# Taxonomic position

- Division : Lycophyta
- Class: ligulopsida
- Order: Selaginellalies
- Family: Selaginellaceae
- Genus: Selaginella

Selaginella

# Distribution and habitat

- It is commonly called as club moss and spike moss.
- It has world wide distribution
- Abundant in tropics and grows in ground and shady places
- Most common species is
- *Selaginella kraussiana*

Mostly the species prefer moist and shady places to grow but a few species are also found growing in xerophytic conditions i.e., on dry sandy soil or rocks e.g., S. lepidophylla, S. rupestris etc. A very few species are epiphytes e.g., S. oregena. It is found growing on tree trunks.

# Vegetative morphology

- The plant body is sporophyte and it is differentiated in to

1. Root
2. Stem
3. Leaves
4. Ligules
5. rhizophores

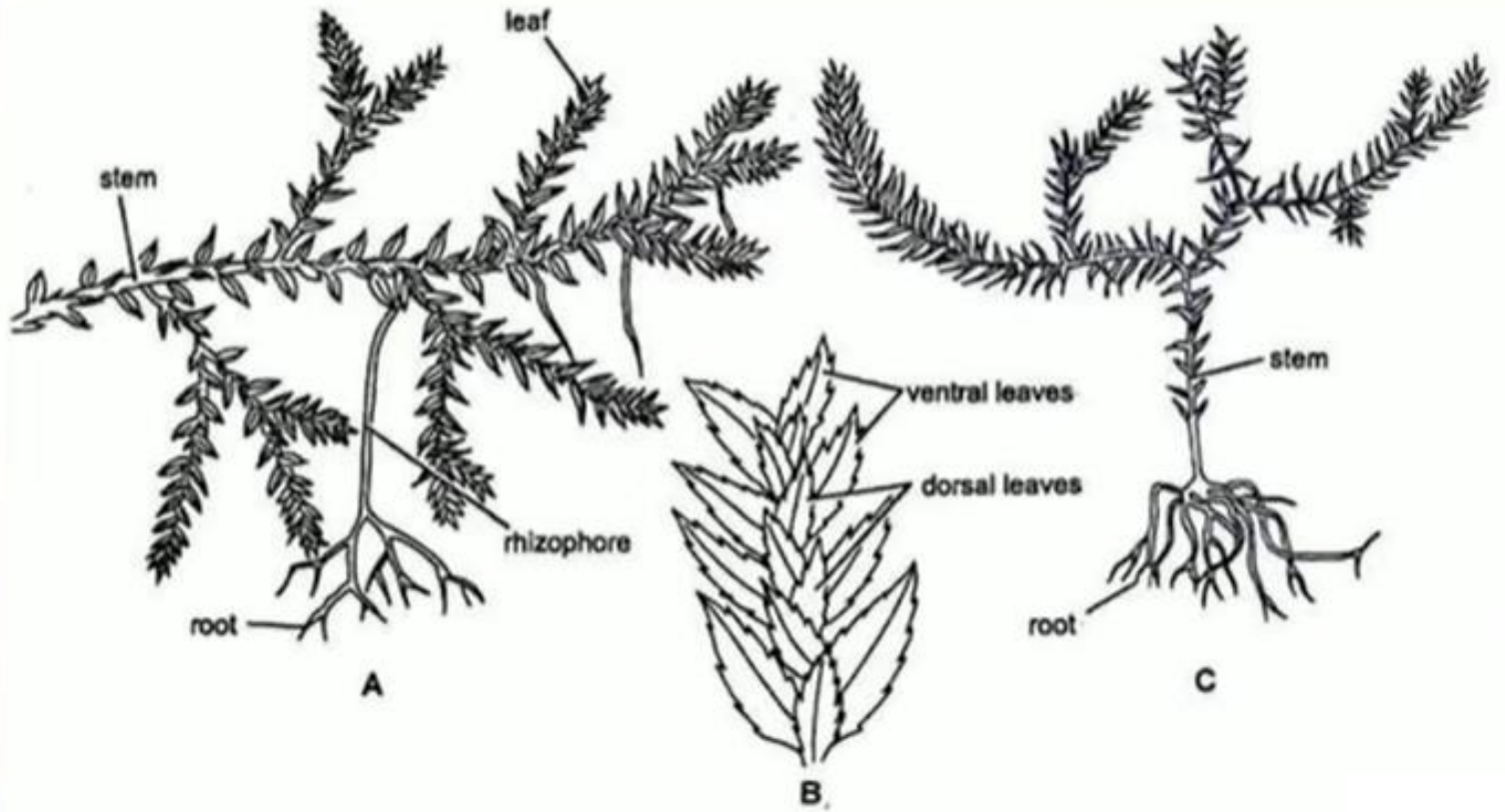



Fig. 1 (A–C). *Selaginella*. External features : A. *S. kraussiana*, B. Leaf arrangement in a branch of *S. kraussiana*, C. *S. spinulosa*

# Root

- The root of young sporophyte is of primary root while others are adventitious
- The adventitious roots are at the tips of rhizophores
- Aerial roots have developed caps, and cutinized epidermal cells And enter soil.

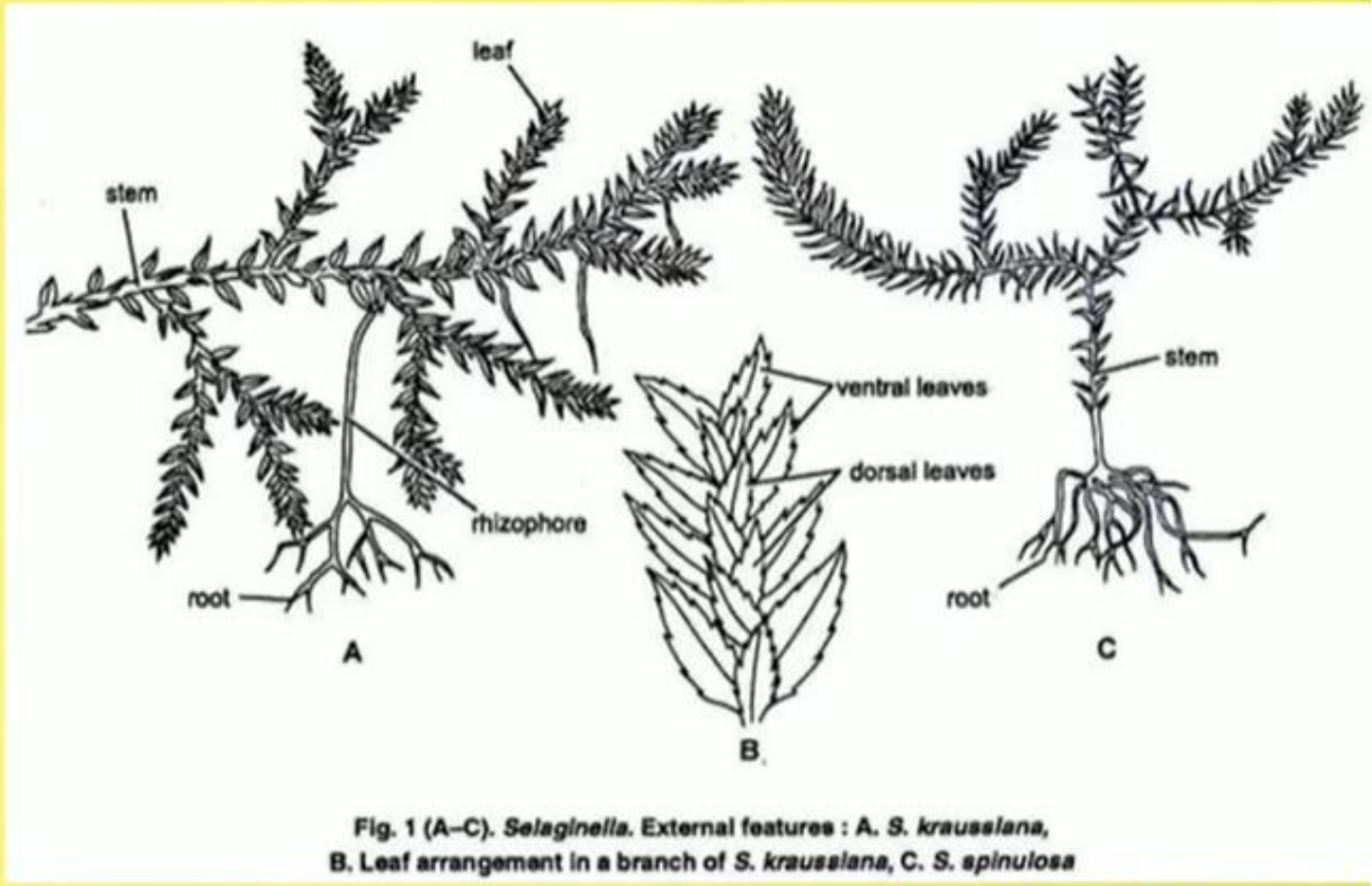



Fig. 1 (A–C). *Selaginella*. External features : A. *S. kraussiana*, B. Leaf arrangement in a branch of *S. kraussiana*, C. *S. spinulosa*

# Stem

- Stem is green, dorsiventral and prostrate with short erect branches
- The branches are arranged dichotomously
- They are also pseudomonopodia ( false ,growth from one point)
- The shoot apex consists of a single apical cell in most cases

# Rhizophore

- In some species , leafless and colorless branches arise from the prostrate stem near point of branching.
- These grow downwards and have group of adventitious roots
- They are called as rhizophores
- Some scientist consider them branches and some consider them as roots and still other consider it as an organ for protection or other function.
- But recently they are known as adventitious roots that have dichotomous branches at tip.

