# GYMNOSPERMS

→ The word 'Gymnosperm' is derived from the Greek word Gymnos = naked & Sperma = seed

That means the plants with naked seeds.

→ The term was used by Theophrastus for the group of plants with unprotected seeds.

→ The gymnosperms have their ovules freely exposed.

→ The group include 70 living genera & 725 living sps. (16 Genera & 53 sps in India).

## General Characteristics

→ The living gymnosperms are woody, evergreen, perennial, grow as trees or shrubs. Tallest trees are sequoia sempervirens (366 ft) & S. gigantia (342 ft).

→ The living members are found in colder region of earth. only the members of cycadales & genetales found in dry climate.

→ The dominant plant body is sporophyte (2n) which may be monoecious or dioecious.

→ Gametophytes are inconspicuous & endosporic i.e. develop with the spores.

→ Sporophyte differentiated into - Root, Stem & leaves.

→ Tap root is exarch & diarch to polyarch. coralloid root & mycorrhizal root also present.

→ Stem is erect, branched or unbranched.
→ Leaves are dimorphic i.e. 2 types foliage & scale leaves.
→ Gymnosperms are xerophytes in nature due to presence of thick bark, thick cuticle, scale leaves, sunken stomata.
→ Xylem composed of xylem parenchyma & tracheids with bordered pits vessels are absent.
→ Phloem composed of sieve cells & phloem parenchyma but companion cells absent.
→ The Gymnosperms are heterosporous means 2 type of spores produced i.e. haploid microspore & megaspores. on respective microsporophyll & megasporophyll.
→ Sporophylls are spirally arranged an axis to form cone or strobilus i.e. male or female cone.
→ ovules are nacked, sessile, uni or bitegmic.
→ Pollination is anemophillous i.e. by wind.
→ Fertilization is siphonogamous i.e. male gametes carried to female gametes by means of pollen tube.
→ After fertilization zygote develops into embryo & ovules become seed.
→ Endosperm or female gametophyte formed before fertilization.
→ Embryo development is mesoblastic i.e. develops from a small part of zygote.
→ Most members show polyembryony i.e. development of more than one embryo, but only one survives at the end.
→ Cotyledons 2 in cycas & many in pinus.

## Class$^{n}$

Undill 1827 Gymnosperms were not recognised as a separate group. Previously the members of gymnosperms were included under the group angiosperms due to the close similarity with the members of angiosperm. The ovules of the members of cycadales were consider as female flowers for time. However in 1827 Robert brown suggested that the female flowers as the actual ovule. After that the gymnosperms were recognised as a separate group & become distincted from the angiosperm.

Bentham & Hooker treated the gymnosperms as a parallel group of plant to the dicotyledons & monocotyledons. so the gymnosperms were kept in bet$^{n}$ these 2 group of angiosperms.

Eichler in 1883 placed the gymnosperms under the group taxaceae. Later on a new order ~~ginkgoales~~ Ginkgoales was added to this group by engle.

Diff. system of class$^{n}$ are proposed to classifing the gymnosperm.

1) Coulter & Chamberlain (1917) they divided the Gymnosperms into 7 orders -

- (i) Cycadofilicales
- (ii) Bennettitales
- (iii) Cycadales
- (iv) Coniferales
- (v) Cordaitales
- (vi) Ginkgoales
- (vii) Gnetales

(i), (ii), (iii) → Cycadophyta

(iv), (v), (vi), (vii) → Coniferophyta

Cycadophyta + Coniferophyta → Gymnosperm

Lavish

64 (2) Arnold (1948) :-

He divided the Gymnosperms ~~first~~ into 3 ~~phylum~~. Phyta.

(i) Cycadophyta

(ii) Coniferophyta

(iii) Gamadospermo Phyta

The Phylum Cycadophyta was divided into 3 orders:-

(a) Pteridospermales

(b) Cycadales

(c) Cycadeoidales

The Phylum Coniferophyta was divided 4 orders:-

(a) Cordaitales

(b) Coniferales

(c) Ginkgoales

(d) Taxales

The Phylum Gamadospermophyta divided into 2 orders:-

(a) Ephedrales

(b) Gnetales

(3) Johnson (1951) :-

He divided the Gymnosperms into 5 Phyta & 10 orders:-

Phylum :- (1) Pteridospermophyta

(2) Cycadophyta

(3) Coniferophyta

(4) Ginkgophyta

(5) Ephedrophyta

→ The Phylum Pteridospermophyta included a order:-

Cycadofilicales.

→ The Phylum Cycadophyta includes 4 orders :-

(a) Bennettitales

(b) Cycadales

(c) Nilssoniales

(d) Caytoniales

→ The Phylum Coniferophyta includes 2 orders :-

(a) Coniferales

(b) Volt ziales

→ Phylum Ginkgophyta was divided into 2 orders :-

(a) Condoutales

(b) Ginkgoales

→ Phylum Epheidrophyta including a single order :-

Gnetales

(4) Class^n Proposed by D.W Bierhorst (1971). Bierhorst (1971) divided Gymnosperms into 3 Classes -

(1) Cycadopsida

(2) Coniferopsida

(3) Gnetopsida

→ Class Cycadopsida included 6 orders :-

(a) Pteridospermales

(b) Caytoniales

(c) Cycadeoidales

(d) Cycadales

(e) Pentoxylales

(f) Glossopteridales

→ Coniferopsida include 5 orders:-

(a) Condaitales
(b) Protopityales
(c) Ginkgoales
(d) Coniferales
(e) Taxales

→ Gnetopsida included 3 orders:-

(a) Ephedrales
(b) Gnetales
(c) Welwitschiales

## CYCAS

S.P

D - Cycadophyta
C - Cycadopsida
O - Cycadales
F - Cycadaceae
G - Cycas

### Morphology

→ Cycas is a living fossil.
→ Cycas Plant is a sporophyte.
→ It is differentiated into root, stem & leaves.

