PTERIDIUM → Monotypic genus

SYSTEMATIC POSITION :

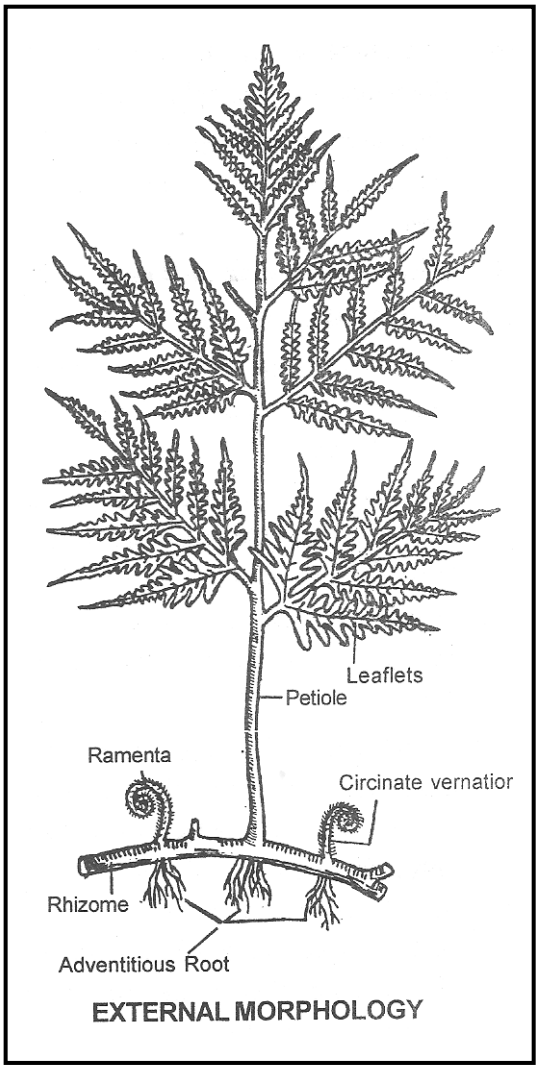
Kingdom — Plantae
Sub Division — Embryophyta
Division — Tracheophyta
Class — Pteropsida
Sub Class — Filicineae
Order — Filicales
Family — Polypodiaceae
Genus — **Pteridium**
Species — **Pteridium aquailinum**

Common name - "Sun Fern" or "Bracken fern

HABITAT AND HABIT :

- Ferns are commonly grow in **moist** and **shady** places.
- They shows **'gregarious'** habit. this habit is due to **vegetative reproduction.**
- It can be grow in the presence of **less moisture** and **high light** so it is called **"Sun fern"**

External Morphology :



EXTERNAL MORPHOLOGY

- The plant body of Pteridium is **sporophytic** and it is differentiated into **root stem** and **leaves**. Root and stem are underground and leaves are aerial. Plants are **perennial.**

(i) ROOT :

- The primary root is short lived. It is soon replaced by **adventitious** roots which develop from the stem in **Acropetal** manner.
- the adventitious roots are thin, small, soft and less branched.
- They are **endogenous** in origin.

(ii) STEM (Rhizome) :

- The stem of fern is **underground rhizome.**
- Rhizome grows **horizontally** in the soil. The main stem is **dichtomosly** branched.
- The young rhizone particularly covered by multicellular brown hairs called as **ramenta.**

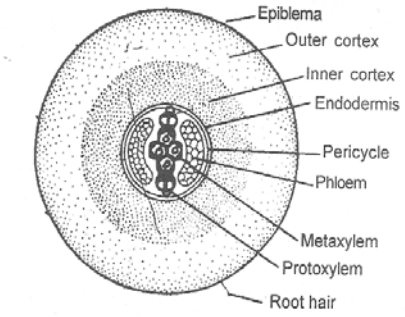
(iii) LEAVES :

- Pteridium is a **megaphyllous** plant. It's large leaf is known as **'frond'**
- The leaves may be 2-12 feet long (height) and in each leaf, the petiole and lamina are almost equal in lenght. They are developed on rhizome in **alternate** manner.
- Leaf lamina is divided into number of **leaflets.** The leaves are **compound, bipinnate and impartipinnate.**
- The young leaf shows typically **open furcate venation.** (The bifurcation of veinlets without attachement, at the anterior end is called open furcated venation)

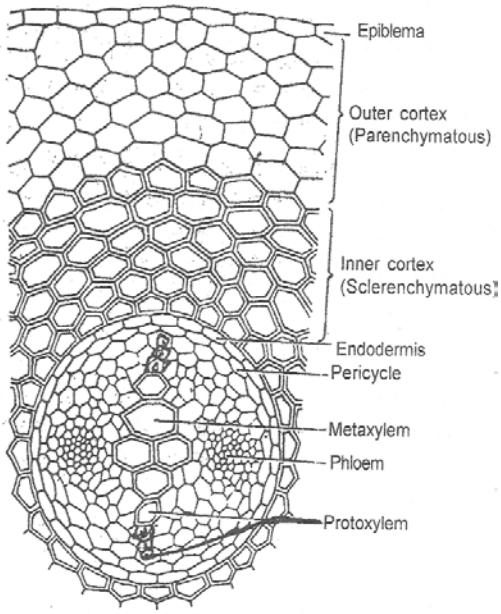
- In these leaves, The young leaves of Pteridium are curled. **Circinate ptyxis** is found. Each young leaf open from the base to apex. Ramenta are also present on young leaves.

(I) INTERNAL STRUCTURE OF ROOT :

- In the transverse section the root appears approximately like a dicotyledons root.
- The outermost layer is called **epiblema**. It possesses unicellular root hairs.
- Below the epiblema there is a broad cortex is present which is differentiated into two zones -
  (i) **outer cortex** which is made up of **parenchymatous** cells.
  (ii) **Inner cortex** which is composed of **sclerenchymatous** cells.
- In the centre a stele is present which is surrounded by single layered **endodermis.** Below the endodermis **pericycle** is present which is **one of** two layered and made-up of thin walled **arenchymatous** cells.
- The **stele** is **diarch** with two xylem bundles alternating with two phloem bundles.
  The xylem is **exarch** in position. The xylem is without vessels and phloem lacks **companion cells.**
- **Seconary growth is absent in ferns root :**



[Pteridium : T. S. of Root Internal Structure]

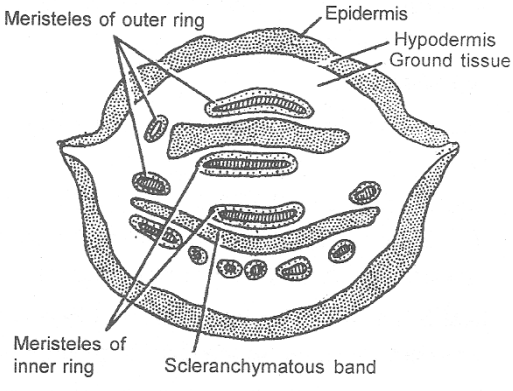


[Pteridium : T. S. of Root-Out line diagram]

(II) INTERNAL STRUCTURE OF RHIZOME :-

In a transverse sectioin the rhizome of **Pteridium** appears somewhat **ablong** being filattnaed dorsiventrally.

- The outer layer is termed as **epidermis**. Inside the epidermis, three-four layers of **sclerenchymatous hypodermis** is present. Whic is **broken** at **two** ends (Points). At these points, the parenchyamatous cells of ground tissues reaches directly up to the epidermis.
- Hypodermis is followed by parenchyamatous **ground tissues** in which two rings of **meristeles** are present. The stele is **polycylic dictoyostele** or **polystele** or Dictyostele type.
- Both the rings of meristele are separated by **two plates** of **sclerenchyama** in dorsiventral position.
- The meristeles of outer ring are smaller in size and more in number, while there are two or three large meristeles are present in inner ring.



T.S. of Rhizome

Meristele :

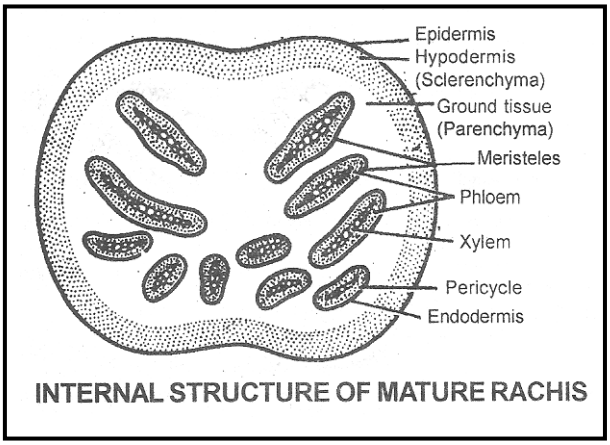
- Each meristele is surrounded by a single layered endodermis.
- Below the endodermis one or two layered parenchyamatous perichycle is present.
- Xylem forms the central core of the meristele, which is **mesarch** in position, ie. protoxylem is surrounded by metaxylem.
- Vessels in xylem and companion cells in phloem are absent.
- In meristeles vascular bundles are **concentric** and **amphicribral** or **hadrocentric type.**
- Meristele is a complete stele because it has its own pericycle, endodermis, Xylem and phloem.
- **Secondary growth in absent in rhizome due to absence of vascular cambium.**

(III) INTERNAL STRUCTURE OF LFEAF :

It is differentiated into rachis and leaf let (pinnules)

(a) Rachis : In a transverse section the young rachis in hemispherical in shape.

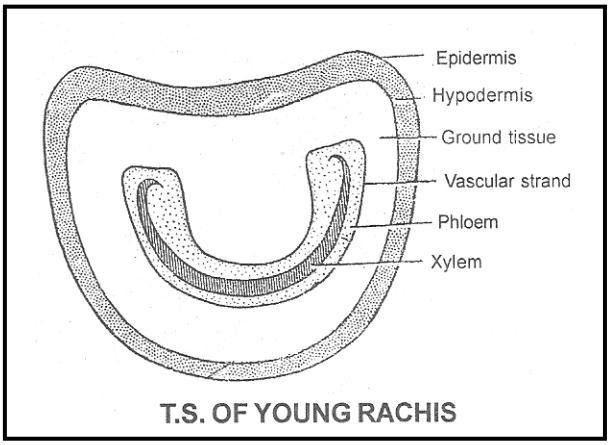
- The outermost layer is **epidermis.**
- Below the epidermis a few layers of thick walled cells forms the **sclerenchymatous** hypodermis.
- Many meristele are arranged in the mature rachis of **Pteridium** in **horse-shoe shaped.**
- In each meristeles vascular bundles re **concentric, amphicribral** and **mesarch.**



INTERNAL STRUCTURE OF MATURE RACHIS

(b) Leaf lef/pinnules :

- Mesophyll is present between two epidermal layers and mesophyll differentiated into palisade and spongy tissue.
- the stomata are present on lower epidermis.
- The epidermal cells of leaf lets also bears **chloroplast** and **concentric** vascular bundles are present in **Pteridium** leaf lets.



T.S. OF YOUNG RACHIS

Note :

1. In **Dryopteris leaf,** mesophyll is not differentiated into palisade and spongy tissue.
2. In **Dryopteris** elaf, **bicollateral** vascular bundle are found in **large veins** where as in **small veins collateral** vascular bundle are present.

REPRODUCTION :

- Three different types of reproduction - **Vegetative by spore formation and** sexual are found in Pteridium.
- The main plant body represent sprophytic phase and reproduced by **vegetative** and **by spore formation.**
- **Sexual reproduction** only takes place in **gametophytic phase** i.e. in the **prothallus.**

(I) Vegetative Reproduction :

(a) By death and decay method :

