Subject – Botany

Paper I Plant Life and Utilization II

Sem II – Term – II

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By

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Chap- 2 Pteridophytes

Learning Objects

- 2.1 Introduction
- 2.2 General characters
- 2.3 Outline classification according to Sporne (1976) up to classes with reasons.
- 2.4 Life cycle of Nephrolepis
- 2.4.1 Habit, habitat, distribution,
- 2.4.2 Morphology of sporophyte
- 2.4.3 Anatomy of Sporophyte
- 2.4.4 Reproduction – vegetative and sexual.
- 2.4.5 Fertilization
- 2.4.6 Alternation of Genration

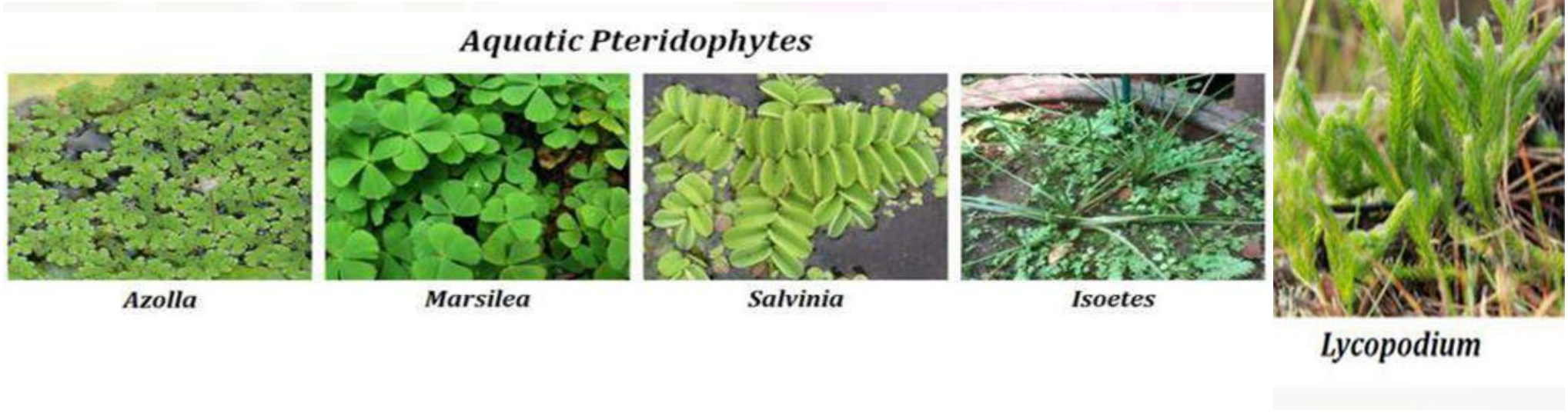
2.1 Introduction

- The first vascular plants and the first successful terrestrial plants with true roots, stem and leaves but no flowers fruits and seeds called as VASCULAR CRYPTOGAMS

- The Pteridophytes are terrestrial, small, either annual or perennial, and grow luxuriantly in cool, moist and shady places. e.g. Ferns.

- They may be **aquatic***(Azolla, Marsilea)*, **xerophytic***(Equisetum)* **epiphytic***(Lycopodium)* i.e.growing on large trunks of trees

- This group of ancient or primitive land plants with wiorldwide distribution represented by 400 genra and 10,000 to 12,000 species in the wo



2.2 General characters

- Pteridophyta (Gr, Pteron = feather, phyton = plant), the name was originally given to those groups of plants which have well developed pinnate or frond like leaves. Pteridophytes are cryptogams (Gr. kruptos = hidden, and Gamos = wedded) which have well developed vascular tissue.

- Plant body is sporophytic and can be differentiated into root, stem and leaves.

- Vascular tissue is present in stem and root. It consists of xylem and phloem. Xylem consists of tracheids only and phloem has only sieve tubes.

- Reproduction takes place by means of spores which are produced inside sporangia.

- Spores on germination give rise to multicellular gametophytic bodies called prothalli (sing. Prothallus).

- Antheridia and archegonia are developed on prothalli.Antheridium is surrounded by a single layered sterile jacket.

- Archegonium consists of four vertical rows of neck cells, 1-2 neck canal cells, ventral canal cell and egg.

- Antherozoids are unicellular, biflagellate (e.g., Selaginella) or multiflagellate (e.g., Equisetum and ferns) and motile.

- Antherozoids are attracted towards the neck of the archegonium chemotactically by certain substances like malic acid) present in the mucilaginous substance formed by the degeneration of neck canal cells and venter canal cell.
- Water is essential for fertilization (zooidogamous). Therefore, Pteridophytes are also known as amphibians of the plant kingdom.
- Fertilization results in the formation of zygote or oospore, which ultimately develops into well-developed sporophyte.
- The fertilized egg divides transversely or vertically. Another cross wall forms a quadrant stage producing stem, leaf, foot and root.
- Plants show heteromorphic alternation of generation. The main plant body is sporophytic and forms a dominant phase in the life cycle.
- Some of the common examples are *Nephrolepis*, *Selaginella*, *Equisetum*, *Pteris*, etc.

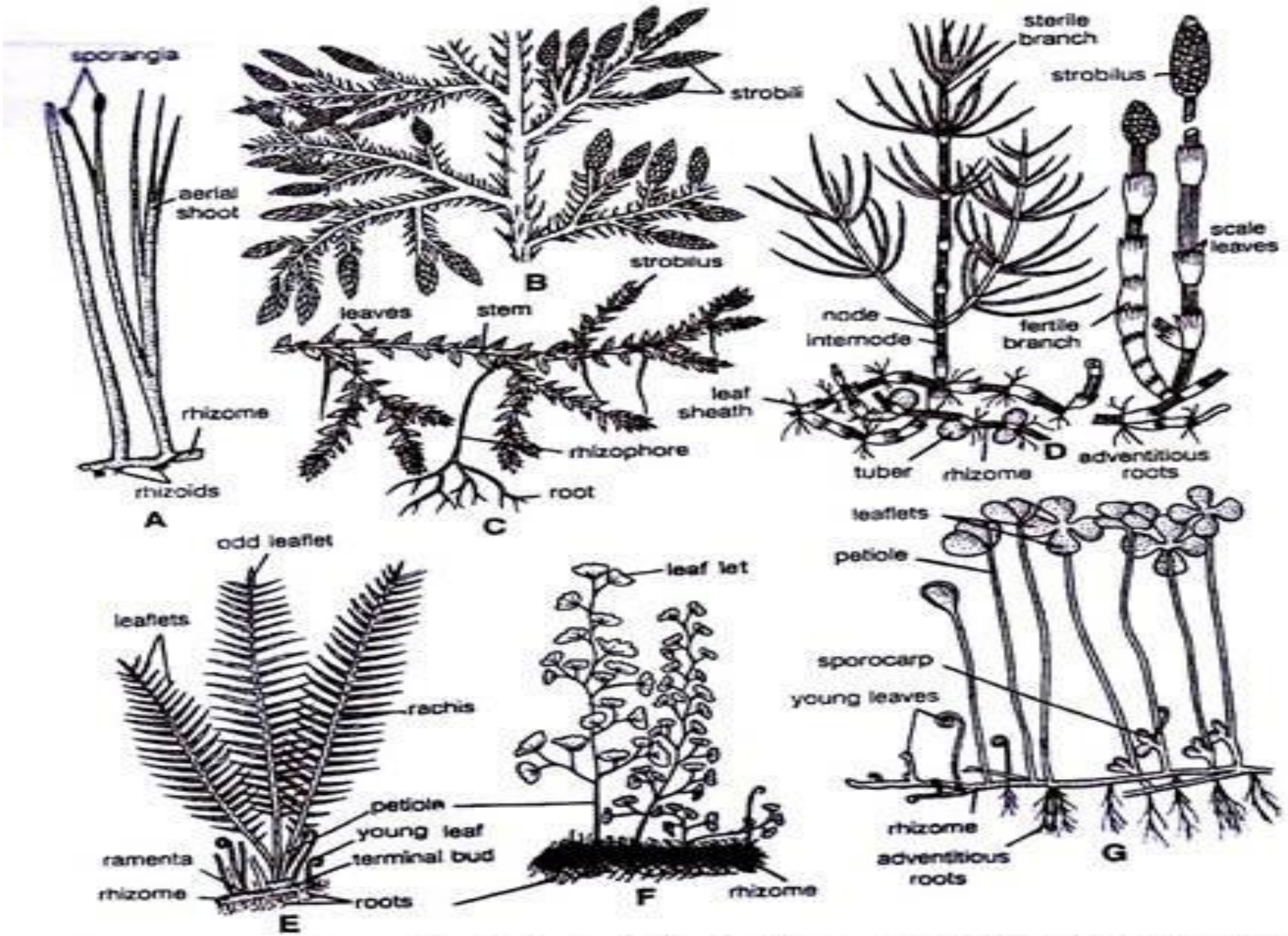


Fig 1 (A–G). Different forms of Pteridophytes A. *Rhynia*, B. *Lycopodium*,C. *Selaginella*, D. *Equisetum* E. *Pteris*, F. *Adiantum*, G. *Marsilea*

- 2.3 Outline classification according to Sporne (1976) up to classes with reasons.