### Stem

→ The stem in the young plants is shoot, tuberous & subterranean.
→ The stem bears adventitious buds of the base.
→ They are large & covered with scales.

67 Leaf

→ The leaves are of two types - foliage leaves & scale leaves.
→ They are arranged in close spiral succession alternating with each other.
→ The leaflets of a pair oppose each other.

Root

→ The roots are of 2 types - tap root & coralloid roots.
→ The primary root is tap root which grows deep into the soil & some dichotomously branched are seen at the base of the stem.
→ Coralloid roots are protrude out over the ground.

Anatomy

Stem

The stem anatomy is simple & it shows primitive features.
It shows the following structures -

Epidermis

→ It is outer protective layer.
→ It is incomplete & ruptured due to present of scales.

Cortex

→ It forms a thick zone below the epidermis.

Endodermis, pericycle & vascular bundle

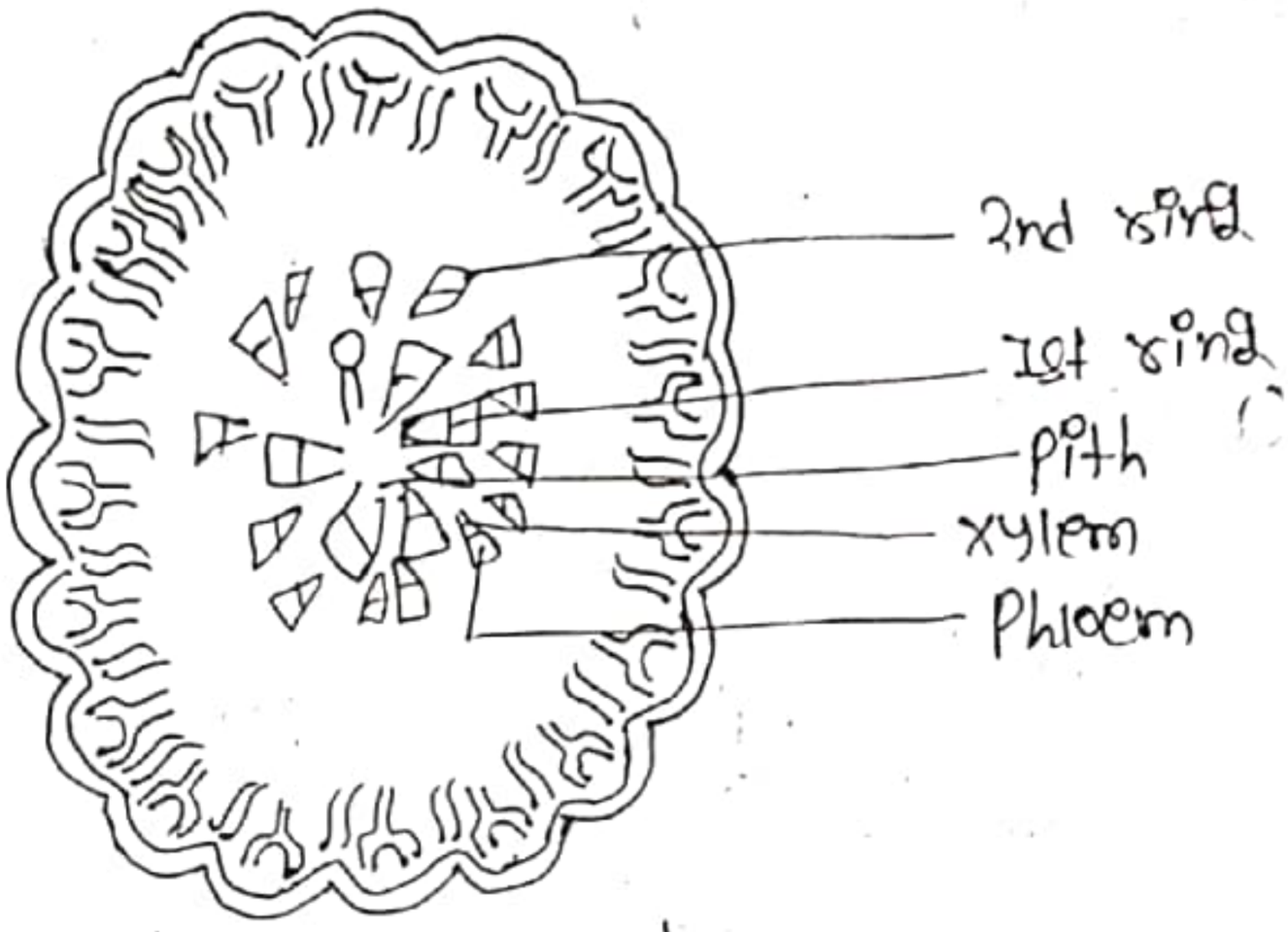
→ Endodermis & pericycle are not distinct.
→ vascular bundles are conjoint, collateral & endarch.

Medullary rays

→ These are well develop medullary rays bet^n the vascular bundles.

