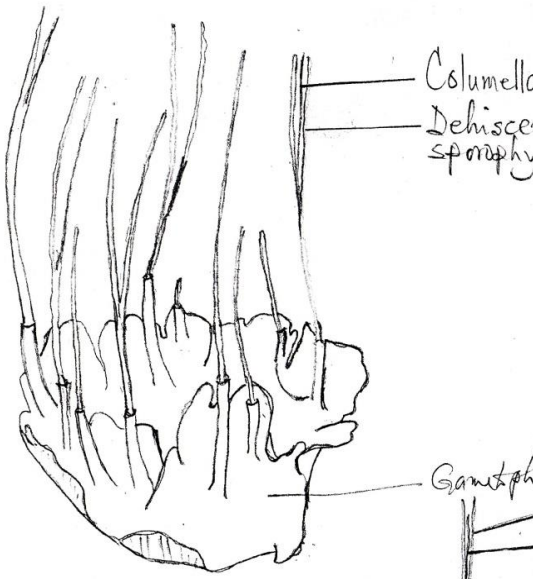
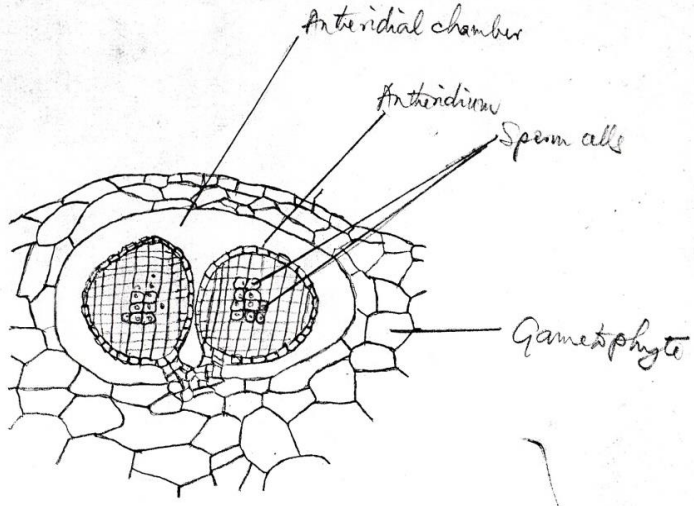
CLASS II

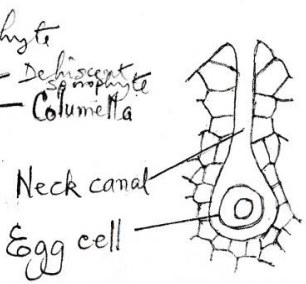
CLASS ANTHOCEROTAE – THE HORNWORTS



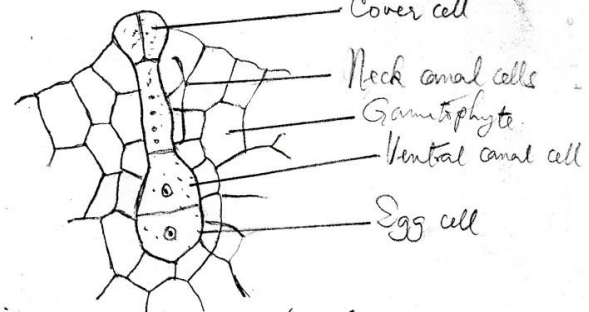
Anthoceros gametophyte with upright dependent sporophyte.



