Anthoceros

Bryophytes

Occurrence and distribution:

- ✓Cosmopolitan in habitat
- ✓Genus comprising 20 species, found in
- ✓25 species reported from India
- ✓Three common Himalayan species: *A. himalyanesis, A. erectus* and *A. chambensis*
- ✓Most commonly found in hilly regions such as Mussoorie, Kumaon hills, Chamba valley and other places, 5000 to 8000 feet altitude
- ✓Some species are reported from South India

Classification and systematic position:

Division: Bryophyta

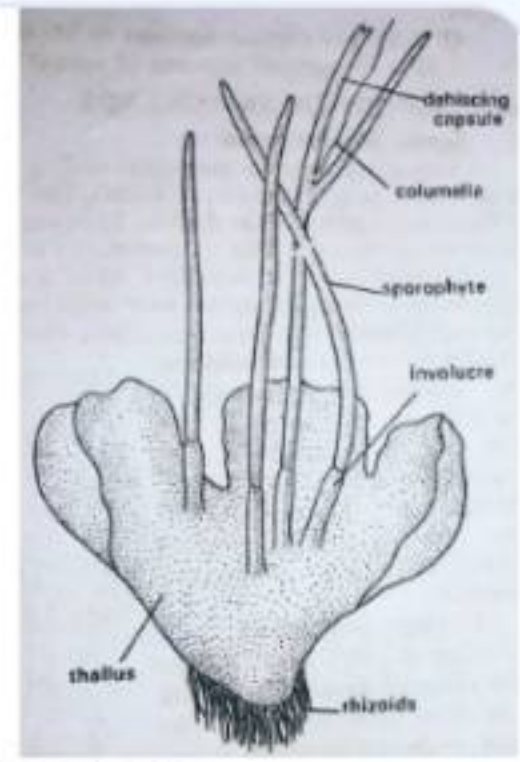
Class: Anthocerotopsida

Order: Anthocerotales

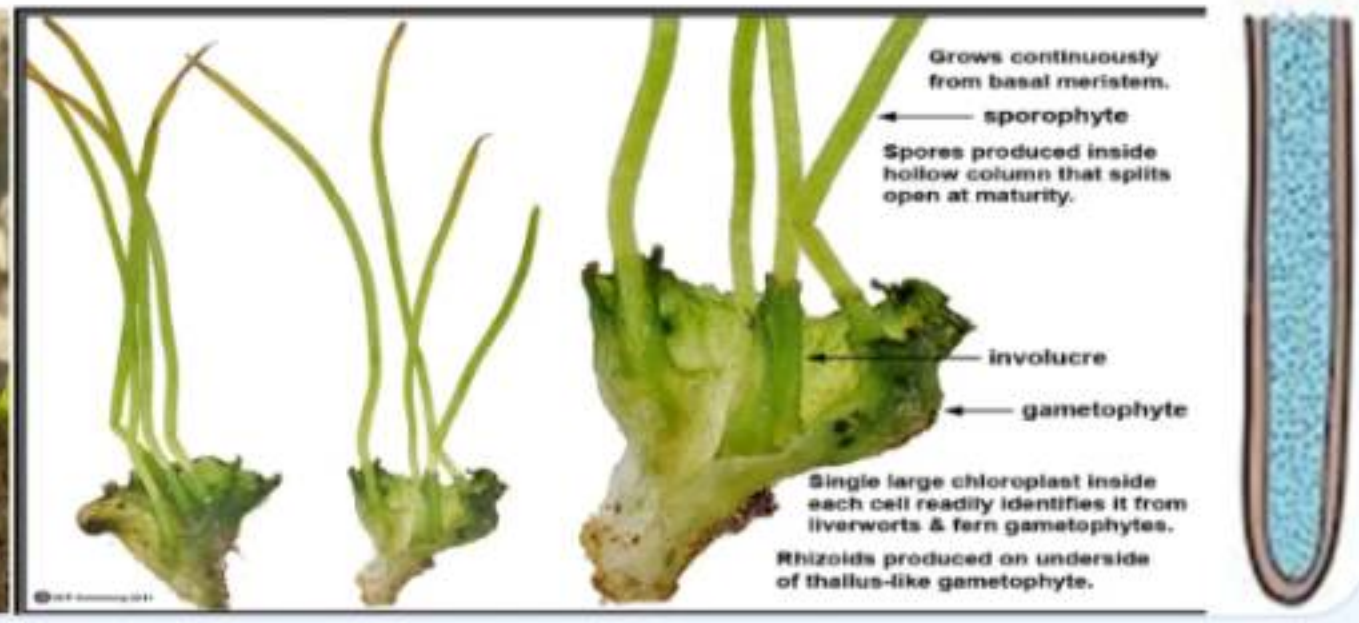
Family: Anthocerotaceae

Genus: *Anthoceros*

External features/External morphology:

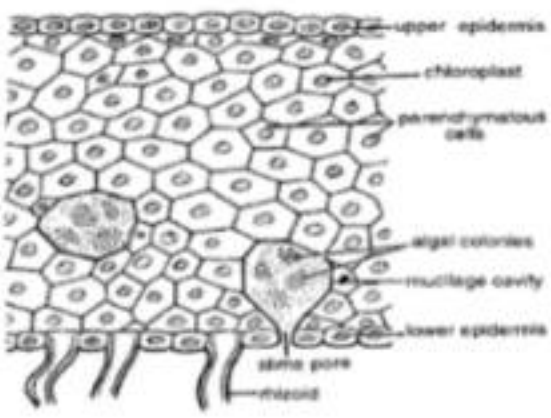


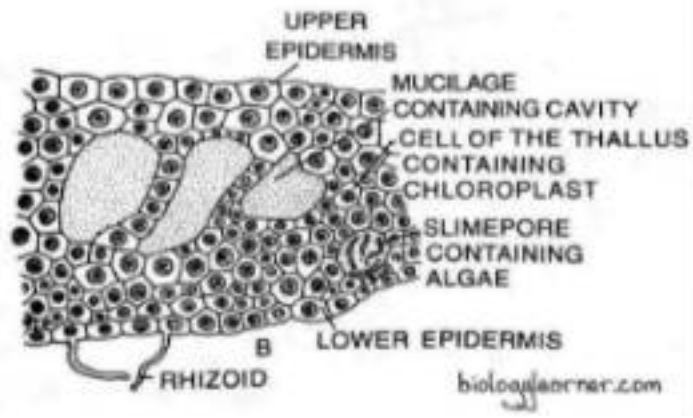
- ✓Plant body is small, thalloid gametophyte, prostrate
- ✓Thallus dorsiventrally differentiated, and dark green in colour
- ✓Thallus lobed and lobes are somewhat divided
- ✓Mid-rib is absent
- ✓Dorsal surface is smooth and dark green
- ✓Ventral surface rough with simple, smooth-walled rhizoids
- ✓Ventral scales and tuberculate rhizoids all totally absent
- ✓Dark green colouration of the thallus is because of presence of *Nostoc* colonies
- ✓Nostoc colonies are seen from the underside

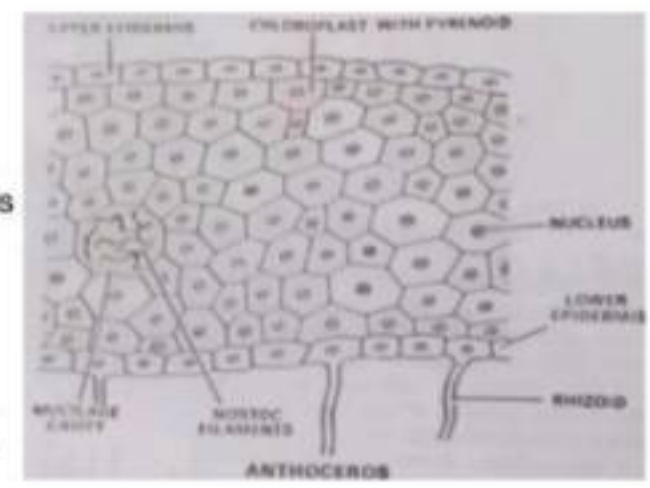


Internal structure of the thallus: (V.S. of thallus)