Pith

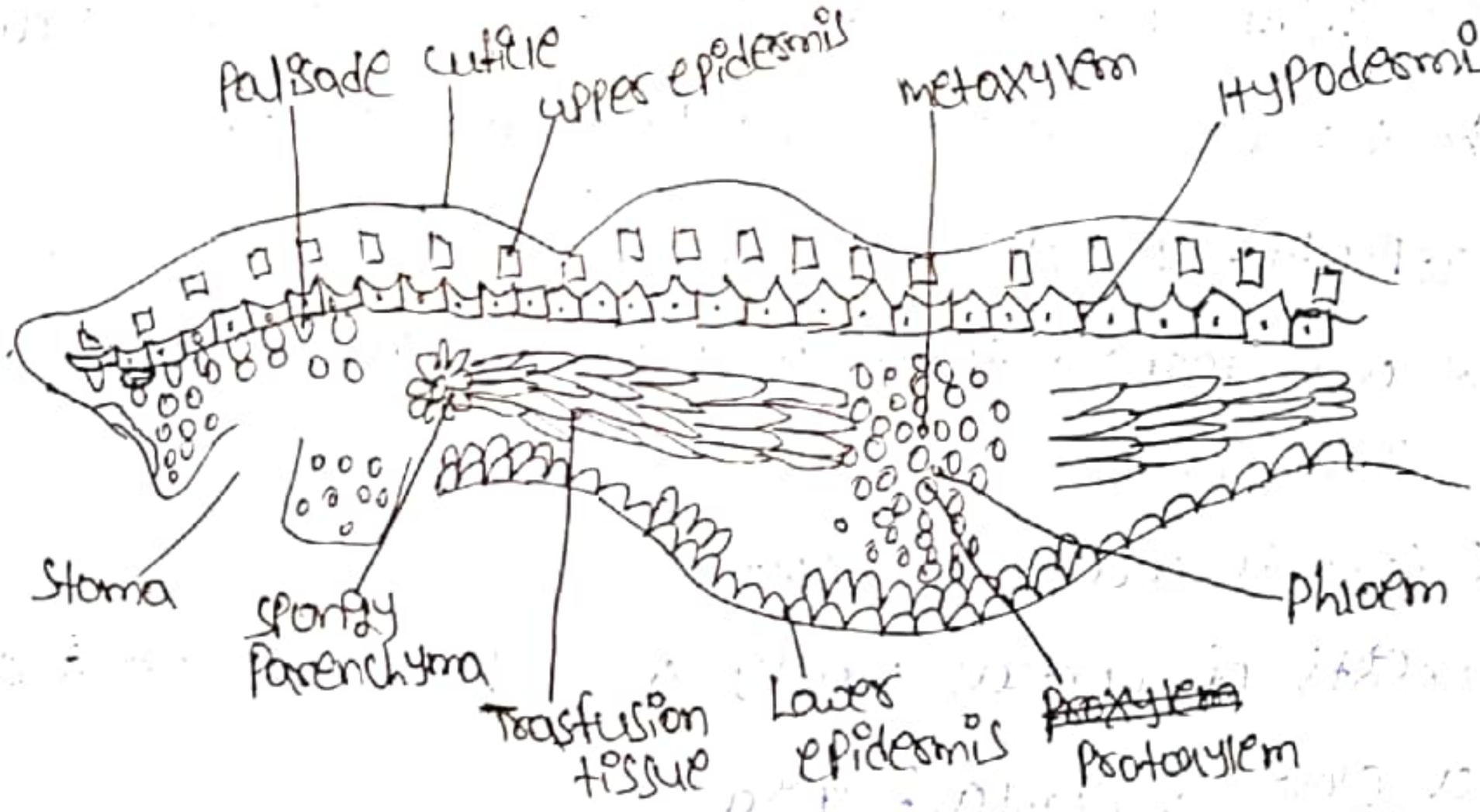
→ The pith is large & consists of parenchymatous cells rich in starch.




( T.S of Stem )

A vertical section of leaflets in the region of midrib shows the following tissues.

① Epidermis - outer most layer
② Hypodermis - Below the epidermis
③ Mesophyll tissue - comprises spongy & palisade parenchyma
④ Transfusion tissue - Lies bet$^{n}$ spongy & palisade parenchyma
⑤ vascular bundle - Restricted only to the midrib region