Section through an antheridium of Anthoceros

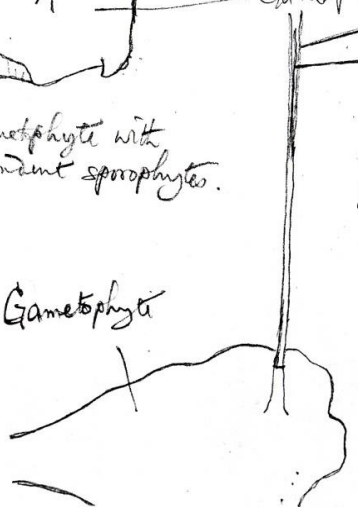


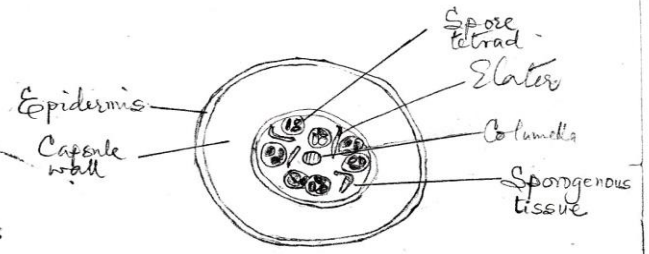
Mature archegonium



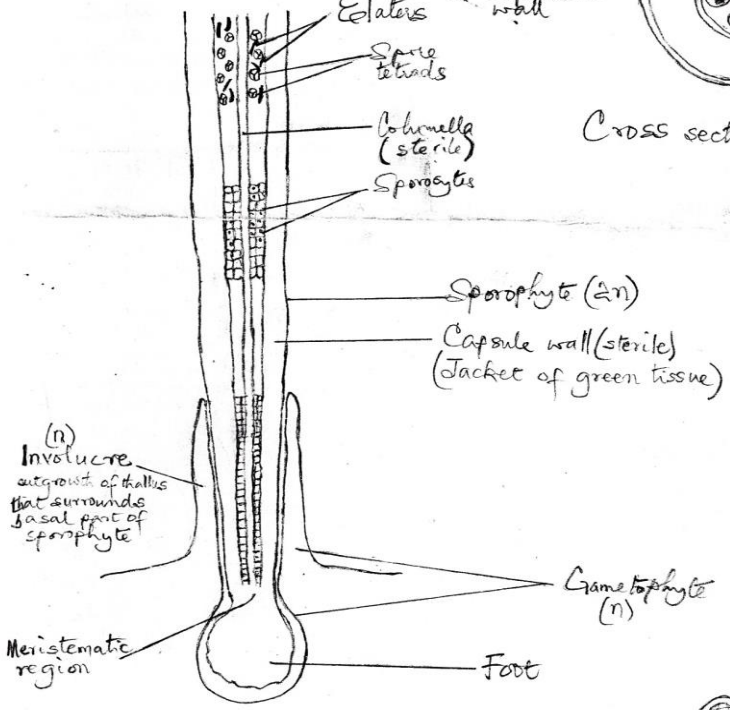
Young archegonium

Section through an archegonium of Anthoceros

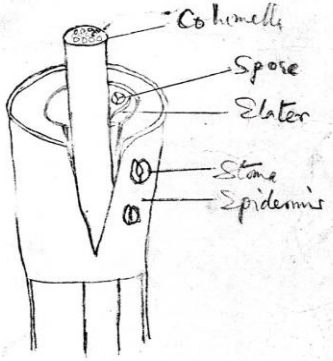


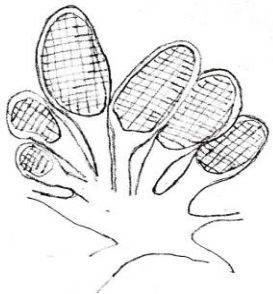


Cross section of sporophyte



Longitudinal median section through sporphyte of Anthoceros





A group of antheridia of Anthoceros.