❖Anatomy of thallus is very simple



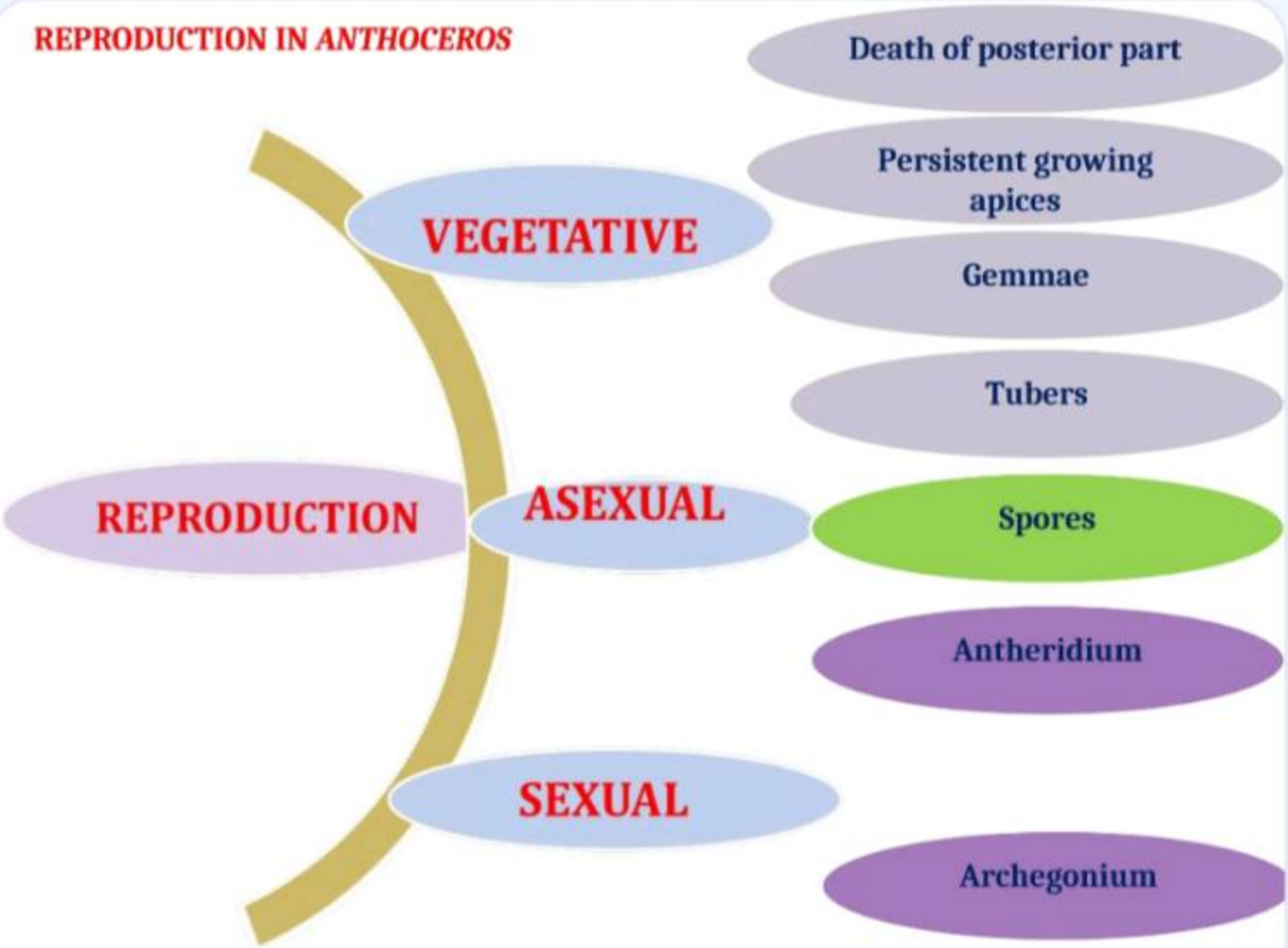




❖Epidermis:

- ✓Both the surfaces are covered by single layered epidermis
- ✓Upper epidermis also called dorsal epidermis and lower is called ventral epidermis
- ✓Epidermal cells compactly arranged with chloroplast
- ✓Air chambers and air pores absent
- ✓Only smooth walled simple rhizoids present on the ventral epidermis
- ✓Internal to upper and lower epidermis, simple parenchymatous cells present
- ✓The cells are large, compactly arranged and hexagonal in shape
- ✓Each cell contains a big lens shaped chloroplast with a single pyrenoid in the center
- ✓Certain intercellular cavities are present on the ventral side of thallus, called mucilage cavities