This classification is proposed by K.R. Sporne (1975). He divided the Division Pteridophyta into 6 clasess.

- 1. Psilopsida (extinct)
- 2. Psilotopsida
- 3. Lycopsida
- 4. Sphenopsida
- 5. Pteropsida
- 6. Progymnospermopsida (extinct)

1. Psilopsida (extinct)

- Fossil Or Living: Fossil
- Sporophytic plant:The plant body was a simple, herbaceous sporophyte with dichotomously branching
- Root: Rhizoids are present.
- Stem: horizontal rhizomes
- Leaf : absent
- Sporangia: Homosporus
- Vascular Strand : Protostelic
- Cambium: Absent , No secondary growth observed
- Sporangia: Homosporus
- Gamatophyte: The gametophytes are not known.
- Example : *Rhynia*

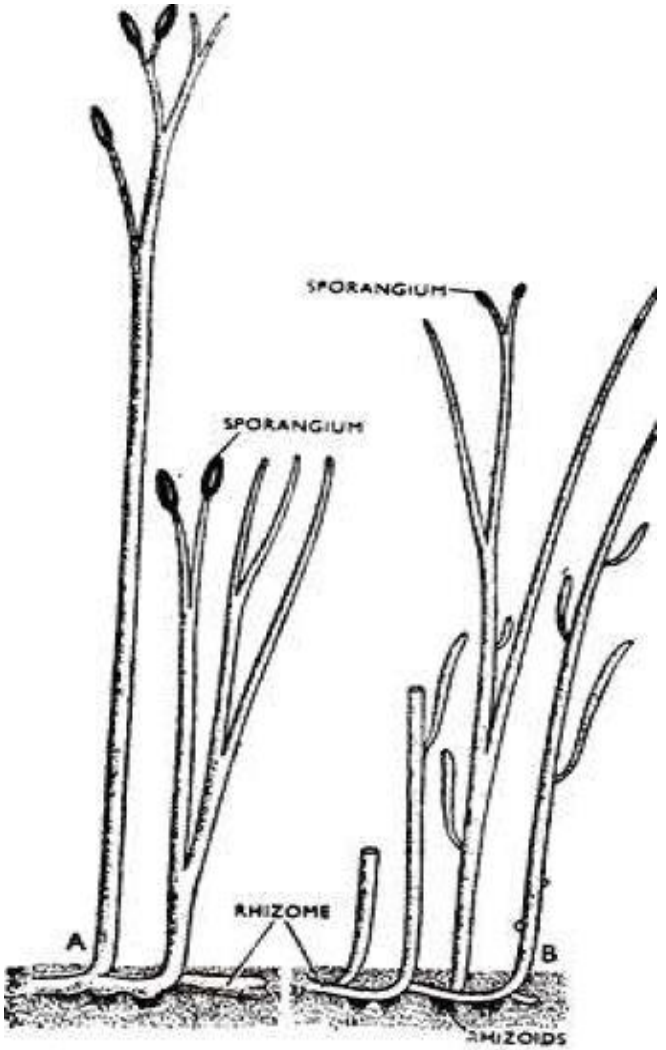
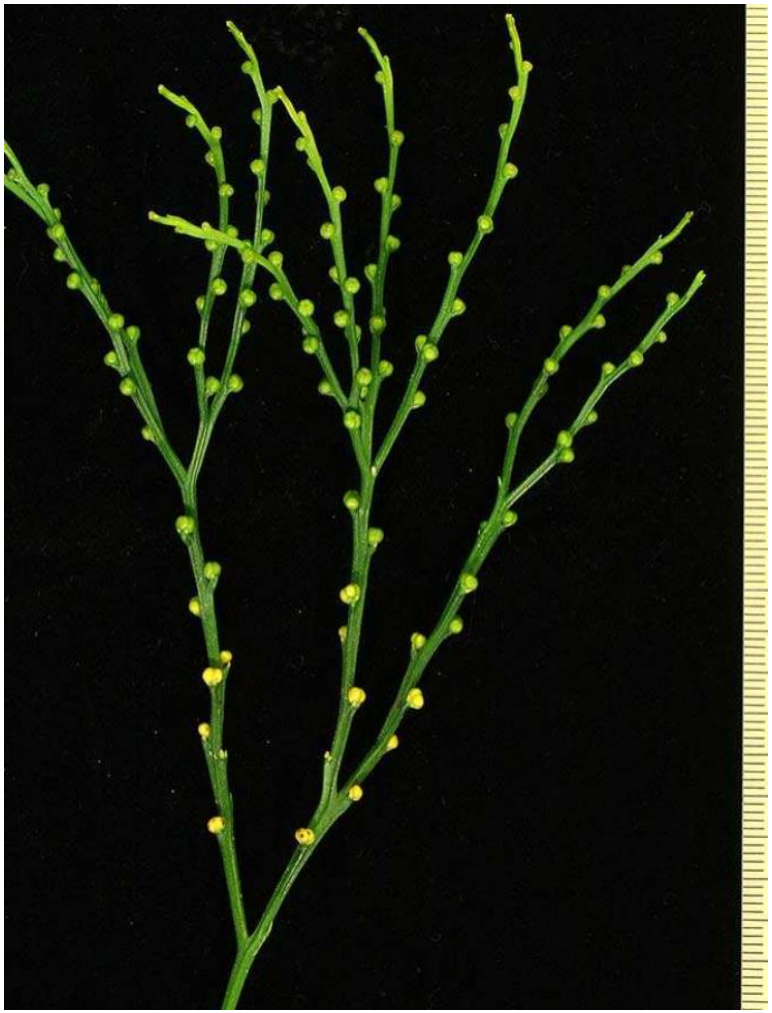


Fig. 517. *A. Rhynia major.* B. *Rhynia gwynne-vaughani* (After Kidston and Lang).

2. Psilotopsida



- Fossil Or Living: Living
- Sporophytic plant:The plant body was a simple, herbaceous sporophyte with dichotomously branching
- Root: Rhizoids are present.
- Stem: The stem is photosynthetic and dichotomously branched.
- Leaf : absent
- Vascular Strand :Protostelic
- Cambium: Absent
- Sporangia :Homosporus sunangium- trilocular structure enclose spongia
- Gamatophyte:
- Example : *Psilotum*

3. Lycopsida

- Fossil Or Living : Both
- Sporophytic plant: plant body is differentiated into root, stem and leaves
- Root :
- Stem :
- Leaf : The leaves are small (microphyllous), simple with a single mid vein.
- Vascular Strand : Protostelic or sometimes siphonostelic
- Cambium : absent , present in Isoetes
- Sporangia : Develop in strobilus (cone), some members are homosporous (e.g., Lycopodium) while others are heterosporous (e.g., Selaginella).
- Gamatophyte : Gametophytes which are in the form of prothalli and autotropic, exosporic or endosporic.
- Example *: Lycopodium*, *Selaginella*, *Isoetes*

5. Pteropsida

- Commenly known as Ferns
- Fossil or Living : Both
- Sporophytic plant:plant body is perennial and differntiated in to root, stem and leaves.
- Root : Ttrue roots
- Stem : Rhizome
- Leaf :Leaves are large with branched veins. Compound, so called as fronds.
- Vascular Strand : simple to advanced (Protostele-siphonostele-solenostele-dictyostele conditions)
- Cambium

- Sporangia : sporangia are grouped – sorus in marginal or abaxial surface of leaf blades.Sporangium development may be eusporangiate (from more than one sporangial initial) or leptosporangiate (from a single sporangial initial).

- Spores –homosporous or heterosporous

- Gamatophyte: Heart shaped autotropic

- Example : *Nephrolepis*, *Adiantum*, *Marsilea.*

6. Progymnospermopsida (extinct)

- Ancestors of the earliest seed plants as well as the first true trees.The progymnosperms were the first modern trees.

- Fossil Or Living: Fossil

- Sporophytic plant:exhibited strong monopodial growth, small tree with dichotomously branched, leaf-like branch tips.