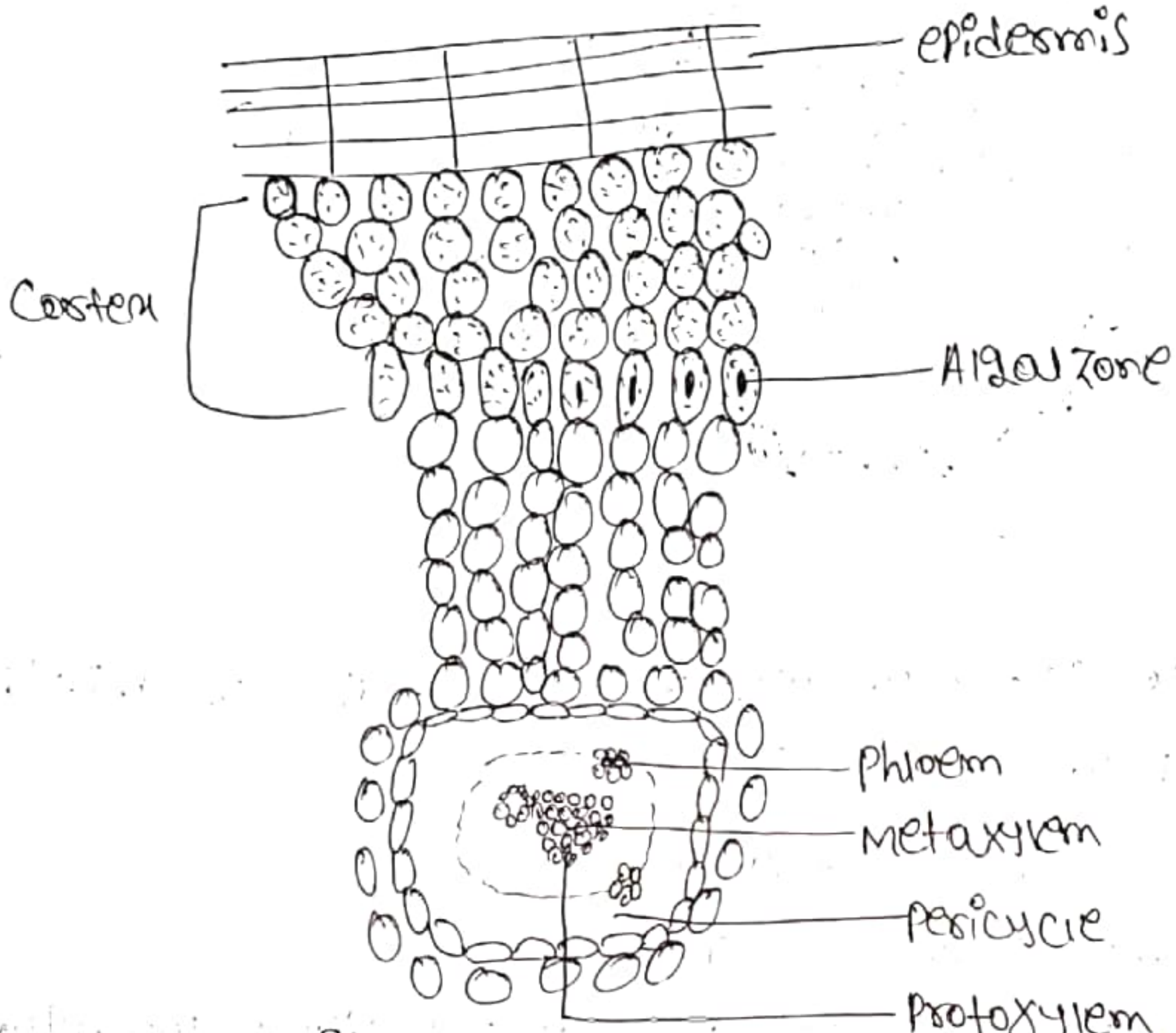

( T.S of leaf let of Cycas revoluta )

→ These are two types of roots are found.

(1) Primary root

(11) Coralloid root

→ The str of primary & coralloid root are similar.




( T.S of Coralloid root )

## Repn

→ All the living sps. of cycas are dioecious as the male & the female structures are on separate plants.

→ The reproductive organ of cycas is strobilus or cone.

→ These are formed terminally on the main axis.

### Male cone

→ Male cone is woody in texture.

→ It consists of central woody axis bearing microsporophylls in a close & compact spiral.

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→ The lower surface of the microsporophyll is covered with numerous microsporangia & thousands of microspores are produced in these sporangia.
→ The archesporium of the sporangium forms a no. of microspore mother cells which divided meiotically give rise to tetrads of haploid spores.

## Female cone

→ In cycas there is no true & compact or properly organised female cone
→ They are loosely arranged & thus forms loose female cone.
→ on the lower ~~#~~ half are two lateral rows of orange coloured big ovule or megasporangium.
→ The ovules of cycas are the largest in the plant kingdom.

## Ovule

→ The ovules are large, erect & slightly flattened in the plane of the megasporophyll.
→ It is enclosed with in a massive integument.
→ Integument differentiated into outer & inner fleshy layer & middle stony layer.
→ The microphyle leads into pollen chamber where pollen grains geminate.
→ Deeped within the ~~nucleus~~ nucellus (which is the inner mass of parenchymatous tissue) female prothallus or endosperm is present.

→ The female prothallus develops from megaspore mother cells.

→ The female prothallus bears two or more archegonia & an archegonial chamber.

→ Each archegonium consists of a short neck with two neck cells & a venter.

→ The venter consists of a ventral canal cell & a large egg cell with distinct egg nucleus.

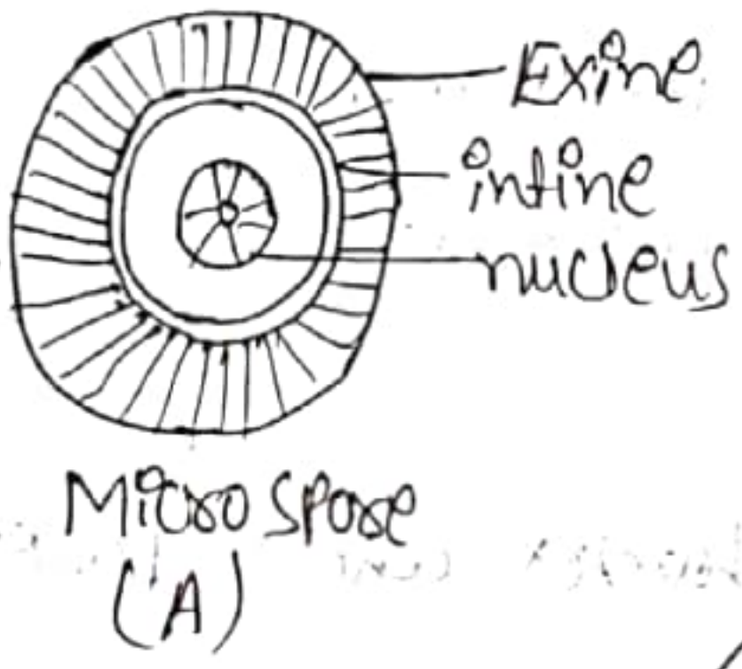
## Male Gametophyte

→ Microspore or pollen grain is the first stage of the male gametophyte.