REPRODUCTION IN *ANTHOCEROS*



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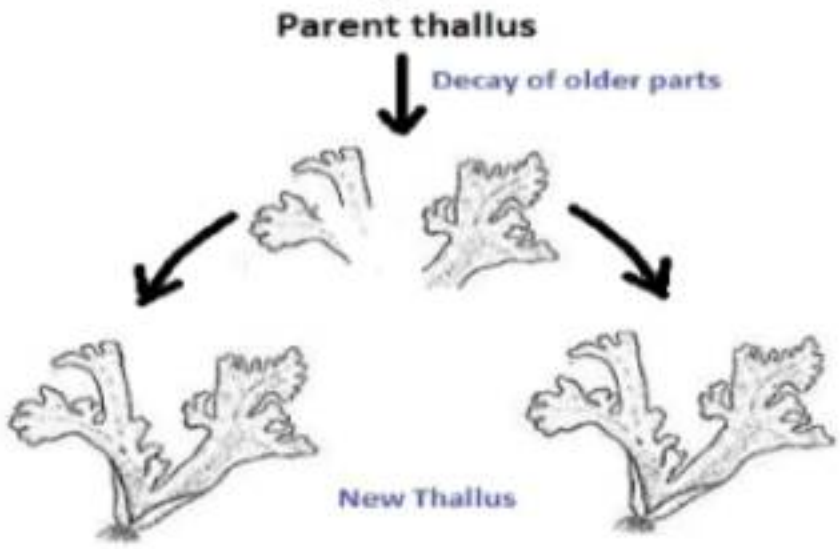
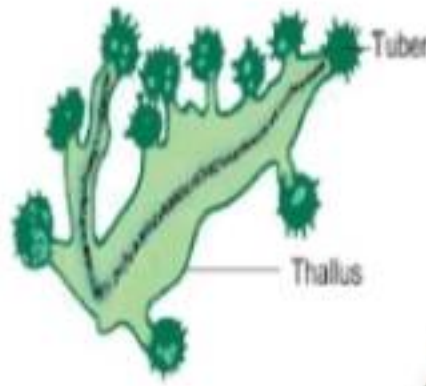
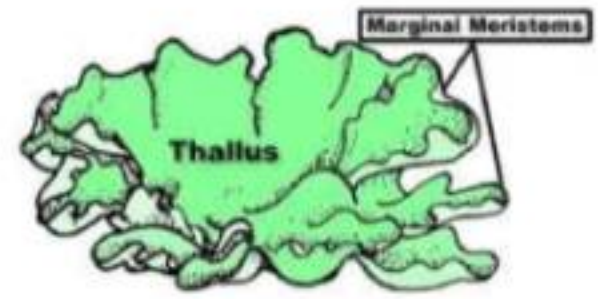
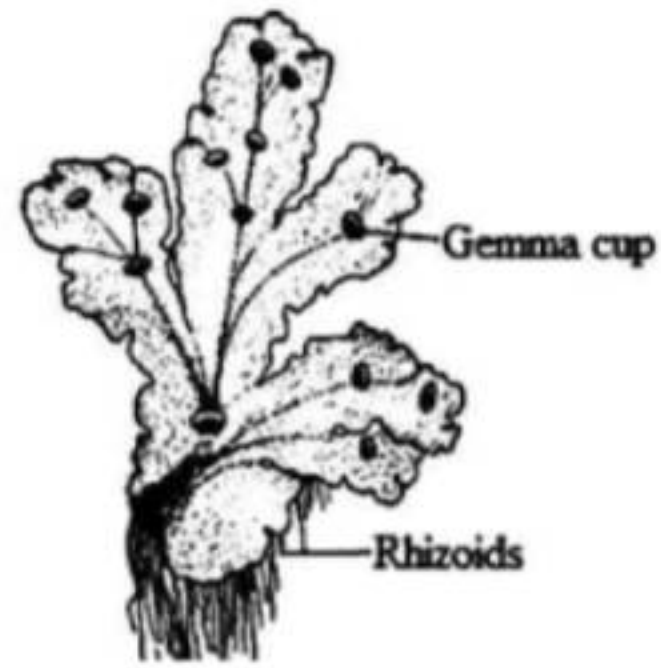








1. Vegetative reproduction:

A. By death and decay of posterior part of thallus:

✓The older posterior part of the thallus disintegrates due to ageing.

✓When this decay of cells reaches dichotomy, the lobes become separated.

✓Each detached lobe with growing point can develop into new plant of *Anthoceros*.

B. Persistent growing apices:

✓The thalli completely dried up during summer, leaving the growing apices

✓Apices tolerate the adverse condition and develops into new thalli during favorable condition

C. Formation of tubers:

✓In certain species, thallus becomes thickened at several places on the margins

✓Such marginal thickenings are called tubers

✓The tubers are perennating structure and can survive during adverse condition

✓They detached from the mother plant and during favorable condition develop into new thalli of *Anthoceros*

D. By gemmae:

✓Gemmae are reported to found on the dorsal surface of thallus in some species

✓Reported in *A. gladulosus, A. formosae*

✓Each gemmae germinate to form new thalli of *Anthoceros*

2. Asexual reproduction:

✓Takes place by spores produced in sporophyte

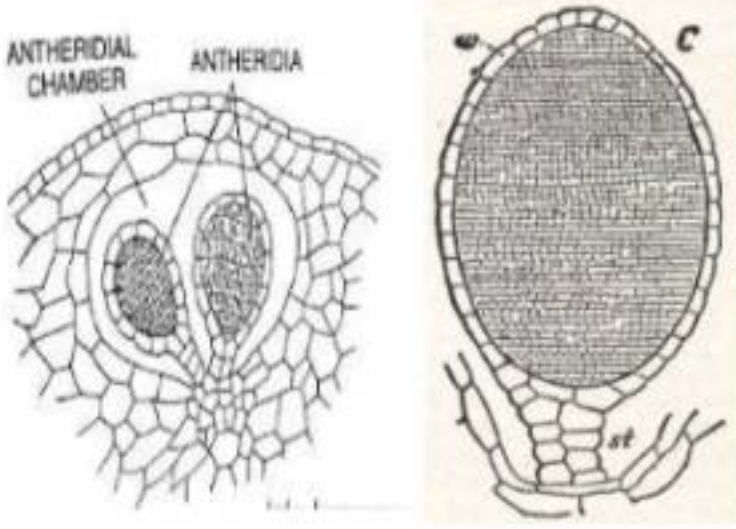
3. Sexual reproduction:

✓Species of Anthoceros may be homothallic (monoecious) or heterothallic (dioecious)

✓Sex organs are antheridia and archegonia

✓Sex organs develops directly on the thallus and are embedded into thallus tissue

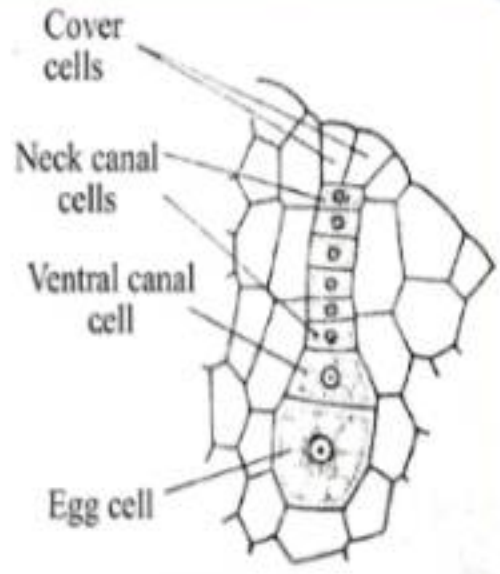
❖Structure of mature antheridium:



- ✓ Antheridia are produced in cavities called anthreridial chamber
- ✓ They may be produced singly or in groups of three to four
- ✓ The anthreridial cavities are covered by roof layer
- ✓ Mature antheridium is stalked and club shaped
- ✓ The stalk is short and multi-layered
- ✓ Body of antheridium is covered with single layered jacket
- ✓ Body accommodates numerous androcytes, which metamorphoses into antherozoids

- ✓ Each antherozoid (sperm) is uninucleate, rod-like, elongated structure
- ✓ It has tapering anterior end and posterior broader portion called vesicle
- ✓ Vesicle contains the male nuclei (n)
- ✓ Two equal lengths flagella arise from the anterior narrow end
- ✓ Antherozoids are chemotactic and motile structure

Structure of mature archegonium:



- ✓ Archegonia are found embedded in the thallus
- ✓ They remain in direct contact with the thallus tissue
- ✓ They do not have their own jacket layer
- ✓ Mature archegonium is a flask-shaped structure
- ✓ Differentiated into posterior broader venter and anterior narrow neck
- ✓ Venter contains basal egg (n) cell and upper venter canal cell (VCC)
- ✓ Neck consist of an axial row of 4-6 neck canal cells (NCCs)
- ✓ Four compactly arranged cover cells (Cap/lid cells) are present at the top

Fertilization:

- ✓ **Act of union of haploid male gametes (n) with haploid female gamete (n) is called fertilization**
- ✓ **Water is very essential for the act of fertilization**

Pre-fertilization changes:

- ✓ Matured antheridia opens due to water and biflagellate antherozoids liberate
- ✓ Chemotactic antherozoids swim on the film of water and reaches the archegonia
- ✓ Prior to fertilization, cover cells detached from archegonium and neck canal become gelatinized due to disintegration of all NCCs and VCC
- ✓ Many antherozoids enter the archegonium, travel through neck and but one lucky antherozoid penetrate the egg and fertilization is affected to produce diploid (2n) zygote

Post-fertilization changes:

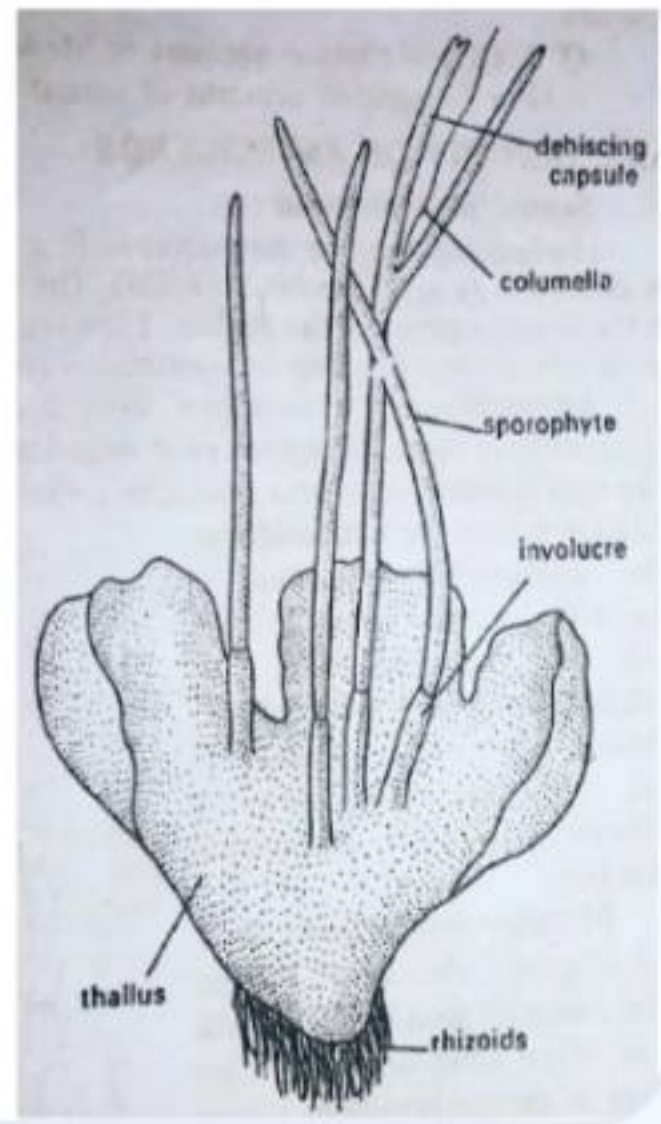
✓After fertilization, zygote (2n) begins to enlarge, secrete a cellulose wall around and begins to develop into embryo

