

Equisetum (Horse Tails | Scouring rushes)

Classification

Division :- pteridophyta

Sub Division :- Sphenopsida

Order :- Equisetales

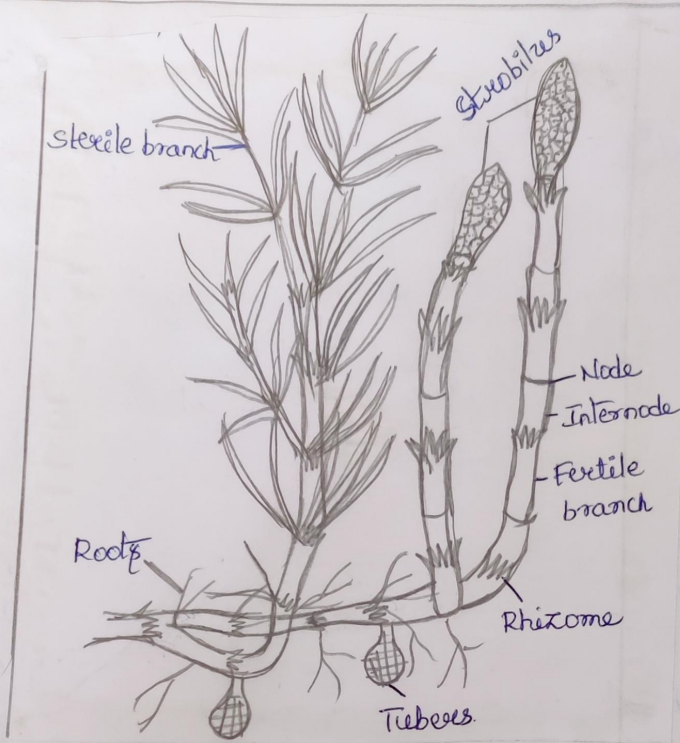
Family :- Equisetaceae

Genus :- Equisetum

This genus comprises of about 25 species, they are world wide in distribution, however, no species have recorded from Australia and New Zealand. They grow in a variety of habitats. Majority of the species are found in north temperate zone. The common Indian species are E. debile, E. arvense and E. ramosissimum. Certain species grow in ponds and marshy places E. palustre some species grow in damp shady place E. pratense. E. debile is found along the banks of the rivers, canals and pools in Indian plains. They are commonly known as Horse Tails.

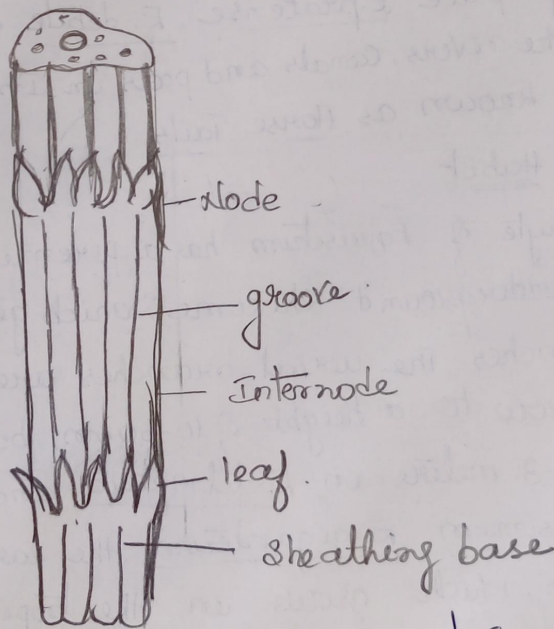
Sporophyte Habit

The sporophyte of Equisetum has a perennials, branched and creeping underground rhizome, which gives annual erect acausal branches. The acausal branches are herbaceous and usually grow to a height of 10-60 cm, but they attain a height of 2-3 meters in E. telmateia and about 4 meters in E. ramosissimum, E. giganteum, the largest species of Equisetum, which grows in the tropics of South America has stem up to 13 meters long, but since the stem is relatively thin (0.5 to 2.0 cm) it is vine like in habit and climbs over adjacent trees. The diameter of the stem varies from few millimeters to 10 cm eg:- E. Schaffneri



External morphology.

The sporophyte of *L. clavatum* is differentiated into stem, root and leaves.



Stem :- The main stem is underground creeping and perennial rhizome, it often lies more than a meter below the surface of the soil. It is differentiated into nodes and internodes. There is a whorl of small scaly leaves at each node. The leaves of a whorl are joined at their bases, forming a sheath around the node.