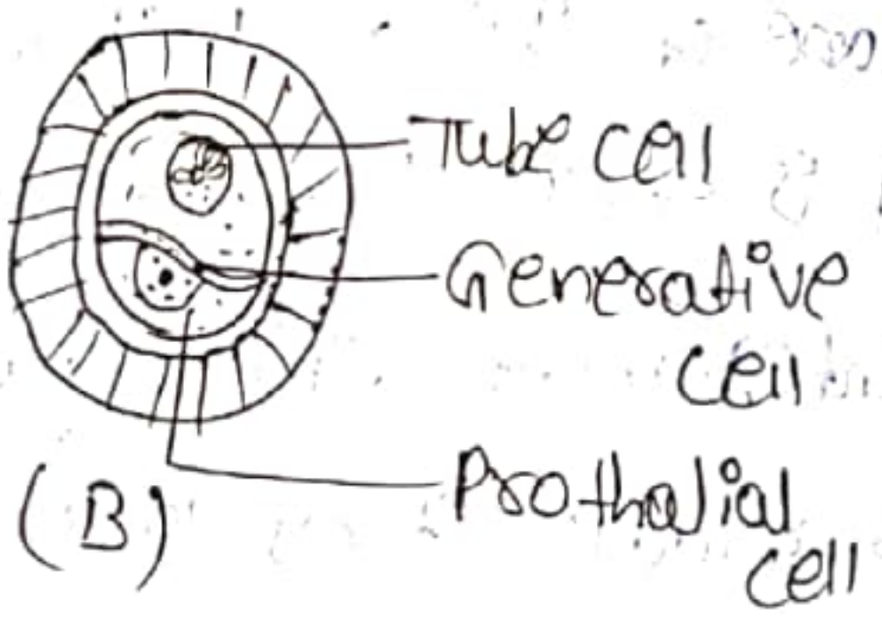
→ The tube cell of the pollen elongates into pollen tube which acts as haustorium & absorbs food from nucellus.

→ The generative cell divides into a stalk cell & a body cell.

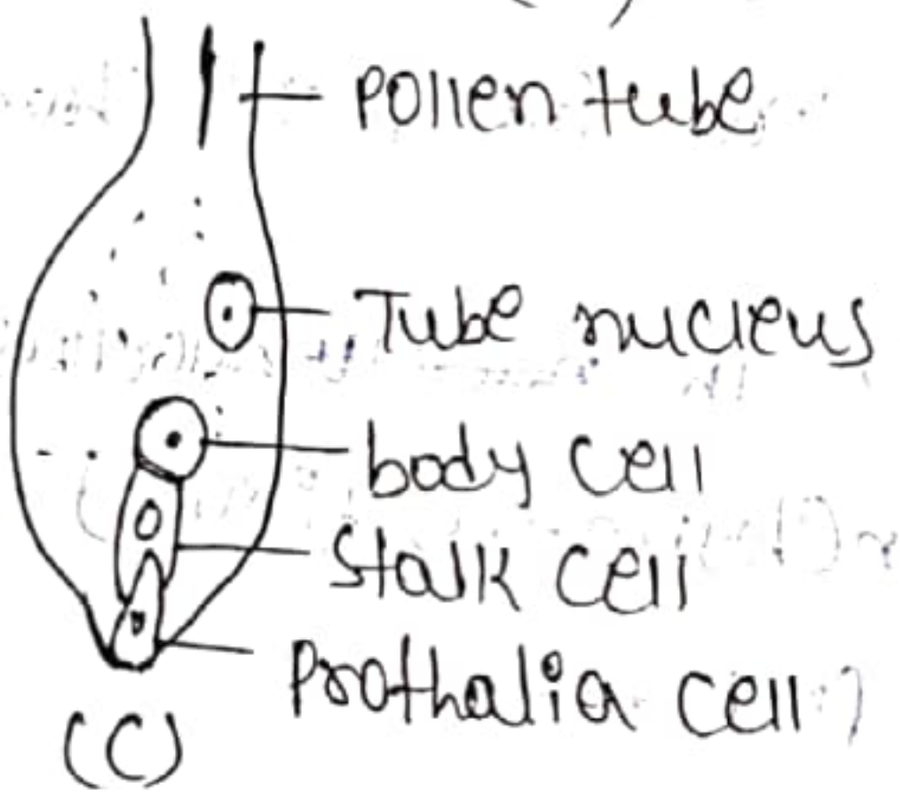
→ The body cell develops into spermatozoids or male gamete.




Microspore
(A)




(B)




(C)

# Female Gametophyte

→ The megaspore is the first stage of the female gameto-phyte of cycas.

→ Geom of megaspore takes place within the ovule.

→ Megaspore mother cell lying within the ~~nucleus~~ nucellus & undergoes meiotic div & give rise to four haploid megaspore which are arranged in linear tetrad.