# Leaves

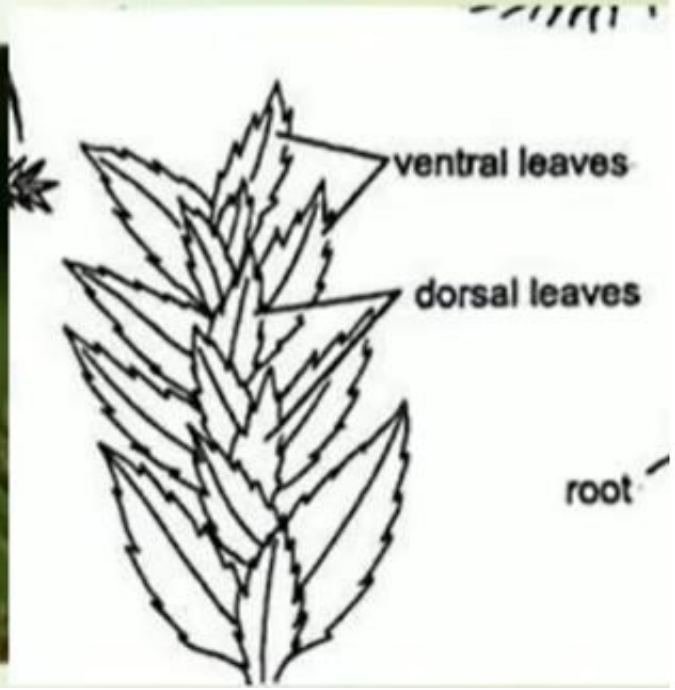
- Microphylls are present. ( leaves are small and single veined. They are of 2 types

1. Isophyllous
2. Anisophyllous.

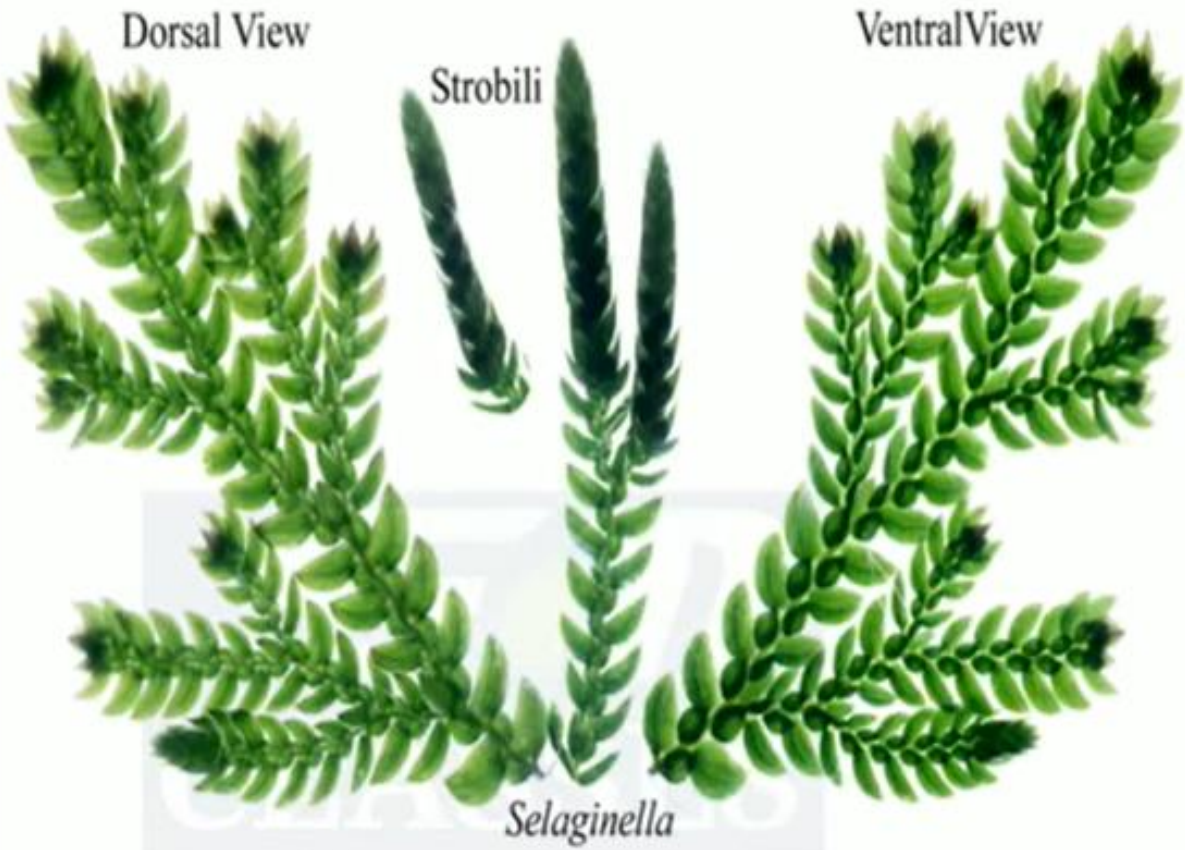
The anisophyllous leaves are in pairs. They may be

- Small: these are inserted on the dorsal side of stem
- Larger: these leaves are inserted on the ventral side of stem

Fig. 209. Selaginella. Part of a plant showing external features.



Usually the leaves near the apical portion of the branch, bear sporangia (micro-or mega) and are called as sporophylls (micro-or mega) respectively. The sporophylls are usually aggregated into a condense structure which is known as strobilus.



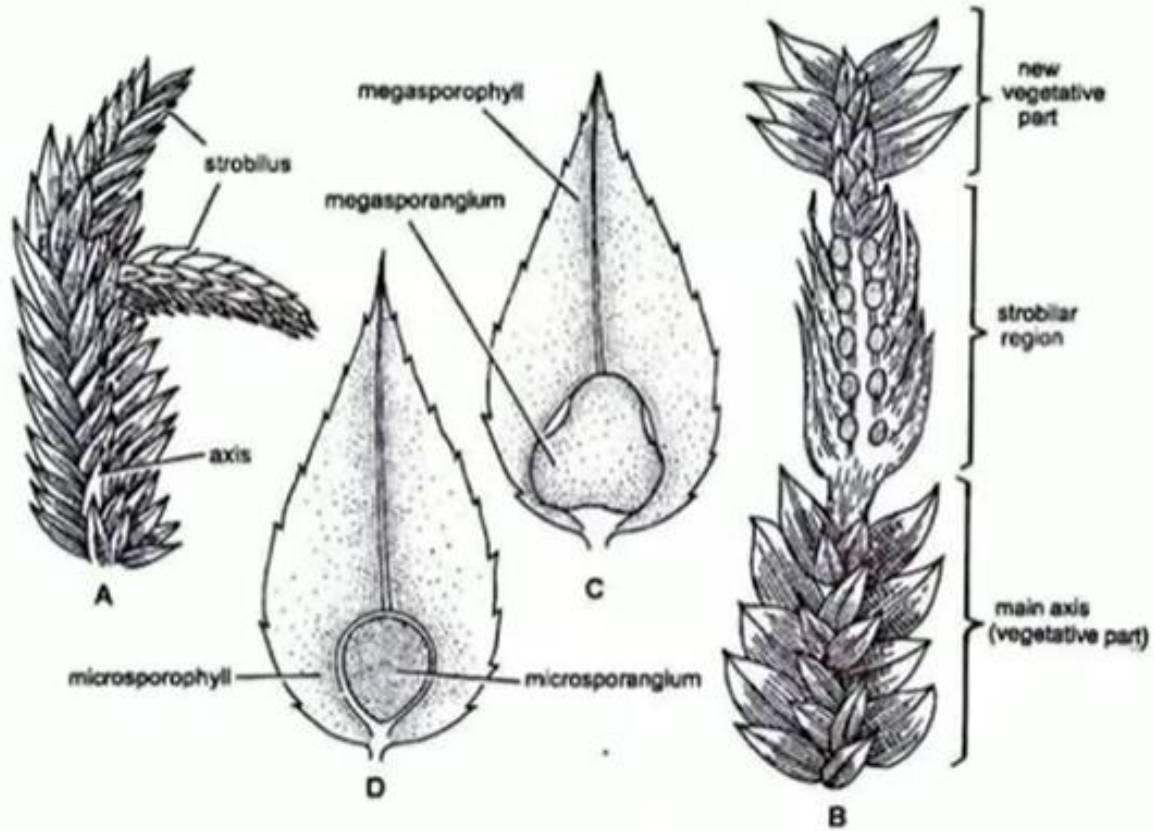




**Fig. 8 (A–D). *Selaginella* : Structure of strobilus. A. A branch bearing strobilus, B. A branch after formation of strobilus region again changing into vegetative region, C. A megasporophyll, D. A microsporopyll**

# Ligules

- Ligule: there is small outgrowth on adaxial side ( upper side) of the leaf near base. It is vestigial organ and provide water .
- the apex. The structure of the ligule can be differentiated into two parts, glossopodium and the body of the ligule (Fig. 2 A, B).