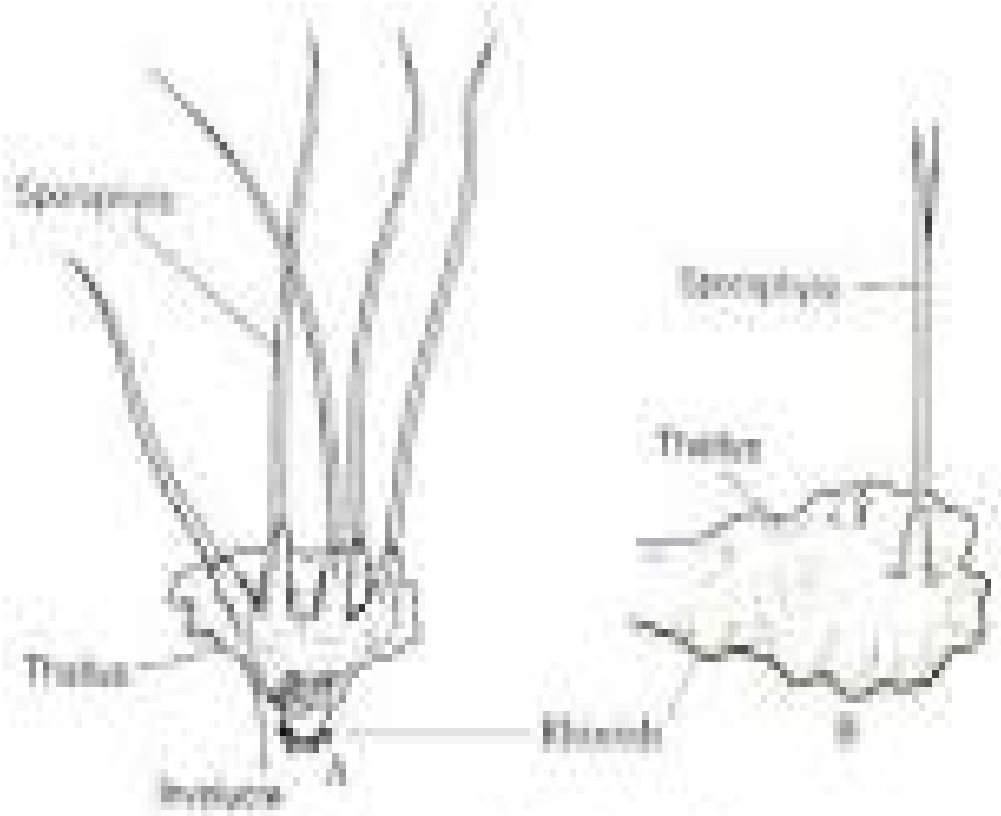


Fig. Anthoceros sp. External morphology
(A) Thallus of A. crassa, bearing sporophyte
(B) A. laevis, bearing elaterate sporophyte