- Root: Its root exhibited perennial root growth and the repeated production of lateral rootlets

- Stem: Erect and woody

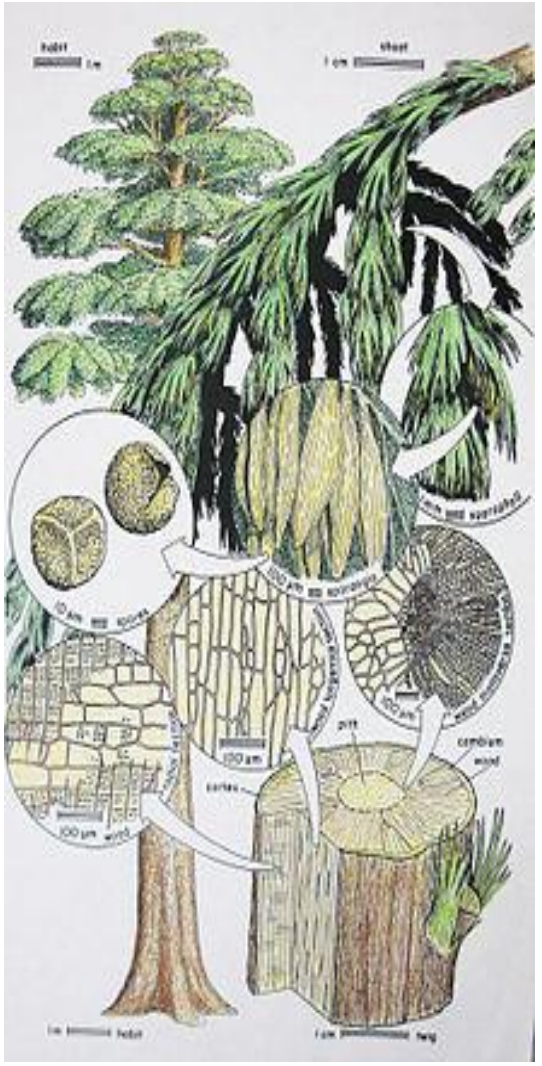
- Leaf : Simple

- Vascular Strand

- Cambium Vascular cambium with unlimited growth potential is present as well as xylem and phloem.

- Sporangia: Sporangia were terminal on the ultimate branches, and Some were heterosporous but others were homosporous.

- Example: *Archaeopteris.*



2.4 Life cycle of Nephrolepis

- Nephrolepis : Greek nephros, kidney, and lepis, scale, in reference to shape of the indusium , *Nephrolepis* is a genus of about 30 species of ferns. The genus is commonly referred to as macho ferns or swordferns

2.4.1 Habit, habitat, distribution

- Habit :The mature plant body is sporophytic and can be differentiated into rhizome, roots and leaves. small prostrate herbs (*Azolla, Marsilea*) to huge tree like (*Cyathea*).

- Habitat :evergreen or semi-evergreen ferns from tropical and subtropical regions around the world. Some are terrestrial, aquatic(*Azolla, Marsilea, Salvinia*) and some are epiphytic(eg. *Ophioglossum*).This fern needs high humidity and moist soil.

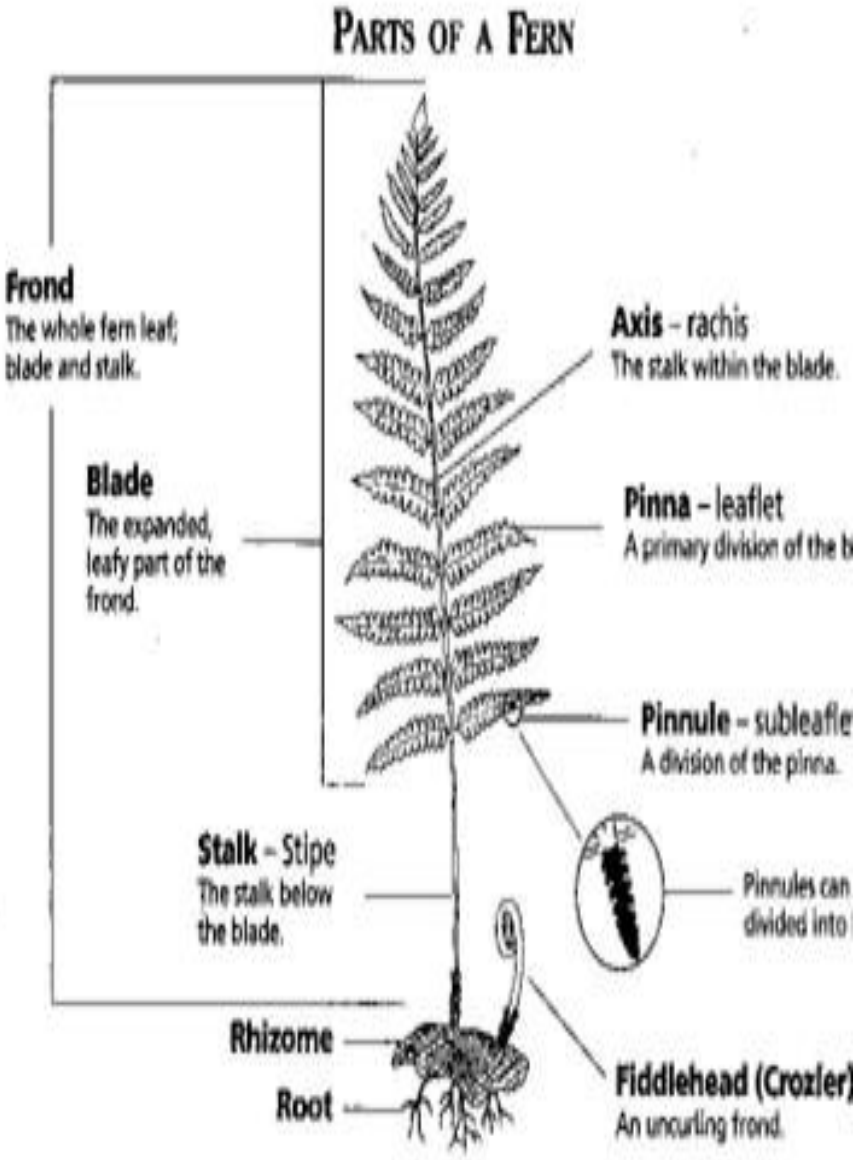
- Distibution:These species are distributed in the tropics of the entire world, especialy south America, North America, Florida, West Indies, India etc.

2.4.2 Morphology of sporophyte

- The plant body consists on an oblique underground rhizome or Caudex or root stock (stem) that bears roots and also bears a close tuft of leaves and long, slender lateral branches called runners/Stolon. The runners spread for a considerable distance and bear roots below andspur above the ground .

- The leaves directly arising from the rhizome is called the frond. The stalk of the frond is called the stipe, while the leaflet bearing region is called the blade. The leaflets are sessile and imparipinnately borne on the central axis the rachis.

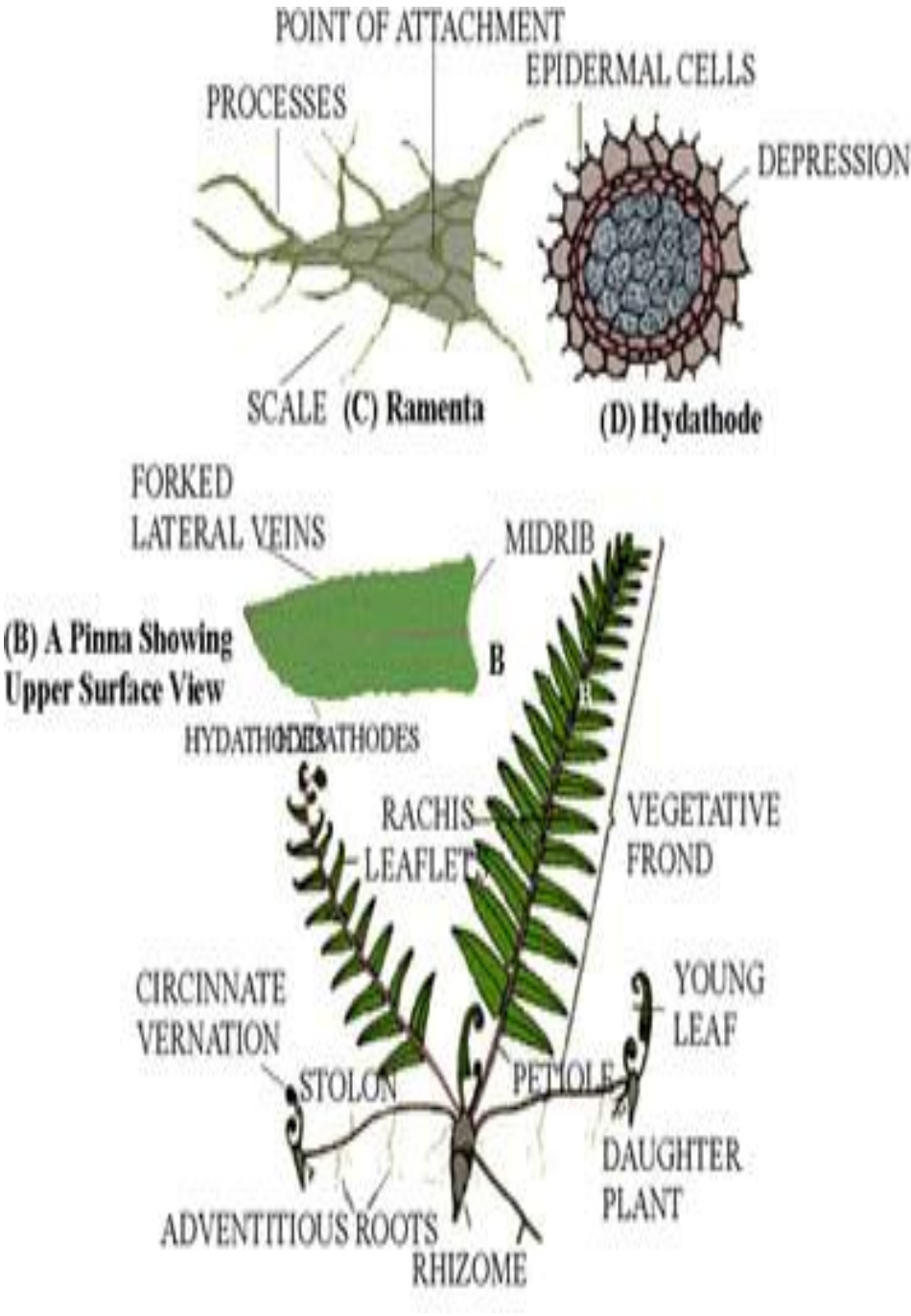
- Immature frond or younger leaf exhibits circinate vernation (young leaves coiled inward).