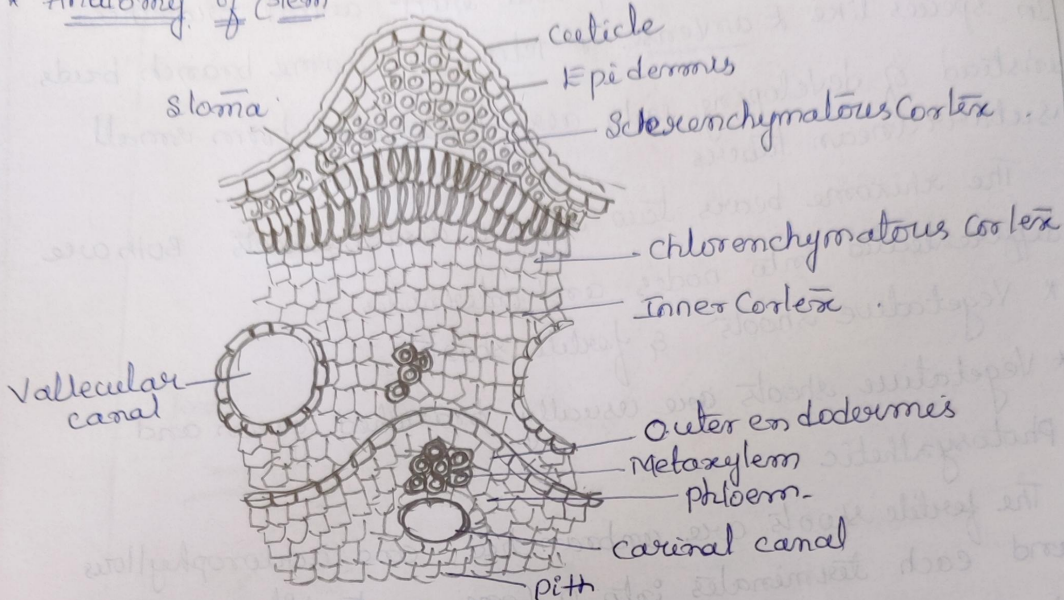
branch bud is formed alternate to each scale leaf at the node and these buds develop into erect aerial branches. In species like *E. arvense*, *E. telmateia* some branch buds, instead of developing into aerial branches form small subterranean tubers.

The rhizome bears two types of aerial shoots. Both are differentiated into nodes and internodes.

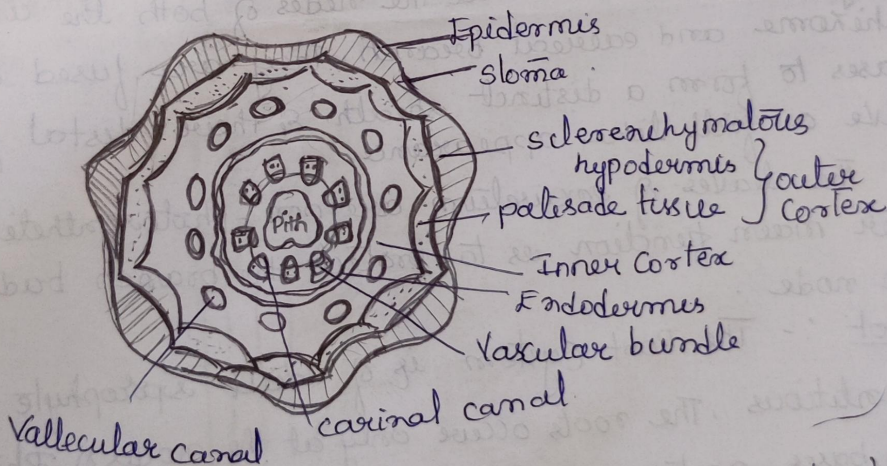
- * Vegetative shoots & fertile shoots.
- * Vegetative shoots are usually branched, green and photosynthetic.
- * The fertile shoots are unbranched and achlorophyllous and each terminates into a cone or strobilus.
- * Leaves :- The leaves are minute, scaly and isophyllous. They arise in whorls at the nodes of both the underground rhizome and aerial branch. They are fused at their bases to form a distinct sheath & their distal free ends give a foil like appearance.
- * The leaves of *exiselum* are non-photosynthetic and their main function is to protect the branch buds at the node.
- * Root :- The Root system of adult sporophyte is adventitious. The roots occur only at the nodes of Rhizomes / stem bases. roots are slender & fibrous and though they live for several years,

Internal structure

* Anatomy of stem



T.S of stem



The stem has distinct nodes and internodes with longitudinal ridge & furrows. The internal structure is as follows.