**Fig. 210. Selaginella. Adaxial surface of a leaf showing ligule.**

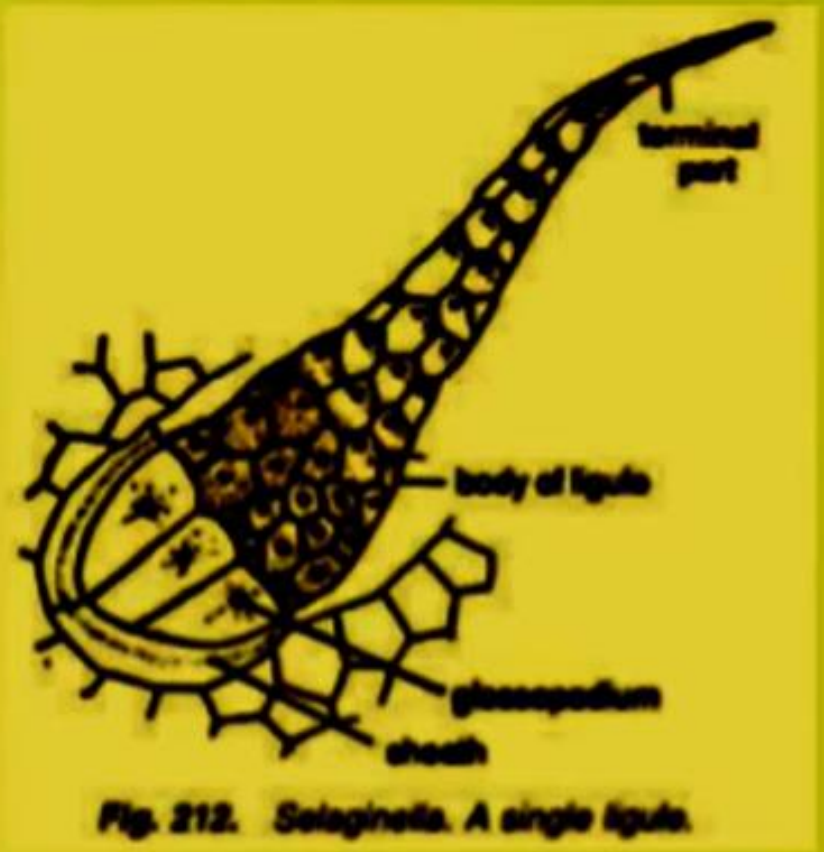


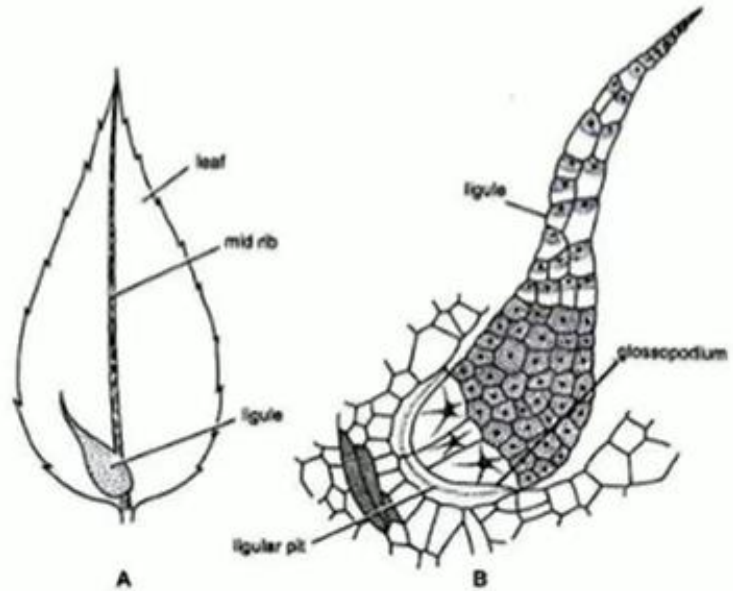

**Fig. 212. Selaginella. A single ligule.**

## Glossopodium:

It is the basal hemispherical part made up of large thin walled cells. It is surrounded by a glossopodial sheath.

### Body of the ligule:

Above the glossopodium is the body of ligule. It is made up of many large and small cells. The function of the ligule is not well known. It may be a water secreting or water absorbing or protective organ. According to Earner (1936) the ligule is perhaps a vestigial organ.



# Anatomy

- Stem anatomy
- Steler system
- Leaf anatomy
- Root anatomy

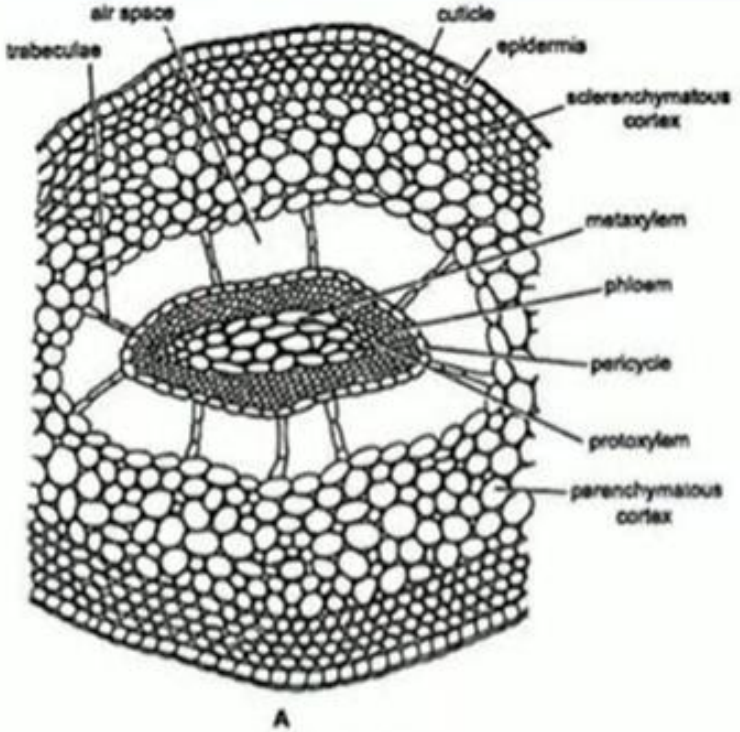



Fig. 3 (A–B). *Selaginella*. T. S. Stem. (A) T. S. monostelic stem, (B) T. S. distelic stem (a part cellular).

# Stem anatomy

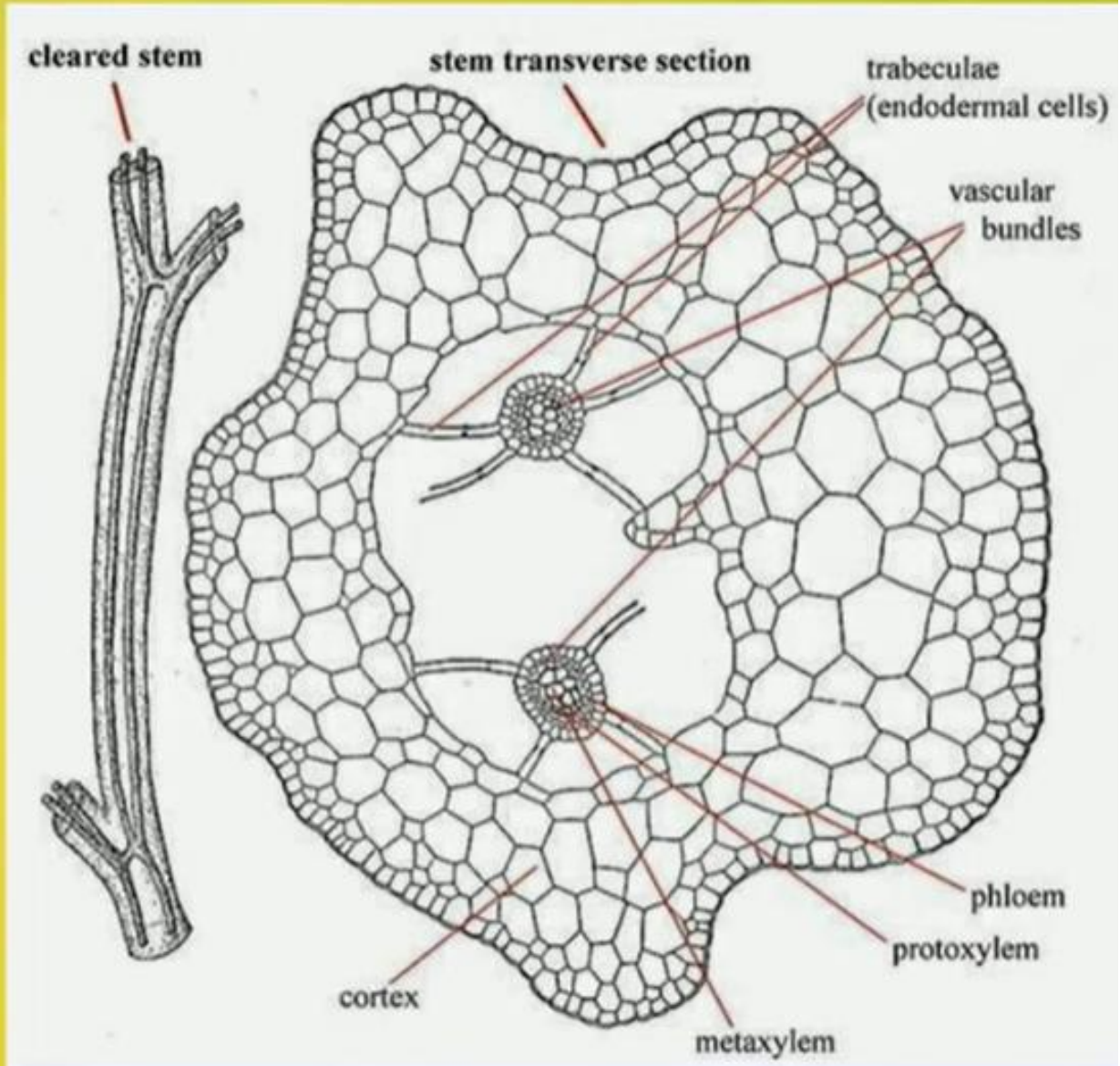
- **Epidermis** : thick epidermis , thin walled, rectangular cells, covered with cuticle
- **cortex** : many layered , outer 2-4 are thick walled called as hypodermis

Below is thin walled parenchyma having chloroplast, have small intercellular spaces.