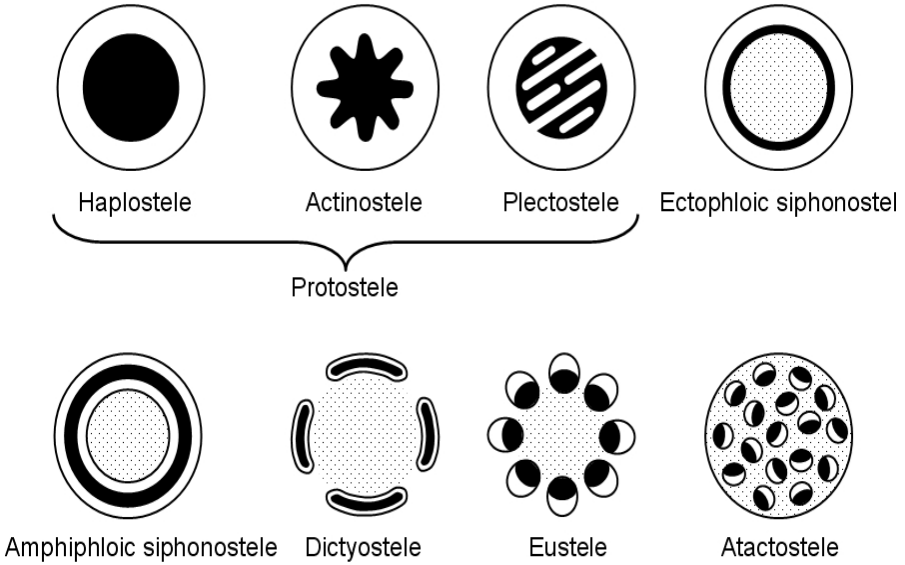
- Each leaflet has a mid-rib that branches into lateral veins, the veins bifurcate at the margin of the leaflets to form the hydathodes.

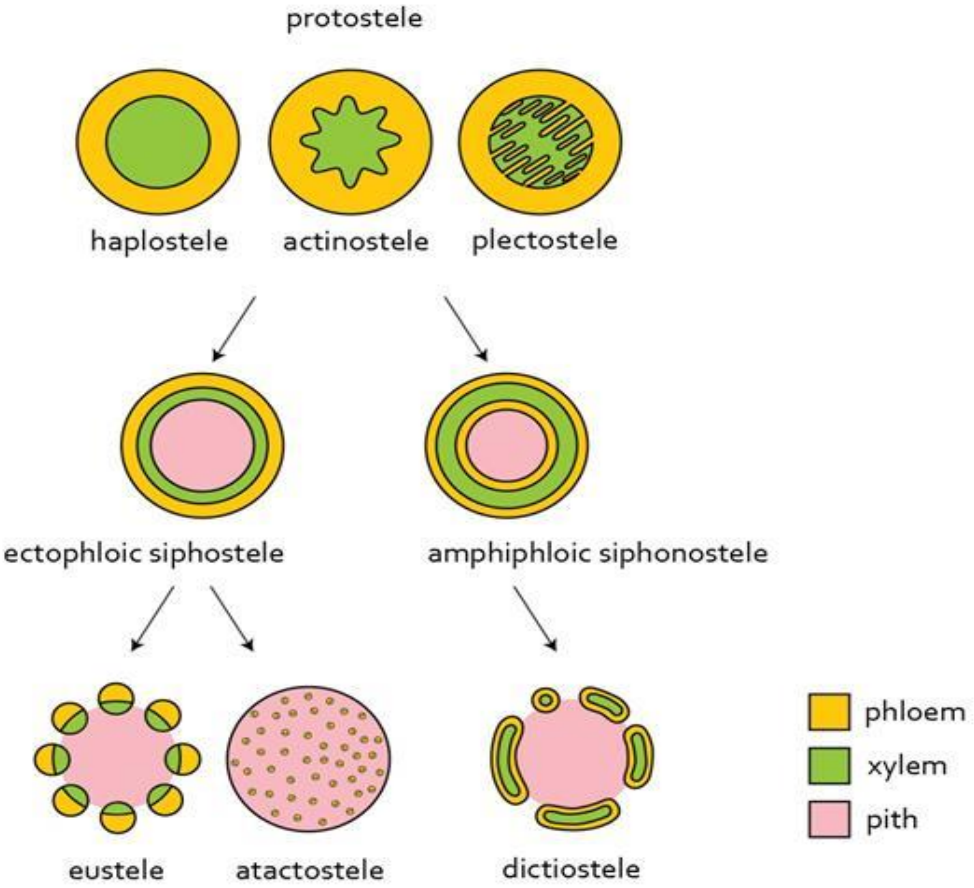
- A hydathode is a type of pore appers in white dots on dorsal surface along the margins of each pinna or leaflets.They are also called as water stomata. They excude water in the form of liquid this processes is known as guttation.

- The underground rhizome, young leaves and rachis of adult leaves remain covered by brown hairy scales called ramenta (singular—ramentum). This is a safeguard against drought. Circinate arrangement of young leaves and presence of ramenta are characteristic features of ferns