* Epidermis:- This is a single outer layer of cells with a deposit of silica in their outer and lateral walls. Its outline is wavy and its furrow has stomata in two rows.

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Sclerenchyma:- The sclerenchyma specially the ridges develops below the epidermis, interrupted in the furrows by the underlying cortex

Cortex:- This is many layered and large air canals (Vallecular canals) each corresponding to a groove are formed in its middle. The outer layer of the cortex contain chloroplast. The leaves being scaly, carbon assimilation is performed by the cortex (chlorenchyma) of the stem.

Endodermis:- This is the innermost layer of cortex, often with a distinct casparian strip in it

Pericycle:- This lies internal to endodermis as a single layer

Vascular bundles:- These are closed collateral and arranged in a ring, each opposite to a ridge, each bundle is made of xylem & phloem with some parenchyma. There is a water containing cavity in it called carinal cavity,

The xylem occurs in separate strands, the protoxylem lying in isolated strands against the carinal cavity and metaxylem strands & consists of sieve tubes and phloem parenchyma.

Pith:- This lies on the inner side of the bundles but a major portion of it forms a large central cavity

Stele:- The nature of the stele as to whether it is Siphonostelic | protostelic.

Rhizome

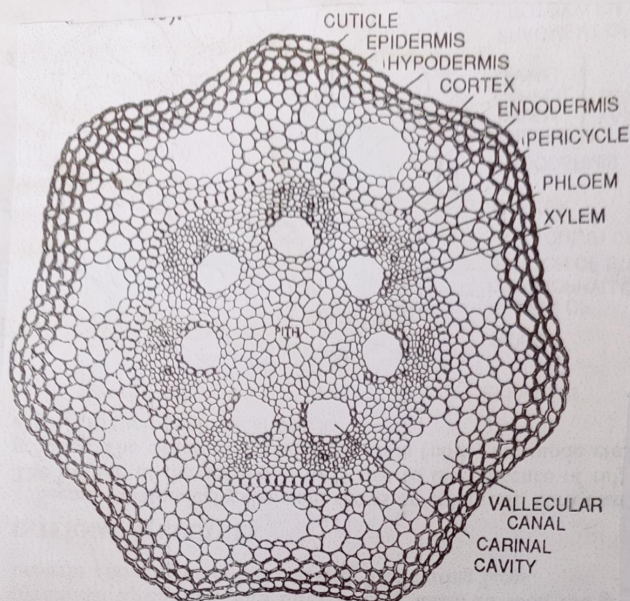


Fig 1.51 Equisetum
T.S. of Rhizome

- * The outline is wavy, with ridges and grooves.
- * The outermost is a thickly cuticularised epidermis. stomata are absent.
- * The cortex consists of large zone of parenchyma spread upto the ring of vascular bundles.
- * Large vallicular canals are present in the parenchymatous cortex below the grooves.
- * The bundle is conjoint, collateral and endarch.
- * The bundle has a large protoxylem lacuna, carinal canal.
- * The centre has a large cavity, called pith cavity.

Root :- A transverse section of the root shows an outermost single layered epidermis, middle cortex & central stele. Here and there root hairs arise from the epidermis. The cortex has two zones. The outer zone is sclerenchymatous while the inner zone consists of thin walled parenchyma with air space. Internal to the cortex is the endodermis.

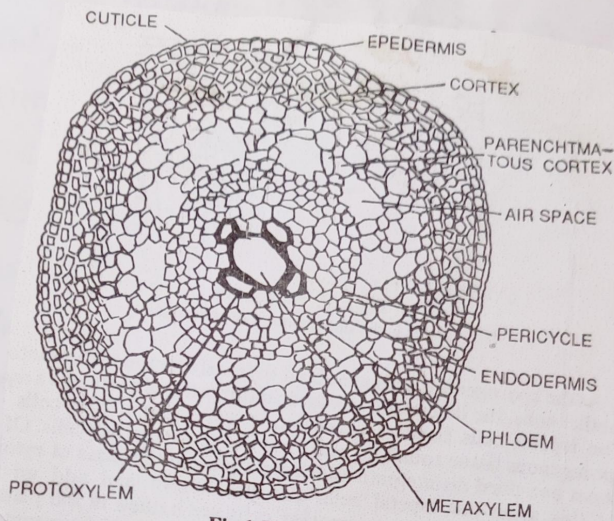


Fig 1.52 Equisetum
T.S. of root

The endodermis is apparently three layered thick because the so called inner layer of endodermis lacks the Casparyan thickenings. In the absence of the thickening it seems best to regard the inner layer as the pericycle, because the initials of the lateral root also originate from this layer. The stele is a protosteles with di- to tetraarch xylem. In smaller roots in the centre there is a large metaxylem element in larger roots there will be more than one metaxylem element.