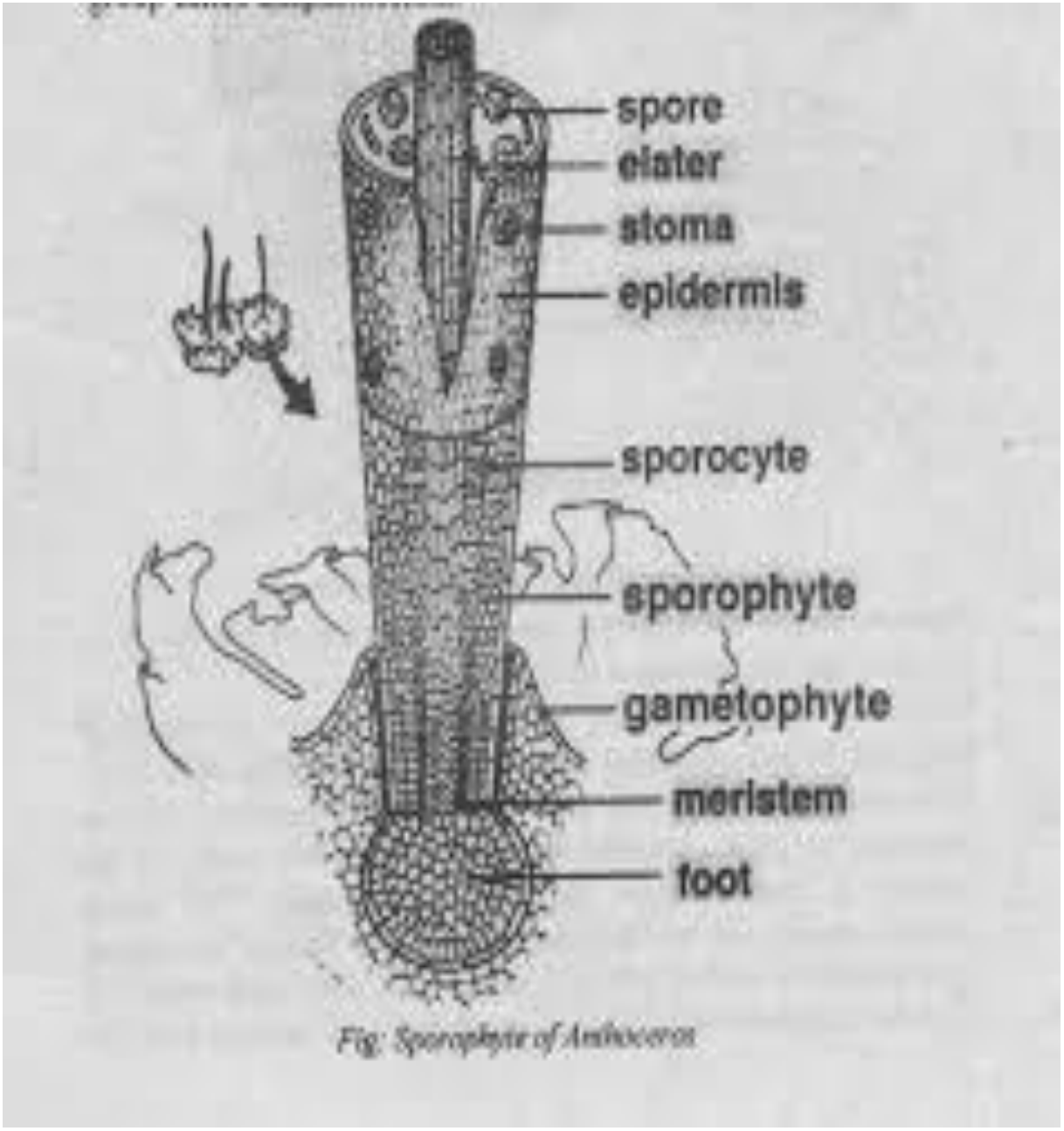


Fig: Sporophyte of Anthoceros

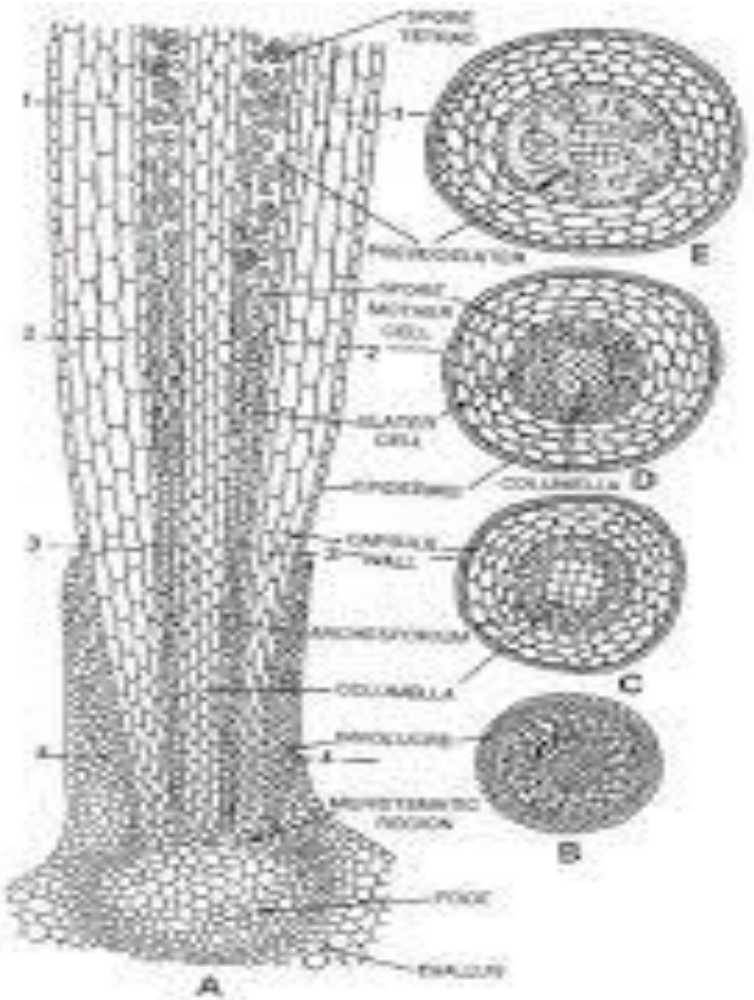
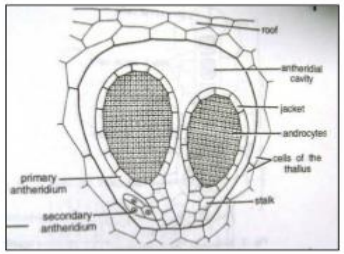


Fig. 22.16. *Anthoceros* sp. A, longitudinal section of sporogonium; B, cross section of sporophyte (A) at 4; C, cross section of sporophyte (A) at 3-3; D, cross section of sporophyte (A) at 2-2; E, cross section of sporophyte (A) at 1-1.

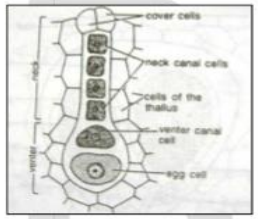
Sexual reproduction is **oogamous** type. Many species are **monoecious** while some are dioecious. In monoecious species, antheridia develop much earlier to archegonia (**Protandrous condition**). Sex organs develop inside the gametophytic thallus.



Structure of Antheridia:

- Develop singly or in groups, in the upper region of the thallus, inside closed cavities called **antheridial chambers**.
- Each antheridium has an **ovoid body** and a multicellular, slender **stalk**. The body is covered by a single layered **antheridial wall**.
- Inside the body, a mass of androcytes or spermatocytes are present. Each spermatocyte is a bi-flagellate 'coma' shaped structure with a single haploid nucleus.

Structure of Archegonia:

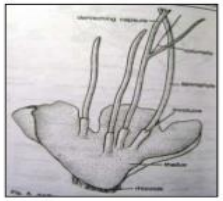


- They are present sunken in the thallus on the upper side, close to the apex, in **acropetal** order.
- Each archegonium is flask-like in appearance with a basal swollen **venter** region and a **narrow neck**.
- The venter has a basal **egg cell** and an upper **venter canal cell**. 4-6 **neck canal cells** are arranged in a row at the neck part.
- There **is no jacket cells covering the archegonium**. The vegetative cells of the thallus provide protection to the archegonium. **Cover cells** or **lid cells** are found at the tip of the archegonium.

Fertilisation: Rain splash mechanism**,** as in Riccia/Marchantia.

Structure of Sporophyte:

The diploid zygote develops into a sporophyte on the upper surface of the gametophyte. Mature sporophytes are elongated (2-3 cm long), horn-like structures with a bulbous base. It is covered at the base by a tubular **involucre** which is developed from the gametophytic tissue.