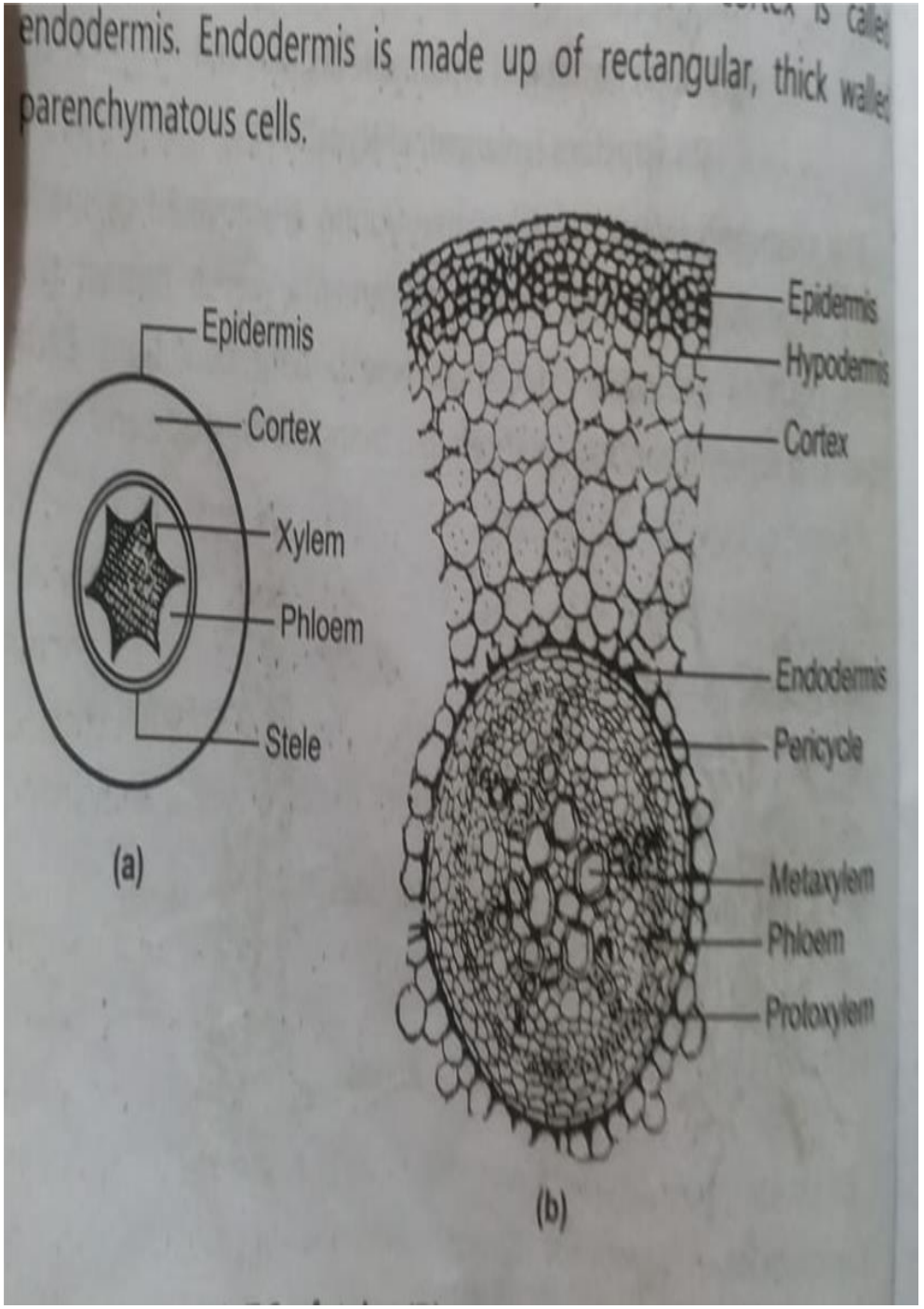
Types of stele





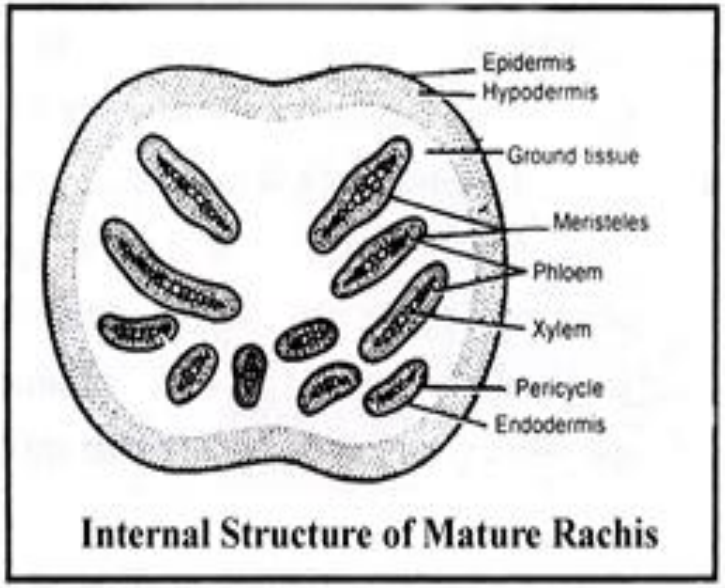
2.4.3 Anatomy of Sporophyte

.T. S. Of Stolon:

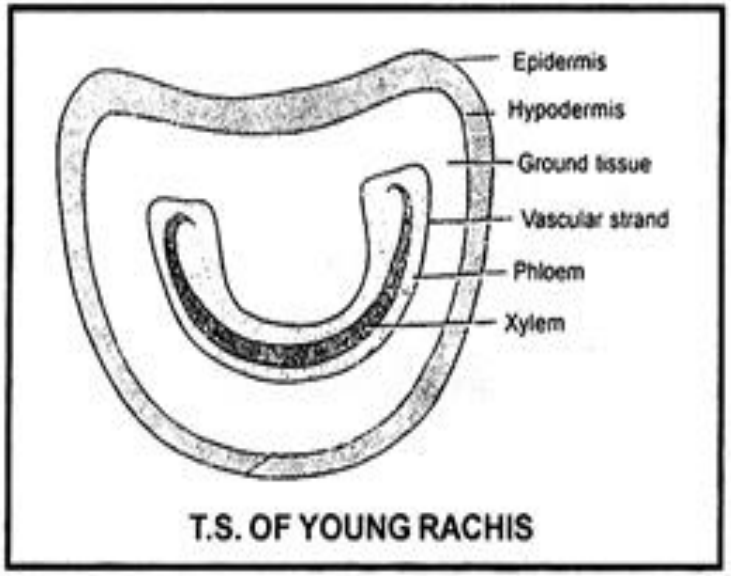


- **T.S. of Rachis**:
- 1. The section appears horse-shoe shaped.
- 2. It shows epidermis, hypodermis, ground tissue and the stele.
- 3. Epidermis is made of single layer of thickly cuticularised cells.
- 4. Hypodermis lies below the epidermis. The cells are sclerenchymatous.
- 5. Cortex is the parenchymatous region extending throughout the section is called
- ground tissue or cortex.
- 6. Stele is situated in the ground tissue which is U-shaped or horse-shoe shaped stele.
- 7. Single layered endodermis surrounds the stele followed by a few layered pericycle.
- 8. Xylem and phloem is centrally located. Xylem surrounded by phloem on all sides.
- 9. The structure of the stele differs at various levels of rachis.
- i. In younger parts, there is a single U-shaped stele.
- ii. Little above the base, the U-breaks at the bottom, thereby producing two steles.
- iii. In mature parts, dissection of the stele results in many meristeles.

- T.S. of rachis:



Internal Structure of Mature Rachis



T.S. OF YOUNG RACHIS

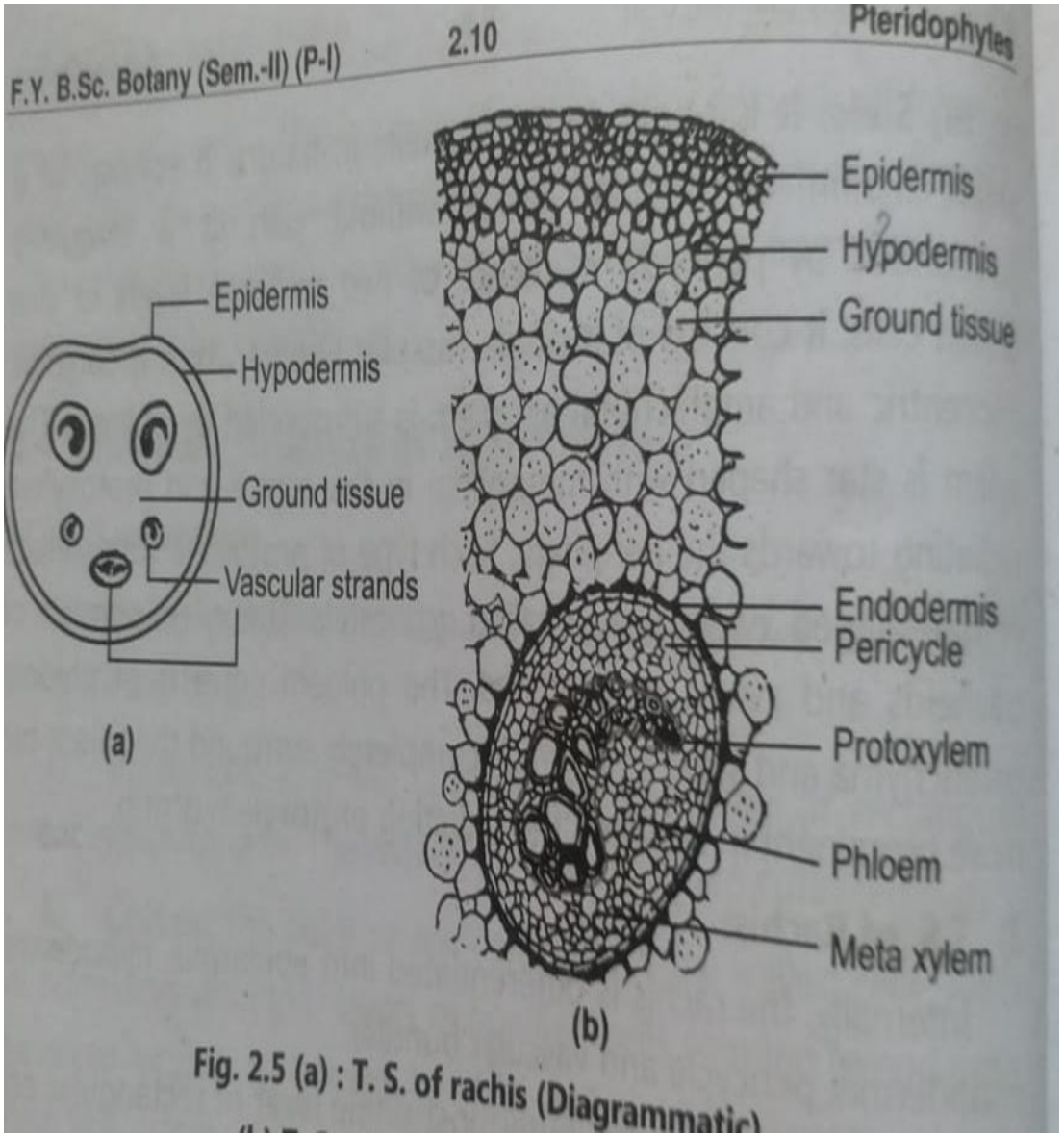


Fig. 2.5 (a) : T. S. of rachis (Diagrammatic)