Central portion is separated from cortex by a cavity having air spaces

- **endodermis** :the cortex and central tissue is connected by radially elongated cells called trabeculae

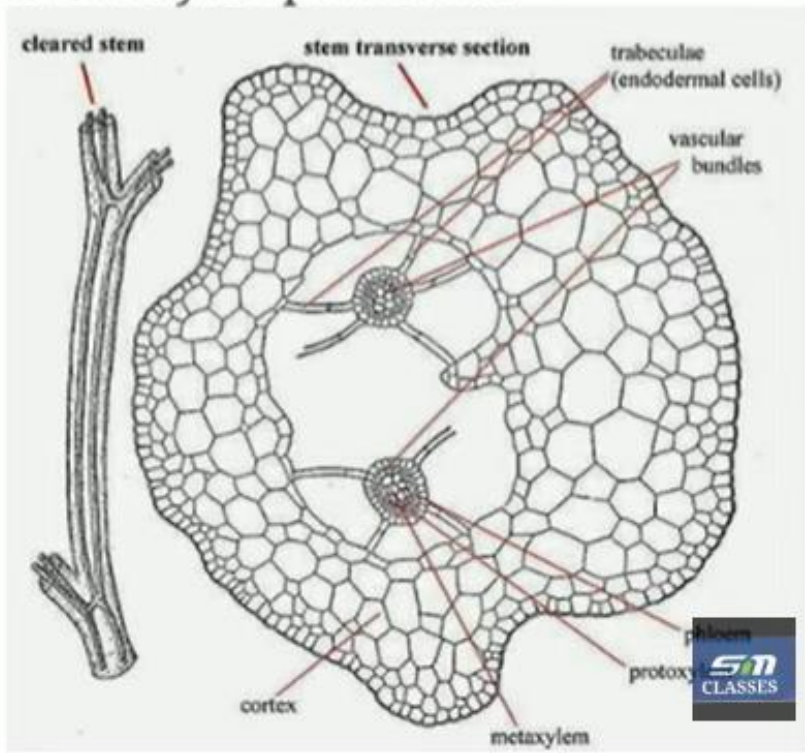
They contain casparian strips, trabuculae are modified endodermal cells.



## (iii) Stele:

The central portion of the stem is occupied by a well-developed stele. The stele is of protostelic type i.e., xylem is present in the centre and surrounded by phloem on all sides. Phloem, in turn, is surrounded by a single layered pericycle. Pith is absent.

The number of stele is variable in different species of Selaginella. It is 1 (monostelic e.g., S. spinulosa), 2 (distelic e.g., S. kraussiana) or 12-16 (polystelic e.g., S. laevigata). The organization of the stele is also variable in different species. It may be protostele (e.g., S. spinulosa) to siphonostele (e.g., S. laevigata, var. lyalli).



# Rhizophore

- Outermost layer is epidermis
- It is of thick walled and single layer cells
- Beneath the epidermis there is cortex

1. Hypodermis ( thick walled)
2. Thin walled parenchymatous region
3. Inner most layer is endodermis

- Thin walled pericycle is present around the vascu tissue
- Stele is protostele ( xylem is in center and phloer surrounds the xylem)

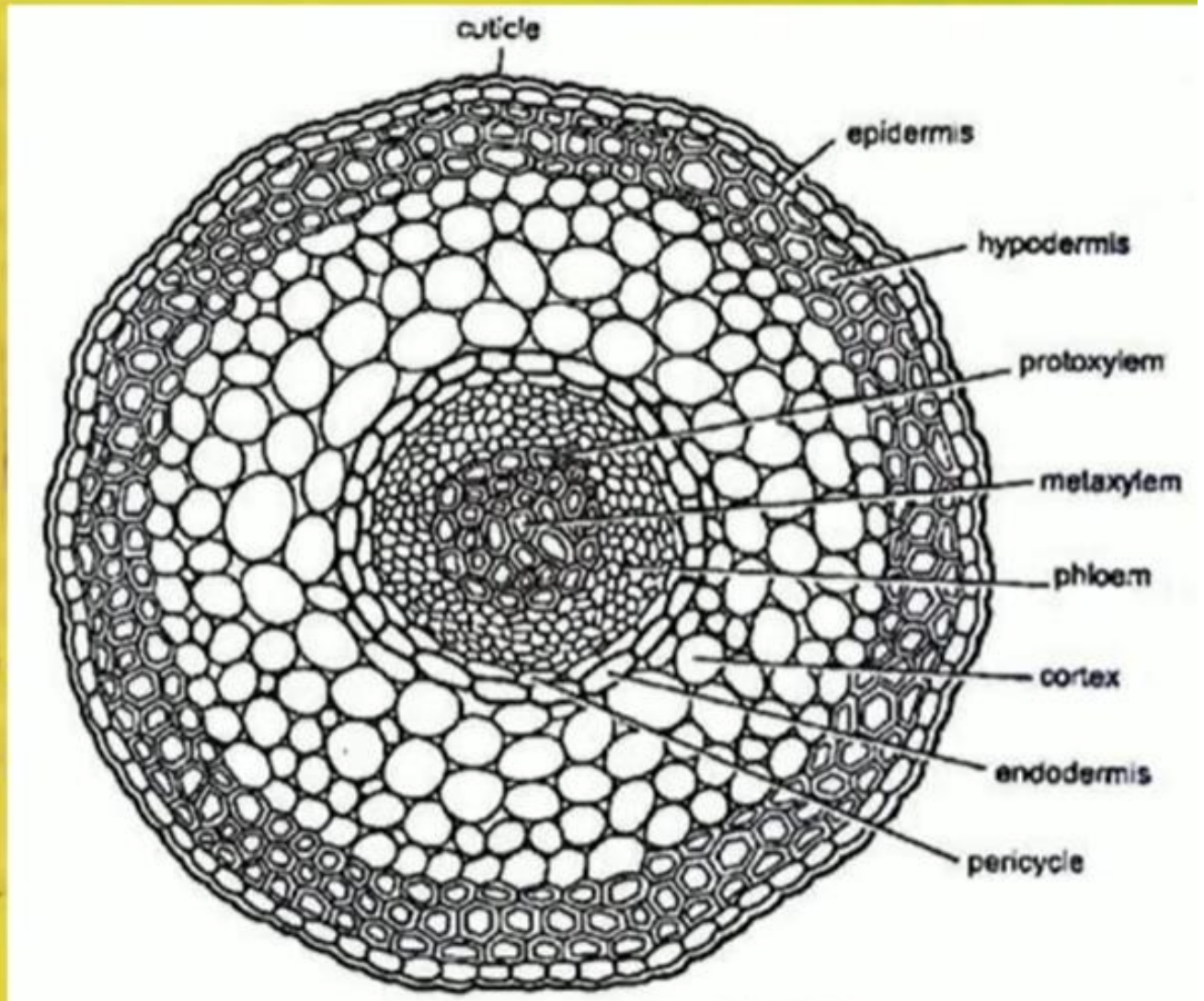



Fig. 5. *Selaginella* . T. S. rhizophore

# Root anatomy

- Outermost layer is epidermis ( single layer ), covered by thin cuticle
- Root hairs are present and arise from epidermis
- Beneath the epidermis, wide zone of cortex is present

1. Outer hypodermis ( have sclerenchyma cells)
2. Endodermis ( inconspicuous )

- Single layered pericycle is present
- Protostele is next
- Xylem is surrounded by phloem

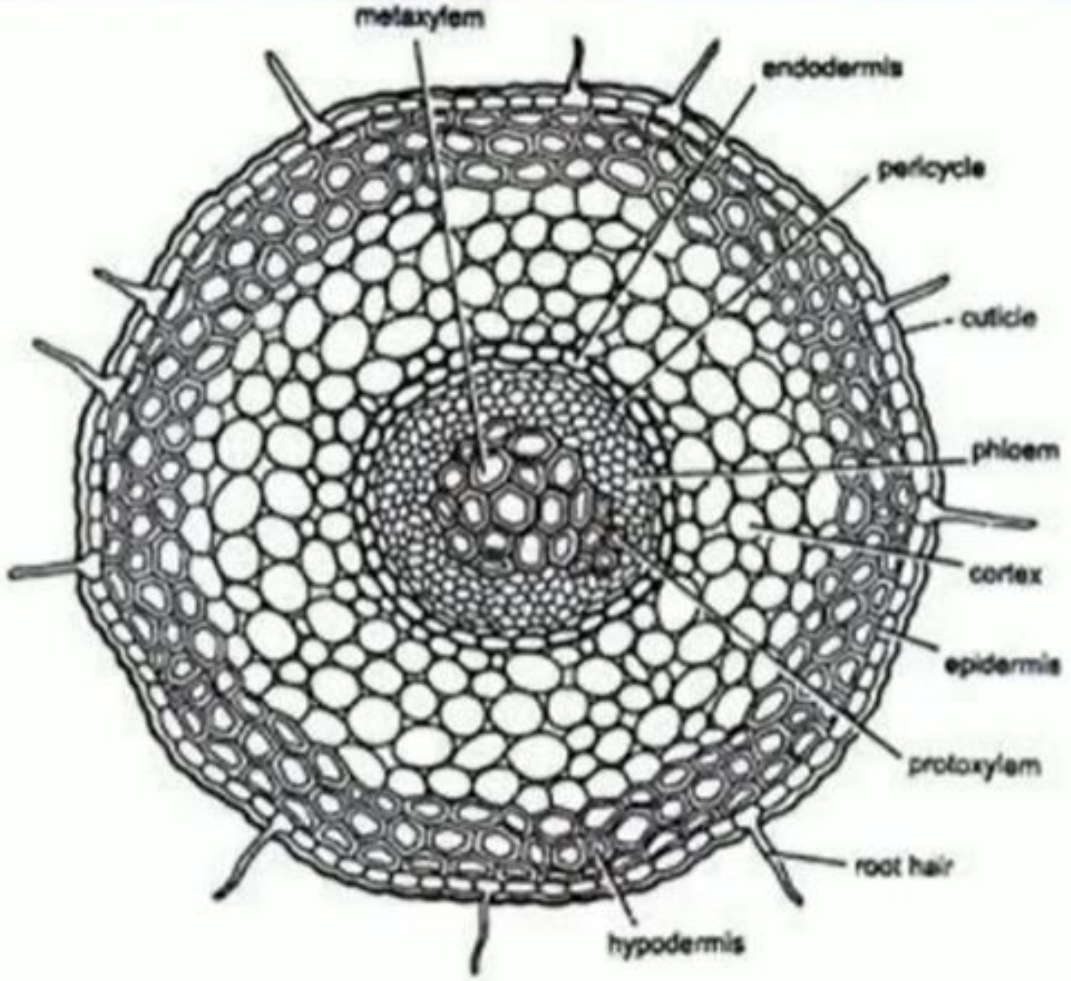



Fig. 4. *Selaginella*. T. S. of root

# Reproduction

- Life cycle in Selaginella is characterized by alternation of generation
- Both spore producing and gamete producing generations are independent .
- Some species reproduce by vegetative reproduction

**1. Vegetative reproduction:**

**It takes place by following methods:**

**(i) Fragmentation:**

Under humid conditions in S. rupestris, trailing branches of the stem develop adventitious branches. These branches later disjoin from the parent plant and develop into separate individual plants.