- Vegetative reproduction takes place through **underground rhizomes.**

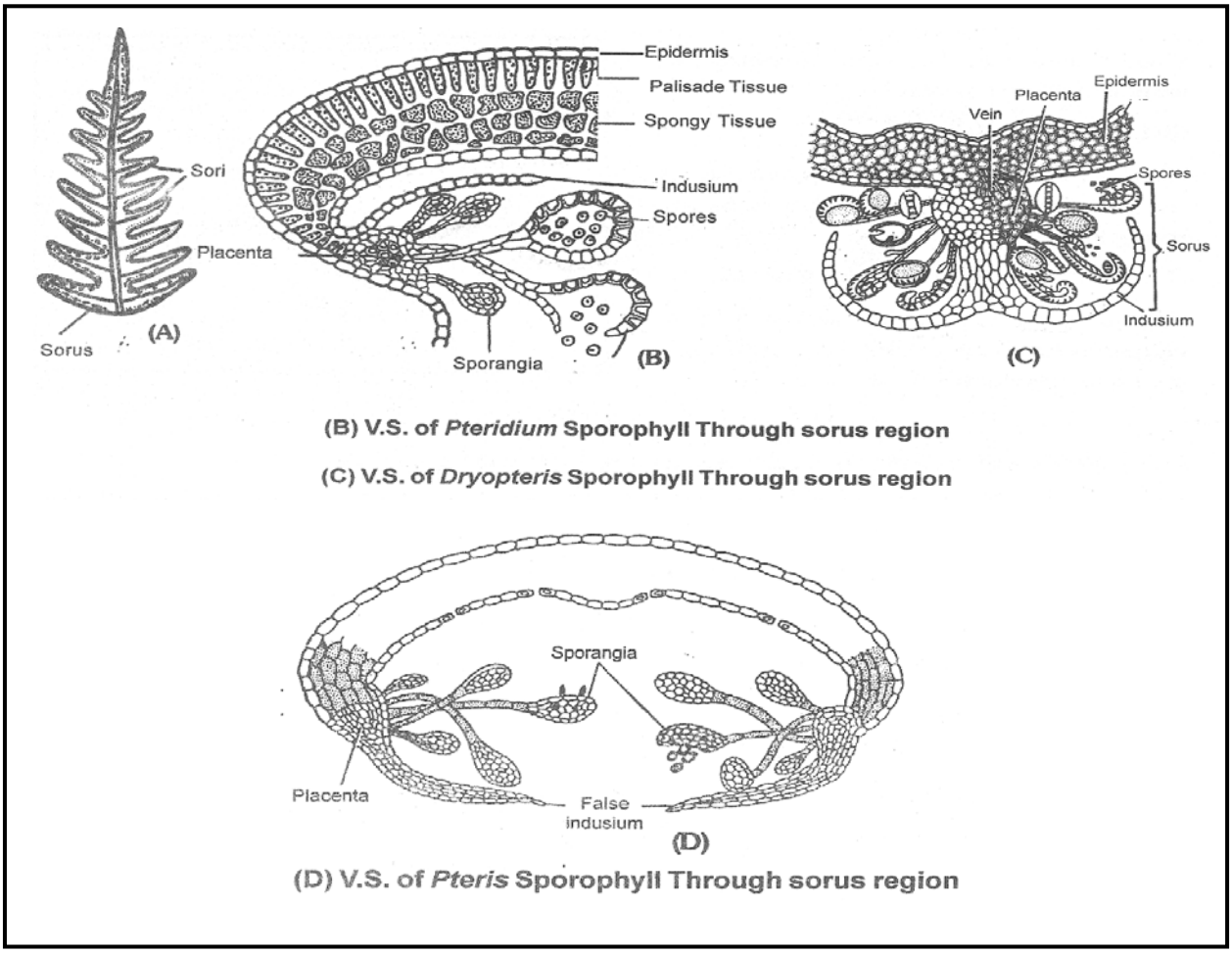
- The rhizome is **dichotomously** branched and grows indefinitely. When the death and decay of rhizome reaches upto the point of dichotomy, both the branches are separate and each grows into a new plant.
- this method is responsible for the **gregarisous** habit of plant.

(b) By adventitious buds : Sometimes a **bud** is formed in the axis of **persistent leaf base.** These buds separate and grow into a new plants.

(III) By spore formation :

- The main plant body of **Pteridium** is **sporophytic** and **reproduces asexually** by the **formation of sproes.**
- The sporesof Pteridium are of one type and this condition is tamers as **homospory.**
- **Leaf let/fronds** at maturity bears small, rounded reniform brown or black coloured spots, called **sori.** Sori bearing fronds are called as **sprophyll.** The sporophylls of **Pteridium** are **photosynthetic** in nature.
- Each sorus consits of mnay **biconvex** stalked bodies called **sporangia** borne on parenchymatous **placenta.**
- **Each sorus** is protected by a covering sheath called **industium** which may be true or false on the basis of origin.
- **A true indusium** arise form the **placenta,** wherease a **false indusium** does not arise from the placenta but it is formed by **curved marign** of the sporophyll.
- Each sorus bears large number of sporangia and each sporangium produce many spores.

Position and Form of sori :



(B) V.S. of *Pteridium* Sporophyll Through sorus region

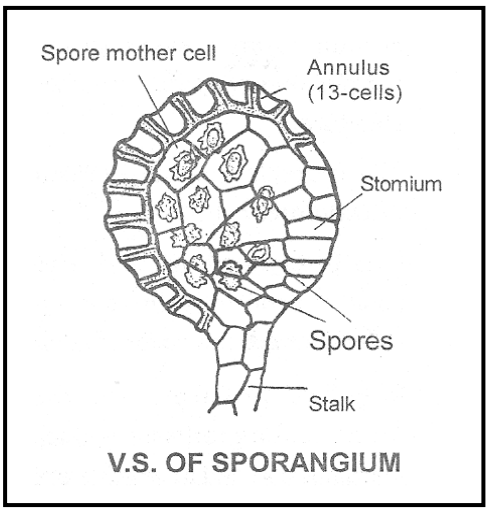
(C) V.S. of *Dryopteris* Sporophyll Through sorus region

(D) V.S. of *Pteris* Sporophyll Through sorus region

- Each sporangium develop on the **abaxial (Lower)** sufrace of the leave
- the sprorangia srises in the groups i.e. in the form of **sori.**
- These **sorus** develops continuous, linerly arranged along an the margin of leaves is termed as **continous linear sorus** or **coenosorus**
- These sorus lies on the maring of sporophylls teremed as **"marginal sorus"**
- Each sorus is covered by **a bilooped indusium.** The main function of indusium is the protection of sori. Outer indusium is alarge and false. It is formed by curved margin of the sprophyll.
- Innter indusium is small and true and it is arises from the placentra.

Note: **(1)** First of all **Bower** studies the development of **sorus.**
(2) Pteridium is a **Leptosporangiate** type of fern. it means each sporogangium develops from a s **single initial cell.**
(3) In **Adiantum, Pteridium & Pteris** sori are marginal but in **Dryopteris** and **Nephrolepis,** sori are arranged in two rows, one of eitehr side of mid rib/vein.
(4) In **Adiantum** and **Pteris** False indusium is found whereas in **Dryopteris** and **Nephrolepis,** true indusium is found.

Structure of Sporangium :

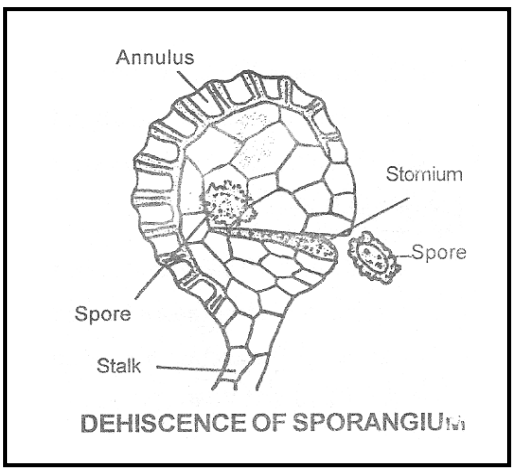


V.S. OF SPORANGIUM

- A sporangium has a long narrow, slender multicellular **stalk** usually composed of **three vertical rows** of cells and a sporangial body of **capsule.**
- The capsule is **oval** or **biconvex (mostly).**
- Sporangium is surrounded by a single layered sterile cell, called **Jacket.**
- The radial and inner walls of the cells of specialized row of jacket becomes heavily thickened while their under tangential wall remain thin.
- these ells constitute the **"annulus".** Which starts from the base of the capsule on one side, run upwards curve on the other side and ceases almost ner the middle.
- Annulus is covered about **3/4 part of the sporangium.** Below this, the cells of marginal row are thin walled and parenchymatous, constitute the **stomium.**
- The annulus and stomium together help in dispersal of spores and dehiscence of sporangium. Sporangium break at the place of stomium during dehiscence of sporangium.
- The cavity of capsule contain **8 or 16 spore mother cells** or **sprocyte** which is **diploid.**
- Spore mother cells divide meiotically to produce **32 or 64** haploid spores.

Dehiscence of sporangium:

- Dehiscence of sporangium takes place in **dry season.** When the sporangium mature, the indusium dries and shrivels exposing the sporangia to dry air.
- In dry weather, the annulus Cells of the sporangial wall loose moisture, diries up and **shrink.** The radial and tangential wall of annulus re thick so they do not shrink or bend easily. But **outer wall** of **annulus** is mainly **thin** which curve **inwards** and becomes **concave.** This carving inwards of the thin walls exerts pulling force on **annulus** cells.
- Due to this **pulling force** (tension) thin cells of stomium tear up. So that a **fissure** once started from the region of stomium and ultimately reaches up to the base of annulus on the opposite side of stomium.



DEHISCENCE OF SPORANGIUM

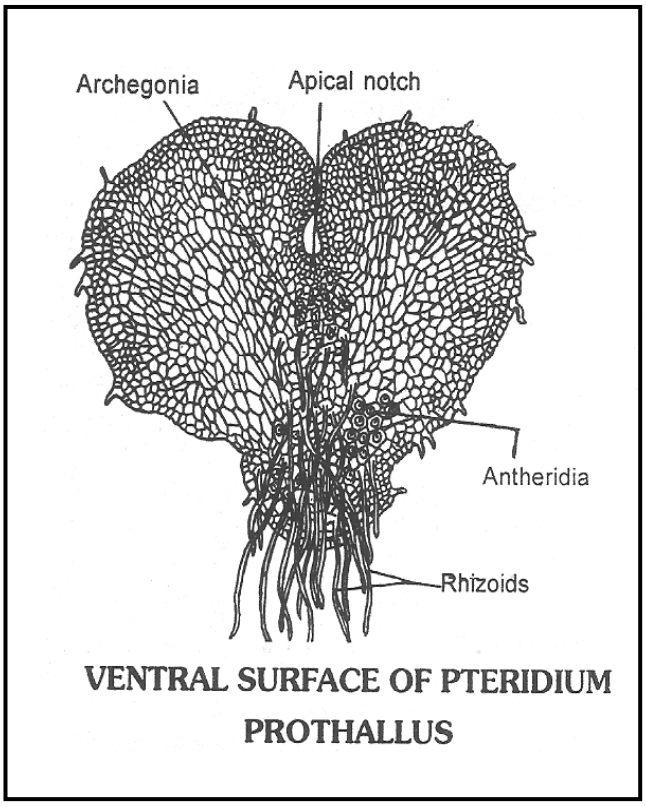
- Due to the pulling force the **entire annulus** turns into the back side Along the annulus most of the spores are attached. The space is created by loose of water is filled **by air** and saturate. Because of this **pulling force** suddenly released from the annulus and annulus immediately comes in original position with a great force. The spores are attached on annulus, during this time are thrown away. Dispersal of spores in **Pteridium** by **"Catapult mechanism"** (By annulus).

SPORES :

- The gametophytic pahge begins with the formation of spres which are **tetrahedral.**
- The spore wall or coat is sually to layered - **The outer layer** which is brown in colour called **exspore** or **exosporium** or **exine**. It is thick and ornamented**. The inner** layer is thin and delicate. It is termed as **endospore** or **endosporium** or **intine.**

PROTHALLUS

- Under the favourable conditions of moisture and temperature the spores germinates of spore. Prothallus is a **heart shaped** structure
- The prothallus is thin, delicate flat, short lived and **dorsiventral** structure.
- It is **independedn** and autotrophic. It is free (independent) from the spprophytic generation. Itis **unvranched .** Diameter of adult prothallus is **3-8mm.**
- It grows prostrate on the soil. The middle region of the prothallus is thick and thin towards the marginal side and in which a apical notch's is present at the anterior end.
- A apical cell is present in the apical notch by which growth takes place in the prothallus. It is **nonvascular.** Unicellular and unbranched **rhizoid** are located on the ventral surface of the **prothallus.**
- They fix the prothallus with the substratum (soil). Sex- organs are developed on the ventral su rfae of the prothallus. Prothallus is a **monoecious** which bears both sex organs- **Antheridia** and **Archegonia.**
- Archegonia borne of prothallus near the apical notch, while the antheridia are developed in the posterior region in between the rhizoids.



VENTRAL SURFACE OF PTERIDIUM PROTHALLUS

Main point

(i) Antheridia matures before the archegonia ie. prothallus is **protandrous.**

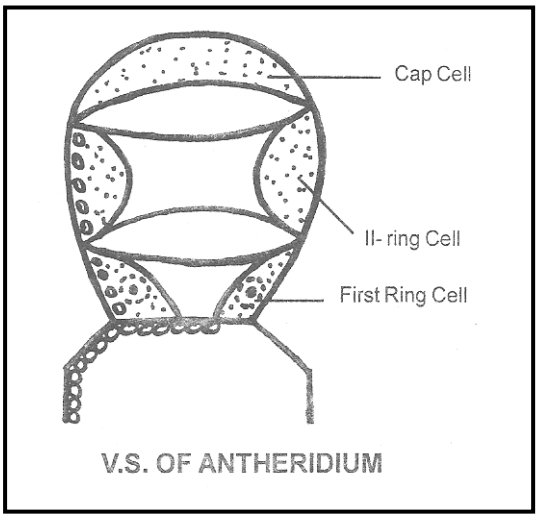
(ii) Always cross fertilization takes place in **Pteridium.**

(iii) Fertilization takes place between the genetically similar gametes in **Pteridium.**

Antheridium :

- Antherdium of **Pteridium** is simpler than **Riccia.** The presence of antheriudium is the primitive character.
- Antheridium of **Pteridium** is a small **sessle** spherical structure.
- The jacket of the antheridium is composed of three cells. The two cells of the jacket lying one above and the other forming the base.

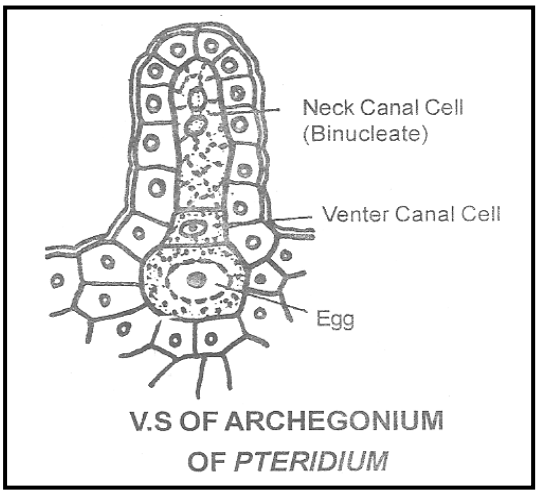
- The lowest and middle cells are called **I-ring cell** and **II-ring cell,** respectively. The upper or apical cell is called **cap cell** or **operculum** forming the top portion of the jacket.
- Inside the antheridium there are **20-50 androcytes** or **antherozoid mother** cells are present which are responsible to form **spirally coiled multiflagellate antherozoids.**
- Dehiscence of antheridium takes place in the presence of **water.**
- When the antheridium fully mature and water in available, its mucilage which is present in the cavity of antheridium, absorb moisture and swells up, resulting, the opening of the lid like cell at the top.
- The antherozoids liberated and after coming in contact with water, they swim freely.



