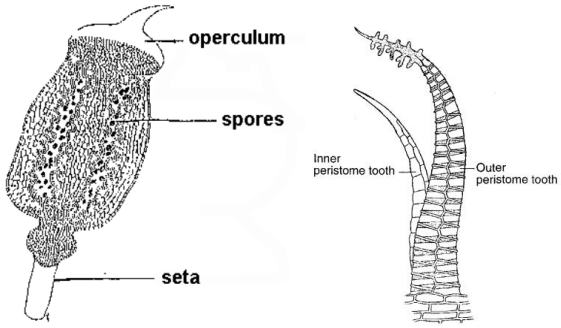


Figure (9): inner and outer peristome

There are some 650 genera and 14,000 species. In addition, a number of fossil species are unknown.