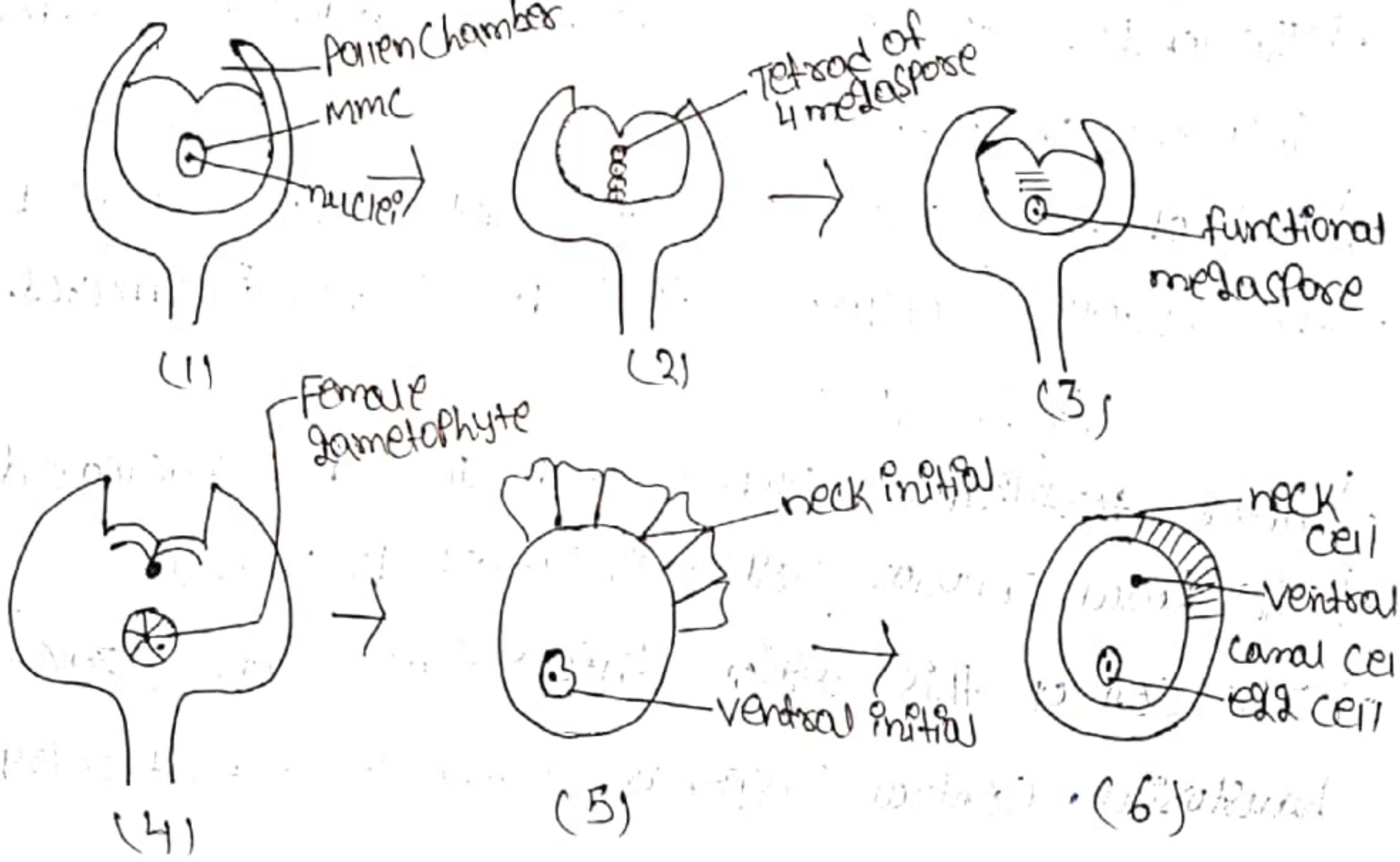
→ The upper 3 megaspores are degenerate & lower one is the functional megaspore.

→ The nucleus of functional megaspore undergoes free nuclear div forming a large no. of nuclei.

→ The newly formed tissue fills up the central cavity & is known as female prothallus.

→ The female prothallus forms 2-8 archegonia.

→ Each archegonium consists of 2 neck cell, small ventral cell below the neck cell & one large egg cell or oosphere.



## Pollination

→ The light dry microspore & at this 3 celled stage of the male gametophyte are liberated & carried out by the wind to the ovule.

→ At this time a drop of mucilagenous fluid exudes as a pollination drop from the micropyle of the ovule.

→ As it dries up, the microspores are drown into the Pollen Chamber.

## Fertilization

→ The spermatozoids move to the tip of the pollen tube.

→ The pollen tube bursts at the apex releasing the spermatozoids.

→ The wall separating the nucellus & archegonial Chamber breaks forming one Chamber.

→ The spermatozoids swim to the archegonium & enter into the venter.

→ one of them fuses with the egg nucleus forming the zygote or oospore & thus fertilization is effected.

## Embryogeny

→ After fertilization, oospore undergoes free nuclear div^n.

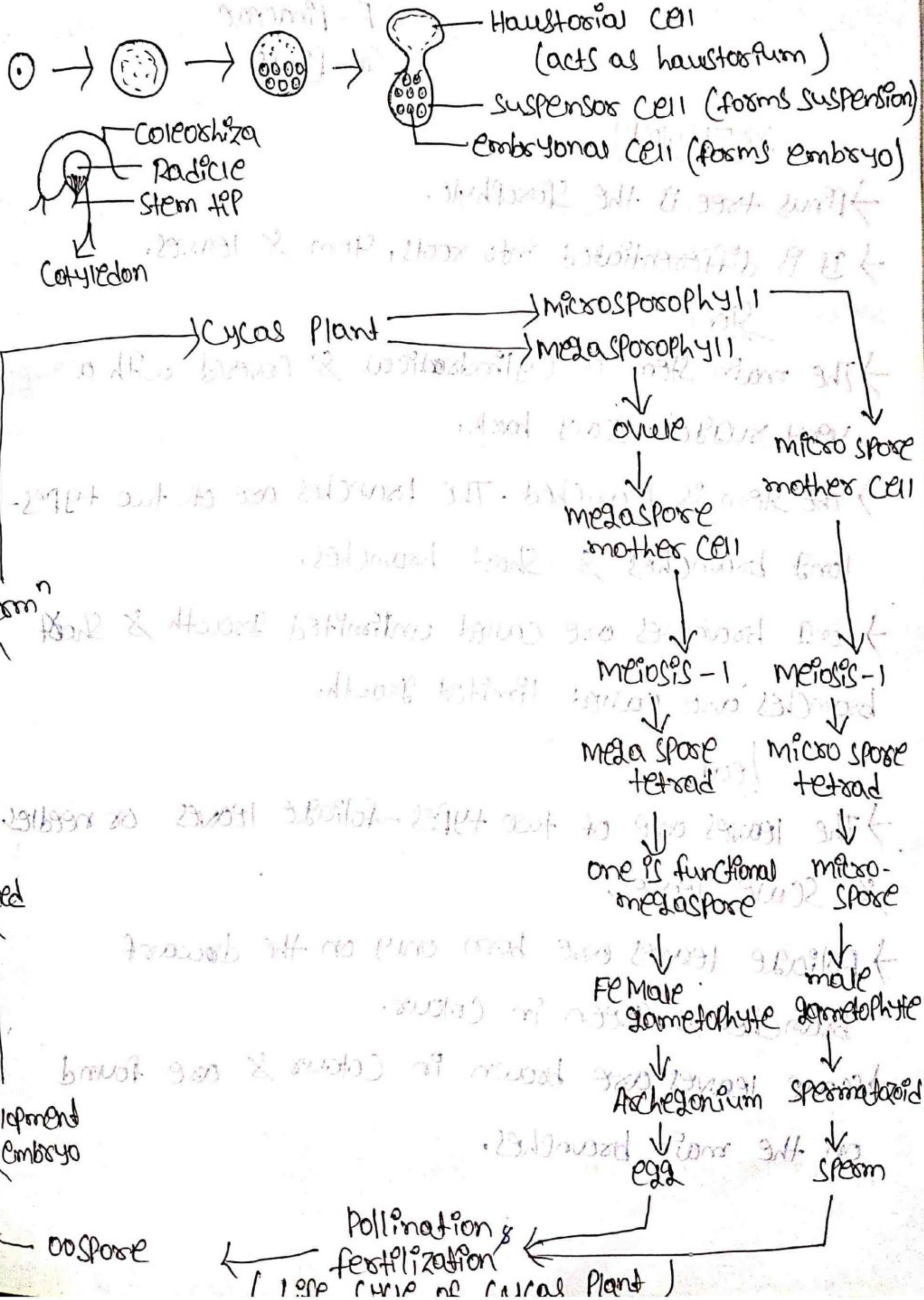
→ The basal cellular region is called proembryo.