V.S. OF ANTHERIDIUM

Archegonium :

- Archegonium is **flas-shaped sessile** structure. It swollen venter embedded in the tissue of prothallus and short, curved neck projecting above the prothallus. Jacket is only found in neck region. Jacket of nexk region is made up of **four vertical rows** of neck cells.
- The venter has a large **ovum** or **egg** and a small **venter canal cell.**
- In the cavity of the neck there is a **single long neck canal cell** which is usually **binucleated** and **cover cells are abets** at the apex of neck.



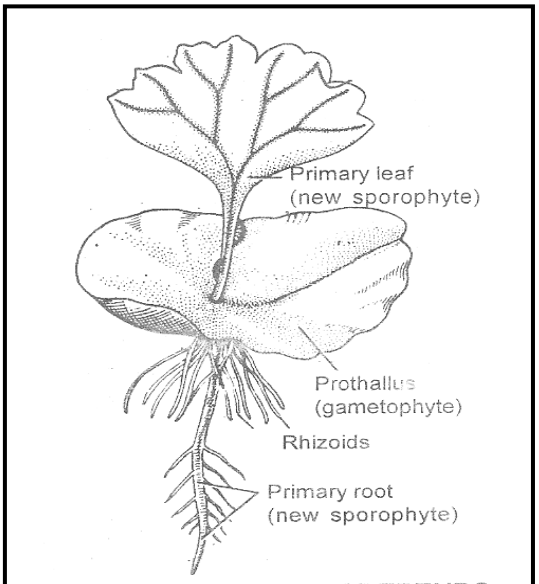
V.S OF ARCHEGONIUM OF *PTERIDIUM*

FERTILIZATION :

- Fertilization takes place in the **presence of water.**
- Just before the fertilization the **venter cnala cell** and **neck canal cell** of the archegonium disintegrate forming a mucilagenous substnace which absorbs moisture, resulting the opening of mouth of the neck.
- Some of the mucilage oozes out at the tip of the archegonium and attracts the antherozoids on account of certain organic substance like **malic acid** present in it.
- As a result of **chemotactic** response and lashing movement of cilia, some of the antherozoids enter the rchegonium and ultimately one of them fuse with the egg. This fertilized egg is termed **oospore** or **zygote.**

Embryo and its development :

- Zygote (oospore) is the first cell of the sprophytic generation.
- The oospore **first divide** by a **vertical** disivion nearly parallel to the long axis of the archegonium.
  Which divide the oospore into two half an **Anterior** or **epibasal** cell 9lying towards the notch of the prothallus) and **Posterior** or **Hypobasal cell** (lying towards the posterior end). Second division also vertical but at right anle to first one so that **four-celled.** stage embryo is formed.



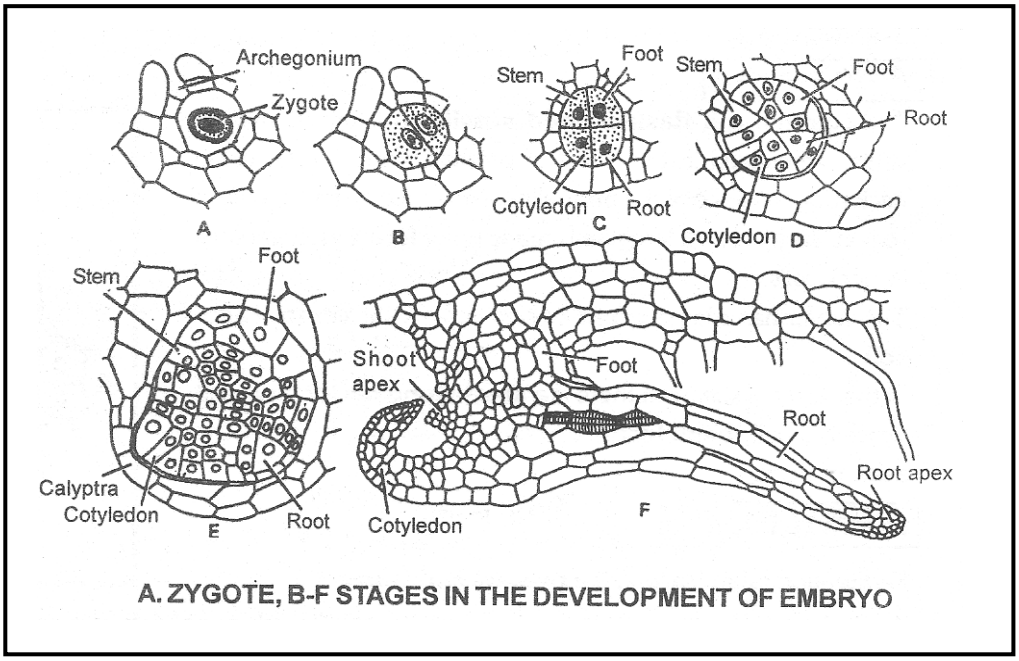
YOUNG SPOROPHYTE DEPENDS UPON GAMETOPHYTE

- There are **two epibasal** or **anterior cells** and **two hypobasal** or **posterior** cells. This stage known as **quadrate stage.**
- Third division is **transverse** and therefore eight cell are formed. This is known as **octanct stage**. Therefore, two cells **inferior hypobasal,** two cells **inferior epibasal,** two cells **superior epibasal,** and two cells **superior hypobasal** are formed. The superior epibasal cell **superior hypobasal** are formed. The superior epibasal cells gives rise to **apical bud** of the stem.
- Both **inferior epibasal cells** give rise **cotyledon.** Both the **superior hypobasal cells** giving rise to the **foot.** Foot is embedded in the prothallus and help in providing nourishment to the embryo. The young sprophyte depends upn **gametophyte.** Both the **inferior hypobasal** cells gives rise to radicle. The radicle grows firt and pierce into the soil and form the **primry root.** Firtly, the priamry root comes out form the prothallus but it is short-lived, it soon dies and it is replaced by **adventitious root** developed from the stem.
- The cotyledons and apical bud of stem comes out into the air from the lower surface of the gametophyte. Plumule grows imediate to form a undergournd **rhizome.** Foot and prothallus dies later on.

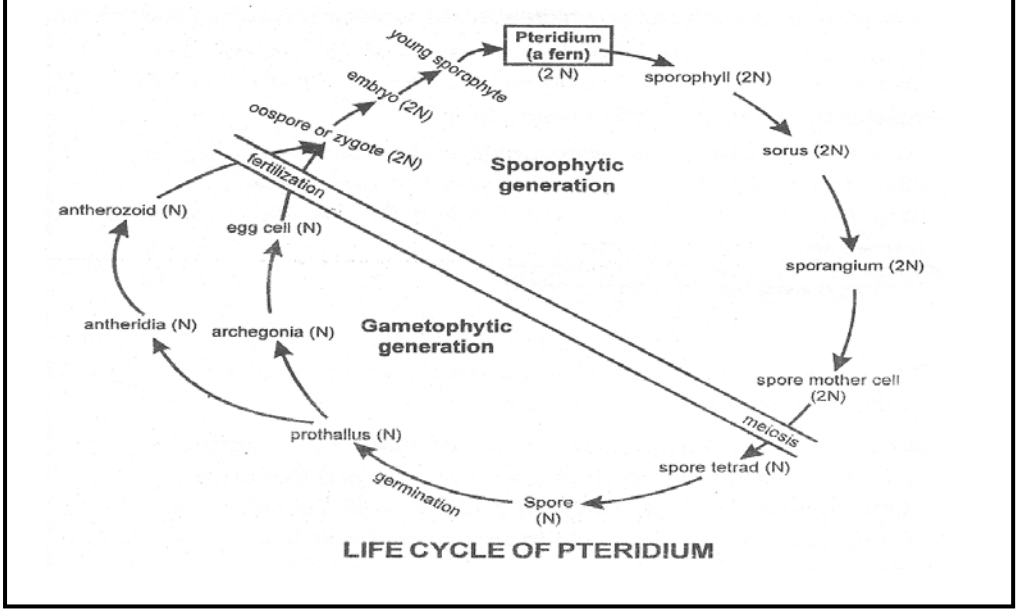
Note :

1. **Lateral polarity** is exhibited by the embryo of ***Ptreridium.***
2. The venter of the archegonium form a protective covering, called calyptra, around the developing embryo.,

- **Primary leaves** are simple and lives for one year and later it dies off. Later on special leaves arises form the rhizome. New leaves are developed each year.
- Old learves left the **leaf-base.** If **1** leaf-bs are present in **Dryopteris** then the age will be **11 years.** Because in first year plant bears simple leaves.



A. ZYGOTE, B-F STAGES IN THE DEVELOPMENT OF EMBRYO



LIFE CYCLE OF PTERIDIUM

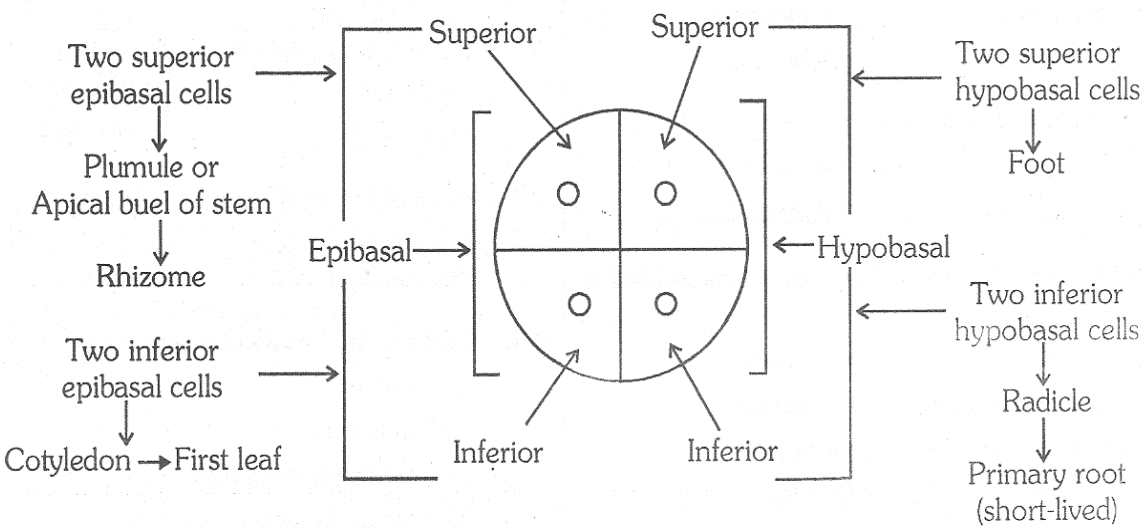
ALTERNATION OF GENERATION :

- Independent alternation of generation is found in **Pteridium.**
- Its life cycle has two independent phases are present. Out of them one is main plant which is sprophyte. This reproduces spore formation. A haploid gametophyte plant body **prothallus** develops from the germination of spore.
- Gametophytic generation begins from the spores till to the formation of the gametes.
- Sprophytic generation begins with **zygote or oospore** formation and pore mother cells are lst cell of sporophytic generation.
- the life cycle of **Pteridium** is known as **Diplo-haplontic type.**

Note : [In Diplo-haplontic type of life cycle pattern the diploid sporophyte is represented by a dominant, independent photosynthetic, vascular plant body. It alternate with multicellular independed but short lived hapolid gametophyte.]

IMPORTANT POINTS :

1. **Dryopterix filix - mas :** male shield fern/Beech fern/Hay scented fern.
2. Sympodial branching found in **Pteridium** rhizome
   Branches are three types :
   Long shoots, Short shoots, Intermediate shoot.
   Short shoots bear fronds
3. In **Pteridium** at the base of each leaf let **a nectary** is present.
4. Main features of ferns :
   1. Presence of rementa on young leaf and rhizome
   2. Circinate ptyxis of young leaf.
5. In Zygote/oospor of Pteridium and Dryopteris :
   I & **II** vertical division (at right angle to each other) & **III**- Transverse
6. In **Dryopteris** & **Pteridium** roots are **Diarch.**
7. In **Drypteris** meristeles are arranged in **one ring** where as in **Pteridium** meristeles are arranged in **two rings.**
8. **Pteridium, Dryopteris, Psilotum** & **Equisetum** re **homosporous** plant.
9. Hetermorphic alternation of generation is found in **Pteridium, Funaria** and **Dryopteris** etc.
10. **Pteridium, Adiantum, Nephrolepis** (Sword fern) & **Dryopteris** etc. are leptosporangiate fern.
11.