✓Zygote divides first by transverse wall producing two celled embryo

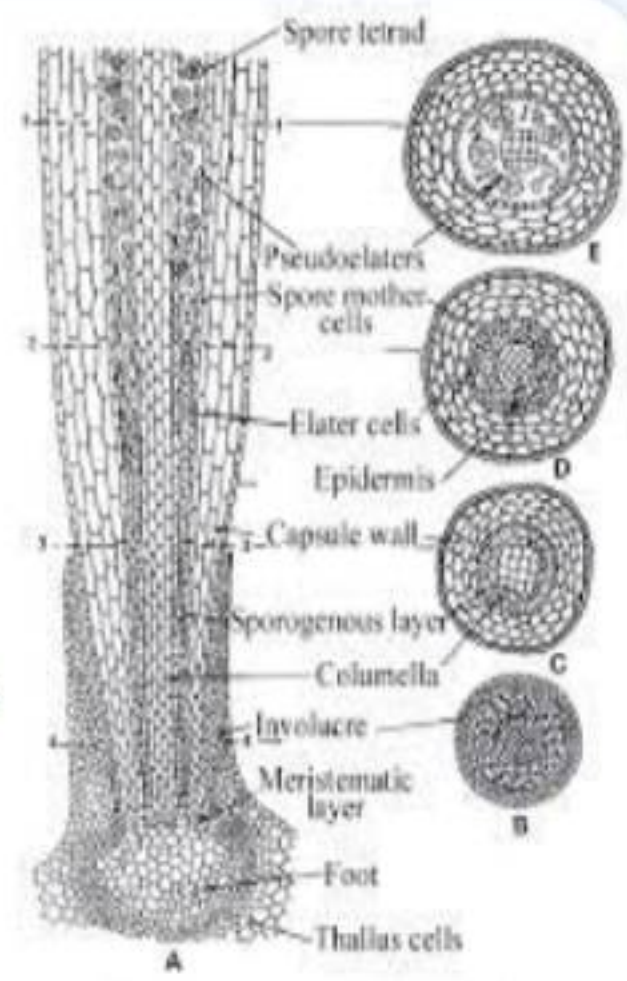
✓Embryo divides and redivides to produce spore producing structure called Sporogonium

External features of sporogonium (Sporophyte):

- *Anthoceros* sporophytes are much elongated structure
- Arise in the form of horny structure at the place of fertilized archegonia
- Usually 2-3 cm long, in some species, they may be 15 cm long
- Because of the horny appearance of sporophyte, the species are called 'hornworts'
- Mature sporogonium differentiated into foot, meristematic zone and elongated, erect capsule
- Place of seta is taken by meristematic zone
- Lower portion of sporophyte is embedded in thallus tissue called involucre
- Capsule is indefinite in growth



Internal structure of sporogonium:



- ✓ *Anthoceros* sporophytes differentiated into three regions: foot, meristematic zone and capsule

❖ Foot:

- ✓ Foot is bulbous and embedded deeply in thallus tissue
- ✓ Consist of compactly arranged cells
- ✓ Absorbs water and nutrition from mother plant

❖ Meristematic zone:

- ✓ Seta is absent, instead presence of middle meristematic zone
- ✓ The cells of this zone divides continuously adding the cells and resulti in continuous increase in length of capsule

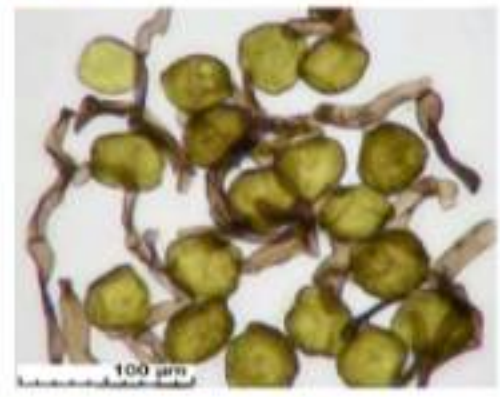
❖ Capsule:

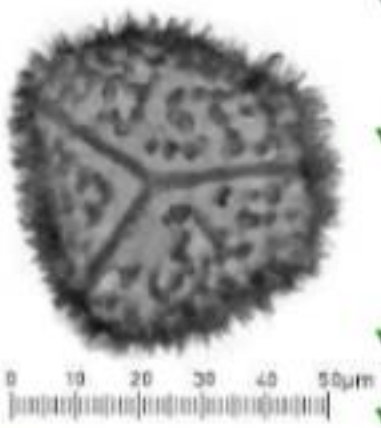
- ✓ Main part of the sporogonium
- ✓ Much elongated, erect and slender
- ✓ Entire capsule is covered by four to six layered wall of parenchymatous cells
- ✓ Outermost layer is epidermis, which is interrupted at several places by stomata
- ✓ The cells of wall layer possesses chloroplast and is photosynthetic in function
- ✓ Centre of the capsule is occupied by sterile tissue called columella
- ✓ It is generally 16 cells in thickness and provides mechanical support to the capsule
- ✓ Also acts as a water conducting tissue
- ✓ Columella remain surrounded by sporogenous tissue

- ✓ Sporogenous tissue is reported to be in different stages of development
- ✓ Just above the meristematic zone, archesporium is young and single layered
- ✓ It is two layered thick above
- ✓ Above region consist of diploid mother cells (2n) and elater mother cells, tetrad of spore (n) and the spore and elaters towards the tip region

❖ **Spores and Elaters:**

- ✓ Sporogenous cavity contains spores and elaters
- ✓ Elaters are elongated and multicellular, called pseudoelaters
- ✓ They may be branched or unbranched with cells joined by oblique septa, hence called pseudoelaters
- ✓ Hygroscopic nature helps in liberation and dispersal of spores
- ✓ Twisting of pseudoelaters exert a pressure on wall of capsule resulting in breaking the wall layer



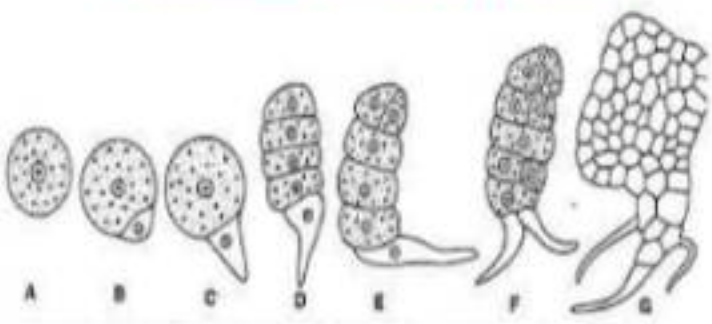


- ✓ Spores are small, somewhat spherical, unicellular, uninucleate and haploid, ranging from 12 µ to 30 µ in diameter
- ✓ Possesses two wall layers: Outer, thick, inelastic, rough, sculptured called exine or exosporium, inner, thin, elastic and smooth called intine or endosporium
- ✓ Colour of the matured spore varies from species to species
- ✓ It may be yellow, brown, dark brown or black

❖ **Dehiscence of capsule and dispersal of spores:**

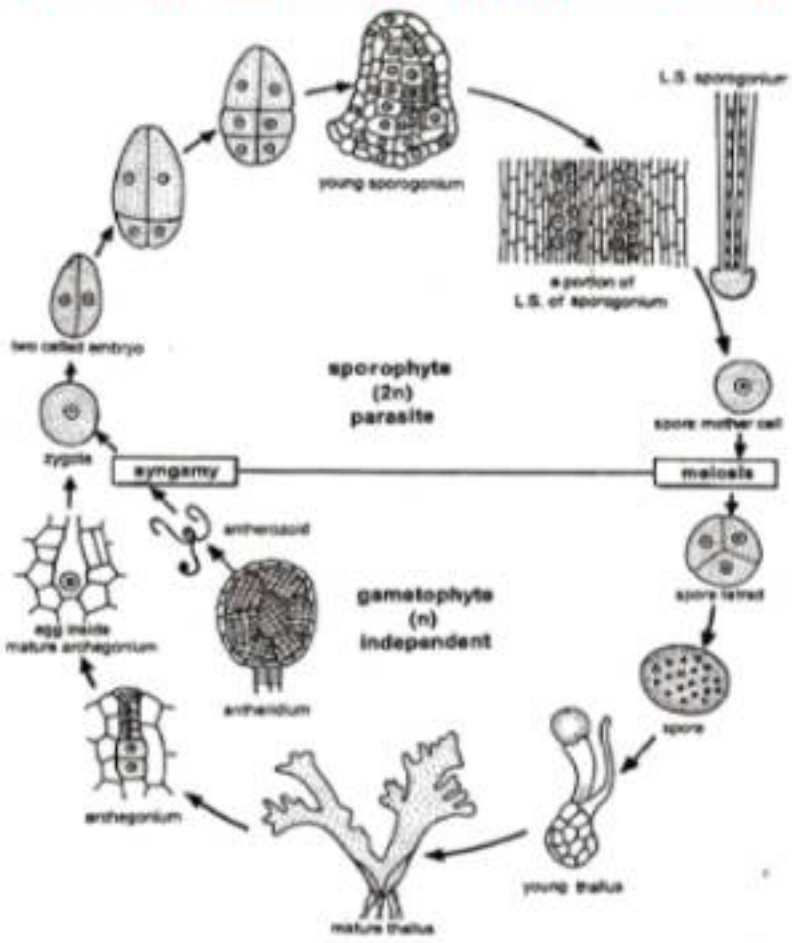
- ✓ On maturation, the tip of sporogonium becomes black or brown in colour
- ✓ Capsule dehiscence depends upon water
- ✓ Dry atmosphere helps in dehiscence of capsule
- ✓ The tip of capsule shrivels up by losing water
- ✓ Dehiscence begins from the tip of capsule by the formation of longitudinal slit
- ✓ The longitudinal slit widen and enlarge and proceed towards base
- ✓ The spores are liberated out and dispersed through the wind
- ✓ Tiny spores are easily carried out by wind current and settled on the substratum