**(ii) Tubers:**

These appear towards the end of the growing season. The tubers may be aerial, developing at the apical end of aerial branches (e.g., S. chrysocaulos) or subterranean (e.g., S. chrysorrhizos). Under favourable conditions tubers germinate into a new plant (Fig. 7A).

**(iii) Resting buds:**

These are the compact structures which develop at the apical end of some aerial branches. The leaves in this region are closely arranged and overlap the growing points. These resting buds are capable to pass on the unfavourable conditions. Under favourable conditions these buds give off rhizophore that bear roots at their tips (Fig. 7B).

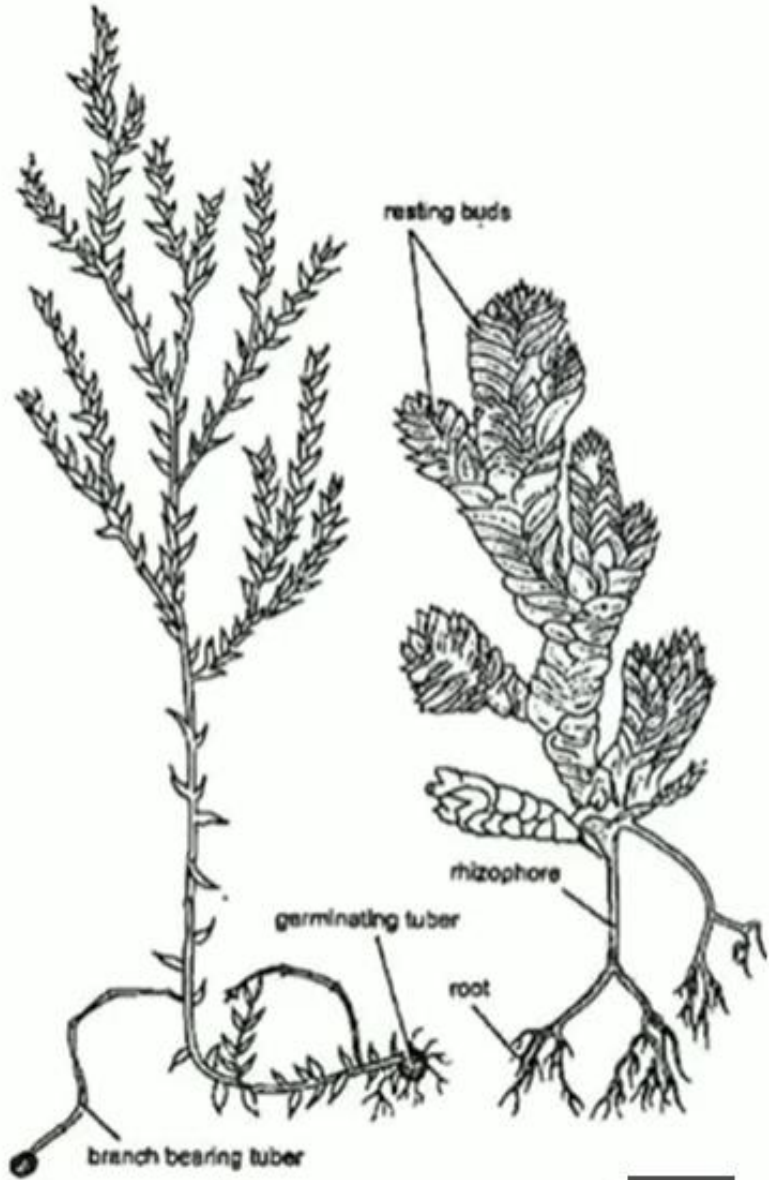



Fig. 7 (A–B). *Selaginella*. Vegetative reproduction
A. Tubers, B. Resting buds

## 2. Sexual Reproduction:

### Spore producing organs:

Selaginella is a sporophytic plant (2x) and reproduces sexually. The plants are heterosporous i.e., produce two different types of spores—megaspores and microspores. These spores are produced in megasporangia and microsporangia, respectively which, in turn, are produced on fertile leaves known as megasporophylls and microsporophylls respectively. Usually both these structures are grouped together to form a compact structure known as strobilus which is usually a terminal structure (Fig. 8 A).

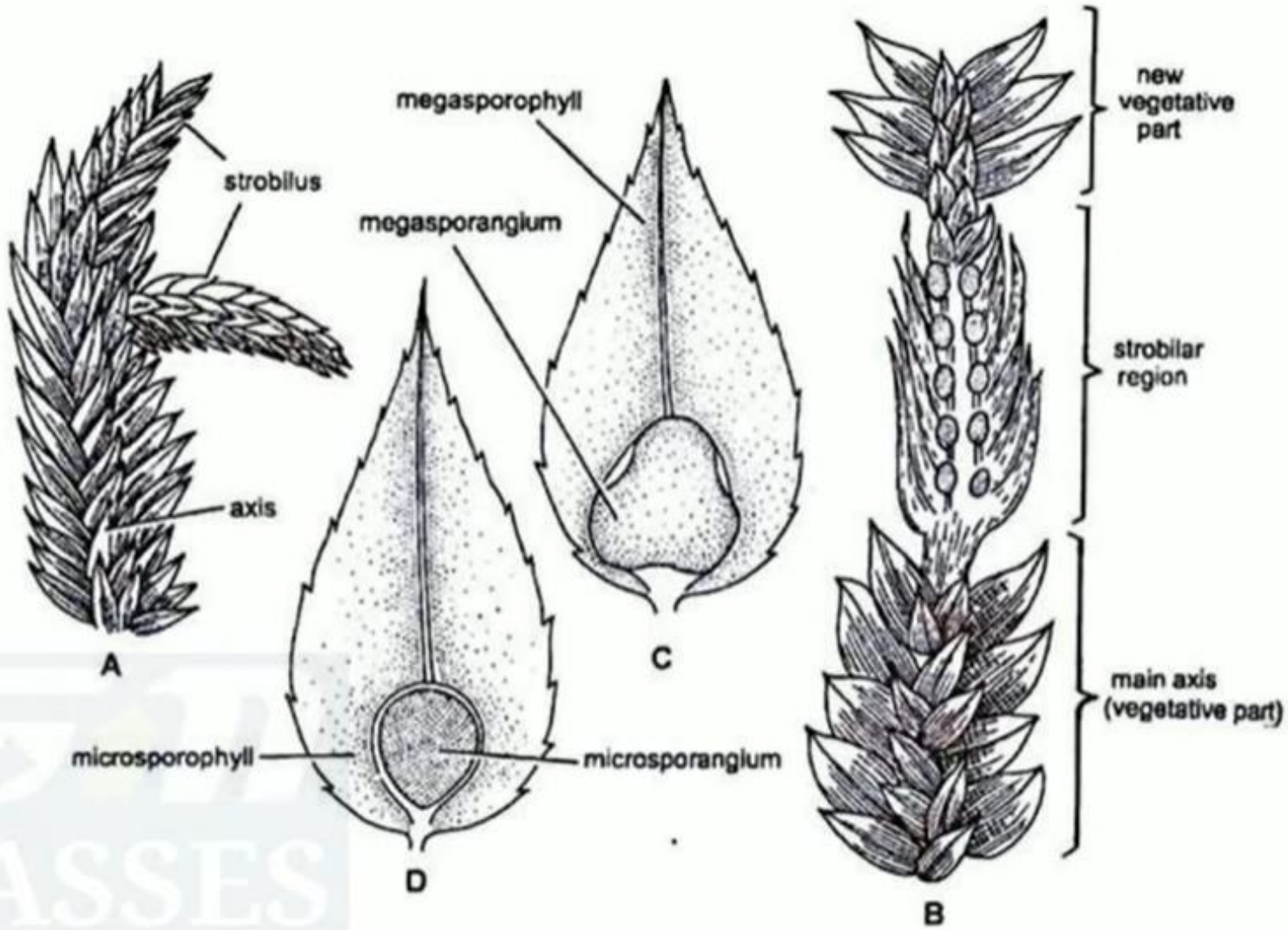
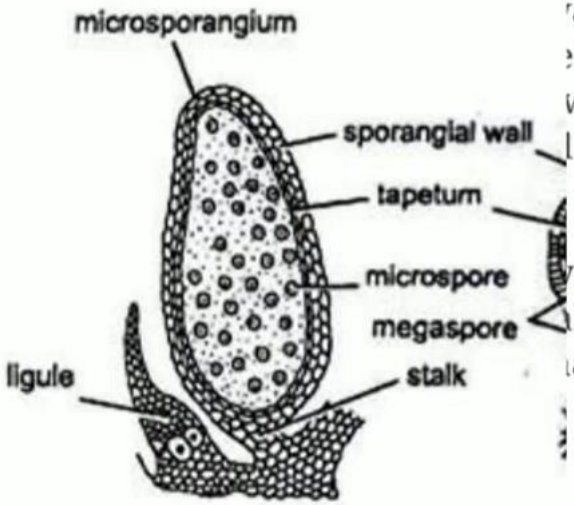