12. **Megaphyllous pteridophytes -** with large pinantified leaves having a complex series of vein : They form prominent leaf gaps in the stem stele.
    eg. **Pteris, Pteridium and Dryopteris.**

PTERIDIUM EXERCISE

1. Which of the following venation is characteristic of fern
(1) Parallel
(2) Reticulate
(3) Open and furcated
(4) Closed and dichotomous

2. The most imporant characteristic of a fern plant is
(1) Circinate pinnules
(2) Photosynthetic sprophyll
(3) Compound leaves
(4) Spores in sprorangia

3. the stele of **Pteridium** root is :
(1) Dirch, exarch (2) Diarch, endarch
(3) Polyarch, exarch (4) Polyarc, endarch

4. Meristele of **Pteridium** is :
(1) Collateral
(2) Concentric and leptocentric
(3) Bicollateral and leptocentric
(4) Amphicribral and mesarch

5. Sori of **Pteris** and **Pteridium** are :
(1) Continous and linear
(2) Discontinous and circular
(3) Discontinous and reniform
(4) Discontinous and vermiform

6. Protective structure of fern sorus is :
(1) Ramenta (2) Indusium
(3) Tapetum (4) Stomium

7. The shape of tern sporangium is :
(1) Bi-concave (2) Bi-convex
(3) Plano-convex (4) Plano-concave

8. Which combination of characteristics is correct for a fern sproangium -
(1) Sessile, Unicellular, non-jacketed
(2) Stalked, unicellular, non jacketed
(3) Sessile, multicellular, non jacketed
(4) Stalked, multicellular, jacketed

9. Which of the following statements is not correct for **Pteridium -**
(1) Young sprophyte is parasite of gametophyte
(2) Free alternation of generation
(3) Exhibits a step in evolution of seed habit
(4) Gametophyte is parasite on sporophyte

10. In **Pteridium** cross fertilization take place due to
(1) Protandry (2) Protogyny
(3) Dicliny (4) Monocliny

11. In **Pteridium,** antheridium and archegonium are respectively.
(1) Stalkless and stalked
(2) Stalked and stalkles
(3) Both stalked
(4) Both stalkless

12. Embryonal leaves of **Pteridium** are
(1) Simple
(2) Bipinante-Peripinnate
(3) Bipinnate-Imperipinante
(4) Unipinnate

13. True and false indusua can be differentiated on the basis of
(1) Origin (2) Function
(3) Structure (4) All the above

14. Stem of **Pteridium** is
(1) Vertical in soil (2) Horizontal in soil
(3) Tuber like (4) Sub-aerial

15. Dehiscence of sporangium in pteridium take place
(1) In dry season by water loss
(2) In wet season by water absorption
(3) By mucilage formation
(4) Any of above

16. In Fern stem xylem is
(1) Exarch (2) mesrch
(3) Endarch (4) Polyarch

17. Neck of the archegonium of fern is
(1) Long & straight
(2) Short and straight
(3) Long and curved
(4) Short and curved

18. Leaf-gap in the vascular cylinder in fern is
(1) Air space
(2) Parenchymatous zone
(3) Collenchymatous zone
(4) Area exclusively of phloem

19. The ferns are usually found in
(1) Near marshy places
(2) Marshy placed
(3) Moist and shady places
(4) Dry climate

20. The sori bearing leaves of pteridium are known as
(1) Aphylls (2) Sporophylls
(3) Tropophylls (4) Sclerophylls

21. The chief characteristic of fern leaf is that they
(1) Have remnta
(2) Are microphyllous
(3) Have rementa and circinate vernation when young
(4) Are simple

22. In **Pteridium** the root are
(1) Tap root
(2) Adventitious roots
(3) Rhizoids
(4) Coralloid

23. In **Pteridium,** main plant body represents
(1) Sprophytic generation
(2) Gametophytic generation
(3) None of the above
(4) May be sprophyte

24. The **Prothallus** of pteridium is
(1) Kideny - shaped
(2) Club-shaped
(3) Heart shaped
(4) Flask shaped

25. The stem and petiole are covered with numerous brownish scale like structure which are called
(1) Root hair (2) Hairs
(3) Ramenta (4) Scales

26. The **Pteridium** plant is
(1) Homosporous
(2) Heterosporous
(3) None of the above
(4) May be Heterosporous or Homosporous

27. the prothallus of **Pteridium** represents
(1) Sporophytic generation
(2) Gametophytic generation
(3) Both of the above
(4) Asexual stage

28. The sex organs that develop towards the rhizoids of tern prothallus are called as -
(1) Archegonia
(2) Antheridia
(3) None of above
(4) Sporangia

29. In **Pteridium** the archegonia are present
(1) Near rhizoid on lower surface
(2) Near anterior notch on lower surface
(3) Distributed on whole surface
(4) On posterior end of prothallus

30. The stele of **Pteridium** is a
(1) Dictyostele (2) Eustele
(3) Siphonostele (4) Protostele

31. The sori of pteridium are covered by a thick multicellular covering known as
(1) Indusium (2) Ramenta
(3) stele (4) Sclerenchyma

32. The sori in pteridium are found on
(1) Lteral surface of sporophyll
(2) Abaxial surface of sporophyll
(3) Adaxla surface of sporophyll
(4) On the margins of leaves

33. The capsule of sporogonium of fern contains
(1) 32 or 64 spores
(2) 8 spores
(3) 128 spores
(4) 16 spores

34. The capsul of fern sporangium brust at a place called
(1) Annulus
(2) Stomium
(3) Placenta
(4) Ramenta

35. Which of the following is not involved in the fertilization of ferns
(1) Pollen tube
(2) Water
(3) Archegonium
(4) Flagellated antherozoids

36. Pteridium prothallus normally is
(1) Haploid (2) Diploid
(3) Teraploid (4) Triploid

37. The major role in the dehiscence of a fern sporangium is played by its
(1) Indusium (2) Annulus
(3) Stomium (4) None

38. Spores of **Pteridium** are
(1) Haploid (2) Diploid
(3) Tetraploid (4) Hexaploid

39. In the archegonium of **Pteridium** the number of neck-canal cell is/are :
(1) (2) 2
(3) 3 (4) 1

40. Prothallus of pteridium bears
(1) Sporangia
(2) Sex organ
(3) Both sporangia and sex organ
(4) None of the above

41. Formation of sprophyte from a vegetative portion of prothallus is called
(1) Apocarpy (2) Apogamy
(3) Apomixis (4) Apospory

42. Sex organ in prothallus develop on
(1) Dorsal surface
(2) Lateral surface
(3) Ventral surface
(4) Dorsolateral surface

43. The ferns in which the entire sporangium develops form a single superficial cell of the sporophyll are known as
(1) Lepto sporangite
(2) Eusporangiate
(3) Unisporangiate
(4) Mesosporangiate

44. Distinct alternation of generation is found in
(1) **Mucor** (2) **Riccia**
(3) **Pteridium** (4) **Ulothrix**

45. In **Pteridium** meiosis occurs when
(1) Spores are formed
(2) Gametes are formed
(3) Prothallus is formed
(4) Sex organ are formed

46. Structures that produce gametes in prothallus are
(1) Anther and archegonia
(2) Ascogonium and anther
(3) Antheridia and archegonia
(4) None of these

47. Young sprophyte of pterdium draws nourishment from prothallus through
(1) haustorium (2) foot
(3) root (4) rhizoids

48. Pteridium phloem lacks
(1) Sieve cell (2) Companion cell
(3) Phloem parenchyma (4) All of the above

49. The heart shaped prothallus of **Pteridium** always
(1) Monoecious
(2) Dioecious
(3) Both monoecious and dioecious
(4) Not certain

50. The xylem of stele of **Pteridium** is made up of
(1)Vessels
(2) Tracheids
(3) Tracheids and xylem parenchyma
(4) None of the above

51. Fern plant are
(1) Ornamental
(2) Of medical value
(3) Of food value
(4) Of no particular value

52. Indusium of **Pteridium** is
(1) Outer false & inner true
(2) Outer true & inner false
(3) Only true type
(4) Only false

53. An indusium is said to be true if it originates form
(1) Sorus region
(2) Extra sorus region
(3) Stelar region
(4) Rhizome

54. In **Pteridium** the annulus is
(1) Transverse (2) Oblique
(3) Vertical (4) Horizontal

55. Prothallus of fern is
(1) Dioecisou (2) Protadrous
(3) Gyanandrous (4) None of these

56. Fern prothallus is
(1) Heterothallic
(2) Hetermorphic
(3) Heterotrophic
(4) Homothallic

57. The sex organs of **Pteridium** which develops on ventral surface of prothalli & intermigled with rhizoids are
(1) Antheridia (2) Archegonia
(3) Sorus (4) Sprorangia

58. Sexuallity in fern is
(1) Isogamy (2) Anisogamy
(3) Oogamy (4) Siphonogamy

59. In **Pterdium** the flagella of antherozoids are attached to
(1) Body surface (2) Nucleus
(3) Blepheroplast (4) Ovum

60. Antherozoid attractant in an archegonila ooze in **Pteridium** (Fern) is
(1) Sugar
(2) Amino acid
(3) Malic acid
(4) Mucilage

61. How many cells from the jacket of fern antheridium
(1) One (2) Two
(3) Three (4) Four

62. Development of Oospore in fern produces
(1) X-Gametophyte
(2) 2X-embryo & sporophyte
(3) Prothallus
(4) Zoospores & Antherozoids

63. The dominant phase in fern plant is
(1) spore
(2) Sporophyte
(3) Gametophyte
(4) prothallus

64. Which is the criteron used in the classification of ferns
(1) Sori
(2) Nature of indusium
(3) Nature of sporophyll & sprorangia
(4) Nature of annulus

65. A feature is common to gametophytes and sprophytes of Moss and **Pteridium**
(1) Independent existence
(2) Unbranched habit
(3) Dichotomous branching
(4) Autotrophy

66. How does the spores of a fern plant behaves :
(1) Joins with another spore to form a seedling
(2) Germinates in to a prothallus
(3) Germinates into a fern plant
(4) Act as a resting structure

67. The male gametes in **Pteridium** are
(1) Non motile
(2) Motile, biflagellate
(3) Motile, multi flagellated
(4) Non-motile, multi nucleate

68. What type of polarity is exhibited by the embryo of **Pteridium**
(1) Apical (2) Basal
(3) Lateral (4) Central

69. **Pteridium** shows : **[RPMT 2000]**
(1) Only true indusium
(2) Only false indusium
(3) Both (1) and (2)
(4) None of these above

70. In which stage meiosis takes place in **Pteridium :** **[RPMT 2001]**
(1) During the spore germination
(2) During the spore formation
(3) During the gamete formation
(4) During the organ formation in prothallus

71. In Fern, gametophyte is : **[RPMT 2001]**
(1) Main plant body
(2) Prothallus attached to the sporophyte
(3) Prothallus free from sporophyte
(4) A structure attached to the rhizome

72. In rhizome of ***Pteridium,*** stele which is composed of two or more than two concentric rings of vascular bundles is called : **[RPMT 2002]**
(1) Polycyclic
(2) Siphonostele
(3) Ectopholic siphonostele
(4) Cladosiphonostele

73. Archegonium of fern has : **[RPMT 2003]**
(1) Four neck canal cells
(2) Binucleated one neck canal cell
(3) Uni nucleated two neck canal cells
(4) Three neck canal cell

74. Fern prothallus produces **[RPMT 2005]**
(1) Gametes
(2) Spores
(3) Both (1) and (2)
(4) None

75. The place of point where sporangium of a fern bursts is (or the place of dehiscence in the sporangial wall of ***Dryoptersis*** is known as) :
(1) Annulus (2) Stomium
(3) Ostiole (4) Operculum

76. The annulus of sporangium of the fern assistas in the dispersal of spores by :
(1) Collapsing in the strong wind
(2) Loosing the air of its cells
(3) Loosing water from its cells
(4) Taking up water form air

77. What may be the possible advantage accrueing out of the presence of antheridia and archegonia on the underside of a fern prothallus :
(1) They are proteted from direct rays of sun
(2) Capillary water ccumalates on the underside of the prothallus between its lower surface and the soil surface. Sex organs projecting in this water can be readily fertilize by the Flagelalted antherozoids which are chemotactically attracted by the archegonia
(3) The sex organs are protected from the wind
(4) Nutrients manufactured by the green prothallus can readily seep downwards to the sex organs due to the action of gravity

78. Which statement is normally true for Pteridium :
(1) Gametophyte depends upon Sporophyte
(2) Mature sporophyte depends upon gametophyte
(3) Young sporophyte depends upon gametophyte
(4) None of these

79. If the aerial parts of a typical pteridophyte are de stroyed by fire which plant part helps to regener ate :
(1) Root (2) Rhizome
(3) Leaf-tip (4) Pinnule

80. Which of the following is not common in **Funaria & Pteridium : [RPMT 2006]**
(1) Root (2) Archegonia
(3) Embryo (4) Motile sperms

81. In the prothallus of a vascular cryptogam, the antherozoids and eggs mature at different times. As a result : **[AIPMT 2007]**
(1) there is no change is success rate of fertilization
(2) there is high degree of sterility
(3) one can conclude that the plant is apomictic
(4) Self fertilization is prevented

PTERIDIUM **EXERCISE**

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**3**	**2**	**1**	**4**	**1**	**2**	**2**	**4**	**4**	**1**	**4**	**1**	**1**	**2**	**1**
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	**2**	**4**	**2**	**3**	**2**	**3**	**2**	**1**	**3**	**3**	**1**	**2**	**2**	**2**	**1**
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**4**	**2**	**2**	**3**	**1**	**3**	**1**
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	**3**	**2**	**2**	**1**	**3**	**1**	**1**	**1**	**3**	**2**	**4**	**1**	**3**	**3**	**3**
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	**3**	**2**	**2**	**3**	**4**	**2**	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**1**	**2**
Que.	76	77	78	79	80	81									
Ans.	**3**	**2**	**3**	**2**	**1**	**4**									

PINUS

SYSTEMATIC POSITION :

Division — Coniferophyta
Class — Conferopsida
Order — Coniferales
Family — Pinaceae/Abitaceae
Genus — **Pinus**

SPECIES OF PINUS :

There are six species of Pinus commonly found in India

(i) Pinus gerardiana - (Chilgoza- Pine) :
(ii) Pinus wallichiana Syn. Pinus excelsa - (Blue - Pine/Kail):
(iii) Pinus roxburghii Syn. Pinus longifolia - (Chir.Pine)
(iv) Pinue merkusii [Teenasserium Pine] : Hegith-3 **mt :**
(v) Pinus insularis Syn. Pinus khasya - (Khashi Pine) :
(vi) Pinus armandi [Armandi's Pine]

Pinus is a **evergreen and perennial** tree which is growing on the slopes of hills in **temperature** climate. It is **conical** in **shape** due to **excurrent growth** of the plant i.e. both main axis and lateral branches grow continuously to acquired **cone like** shape.