The sporophyte is differentiated into 3 distinct regions:

1. **Foot**: It is the basal, bulbous structure which is found deeply embedded in the gametophytic tissue. It helps in attaching the sporophyte to gametophyte and in absorption of water and nutrients from it. Foot is made up of parenchyma cells.
2. **Intermediate or intercalary zone**: It is a narrow zone of **meristematic cells** located between the basal foot and the upper capsule. These cells help in the continuous growth of the sporophyte.
3. **Capsule**: It is the fertile, major and conspicuous part of the sporophyte which is long and cylindrical. It is green when young, but turns grey or brown on maturity. The capsule is composed of the following structures:
   a) **Columella**: It is the central solid core of sterile cells, consisting of 16 vertical rows of cells. It extends from the base to almost to the tip of the capsule.

- The Class Anthocerotae contains a single order Anthocerotales
- Although formerly included with the Hepaticae the Anthocerotales are now placed in a separate class
- ✓ Mainly on account of their unique sporophyte

CLASS ANTHOCEROTAE Cont'd

- Mature sporophytes of the Anthocerotae (hornworts) look like miniature, greenish cattle horns
- *Anthoceros* is representative of its class

STRUCTURE AND FORM

- The Anthocerotae have the simplest gametophyte of the Bryophytes
- But the sporophytes are more complicated than that of any other Order

STRUCTURE AND FORM Cont'd

- They are slightly lobed with numerous rhizoids growing from the lower surface
- They are small, green thalloid plants with little internal differentiation of vegetative tissues

STRUCTURE AND FORM Cont'd

- They are usually less than 2cm in diameter and thrive in moist soil in shaded areas although some occur on trees
- Hornworts usually have one large chloroplast in each cell (a few have up to eight)

STRUCTURE AND FORM Cont'd

- Each chloroplast has pyrenoids similar to those of green algae, a feature not found in other Bryophytes
- The pyrenoid consists of a mass of minute disc or spindle-shaped bodies which are the rudiments of starch grains
- The thalli have pores and cavities filled with mucilage in contrast to the air-filled pores and cavities of thalloid liverworts

STRUCTURE AND FORM Cont'd

- Nitrogen-fixing blue-green bacteria/algae (e.g. *Nostoc*) often grow in the mucilage
- The internal structure of the thallus is very simple consisting of a mass of thin-walled parenchyma cells without any differentiation of tissues

ASEXUAL REPRODUCTION

- Hornworts reproduce asexually primarily by fragmentation
- Or as lobes separate from the main part of the thallus
- A few hornworts form tiny tubers on the margin which grow into new gametophytes

SEXUAL REPRODUCTION

- Like both mosses and liverworts some species of hornworts are **monoecious** (bisexual/homothallic) bearing both antheridia and archegonia
- ✓while other species are **dioecious** (unisexual/heterothallic) bearing either of the two

SEXUAL REPRODUCTION Cont'd

- The **antheridia** are similar in structure to those encountered in the Hepaticae
- They grow in small groups usually 2-4 and are located on roofed chambers in the upper portion of the thallus
- **Each antheridium** consists of

✓ a short multicellular stalk

✓a sterile outer layer (one or more cells thick) and,

SEXUAL REPRODUCTION Cont'd

- ✓a compact mass of antherozoid mother cells
- Each mother cell gives rise to a single minute biciliate antherozoid (sperm cell)
- The **archegonia** develop singly and separately and are embedded within the thallus and in direct contact with the vegetative cells surrounding them

SEXUAL REPRODUCTION Cont'd

- When fully developed each archegonium consists of a **venter** and a **neck**
- The neck consists of a vertical row of 4-6 **neck canal cells**
- The venter consists of a **ventral canal cell** and an **egg cell**

SEXUAL REPRODUCTION Cont'd

- At maturity the neck canal cells and the ventral canal cells get disorganized and become converted into mucilage
- While the major part of the archegonium remains sunken in the thallus the upper end of the neck only projects out of it

SEXUAL REPRODUCTION Cont'd

- When young the neck of the archegonium is covered by four cells which separate out later