**Fig. 8 (A–D). *Selaginella* : Structure of strobilus. A. A branch bearing strobilus, B. A branch after formation of strobilus region again changing into vegetative region, C. A megasporophyll, D. A microsporopyll**

**Microsporangium:**

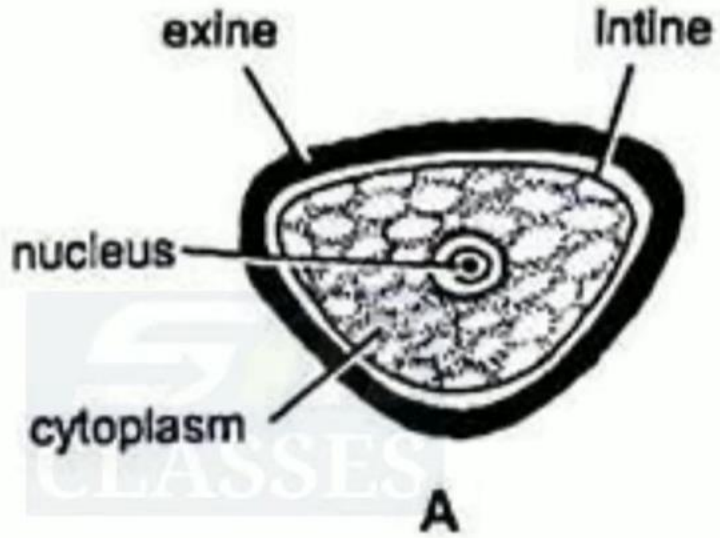
Each microsporangium is a stalked, globular or elongated structure (Fig. 8 D). Its colour varies from red, yellow to brown in different species. The wall is 2 layered thick which is followed by a conspicuous tapetum (Fig. 10 F). In the young sporangium inside the wall is present a mass of sporogenous cells which in due course of development separate into microspore mother cells and later on by meiotic divisions produce numerous haploid tetrads of microspores.

The microspores at maturity separate from each other. At maturity the tapetal cells as well as the inner wall of the microsporangium disorganizes i.e., wall of the sporangium is usually one layered at maturity. Microspores are smaller in size.

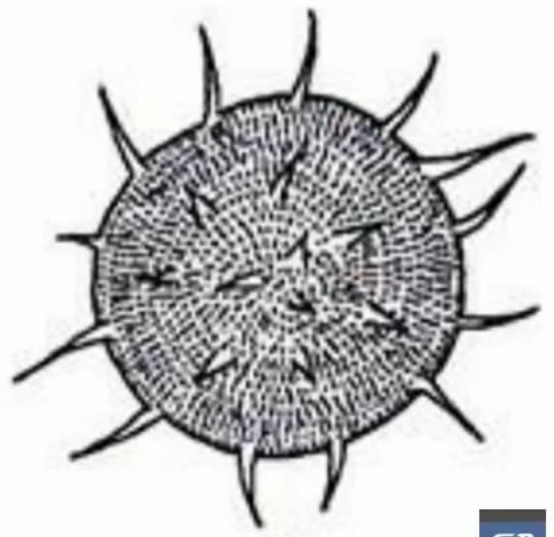



F

of sporanigum. (A–E). Successive stage
, F. Mature microsporangium, G. Mature




A

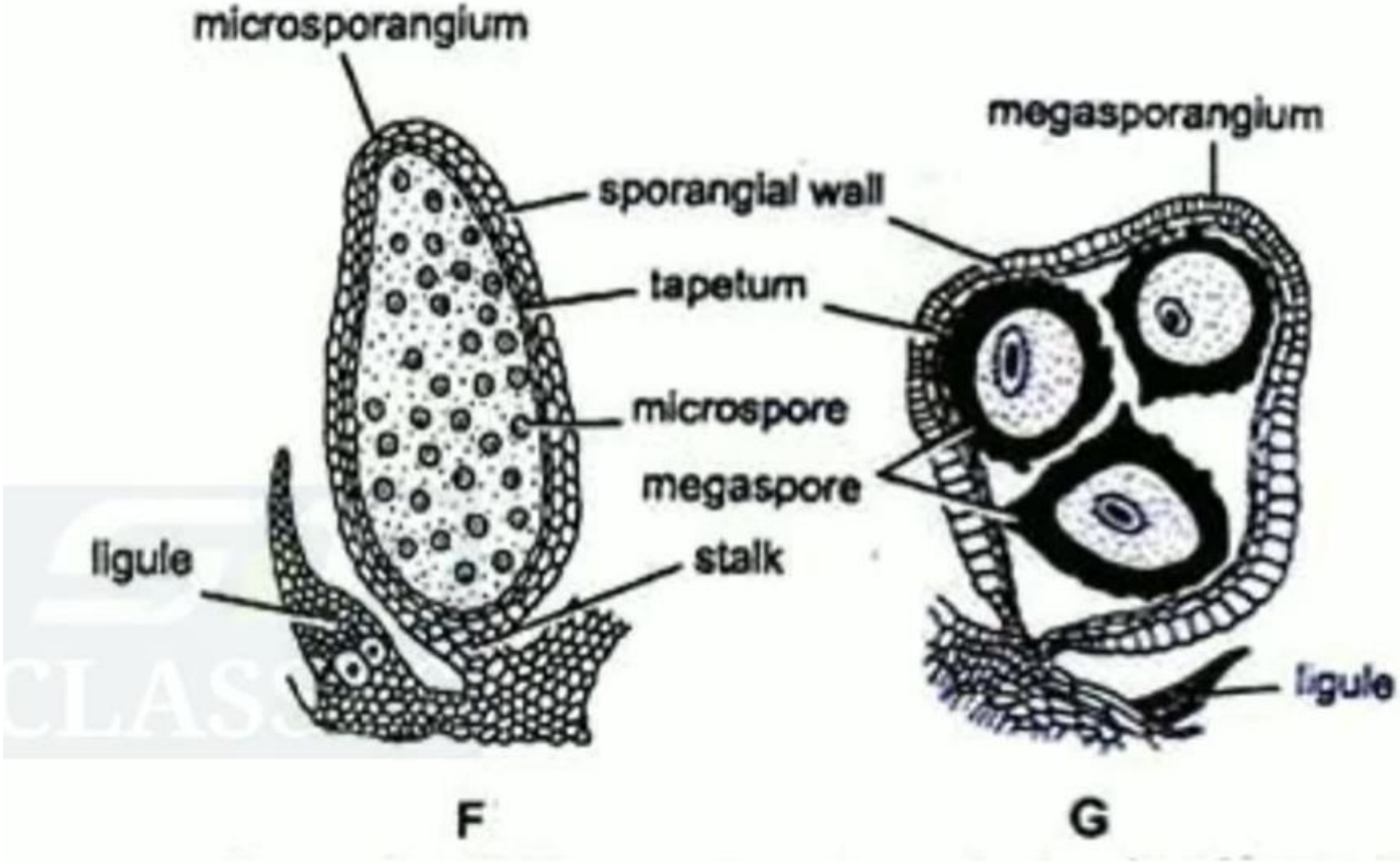


C

**Megasporangium:**

Each megasporangium is also a stalked but lobed structure and somewhat bigger than the microsporangium. Its colour varies from whitish yellow to red. Its wall is also 2 layered thick and followed by a single layered tapetum (Fig. 10G). In the young sporangium inside the wall is present a mass of sporogenous cells which in due course of development separate into megaspore mother cells. All the megaspore mother cells accept one degenerate.

The remaining one later on by meiotic division produces only 4 haploid megaspores. Sometimes less than 4 megaspores are produced inside each megasporangium. As for example, S. rupestris produces only one megaspore per megasporangium. At maturity the tapetal cells usually along with inner wall of the sporangium disorganise. Megaspores are larger in size than microspores (Fig. 10 G).


microsporangium
sporangial wall
tapetum
microspore
megaspore
stalk
ligule
megasporangium
ligule
F
G