Note :

The ex current/conical habit of **Pinus** tree is caused by auxin effect on the growth of stem tip & axillary branches

External morpholgy of pinus :

Main plant body of **Pinus** is sporophytic and which is differentiated into root, stem and leaves.

1. Root :

- Well develoment tap root system is found in **Pinus.** Root hairs are **poorly developed** due to presence of **ectotrophic mycorrhiza.**
- Basidiomycetes fungus like ***Clavatia, Scleroderma Amanita*** and ***Boletus*** etc. are present in mycorrhiza in the form of symbiont in root of pinus.

2. Stem :

- Stem of the **Pinus** is erect/straght, cylindical, long, woody and branched.
- Branches are **monopodial** and developed from the axis of scaly leaves which re present on the stem. Branching gives **conival** appearance to plant.
- Branches are **Dimorphic.**

Branches

Long shoot	**Dwarf Shoot**
or branches of unlimited growth.	or branches of limites growth of **Brachyblast.**

1. Long Shoot :

- These are developed in the axis of scaly leaves on stem after the growth of every year. In long shoots, apical bud is found. These are responsible for unlimited growth.
- These branches bear only **scaly leaves.**

2. Dwarf Shoot/Branches of limited growth or Brachyblast :

- They develop in the axis of scaly leaves on the long shoot and bear both **scaly** and **foliage** leaves.
- They possess foliage leaves at their apex.
- These branches **do not have apical bud** and hence show only limited growth.
- **A dwarf shoot with a group of needle like foliage leaves, called as foliar spur.**

3. Leaves :

The leaves re **Dimorphic.**

1. Scaly leaves
2. Foliage leaves/Photosynthetic leaves

* **Scaly leaves :**

- The scaly leaves re dark brown, membranous, thin and small, and present on both long and dwarf shoots.
- They do not help in photosynthesis
- **Main function :** protection of the young bunds.
- They do not help in photosynthesis
- **Main function :** protection of the young buds.
- They fall off as the branches are mature

The scalv leaves on the dwarf shoots have a distinct midrib and thev are called **cataphvlls.**

Foliage leaves : (or Photosynthetic leaves)

- They **develop** only on the **dwarf shoot** and present on their apex.
- The foliage leaves are green & needle like

Species of Pinus	Number of needles	Types of spur
1. Pinus monophylla	**1**	Monofoliar
2. P. merkusis and **P.sylvestris**	**2**	**Bifoliar**
3. Pinus gerardiana **Pinus insularis** **P. roxburghii syn. P longifolia**	**3**	**Trifoliar**
4. Pinus quadrifolia	**4**	Quadrifoliar
5. P. armandi **Pinus wallichiana syn. P. excelsa**	**5**	**Pentafoliar**

Note :The foliage leaves are Photosnthetic and remain persistent for several years. The needle like nature of the foliage leaves indicates xerophytic adaptation.

(A) INTERNAL STRUCTURE OF ROOT :

Internal structure of primary root of **Pinus** is similar to dicot root.

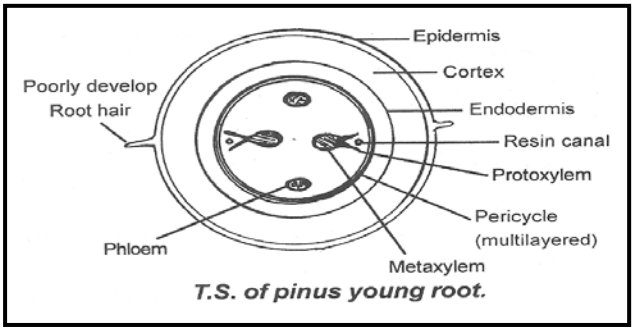
(i) **Epidermis/Epiblema/Pilliferous layer :**
Outer most layer is known as epiblema. It is single layered. It gives out unicellular **(Poorly developed) root hairs.**

(ii) **Cortex :**
The cortex is composed of 4-5 layers of **parenchyamatous** cells. Some of these cells are filled with **resinous** substances.

(iii) **Endodermis**

The inner most layer of the cortex represent endodermis. The cells of this layer have typical **thickening bands** on their radial walls. **Suberin** & **Tannis** are present in endodermis

(iv) **Pericyle :**
The endodermis is flowed by a **multilayered** zone of parachymtous cells which forms pericycle. **Tannin** & **starch gain** are present in pericycle



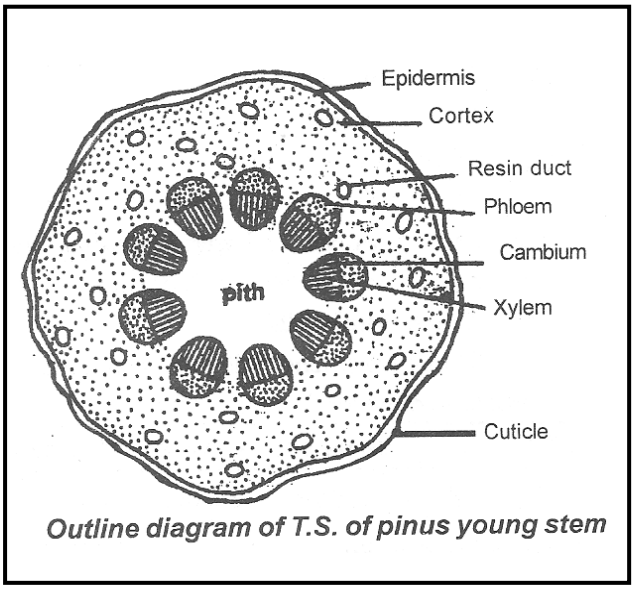
T.S. of pinus young root.

(v) **Vascular Bundle :**
Vascular Bundles are **rarial exarch** and commonly **diarch.** The protoxylem bifurcates to form a **'Y' shaped** structure and a **resin canal** lines in between the **two arms** of protoxylem.
The xylem consists of only **tracheids.** Phloem strands are present in alternate positions to the xylem strands. The phloem is composed of **sieve cells** and **phloem parenchyma.** Companion cells are absent.
Pith : It is poorly developed or absent.

(B) INTERNAL STRUCTURE OF PINUS STEM.
The internal structure of **Pinus** stem is similar to that of a dicotyledon stem.

1. **Epidermis :** It is the outer msot layer and composed from compactly arranged and heavily **cutinised** cells.

2. **Cortex :**
   - **Hypodermis :**
     The outer scelechymatous zome of the cortex forms hypodermis.
   - **General cortex :**
     It is formed by several layers of prenchymatous cells. Some cells of this zone re filled with **tannins.** several resin canals are also distributed irregularity in the cortex. (In Cycas, mucilage canals are present)
   - **Endodermis :** The inner most layer of the cortex represents endodermis. It is indistigunishable from the cortical cells.
   - **Pericycle :** 2-3 layered pericycle is present which is indistinct and undifferentiated.



Outline diagram of T.S. of pinus young stem

3. **Vascular Bundles :**
   5-9 Primary Vascular Bundles are presents. They are arranged in a ring. The vascular bundles re **conjoint, collateral, Open & endarch.** The protoxylem tracheids prosses **spiral** thickening where as emtaxylem tracheids have **reticulate** thickening.
   The phloem consists of **sieve cells** and **phloem parenchyama.**
   Note : In **Cycas,** spiral thickening is found in protoxylem tracheids whereas saleriform thickening is found in metaxylem tracheids.

4. **Pith :**
   A parenchymatous pith is present in the centre of the stem, Some pith cells are filled with **resinous substances. Note :** In tranverese section of the stem (long shoot) appears wavy or irregular in outlife due to the presence of clos apprising scaly leaves and dwarf shoots.

INTERNAL STRUCTURE OF PINUS NEEDLE :

Leaf of the pinus is **xeromorphic.** Outlife of the T.S. section of **Pinus** leaf (Needle) depends upon number of foliage leaves on foliar Spur :

Species	Numer of foliar leaves	Out life
P.monophylla	**1**	Circular
P.sylvestris	**2**	Half circular/semi circular
P.longifolia	**3**	**Triangular**

1. **Epidermis :**
   The single layered epidermis consist of heavily cutinized thick walled cells. It has many **sunken stomata.** Each stomaa conists of **two** guard cells and **6-9 subsidiary** cells.

2. **Hypodermis :**
   It is more than on layered and composed of **sclerenchyamatous cells.** Due to the presence of Sub stomatal cavities hypodermis is discontinuous.
   (In P. longifolia, the hypodermis is more developed at the corners).

3. **Mesophyll :** Mesophyll (3-5 layered) is made up of parenchyamatous cells. Uncounted long peg like process are formed by **infolding** or **internal cell well** of mesophyll. So it is known as **"armed mesophyll".** It increases the photosynthetic area of lef.

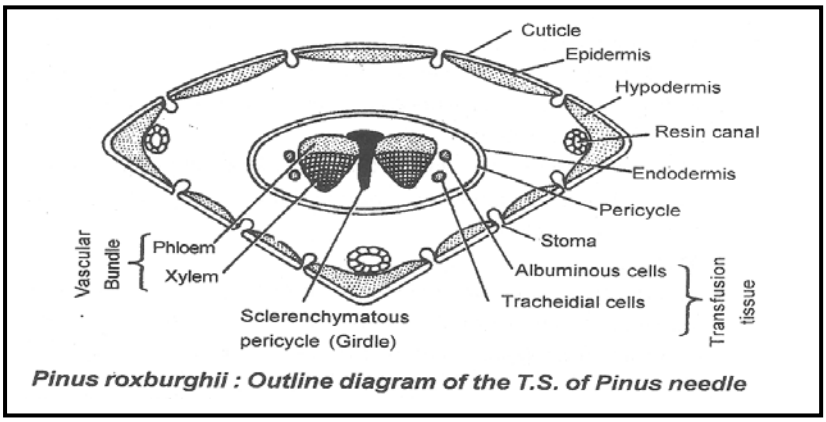
4. **Endoermis :**
   It is made up of **barrel shaped** cells. **Casparian thickening** are present on their radial wall.

5. **Pericycle :**
   A multilayerd pricycle is present next to endodermis. It consist of the following types of cells.
   (i) Parenchyamtous cell :
   Most of the pericycle is composed of parenchymatous cells which are densely filled with **starch grains.**
   (ii) Albuminous cell :
   The cells occur in close contact with the **phloem cells.** They are also parenchymatous cells which are packed with **proteins** and **starch grains.** They **do not possess pits** and probably helps in translocation of nutrients from mesophyll to phloem cells.
   (iii) Tracheidial cells :
   These are trachieds like cells which occur close to **xylem cells.** These cells **possess pits** & helps in conduction of water & minerals from xylem to mesophyll cells.