Reproduction

Sporophyte reproduces vegetatively as well as by spore production. Vegetative propagation take place tubers which are produced on the rhizome. The tubers represent short rounded branches consisting of a single internode. At maturity a tuber detaches itself from the rhizome and develops into a new individuals.

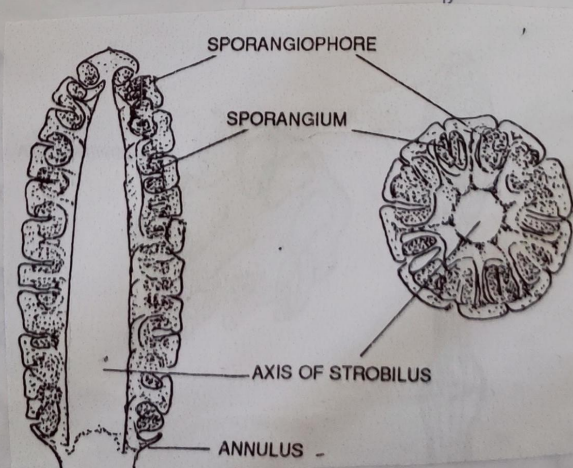


Cone & Sporangiphore

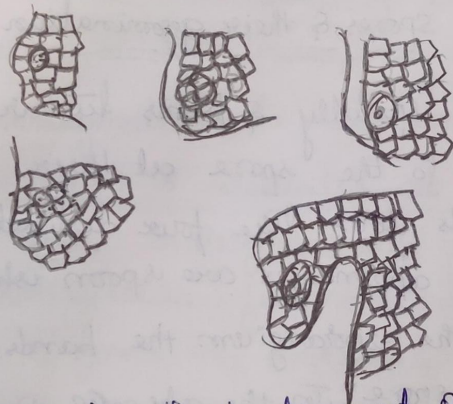
Spore producing Organs:- At the apices of the aerial shoots are produced the cones / strobili. Each cone has a stout central axis bearing whorls of peltate appendages called the sporangiphores. In each whorl there are 10-20 sporangiphores. Below the lowermost whorl of sporangiphores, there is a ring like out growth called the annulus.

Development & Structure of the Sporangium

The sporangiphores arise first on the cone axis in the form of hemispherical swelling. A constriction appears in the emerging sporangiphore delimiting the basal stalk and the terminal peltate appendage. The sporangial initials first arise on the dorsal surface of the peltate disc. But centrifugal growth taking place in the centre of the disc & subsequently towards the ventral surface, where they lie ultimately.



A single superficial cell is differentiated as the sporangial initial, but the surrounding cell also take part in the further growth of the sporangium hence the development is of the eusporangiate type. The outer daughter cell divides periclinally as well as anticlinally to form several layers of cells, of these, some of the inner layers contribute to a part of the sporogenous tissue while the remaining from the jacket of the sporangium. Meanwhile the inner cell divides in all the the planes to produce a mass of sporogenous tissue.