  Fertilization

- By the breakdown of the roof of the antheridial chamber an outlet is formed for the antherozoids to escape

SEXUAL REPRODUCTION Cont'd

- They swim to the archegonium and enter through the neck
- Finally one antherozoid fuses with the egg nucleus in the venter
- A zygote is formed after fertilization

SPOROPHYTE

- The sporophyte develops from the zygote and consists of a **FOOT** and **CAPSULE**
- For a time it is surrounded at the base by a sheath or **INVOLUCRE** formed by an upward growth of the archegonium

- Soon after fertilization the zygote grows and completely fills up the venter
- By repeated divisions it gives rise to

✓ the **FOOT** embedded in the thallus below, serving as an absorbing organ

✓ and the **CAPSULE** above

- There is no seta of the capsule in *Anthoceros*

- The capsule (sporangium) is
- ✓an upright
- ✓slender, cylindrical
- ✓deep green structure
- ✓usually 1-3cm long
- ✓but sometimes much longer in a few species
- The following regions can be seen in a longitudinal section through the capsule:

❖A **MERISTEMATIC TISSUE**

- at the base of the capsule just above the foot through the activity of which the sporophyte continues to elongate and the sporocytes (spore mother cells) continue to be formed

- ❖Centrally there is a sterile tissue, the **COLUMELLA,** consisting of rows of elongated cells
- The sterile columella is an early indicator of the differentiation of the conducting system at a later stage in higher plants

❖Surrounding the columella is a cylinder of **SPOROGENOUS TISSUE**

- The sporogenous tissue is surrounded by the **CAPSULE WALL** which is a jacket of green sterile tissue 4-8 layers of cells in thickness each cell having 2 or sometimes more chloroplasts

- The outermost layer of the capsule wall is the **epidermis** which is strongly thickened and cutinized and provided with stomata
- The **sporogenous tissue** may extend down to the base of the capsule or only half-way down and may be 1, 2, 3 or 4 layers of cells in thickness

- The sporophyte matures from the apex downwards i.e. the base is younger than the apex
- The sporogenous cells develop into small groups of sterile cells called **ELATERS** and small groups of **spores** in an alternative manner
- The elaters are mostly smooth-walled and rarely with spiral bands

- Each **spore mother cell** undergoes reduction division and four **spores** are formed in a tetrad
- Spores mature in progression from top to down
- The **gametophyte generation** begins with the formation of the spores

- When the spores at the top of the capsule are ripe
- the tip of the sporophyte horn splits into two or three ribbon-like segments releasing the spores
- And the segments continue to peel back

  as long as the meristem is producing new tissue at the base with the slender columella standing free in the center

- Because of the presence of **chloroplasts**

  the sporophyte can manufacture most of its **food** and is dependent on the gametophyte only for **water and mineral salts**
- The sporophyte is therefore a **semi-independent body**

- Under exceptionally favourable growing conditions the sporophyte may lengthen greatly
- Some sporogenous tissue at the base of the capsule may be replaced by a conspicuous conducting strand
- The foot enlarges and through decay of gametophyte comes into more or less direct contact with the soil

- Such sporophytes are capable of maintaining themselves independently for some time
- And they represent the most primitive sporophytic terrestrial plants

DEVELOPMENT OF ANTHOCEROTAE SPOROPHYTE TOWARDS INDEPENDENT LIFE

i. The development of a considerable amount of green tissue and stomata
ii. Development of massive foot to facilitate greater absorption of water and mineral salts from the gametophyte

- With the decay of the gametophyte tissue the foot may even touch the ground and absorb water and mineral salts from the soil

iii. The complexity of the sporophyte with a considerable development of sterile tissue is an early indication of a more complex and quite independent sporophyte at a later stage in the evolution of higher plants

iv. The development of the sterile axis (columella) represents the beginning of a conducting system

v. The method of shedding spores can be compared to that of ferns and allied plants