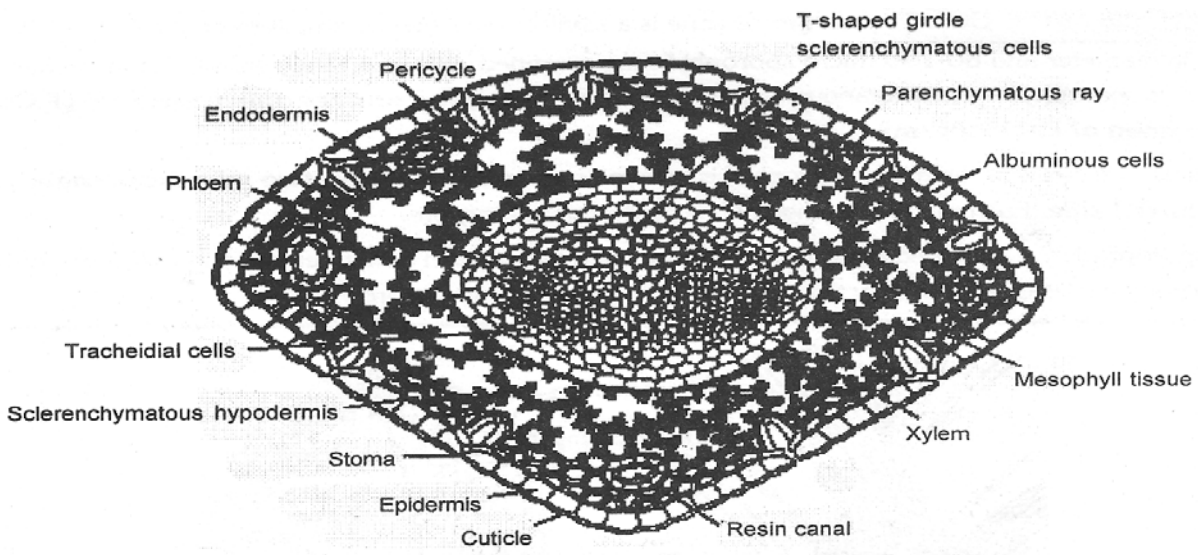
Albuminous cells + Tracheidial cell $\longrightarrow$ Tarnsfusion tissue

(D) **"T"** Shaped sclerenchymtous girdle

6. **Vascular Bundle :**
   In the middle of the leaf two vascular bundles are Surrounded by bundle sheath. vascular bundles are conjoint, colateral, Open & endarch **"T" shaped girdle is found between the both vascular bundles. 'T' shaped girdle is composed of sclerenchymatous cells.**



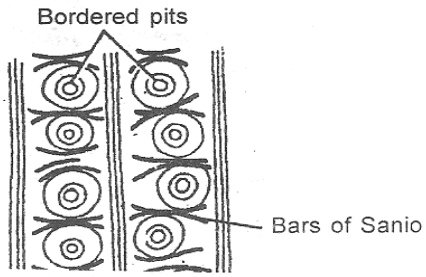
Pinus roxburghii : Outline diagram of the T.S. of Pinus needle



Detailed cellular structure of the T.s. of pinus needle

The needle possesses basal maristem which helps in their elongation

- **Pinus needle → Amphistomatic.**
  Stomata - Haplochielic type. i.e. subsidiary and guard cells are arises from separate cells.
  Secondary Growth in Pinus root is similar to that of a dicot root
  Secondary Growth in Pinus stem is similar to that of a dicot stem
- Linear **uniseriate bordered pits** are present in **tracheids** whereas in **Cycas** multiseriate bordered pits are present.
- Clear annual ring are found in **Pinus.**
- **Resin canals** are also found in **secondary xylem.**



Bars of Sanio in between bordered pits in trachieds

IMPORTANT POINT :

- An important characteristics features of **Pinus** wood is the presence of **bars of Sanio.** They occur in the form of **crescentic bars** in between the bordered pits. These bars are formed by the deposition of **cellulose & pectin** on **Tracheidial walls.**

REPRODUCTION IN PINUS :

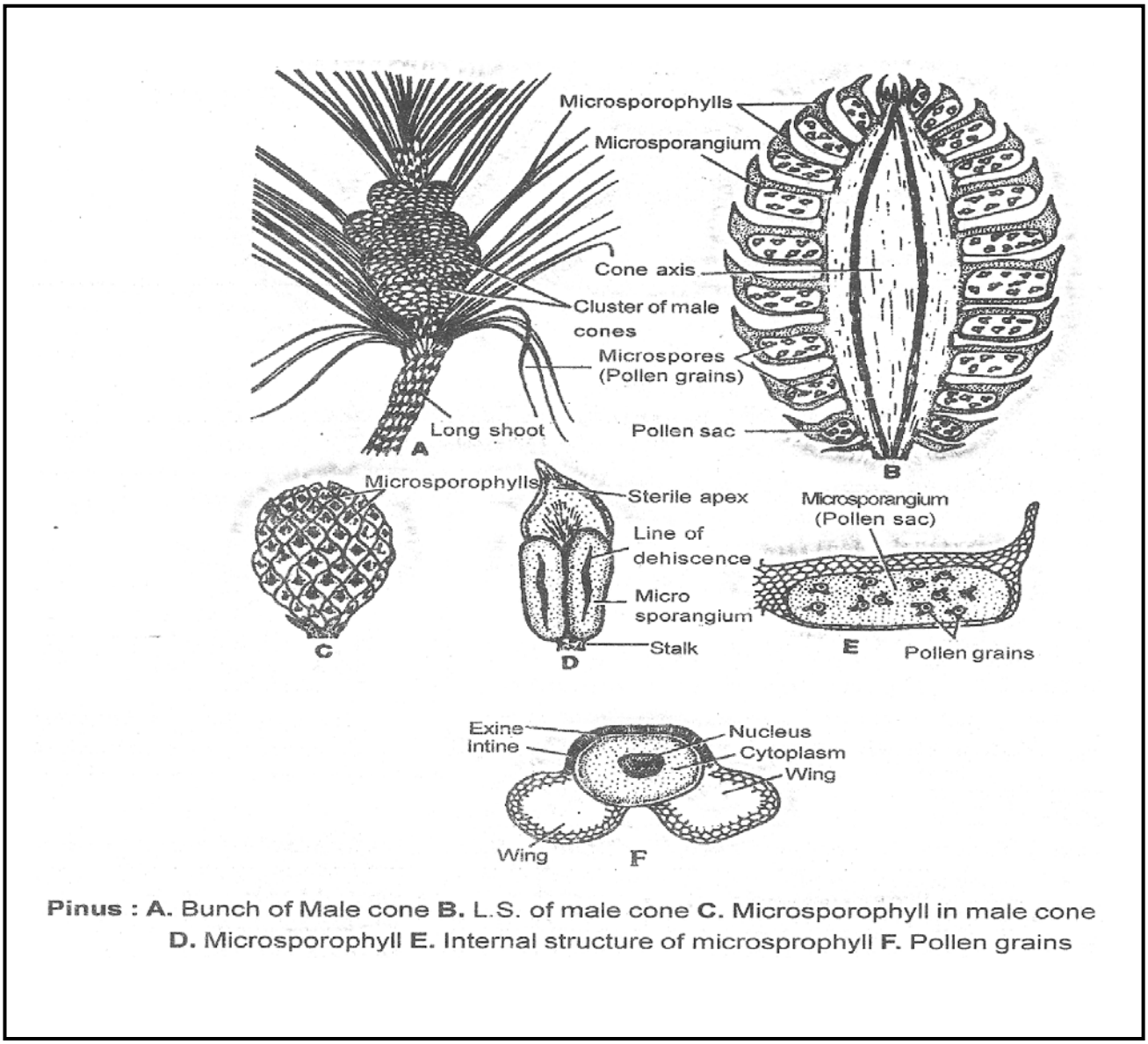
- Pinus is a **Sporophytic & hereosporous** plant. The plant body forms two types of spores i.e., **microspors** and **megaspores.** These spores are haploid which indicate the first cell of gametophytic phase.
- The plants are **monoecious** and amel & female cones are formed on different branches of the same plant. It means it is **a autoicous** plant. [**Cycas** is a dioecious plant]
- Male & female cones are monosporangiate.
- **Exception :** In **Pinus roxburghii, P. montana** and **P. maritima** the cones are **biosporangiate.** i.e. cone possess two types of sporangia.

MALE CONE : Male cone are developed in the axis of scaly leaves on the branches of unlimited growth in **place of dwarf shoot.** The male cones are considered as modified dwarf shot. They are develop in groups, just behind the apical bud on the branches of unlimited growth. Thus main shoot continues to grow further. The number of cones in a cluster varies from **15 (Pinus wallichiana)** to **140 (pinus roxburghii).**

STRUCTURE OF MALE CONE :

Each male cone is a small & oval shaped structure bout **2-4 cm** long and **5-6 mm** in diameter and 60-150 micro sporophylls are arranged spirally on the central axis of each male cone. Each micro spprophyll is a membranous, stalked & **roughly triangular** structure. (**microsporophyll Compared with stamen of angiosperm**)

- the apical sterile part of the micro sporophyll is known as **apophysis.** In bears **two microsporangia** at the base of its **abaxial side.** Each micro sporangium has numerous microspore.
- Microsporophylls are arranged at right angle to the cone axis in such a manner that the apophysis of the upper micro sporophyll is overlapped by the apophysis of the lower microsporophyll.



Pinus : A. Bunch of Male cone **B.** L.S. of male cone **C.** Microsporophyll in male cone **D.** Microsporophyll **E.** Internal structure of microsprophyll **F.** Pollen grains

Development of microsporangium : Eusporangiate type.

STRUCTURE OF MICROSPORE :

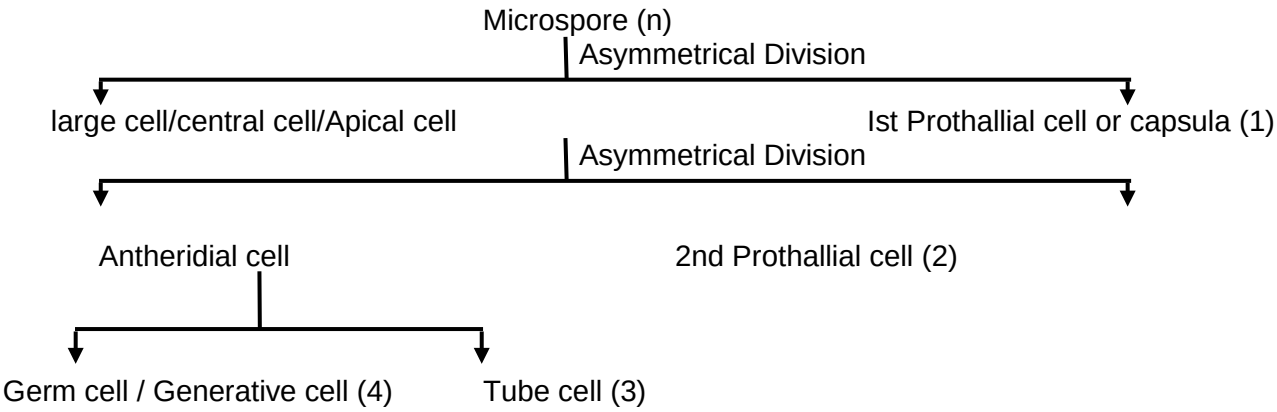
(i) **Exine :** This layer is highly cutinized and it is found only at one side.
(ii) **Exointine : Two wings** are developed on laterer side of this layer of microspore. It is a part of exine.
(iii) **Intine :** It is inner most layer of microspore.

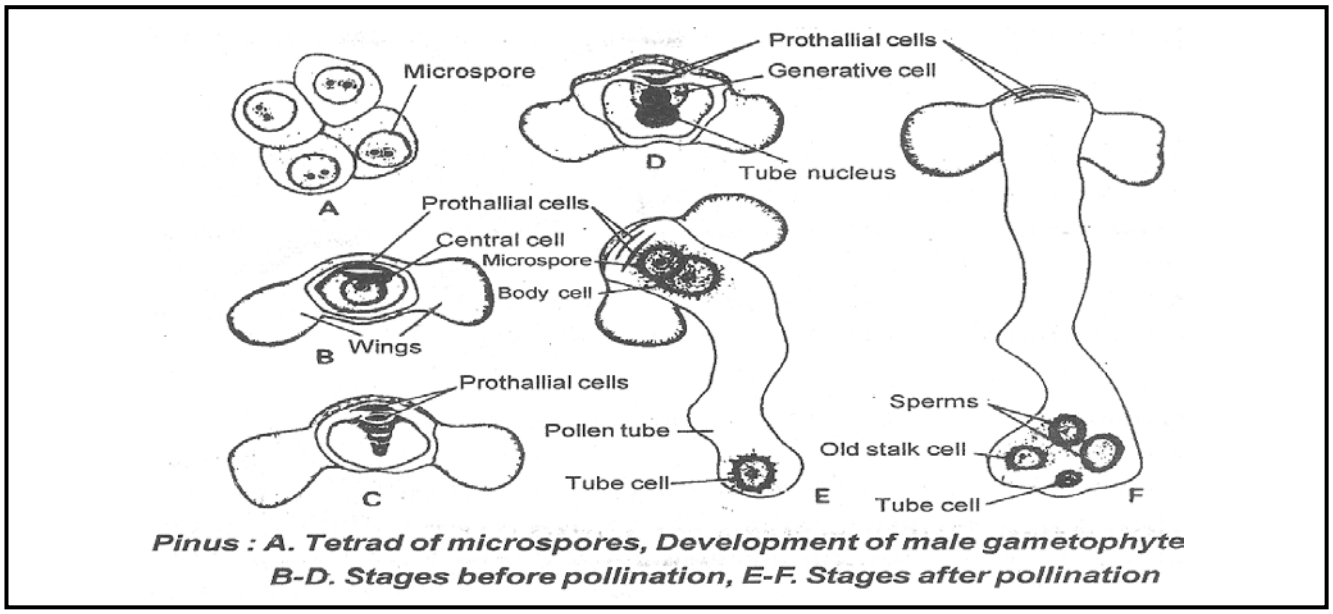
DEVELOPMENT OF MALE GEMETOPHYTE :

The microspore is the first cell of the male Gametophyte. The Germination of microspore starts in situ i.e, they germinate while still inside the microsporangium.

The microspore are released from the microsporangium after partial development of male gametophyte. The rest of the development of male gametophyte takes place in the **pollen chamber of the ovule** after pollination.

(A) Development of male gametophyte with in microsporangium before pollination :





Pinus : A. Tetrad of microspores, Development of male gametophyte
B-D. Stages before pollination, E-F. Stages after pollination

Pollination : Pollintion takes place through the **air** at **4-celled stage.** In India dehiscence of microsporangium takes place in **warm & dry** environmental conditions.

The microspores are released in such a large, quantity that pine forests appear yellow at the time of dehiscence of microsporangium. this is called **"shower of sulphur"**

Note - In **Cycas** pollination takes place at **3-celled** (1-prothallial cells + 1-Generative cells + 1 tube cell) stage by air.