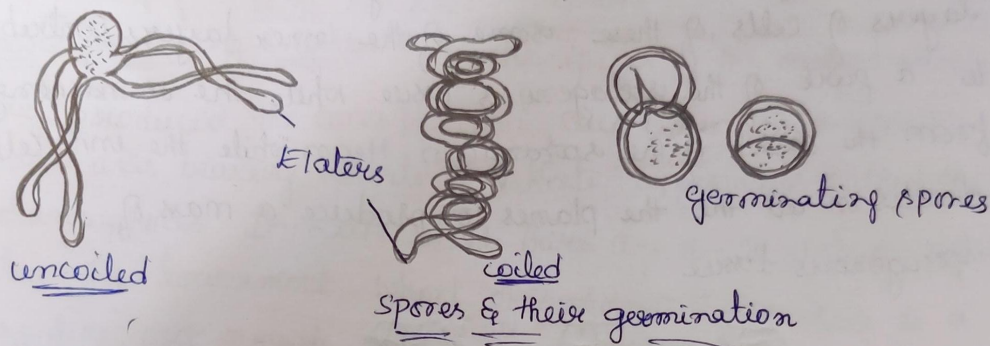


Stages in the development of sporangium

As the sporogenous cells are about to transform themselves into spore mother cells, the innermost wall layer differentiates itself into a tapetum. The tapetal cells become glandular in appearance. The cells of the sporogenous tissue round off and form the spore mother cells of these about one third disintegrate and form a plasmodial mass of cytoplasm. At this stage the tapetal cells also breakdown and add up to the plasmodial mass. The spore mother cells are bathed in the plasmodial mass from which they derive the nutrition. The nuclei present in the plasmodium increase their number by amitotic divisions. The spore mother cells undergo reduction division and produce tetrads of haploid spores. The developing spores absorb the plasmodium.

Gametophyte :- structure and germination of the spores

The spores are minute in size and are spherical in shape. The spore wall is four layered. The outermost is the epispore. Internal to this is a cuticular middle layer. the middle layer internally is the exine. The innermost wall layer is the cellulosic intine.



The epispore splits spirally & forms two ribbon like bands which are attached to the spore at their central points. Due to this the bands look like four distinct appendages. The free ends of these appendages are spoon shaped, when the spores are in the sporangium the bands remain spirally coiled around the spore. In the absence of moisture they open out. This can be easily seen by placing a few spores in a drop of water on a slide, when observed under a microscope the spiral bands gracefully uncoil as the water dries up. The spiral bands are given the elaters as they are believed to help in spore dispersal.

The spores of *Chara* are chlorophyllous.

The spore germination takes place immediately on liberation from the sporangium. The first division results in the formation of a small lenticular cell and a larger cell. The small cell elongates and forms the first rhizoid. The remainder of the gametophyte is derived from the larger cell. The development of gametophyte apparently do not follow any pattern.

first few divisions in the larger cell may be transverse, resulting in a filamentous gametophyte & oblique producing a cushion like prothallus.

Structure of the mature gametophyte :- The gametophyte has two regions, the basal compact cushion like region & an upper photosynthetic region made up of a number of chlorophyllous lobes.



Some of the prothalli when growing under crowded conditions may not show these well marked regions. The gametophytes are wholly parenchymatous. The nutrition is autotrophic. The meristematic tissue is situated at the basal cushion in the form of a rim. Archegonia are formed first in between the photosynthetic filaments, later the meristematic edge turns up & forms the antheridia. With the formation of the antheridia the growth comes to a stop.

Reproduction :- Development & Structure of the antheridia

Generally the antheridia are formed later than the archegonia. The meristematic rim of the basal cushion turns up & it is in this upturned part that the antheridial initials differentiate. The same of the dwarfed and starved prothalli soon after the formation of antheridia they die.

The antheridia are of two type embedded type and the projecting type. While the former develops on the basal cushion, the latter develops on the margin of the photosynthetic lobes.

The development is essentially similar in both the types of antheridia except for the first one / two divisions