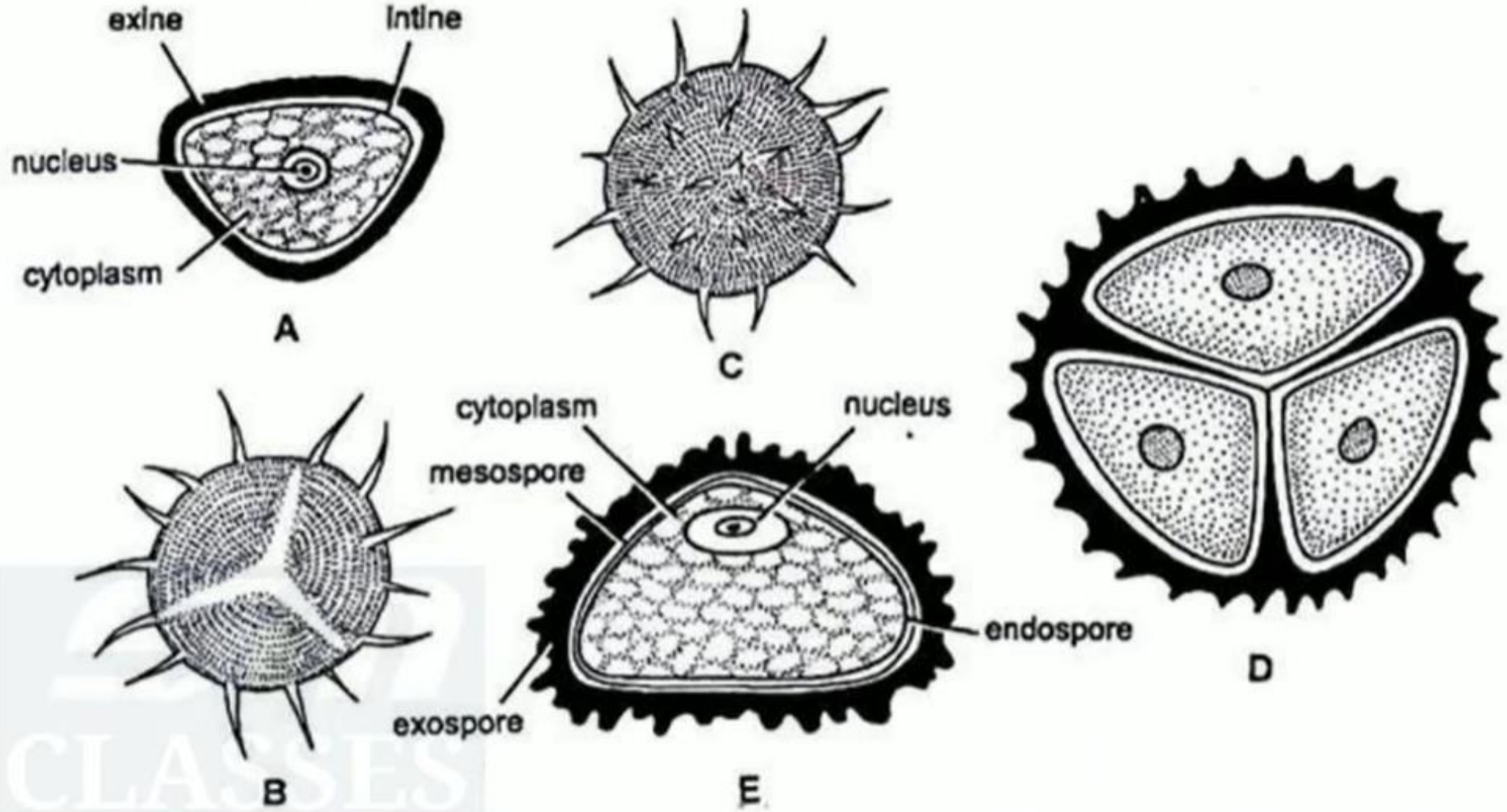



**Fig. 11 (A–E). *Selaginella*. Structure of spores : A. A single microspore showing detailed structure, B. Apical view of spore, C. Basal view, D. Megaspore in tetraed, E. A single megaspore.**

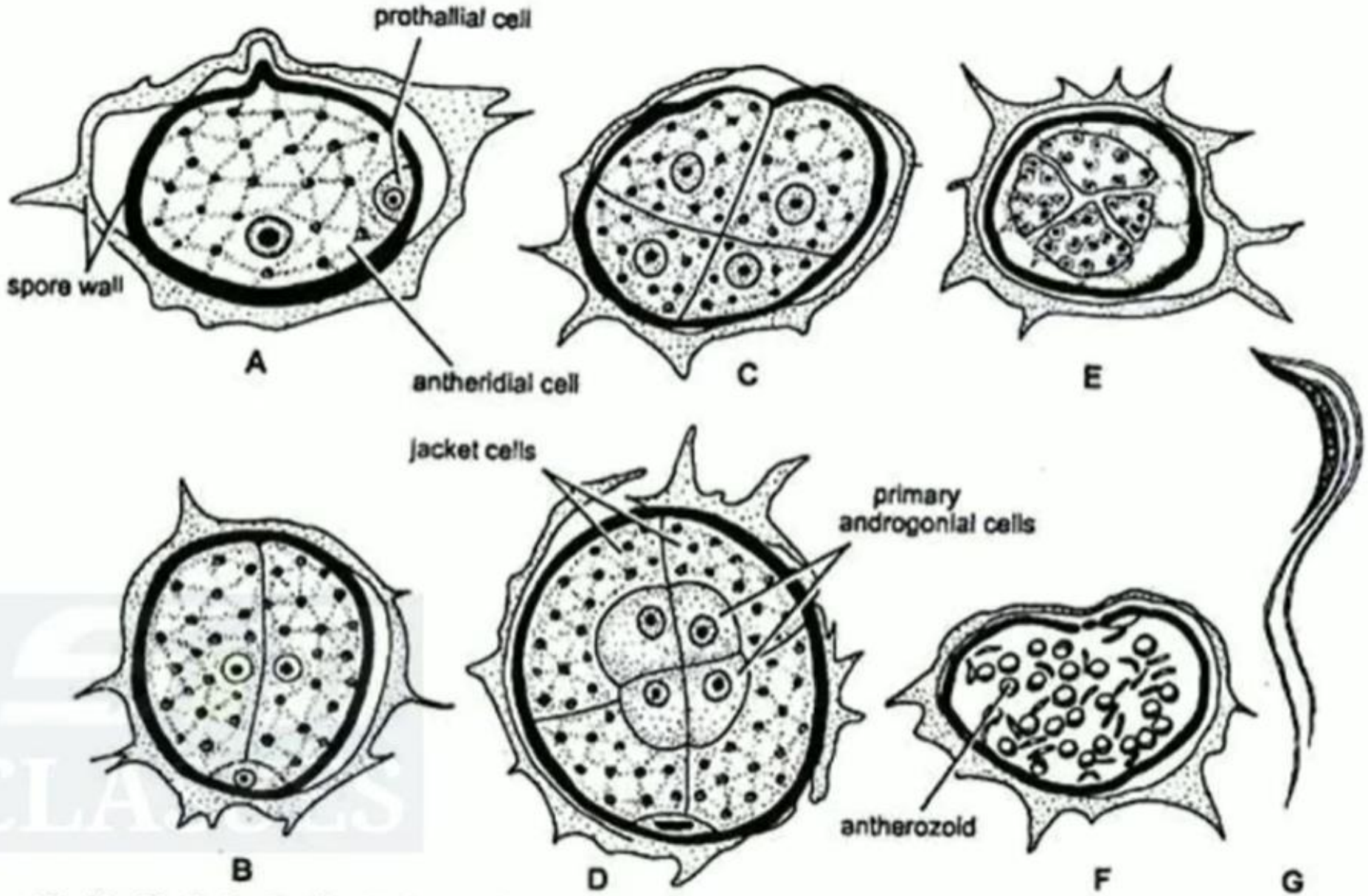



**Fig. 13. (A–G) *Selaginella*. Schematic representation of the development of male gametophyte**

**Development of female gametophyte:**

The megaspore is the initial stage in the development of female gametophyte. The development of female gametophyte starts while the megaspore is still inside megasporangium. The megaspores are liberated from the megasporangium either at the time of first archegonium formation or just after fertilization.

First of all the exospore or outer wall grows faster than the mesospore which result in the formation of space between exospore and mesospore. The whole structure increases in size as a result of which a big central vacuole appears (Fig. 14 A).

Now nucleus divides by free nuclear divisions, forming a large number of nuclei. First the nuclei are equally distributed in the cytoplasm but later on more nuclei collect in the apical region.