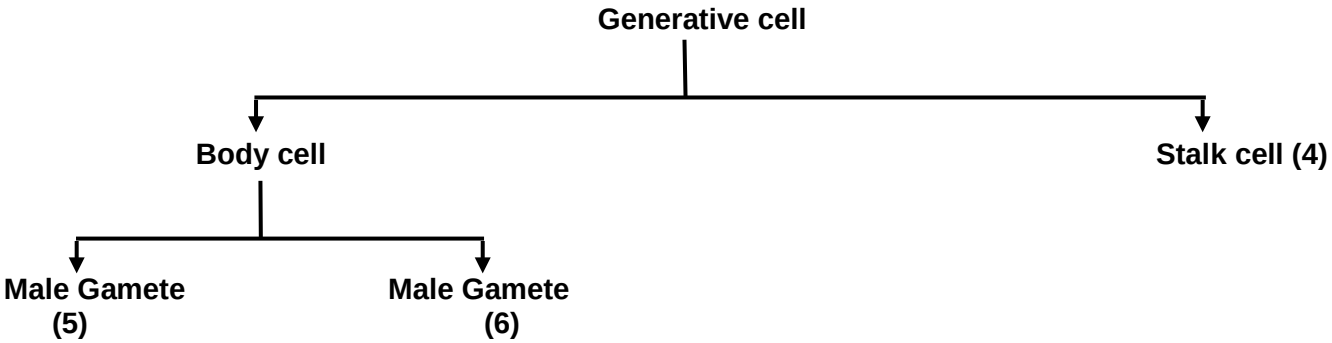
DEVELOPMENT OF MALE GAMETOPHYTE AFTER POLLINATIOIN :

- After pollination the 4-celeld male gametophyte reaches to the pollen chamber and there it remains **inactive** for about **11 months. (The ovuliferous scale during this period have thickened and closed the cone completely. The ovule is not yet ready for fertilization).** Further development of the male gemetophyte starts in the next spring.

- Exointine breaks off from the middle of the wring and the tube cell comes out in the form of **poolen tube.** Pollen tube reaches to archegonia through nucleolus.

- Pollen tube is rich with starch grains & it may be **branched** or **unbranched.** It acts as a sperm carrier. Tube nucleus moves into the pollen tube while germ cell remains inside the poollen grain.

- The generative cell of the **4-celled gametophyte** divide to form a **body cell** and a **stalk cell.** The nucleus of the body cell divides to form **two nuclei** just before fertilization. The male nuclei function as **sperm** which is **microscopic, non flagellate** & **ephemeral** structure.
  (In **Cyas** male gametes are motile, multi flagellated or multi collated top shaped & measuring 180-210)



Thus mature male gametophyte of **Pinus is 6 celled** stage. (In **Cycas** mature **male gametophyte is 5-celled)**

FEMALE CONE :

- Female cones are developed on long shoot in place of dwarf shoot. Female cones are also called as **modiried dwarf shoot.** (In Cycas megasporophylls do not form female cone).

- The female cone are formed in groups (1-4 in each group), in the axis of the scaly leaves towards the tips of long shoots of the current year. The female cone with seed takes about three year to mature.

- The female cones re much larger than the male cones. They are usually 15-20 cm long.
  [Pinus coultre = 25-35 cm & Pinus lambertiana = 60 cm]

STRUCTURE :

- The female cone is complicated structure. It has a central axis around Which many (80-90) megasporophylls are arranged spirally.

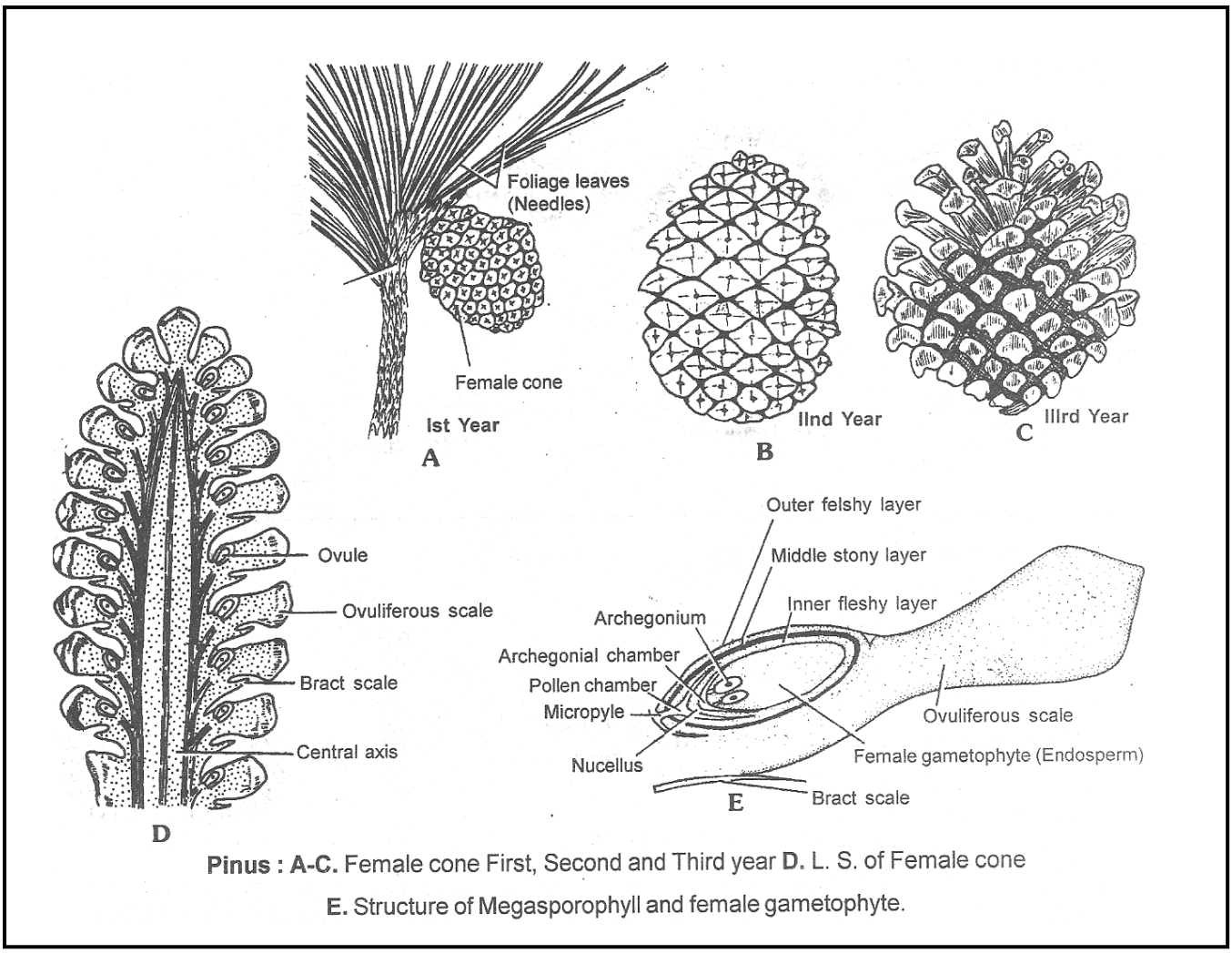
- Some basal megasporophylls are small & sterile & the rest are fertile. The megasporophyll is a compound structure, consisting of two types of scales :
  - **Bract scale**
  - **Ovuliferous scale**

(A) Bract scale :

It is small membranous structure which is directly attached to the cone axis just below the ovuliferous scale. At the maturity of the cone, the bract scale curve inwards so that the seeds are dispersed easily. Each bract scale has **a single vascular bundle** with its xylem pointing upwards.

(B) Ovuliferous scale : It is a thick, large woody and brownish structure, attached to the **dorsal** surfaces of the bract scale.

It is roughly triangular in shape and its upper broad and thick part is known as **apophysis.** Two ovules are present at the base of the ovuliferous scale on its **dorsal surface.**
The microphyle of each ovule is directed towards the cone axis.



Pinus : A-C. Female cone First, Second and Third year **D.** L. S. of Female cone

E. Structure of Megasporophyll and female gametophyte.

Development of megasporangium/Ovule : Eusporangiate type i.e. the megasporangium develops from more than one superficial initial cells.

STRUCTURE OF OVULE : Ovule of pinus is **anatropous unitegmic & sessile.** The following part can be seen in a longitudinal section of the ovule.

(In **Cycas : orthotroponus)**

(i) Nucellus : It is the massive **parenchymatous** region of the ovule.

(ii) Integument : It is the thick protective covering around the nucleolus. It has a very narrow aperture at the nucellus. It is known as **micropyle.**

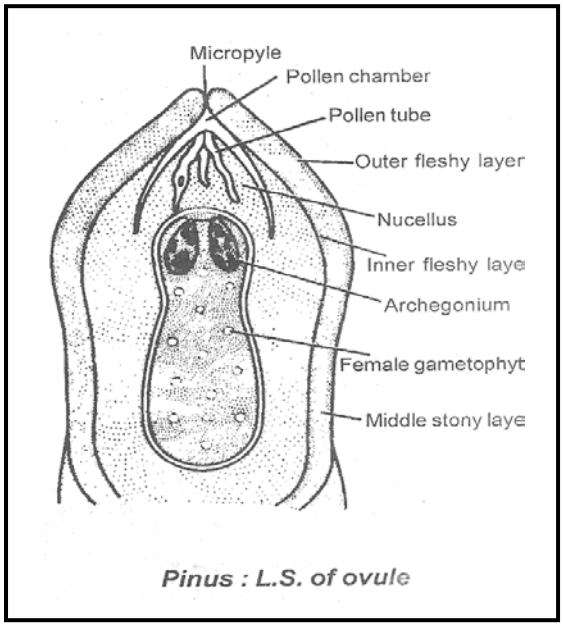
The integument is differentiated into three layers.

(i) Outer fleshy layer

(ii) Middle stony layer

(iii) Inner fleshy layer.

(iii) Pollen chamber : A small furrow is present opposite to the micropyle in the **nucellus region** which is known as **pollen chamber.** Material secreted by nucellus is found in this chamber during pollinateion which is known as **"Pollendrop"**



Pinus : L.S. of ovule

- **Endosperm & Archegonia are present in the centre of nucellus region.**

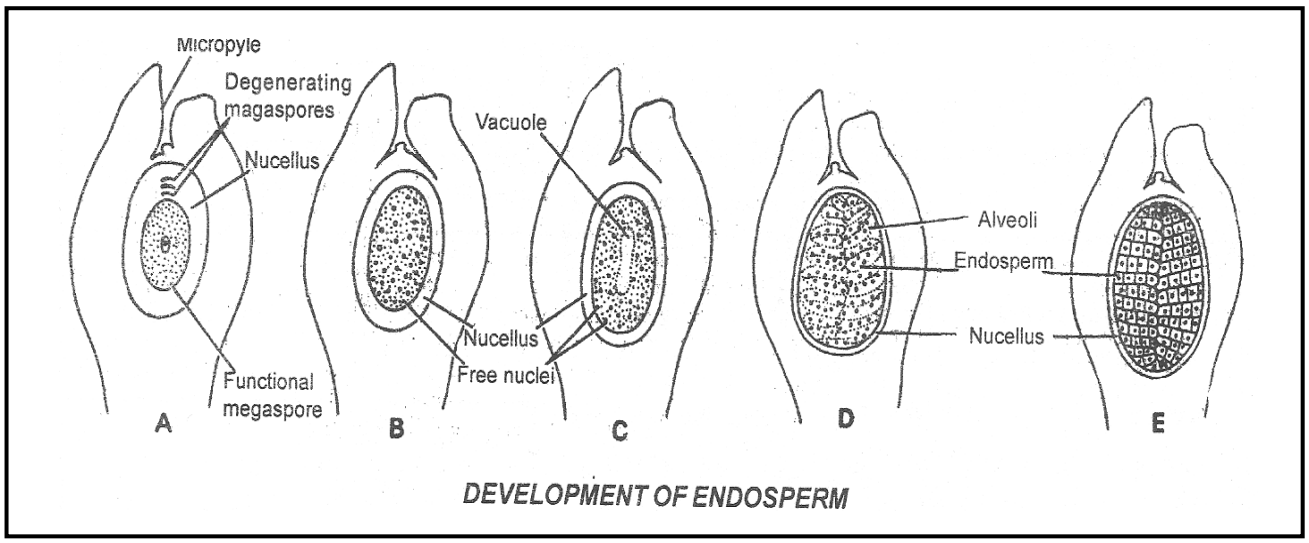
MEGASPOROGENESIS :

- At the apex of nucellus (**towards micropyle**), a hypodermal is differentiated from other cells by its larger size called as **archesporial cell.** Archesporial cell divides by periclinal divisioin to form a outer primary parietnal cell & inner sporogenous cell. Sporogenous cell function as a **megaspore mother** cell. Megaspore mother cell divide **meioticall** to form a linear tetras of megaspore. Out of four, three megasproe degenerate which **lies** towards the micropyle. Onle one megaspore remain functional which is present towards the **chalazal end.**

[DEVELOPMENT OF FEMALE GAMETOPHYTE]

A. DEVELOPMENT OF ENDOSPERM :

- Functional megaspore first of all increases in size then after **free nuclear division** take place in nucleus of functional megaspore resulting 2000-2500 nuclei are formed. All the nucleus moves towards the periphery due to vacuole is formed in the centre.
- There is one characteristic feature of pinus, in which long **multinucleated** tube like cells are developed radially in early storage. These are known as **alveoli.** Later on **uninucleated** cells are formed due to formation of walls. The structure is known as **endosperm.**
- **Endosperm is haploid structure because it is derived from the megaspore before fertilization.**
- The nucellus cells surrounding the **endosperm** from a 2-3 layered nutritive layer. This layer is known as **spongy layer or endosperm jacket & it is equivalent to the tapetal layer.**



DEVELOPMENT OF ENDOSPERM

B. ARCHEGONIA :

- 2-5 archegonia (normally two) are formed towards the micropylar end in female gametophyte.
- Each archegonium at maturity consists of **eight neck jecket cells** arranged in to tiers of four each and a venter having a small venter canal cell and large egg cell. **neck canal cells are absent.** The venter canal cell disorganizes before fertilization.
- A nutritive layer is differentiated around the central cell & this layer is known as **archegonial jacket.** The jacket helps in **conduction of nutrients** from the endosperm to the archegonium.
  Note : P.roxburghii and P.wallichiana 4-4 neck cells & in **Cycas** archegonium 2-4 neck cells are found in neck region.