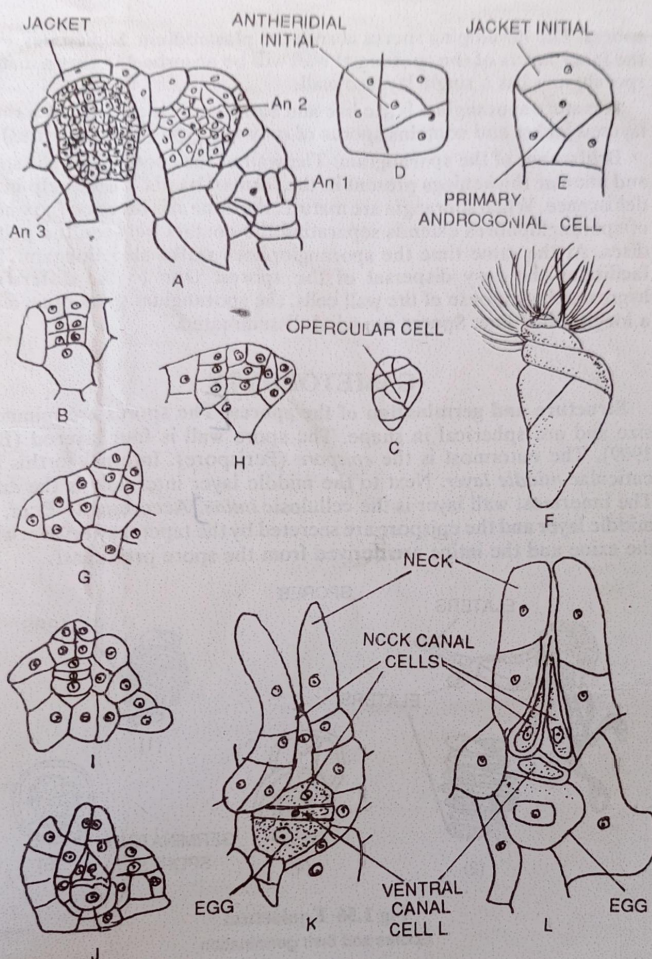


Fig 1.58 Equisetum

Development of sex organs

A-E Development of embedded and projecting types of antheridia, F An antherozoid enlarged, I-L stages in the development of archegonium

While a superficial cell directly functions as the antheridial initial in the embedded type, a superficial cell on the photosynthetic lobe after cutting off of these peripheral cells functions as the antheridial initial in the projecting type. Further development is similar in both the types of antheridia. The antheridial initial divides periclinally and produces two superposed cells. Of these, the outer by undergoing several anticlinal divisions builds up the single layered Jacket of the antheridium.

The inner cell divides in all the planes to form a mass of androgonial cells. A mature antherozoid is specially coiled & multiflagellate.

The embedded type of antheridium is sunk in the gametophytic tissue while the projecting type as the name indicates, protrudes a little above the surface of the gametophyte. About 256 antherozoids are formed in each antheridium. A mature antheridium dehisces by the splitting open of one of its jacket cells.

Development & structure of the Archegonium

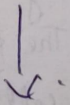
Archegonia normally appear in the meristematic region in between the photosynthetic lobes. Any superficial cell near the meristem can function as the archegonial initial. As usual the first division is periclinal and an upper primary cover cell and a lower primary central cell are formed. The former divides by quadrant walls to form a neck of 2-4 cells in height. The primary central cell divides transversely to form an upper neck canal initial and a lower central cell. Usually the neck canal initial divides to form two boot shaped neck canal cells. The central cell divides to form an egg and a venter canal cell.

In a mature archegonium the neck projects out a little while the venter region is sunk in the prothallial tissue. Fertilization :- This is brought about by the antherozoids swimming down the canal of the archegonial neck, several enter the archegonial neck but only one fuses with the egg forming a diploid zygote. many archegonia are fertilized on the same prothallus resulting in the development of several sporophytes on a prothallus.

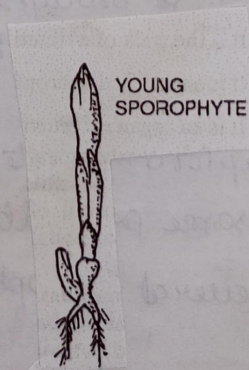
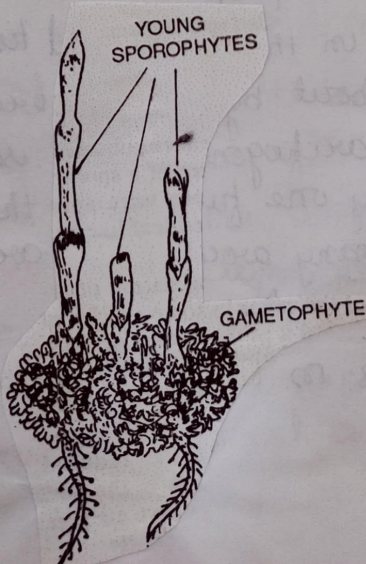
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Embryogeny :- The first division of the zygote is usually at right angles to the long axis of the archegonial neck resulting in the formation of an epibasal cell and a hypobasal cell. No suspensor is formed. Both the epibasal and hypobasal halves contribute to the embryo. The walls of the next division are laid perpendicular to the plane of the first division resulting in the formation of a Quadrant. But the four quadrants do not give rise respectively to stem, root, foot & cotyledons. As soon as the root established itself on the soil the stem tip pierces through. The archegonial neck region & grows up, differentiation of nodes & internodes in the stem.

Diagram



The growth of the first shoot is limited. it ceases to grow after it has become 10-15 internodes long. A secondary shoot develops by a bud at the base of the primary shoot.



Life cycle of Equisetum

Graphic