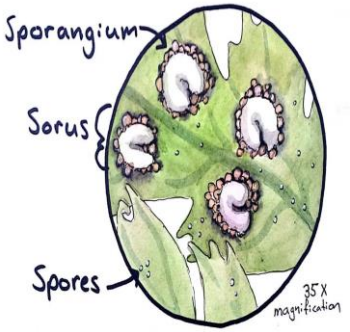
T.S. Of Leaflet or Pinna

- The internal structure of the leaflet is differentiated into upper and lower epidermis, spongy mesophyll and vascular bundles.
- Both the upper and lower epidermis are single layered, non-green and covered with cuticle. Stomata are generally present in the lower epidermis only. Mesophyll tissue is spongy in nature. This is composed of thin walled, green and loosely arranged cells.
- The vascular bundles of lateral veins are seen in the mesophyll region. Each vascular bundle is concentric and hadrocentric (i.e., it has xylem cells in the center surrounded by the phloem cells).
- The sorus is seen attached to the lower epidermis. It consists of a placenta, numerous sporangia and indusium.
- The placenta is a fertile tissue of colorless cells. It develops as a cylindrical out-growth from the lower epidermis and bears sporangia and an indusium.
- Sporangia are the spore producing organs. They develop laterally from the placenta. The indusium is a thin membrane attached at the end of the placenta which protects the sporangia in a young sorus.

Reproduction – vegetative, Asexual and sexual

- Vegitative reproduction take place by stolon.
- The fern life cycle shows both asexual and sexual reproduction. Asexual reproduction takes place in the sporophyte (diploid) generation while sexual reproduction takes place in the gametophytic generation.

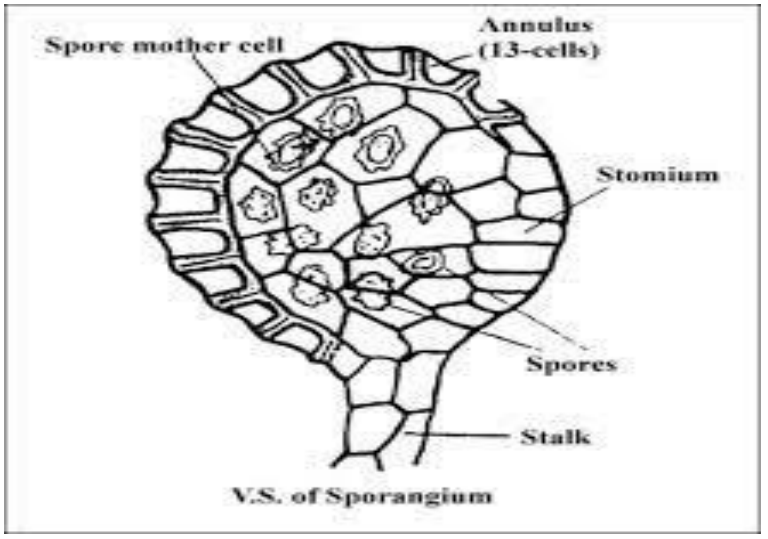
- **Asexual reproduction:** As stated earlier, this takes place by spore formation. Spores are produced in sporangia which develop in sori and sori develop on dorsal side of pinna such leaf is called as sporophyll.
- **Sporangium** : Each sporangium has a slender multicellular stalk and a body called capsule. The capsule is oval or circular and flattened on two lateral sides like a biconvex lens.

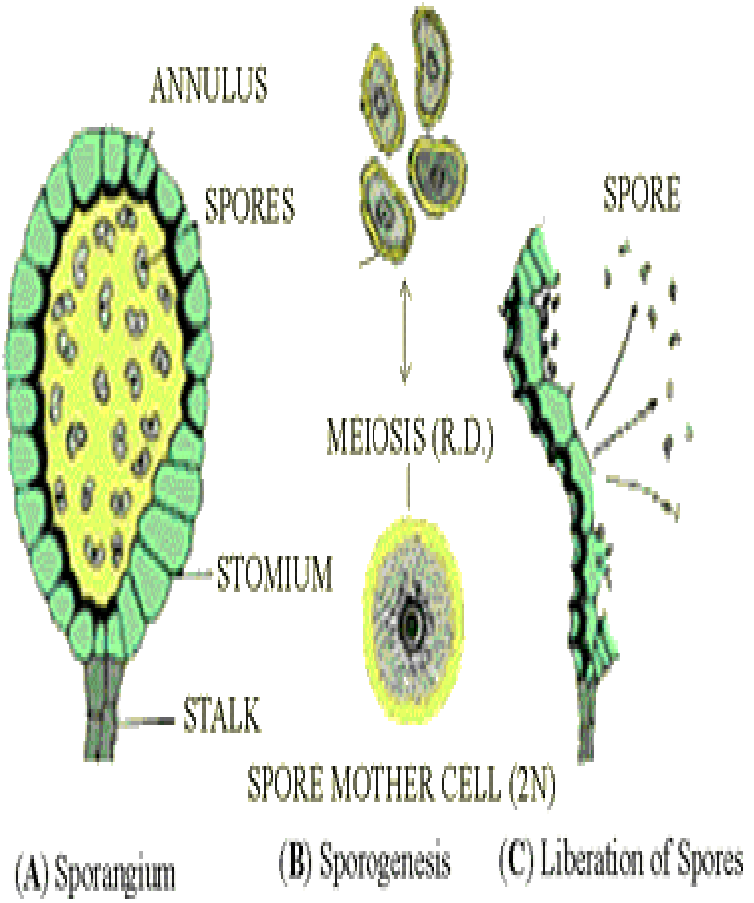


- The capsule wall is single layered and composed of thin-walled cells. There is a ring of special cells in the wall that runs around the capsule along its median edge. A major part of the ring is formed by the annulus, in which cells have very thick inner walls. The remaining part of the ring is called the stomium region. It is formed by large, thin walled delicate cells. This ring plays an

•Each sporangium contains 16 diploid spore mother cells. These divide by meiosis and produce 64 haploid spores (n). Nephrolepis is homosporous. All spores are small and kidney-shaped. The diploid sporophyte generation ends with the meiosis.

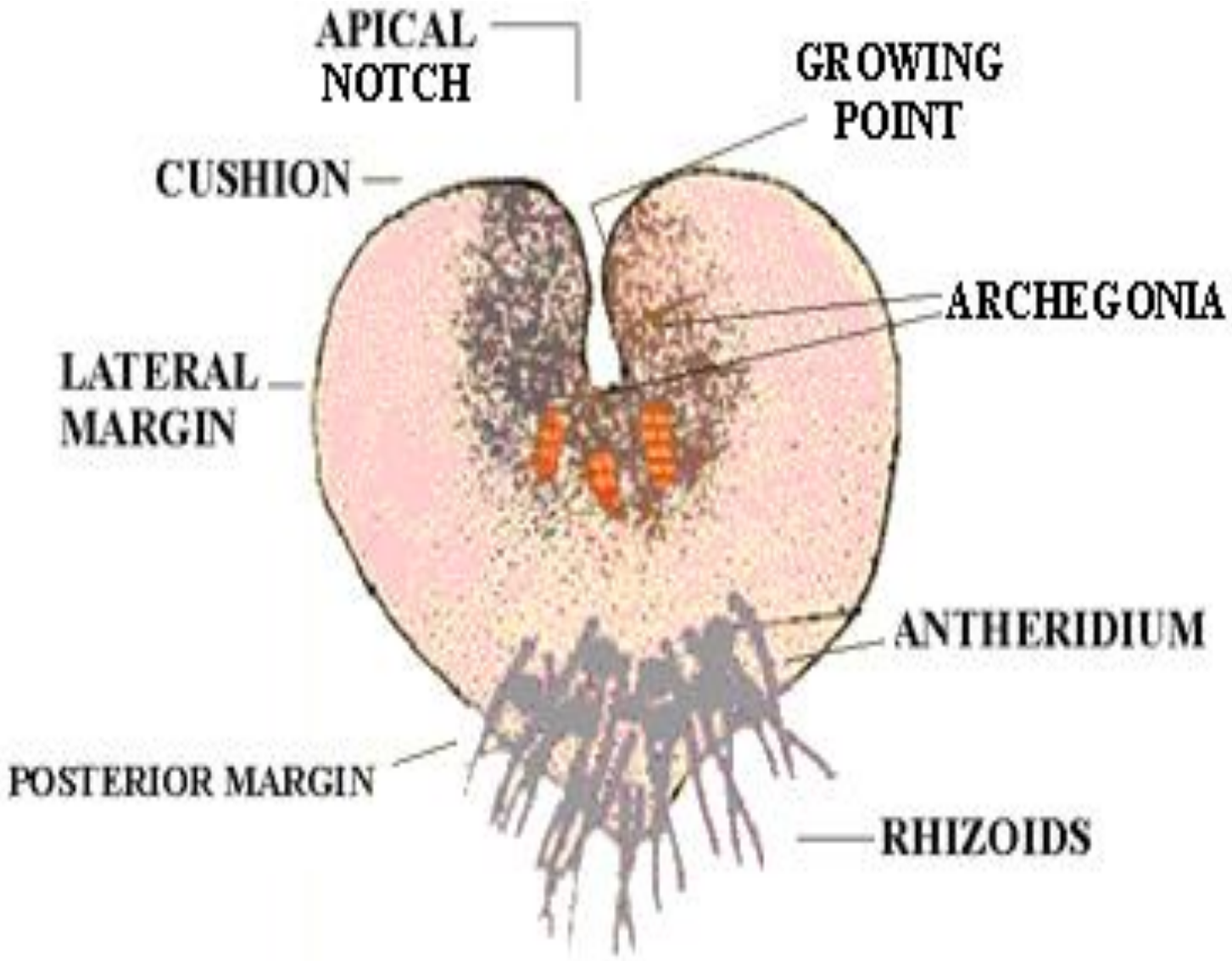
•**Liberation of spores :** The spores are liberated from the capsule when the sporangium matures. The sporangium (capsule) wall breaks open in the region of the stomium and the spores are liberated through the opening. This is caused due to movements of the annulus in hot and dry conditions.