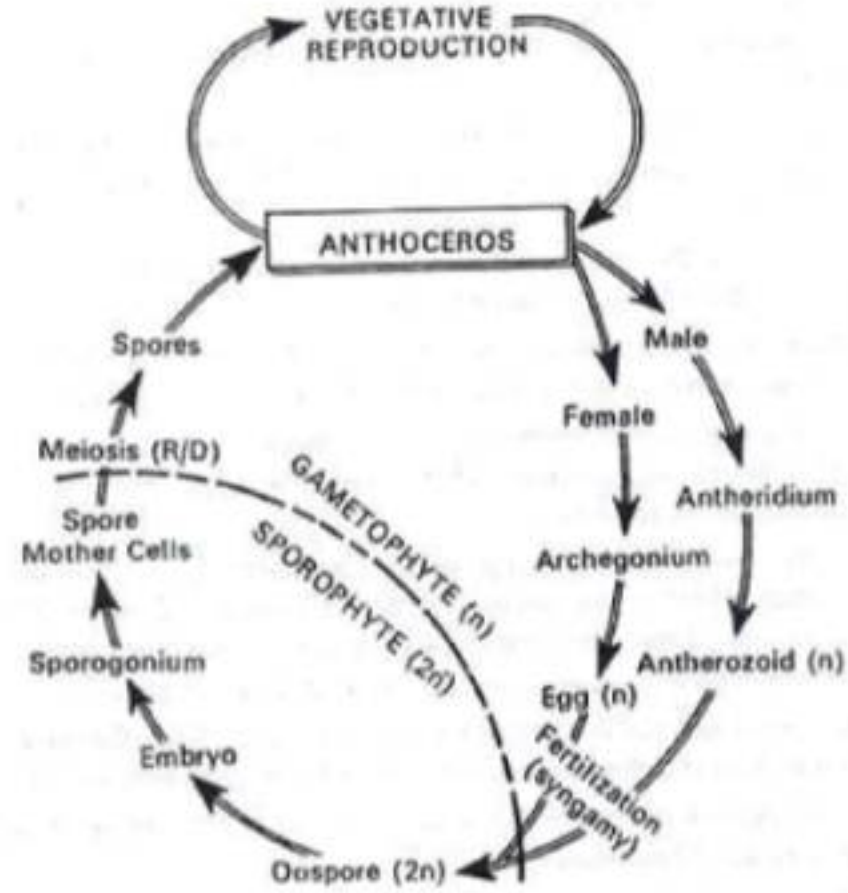
❖ **Germination of spores:**



- ✓ After liberation from the capsule, the spores undergo a period of rest for some period
- ✓ The germination starts during favourable condition
- ✓ Spore enlarge in size by absorption of water
- ✓ Exine of the spore ruptures and intine comes out in the form of germinal tube through germ pore
- ✓ Nucleus divides to produce two celled embryo, that divides to form irregular protonema
- ✓ Rhizoids comes out from lower surface and enter the soil
- ✓ Finally, it develops into young gametophyte of *Anthoceros*

Life cycle and alternation of generation:





- Life cycle is heteromorphic and haplodiploidy type
- Consist of two phases i.e. *gametophytic* and *sporophytic*
- Gametophytic phase is haploid, first, dominant and independent
- Sporophytic phase is diploid, second, conspicuous and dependent on the gametophyte
- Two important events takes place in life cycle i.e. *fertilization* and *meiosis*
- Fertilization results in diplodization (2n)
- Meiosis results in haplodization (n)
- Two phases comes in alternate manner with one another, hence called *alternation of generation*