FERTILIZATION :

- Fertilization in pinus first of all described by **Gauroschenchin.**
- Fertilization ins **siphonogamous.** The process of fertilization takes place after the **12-14 month** of pollintion (In **Cycas** after **3-4 months**)

- Pollen tube reaches up to the egg cell through the neck of the archegonium and its terminal end degenerates. Both the male gametes become free, one male gamete fused with egg nucleus to form **a zygote** or **oospore** and another male gametes degenerate. Many archegonia fertilized in a female gametophyte but only one zygote is able to form a embryo successfully.

Embryo :

Embryo is formed from oospore, development of embryo **meroblastic** and **endoscopic** i.e. embryo is formed by only a part of oospore are inside the megasporangium **(toward chalaza)**

DEVELOPMENT OF EMBRYO :

The development of embryo can be studies in the following two steps.
(A) Development of pre-embryo (16-celled) from zygote
(B) Development of embryo from proembryo :

(A) Development of pre-embryo form zygote :

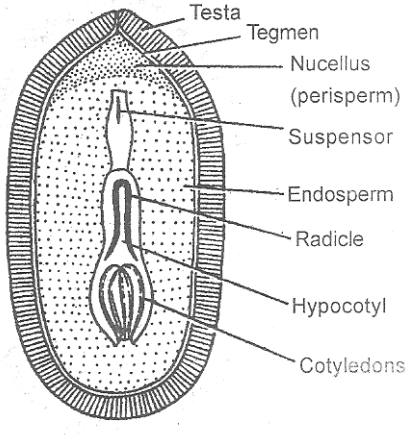
- Following fertilization the diploid nucleus of the **zygote** migrates towards its base and then divides by two mitotic division to form four nuclei. These nuclei divide further and form eight nuclei which are arranged in to tiers of four each. There fter wall formation takes place in such a way that **four complete cells** are formed in the lower tier. (i.e. these cells possess a wall of all around) and **four incomplete cell0s** in the upper tier (i.e. these cells have wall only on the lower side). The incomplete ells belonging to the upper tier to not take active part in embryo formation. The cells of the lower tieir divide twice to form three tiers of four cells each. At this stage the prembryo consist of **16 cells** arranged in four tiers.
  (i) Nutritive tier : The upper most tier consisting of incomplete cells in known as nutritive tier and it provides nutrition.
  (ii) Rosette tier : Function **conduction** of nutrient between **embryo & suspensor.**
  (iii) Suspensor tier : The cells of the suspensor tier elongate to form suspensor. Its cells are long which pushed the embryo into the endosperm.
  (iv) Embryonal tier : The lower most tier is known as the embryonal tier; its cells divide to form **embryo**

(B) Development of embryo form proembryo :

- All the four ells of the suspensor tier elongate considerably and as a result the embryonal cells present at their base are embedded in the endosperm.
- Due to the limitation of space in the endosperm, the primary suspensor cells become coiled to each other.
- At this stage, the cells of the embryonal tier divide by **transverse division** and form another tier of cells, known as **embryonal tubes** or **secondary suspensor.**
- The cells of the embryonal tier separate from each other and form **four independent embryos.** The phenomenon of the formation of more then one embryo form zygote is known s **polyembryony.**
- In pinus, as the polyembryony occurs by the splitting of a zygote. It is known as **cleavage polyembryony.**
- Another type of polyembryony found in pinus is **simple polyembryony** (when more than one embryos are developed as a result of fertilization of different archegonia).

STRUCTURE OF EMBRYO :

(i) **Cotyledons :** Usually more than two **(3 to 18)** (In **Cyacas** two cotyledons)
(ii) **Plumule** or **Shoot apex :** Present between the cotyledons in the opposite direction of the microphyl.
(iii) **Radicle :** Directed towards the microphyle
(iv) **Hypocotyl :** Present in between the plumule & radicle.



Pinus : L.S. of Seed

Parts of Ovule		Parts of seed
(1) Integument -		
(i) Outer fleshy layer	-	Disappear
(ii) Inner fleshy layer	-	**Tegmen** in formed in the form of thin layer
(iii) Middle stony layer	-	It forms the outer most covering of the seed called **testa.**
(2) Nucellus	-	Present in the form of thin layer which in known as **"perisperm".**
(3) Micropyle	-	On the apex of seed in the form of a pore.
(4) Thin layer of Adaxial surface of ovuliferous Scale	-	Form **wing** of seed.

The **mture seed** represents **three** generations -

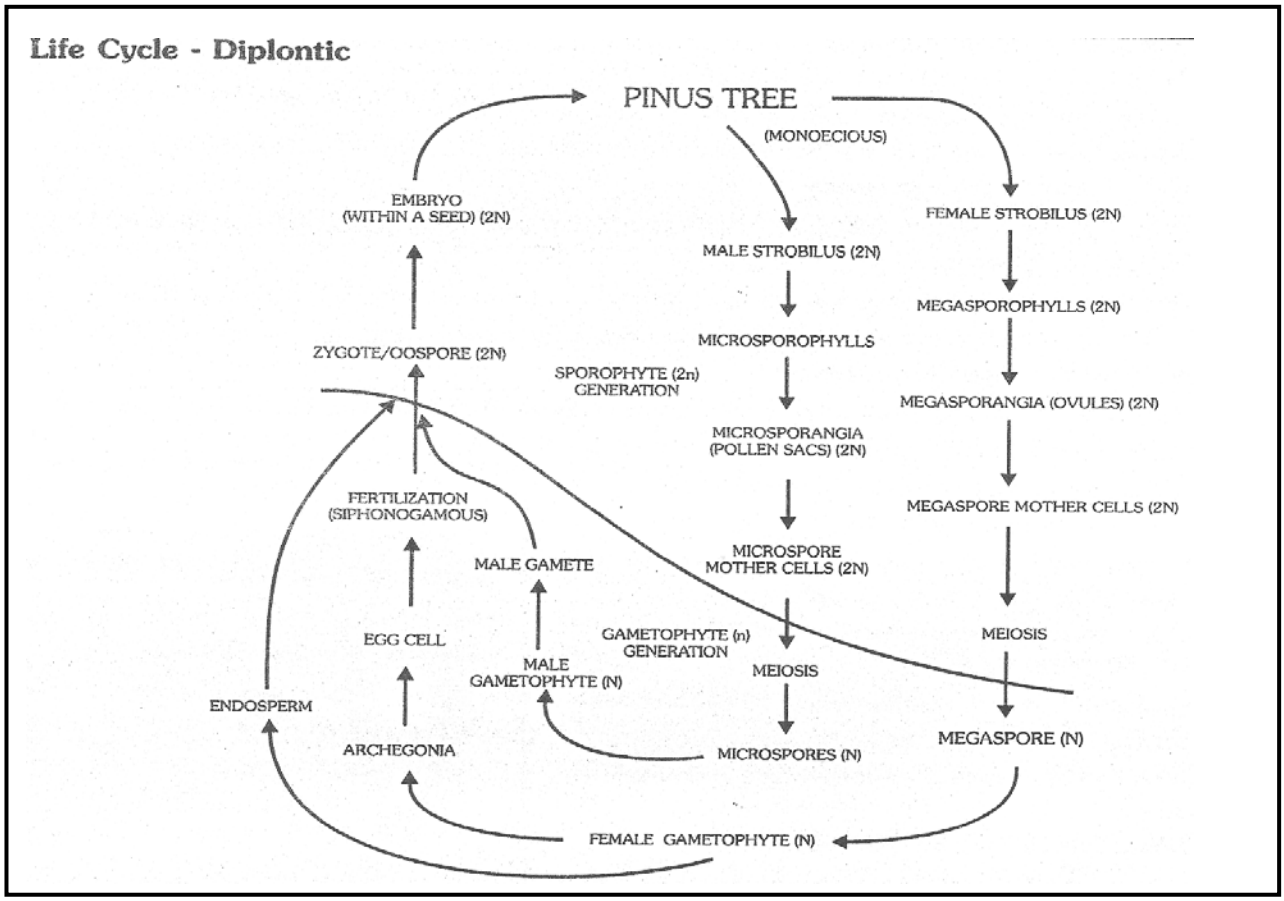
(1) Old sporophyte - Testa, tegmen and nucellus
(2) Gametophyte - **Endosperm** (female gametophyte)
(3) New sprophyte - Embryo

Note : Three generations are also found in **Cycas seed.**

- Dormancy absent in Cycass seed
- Cycas seeds are Large, round & red or orange in colour.

Germination of seed :

"Epigeal" type of germination is found in seed of **Pinus** i.e. cotyledon come outside the soil surface by elongation of the **hypocotyl.** (In **Cycas hypogeal**)



ECONOMIC IMPORTANCE OF PINUS

- The wood of **P.roxburghii** (Chir) and **P.wallichiana** (Kail) is an important timber. It is suitable for making railway sleeper, packing cases, furniture , etc. Besides, it is also used for making match sticks.
- **Pinus roxburghii, P.wallichiana, P.insularis** and **P.merkusii** are the chief sources of **turpentine** in India. Rosins, obtained s residue after the distillatio of pine resin, are used in paper sizing, varnish making, enamels and in the preparation of plaster and ointments.
- The rostated seeds of **P.gerardiana** (Chilgoza pine), **P.edulis** and **P.monophylla** are **edible.**
- The **oleo-resin** obtained from **P.roxburghii** is**diuretic.**
- The **fossilized resin,** obtained from a fossil species of Pinus (e.e., **P.succcinifera),** is known as **amber**. It is widely used in **ornaments** and **decoration work.**
- The wood and female cones of Pinus are used use fuel.

IMPORTANT POINTS

1. Endosperm is formed before fertilization in gymsoperm whish is **hapoloid.**
2. **Sequoia semapervirans** is called **"Red wood tree"**
3. All the species of **Cycas** are **"Dioecious"**
4. The ovule sperm [Antherozoids] and egg cell of the cycas are largest in the plant kingdom which ban be seen by nked eyes.
5. **Winged pllen grains** are found in **Pinus.** Wings are formed from exine of pollnes. These are **acellular.**
6. In Vascular bundles of Cycas rachis and leaf let xylem is "diploxylic". (It means **centripetal** & **centrofual** xylem present) & V.B. are conjoint collateral & open
7. **Pycnoxylic** wood is compact, hard in which parenchyamatous tissues is less developed or absent while **Mnoxylic wood** is soft and siwth well developed parachyma.
8. In Gymonosperms, gametes of **Cycas** and **Ginkgo** are motile and ciliated/Flagellated.
9. **Ephedra** is found in **Rajasthan** and **Ephedra** pollination takes place at **5-celled** state.
10. Pllen grains of **pinus** release at **four celled** stage and pollens of **cycas** release at **three celled** stage.
11. **Two** cotyledons re present in embryo of **Cycas** and **3-18** cotyledons re present in embryo of **Pinus.**
12. **Pinus longifolia** is called **"Red wood of China"**
13. A tall conifer **Auracaria** from **S.America** clled **"Monkey's Puzzle"**
14. **The** edible part of **cholgoza seed** is **female gametophye.**
15. The starch of stem pith and cortex of **Cycas revoluta** is uitlized for the production of **sago & plant appears like palm.** So it is also called **"Sagopalm"**
16. ***Ginkgo biloba*** is commonly known as **"Maiden hair tree"** and it is living.
17. In **Pinus : Pycoxylic wood,** in **Cycas - Manoxylic wood.**
18. In **Cycas,** root are of two types :
    1. Normal root/Tap roots **-Diarch & geotropic**
    2. Coralloid root - **Triarch & Apogeotropic**
19. **Nostoc punctiform, Anabaena cycadae** and **Oscillatoria** species are found in coralloid roos of **Cycas.**
20. The yound stem of **Cycas** is tuberous and sub terranean. In older plant, the stem becomes thick, columnar & woody. It is covered with persistent and wooly leaf bases.
21. **Cycas** stem is **usually unbanched**
22. In **Cycas** leaves re **dimorphic :**
    (a) Foliage or assimilatory leaves(b) Scaly leaves.
    Foliage leaves : Pinnately compound, unipinnate & peripipnnate. In leaf lets single midrib is present. Lateral veins are absent. Young rachis & pinnae show circinate ptyxis. They young leaves are covered with ramenta.
23. In cycas ● Young stem - Monoxylic ● Woody stem - Polyxylic
24. In **Cycas** vegetative reproduction takes place **by bulbils.** They develop in the crevices between persistent leaf bases from parenchymatous cells of the cortex.
25. In all seed bearing plants dipolintic **life cycle** is found. In this type of life cycle pattern the diploid sprophyte is dominant. Photosynthetic independent phase of the plant. The gametophyte phase is represented by the single to few-celled haploid gametophyte.
26. In **Cycas** rachis, vascular bundles are arranged in **inverted omega** shape.