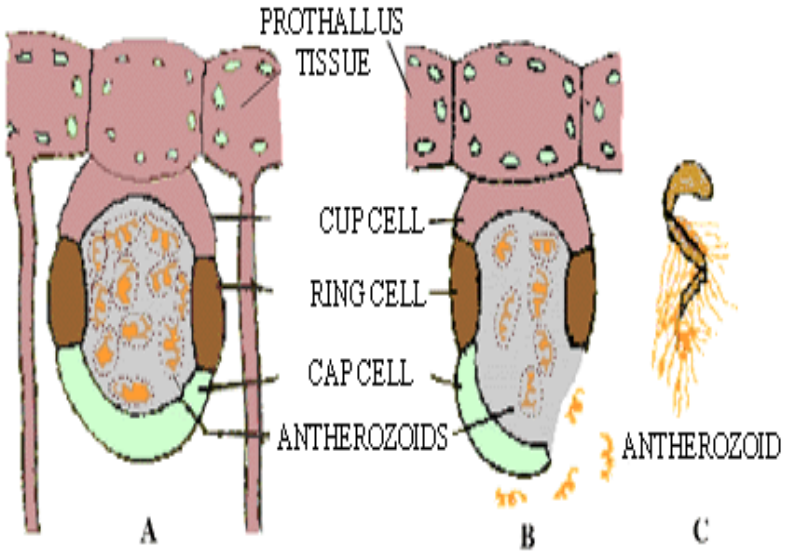
Gametophyte

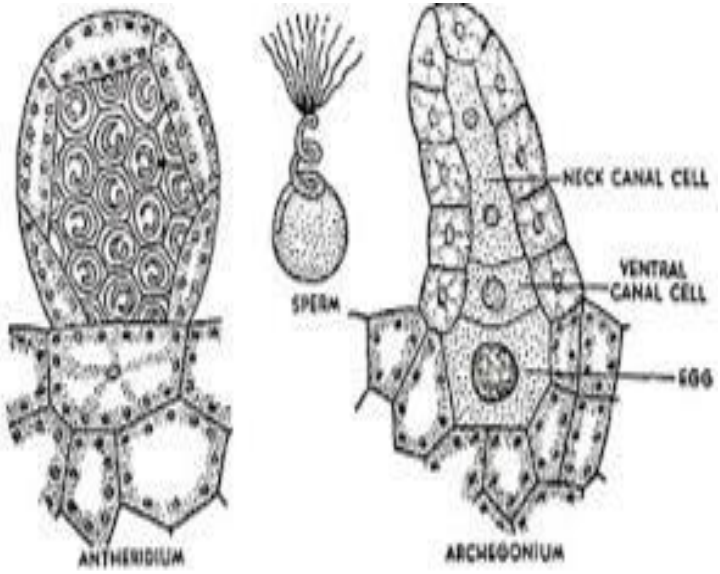
- The gametophyte represents the sexual haploid generation in the fern life cycle. The haploid generation begins after meiosis in diploid spore mother cells. The adult gametophyte is called a fern prothallus. It is produced on moist, cool and shady soil, when a spore (n) germinates under favorable conditions.
- The prothallus is very small (about 0.5-2.0 cms in diameter), delicate and almost transparent. It is heart-shaped (Fig. 15.3) and flat with dorsoventral symmetry. The prothallus has a deep apical notch. An apical cell (growing point) is situated in the notch. The central part of the prothallus is fleshy and is thick because of a number of cell layers. This is called the cushion region. The peripheral part has only one cell layer and is called the margin. Numerous hair-like rhizoids develop from the lower surface of the posterior margin region. Rhizoids help in fixation and absorption. The cells of a prothallus contain chloroplasts. Therefore, it is photosynthetic and independent.
- The prothallus (gametophyte) produces male sex organs (antheridia) and female sex organs (archegonia) during sexual reproduction. These develop on the lower surface facing the soil.


APICAL NOTCH
GROWING POINT
CUSHION
ARCHEGONIA
LATERAL MARGIN
ANTHERIDIUM
POSTERIOR MARGIN
RHIZOIDS

•Sexual reproduction: It takes place in the haploid gametophyte generation and involves the formation of specialized male and female sex organs.

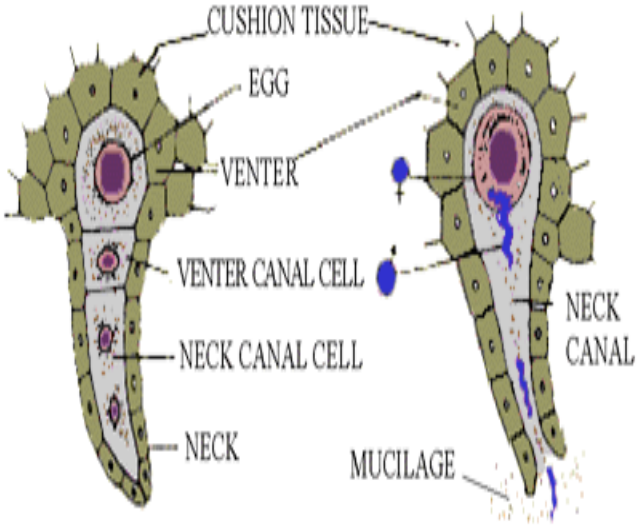
•Antheridium : This is the male sex organ. Antheridia develop on the lower surface of the prothallus in the region of posterior margin among the rhizoids. Each antheridium is sessile. It has a very small, delicate and globular body. The body wall is called jacket. It is composed of only three cells: basal cup cell, middle ring cell and apical cap cell. Antherozoids are produced in each antheridium. These are haploid male gametes. Each one has a spirally coiled body with many flagella. The wall of the mature antheridium breaks open in the presence of water, and the antherozoids are liberated on the moist soil.





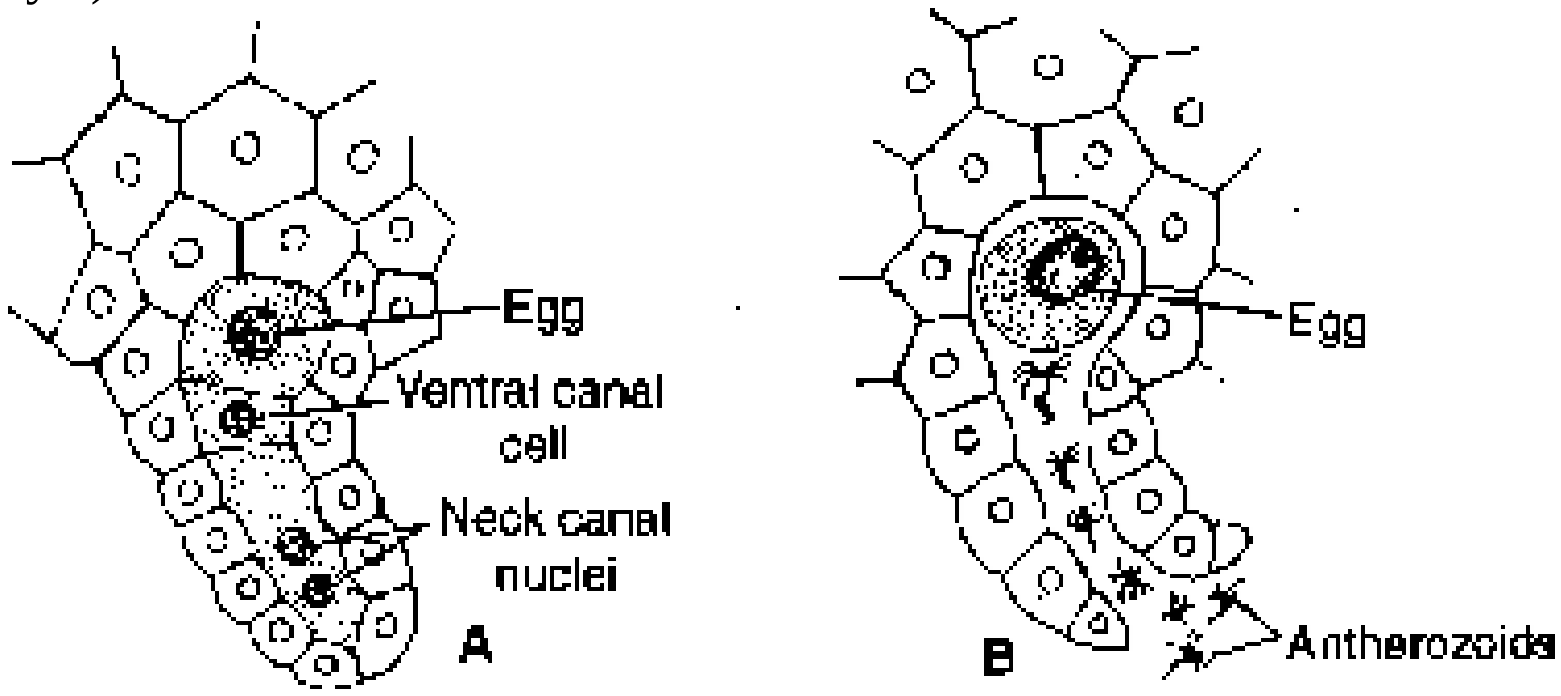
•**Archegonium** : This is the female sex organ. Archegonia develop towards the lower surface of Prothallus in the cushion region.