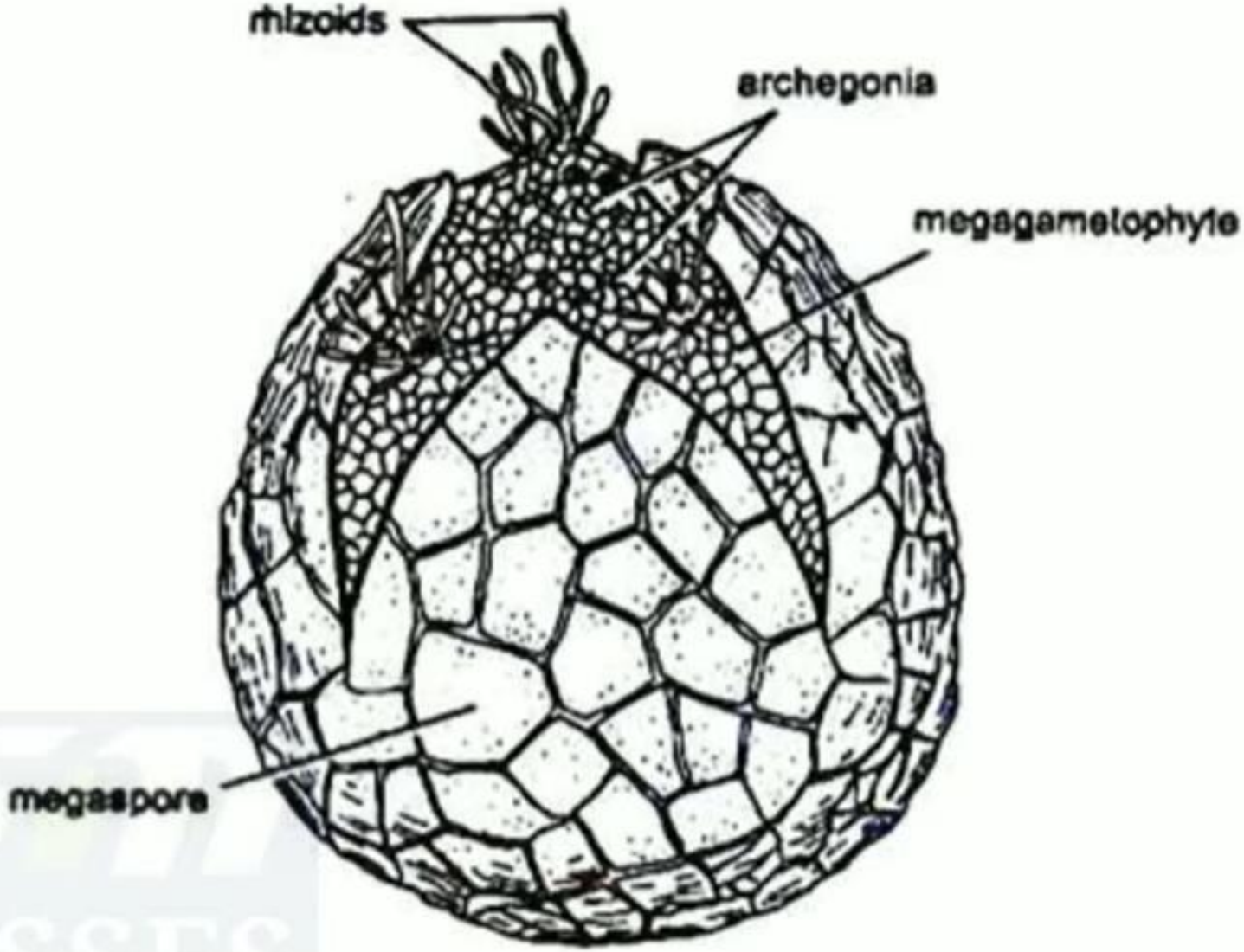



**Fig. 15. *Selaginella*. Female gametophyte. A. Dehiscent megaspore and rhizoids in *S. kraussiana***

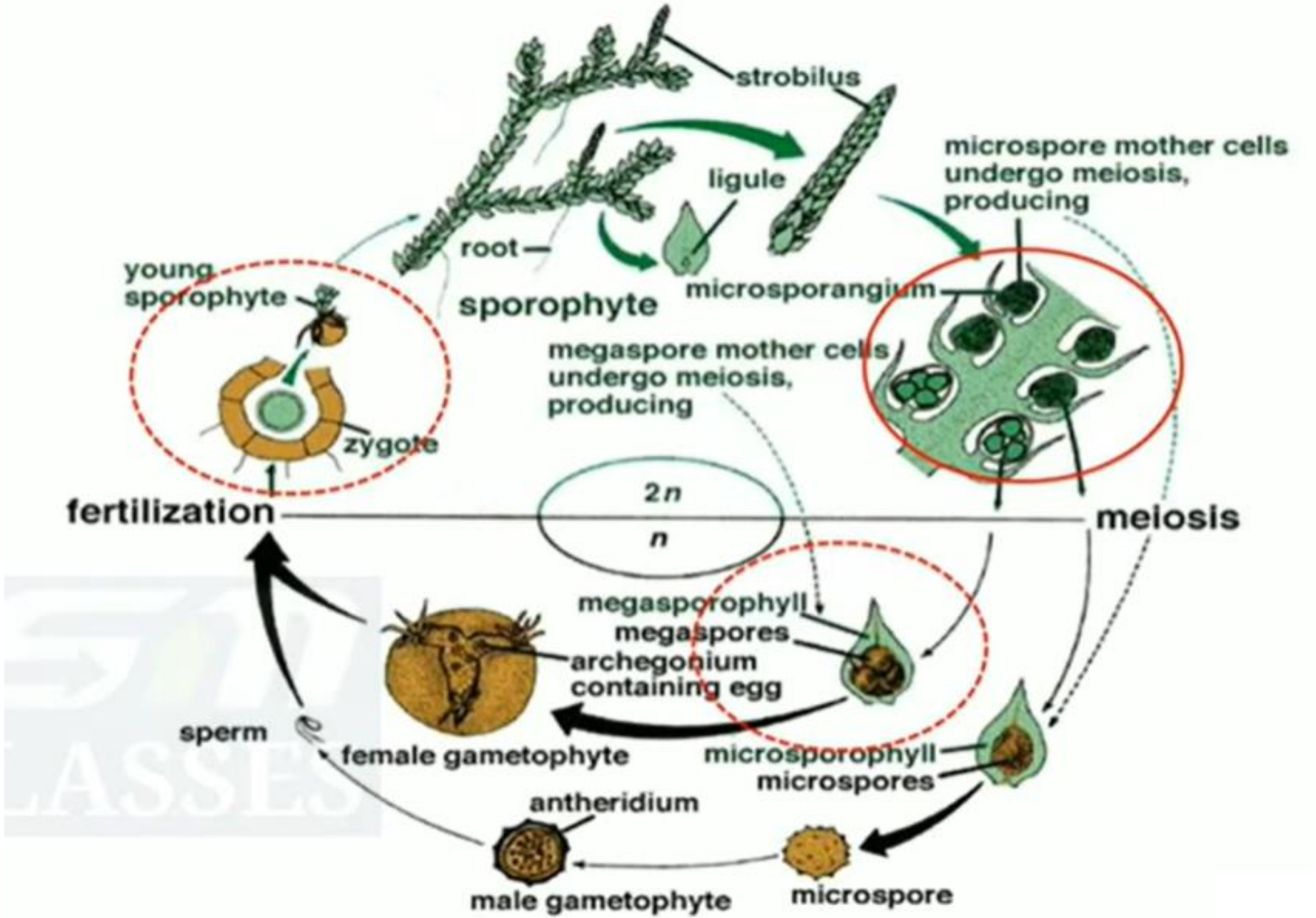
**Fertilization:**

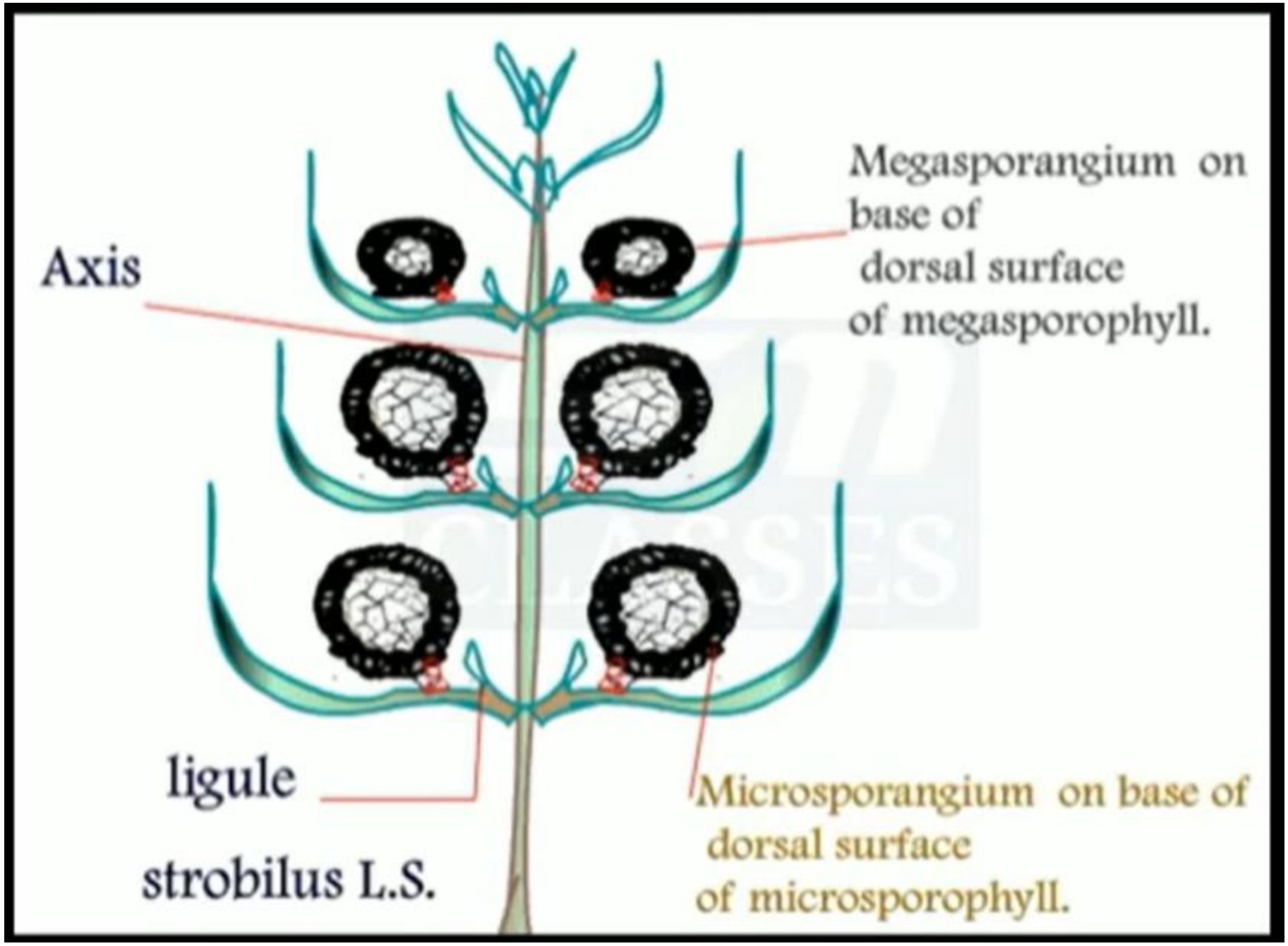
Water is necessary to carry out the process of fertilization. The swimming antherozoids reach the egg through the neck of archegonium and the nucleus of antherozoid fuses with the egg nucleus thus forming a zygotic nucleus. The fertilized egg secretes a wall around it forming a diploid structure known as zygote or oospore (2x). Thus the gametophytic generation ends and the initial stage of sporophytic generation is formed.

## Life Cycle Patterns of Selaginella:

Selaginella is a sporophytic plant (2x) and produces two different types of spores i.e., microspores and megaspores. In other words we may call it as heterosporous plant. These spores on germination produce male and female gametophytes (x) respectively which in turn developing upon the strobilus of parent produce antherozoids and egg in antheridia and archegonia respectively.

These reproductive structures after fertilization produces zygote (2x) which again on germination gives rise to a sporophytic plant (2x). In this way the sporophytic and gametophytic generations alternate with each other although the sporophytic phase is dominant over gametophytic phase (Figs. 19, 20).


strobilus
ligule
root
young sporophyte
sporophyte
microsporangium
microspore mother cells undergo meiosis, producing
megaspore mother cells undergo meiosis, producing
zygote
2n
n
fertilization
meiosis
megasporophyll
megaspores
archegonium containing egg
sperm
female gametophyte
microsporophyll
microspores
antheridium
male gametophyte
microspore


Axis
Megasporangium on base of dorsal surface of megasporophyll.
ligule
strobilus L.S.
Microsporangium on base of dorsal surface of microsporophyll.

**THANK YOU**