•Each archegonium is sessile with a flask-shaped body. It is differentiated into basal globular venter and a tube shaped neck. The venter is embedded in the tissue of cushion but the neck projects out towards the soil. It is slightly curved. The venter cavity contains a female gamete called an egg (n) cell and a smaller venter canal cell. The neck cavity contains one neck canal cell with two nuclei.



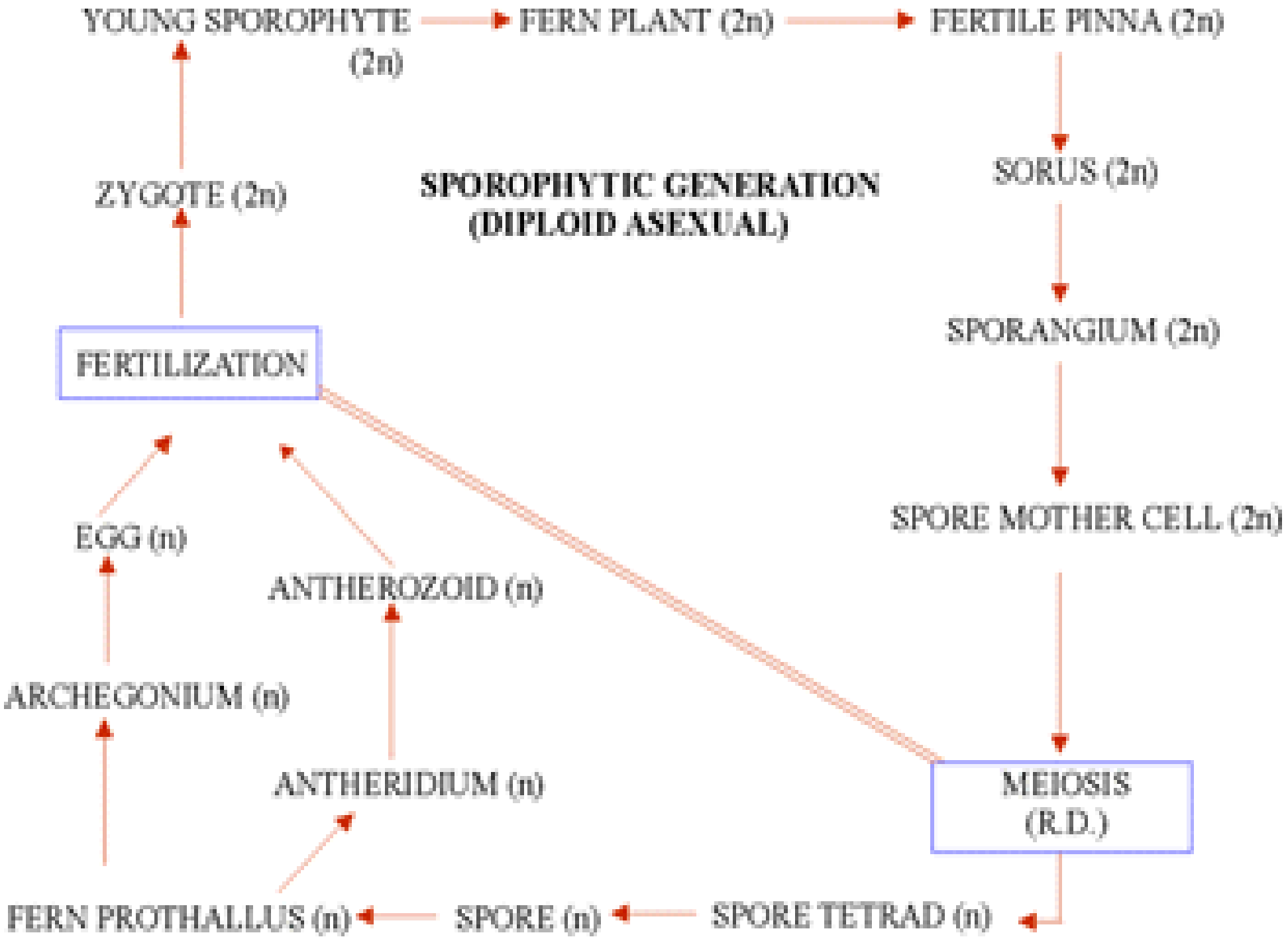
•The neck of the mature archegonium opens in presence of water. The venter canal cell and the neck canal cell disintegrate. Their contents form a substance similar to mucilage which comes out through the open neck. Mucilage contains malic acid which attracts the antherozoids for fertilization. This phenomenon is called chemotaxis.

.Fertilization: Many antherozoids may enter the open archegonium. However, only one fertilizes the egg. This results in the formation of a diploid zygote (fertilized egg) in the venter cavity. Haploid gametophytic generation ends with fertilization (Fig. 15.6B). The diploid zygote (2n) starts a new sporophyte generation and develops into a fern plant (adult sporophyte).



Alternation of generations

- The sporophyte (diploid) and the gametophyte (haploid) generations in fern are produced in alternate succession one after the other. This phenomenon is called alternation of generations. Meiosis and gamete fertilization are the two important events which regulate this phenomenon. As the sporophyte (fern plant) and gametophyte (prothalths) are morphologically dissimilar, it is described as a heteromorphic alternation of generations.
- The sporophyte generation ends when diploid spore mother cells divide by meiosis and produce haploid spores. The spore starts the gametophyte generation. This generation ends when the haploid gametes fuse during fertilization and form a diploid zygote. The zygote again starts a new diploid generation. Alternation of generations is represented schematically in the life cycle of a fern .


YOUNG SPOROPHYTE (2n)
FERN PLANT (2n)
FERTILE PINNA (2n)
SORUS (2n)
SPORANGIUM (2n)
SPORE MOTHER CELL (2n)
MEIOSIS (R.D.)
SPORE TETRAD (n)
SPORE (n)
FERN PROTHALLUS (n)
ANTHERIDIUM (n)
ARCHEGONIUM (n)
ANTHEROZOID (n)
EGG (n)
FERTILIZATION
ZYGOTE (2n)
SPOROPHYTIC GENERATION
(DIPLOID ASEXUAL)

Quiz

- Gameophyte of Nephrolepis is otherwise known as
- a) Antheridium b) Male gamete c) Prothallus d) Antherozoid
- 2. When a mass of parenchyma found in the centre xylem, the stele is called
- a) Dictyostele b) Solenostele c) meristele d) actinostele
- 3. Multicellular prawn hairs or scales found on the rachis are called
- a) scale leaves b) ramenta c) vernation d) cirinat
- Fill in the blanks
- 1. A cluster of sporangia is known as .....
- 2. The outermost cell layer that covers root is called .....
- 3. The egg of Nephrolepis gametophyte is found in the..... of
- archegonium.
- 4. The gametophyte of Nephrolepis is attached to the soil with the help of

Reference

- https://www.toppr.com/ask/question/sketch-and-label-the-figure-of-the-following-plant-and-explain-them-into-brieffern/
- http://pinkmonkey.com/studyguides/subjects/biology-edited/chap15/b1515104.asp
- https://www.entrancei.com/chapter-plant-kingdom-class-11/dryopteris
- https://walkaboutem.com/2012/10/11/fern-sex/
- https://regi.tankonyvtar.hu/hu/tartalom/tamop412A/2011-0073_structure_of_plants_fungi/ch04s04.html