→ The cell of this region differentiated into 3 zone- haustorial, central suspensor & the lower most embryonal.

7) The haustorial cell absorbs food from the upper part for the development of embryo.

→ Embryo reaches the whole length of the seed.

→ Germ$^{n}$ of cycas seed is hypogeal.



# PINUS

S.P

C- Coniferopsida

O- Coniferales

F- Pinaceae

G- Pinus

## Morphology

→ Pinus tree is the sporophyte.

→ It is differentiated into roots, stem & leaves.

## Stem

→ The main stem is cylindrical & covered with a very rugged, scaly bark.

→ The stem is branched. The branches are of two types- long branches & short branches.

→ Long branches are called unlimited growth & short branches are called limited growth.

## Leaf

→ The leaves are of two types - foliage leaves or needles & scale leaves.

→ Foliage leaves are born only on the dwarf branches & green in colour.

→ Scale leaves are brown in colour & are found on the main branches.

Lavish

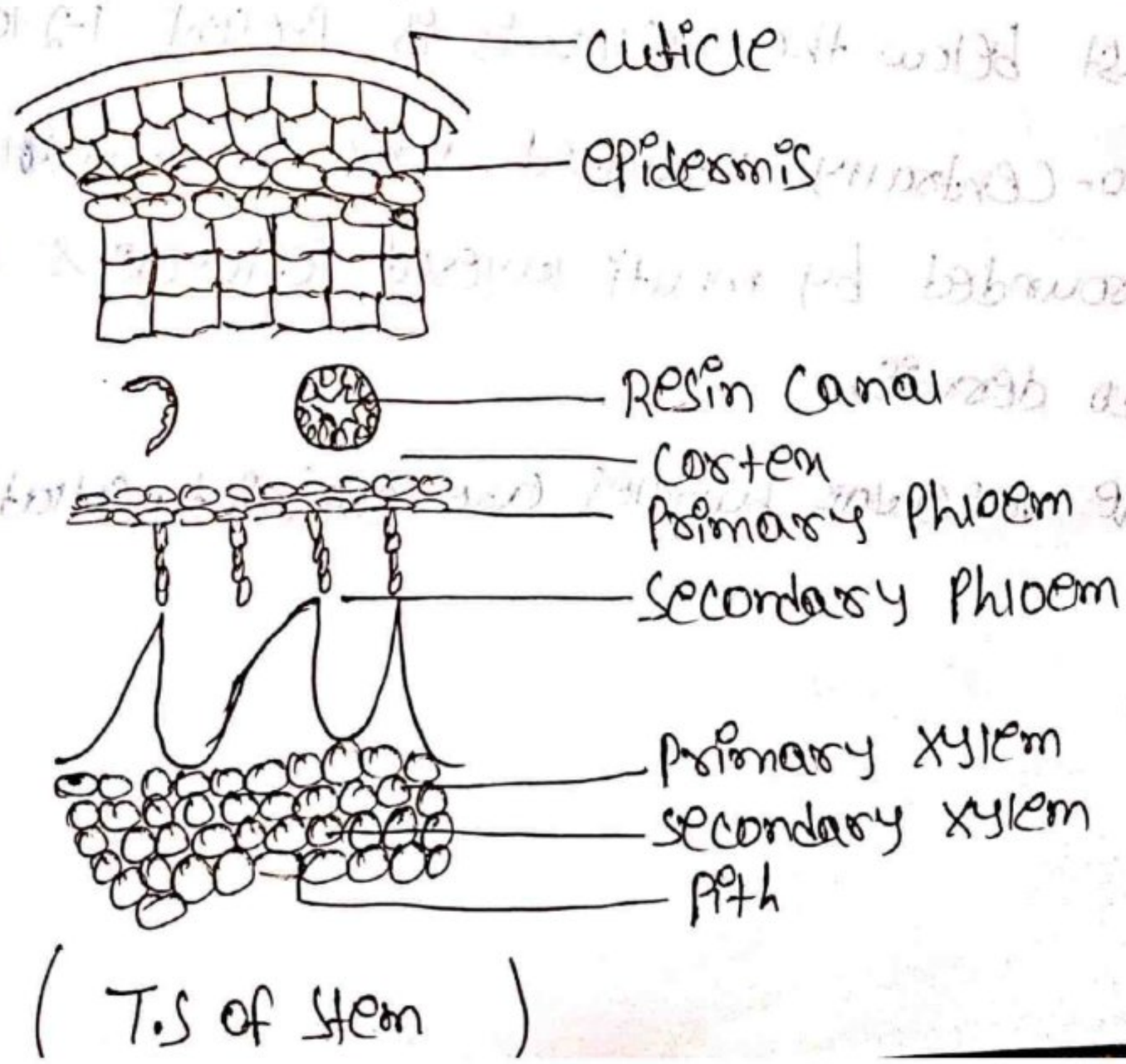
## Root

→ Tap root are deeply penetrate with the soil.
→ They are formed mycorrhiz.
→ under the microscope they are seen to covered with a close weft of colourless hyphae.

## Anatomy

## Stem

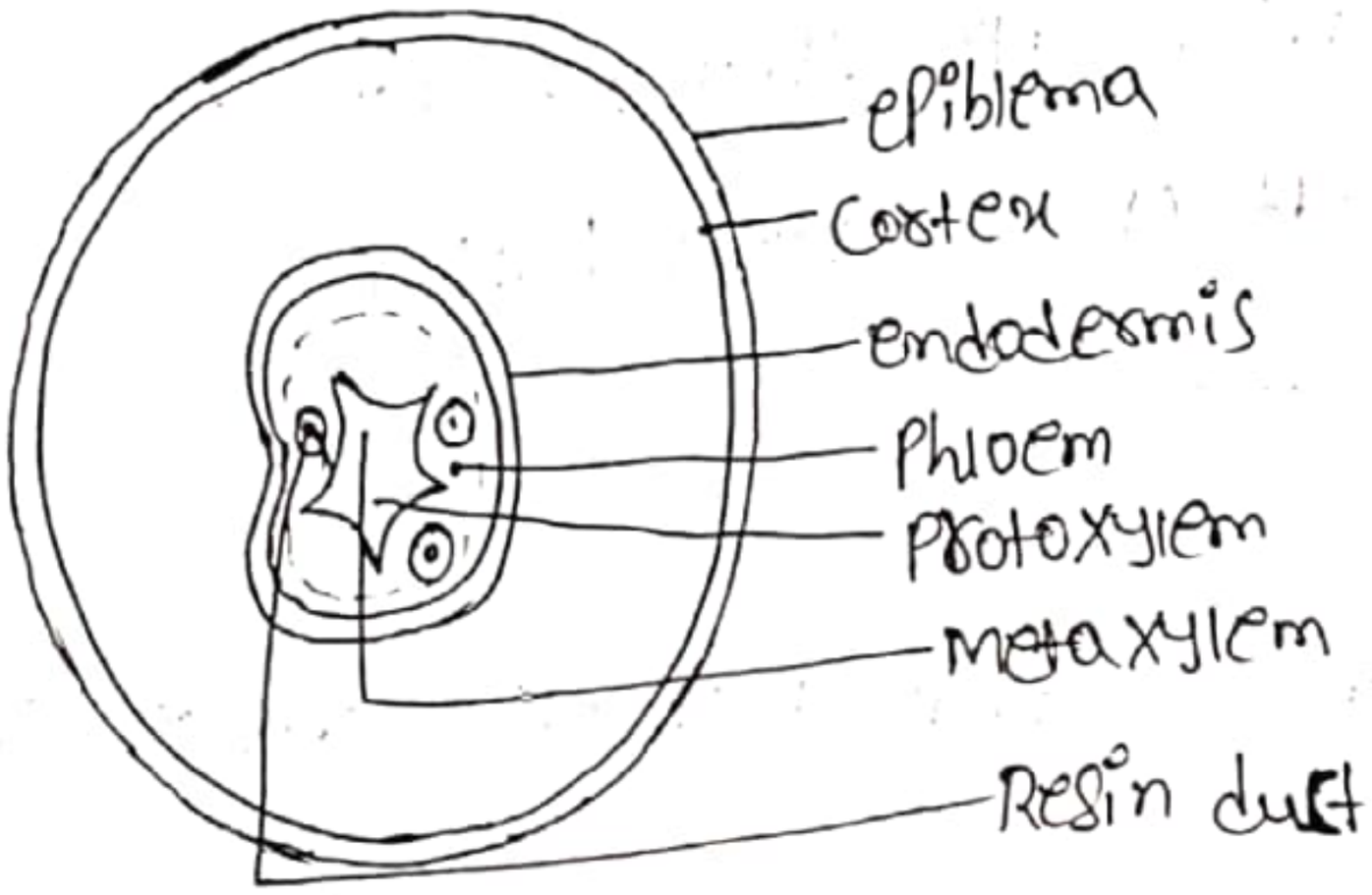
→ The epidermis is composed of thick walled cuticularized cells.
→ It is followed by hypodermis which is made up of thick lignified cells.
→ The cortex is comparatively thin & made up of parenchymatous cells.
→ The vascular bundles contain xylem & Phloem.
→ Bet^n the primary bundles are parenchymatous primary medullary rays connecting the pith with the external cortex.




( T.S of stem )

## Root

→ The root is covered with short root hairs which are prolongation of the thin walled cells of the piliferous layer.




( T.S of root )

## Leaf

→ The internal str of the leaf or "needle" of Pinus shows xerophytic features.

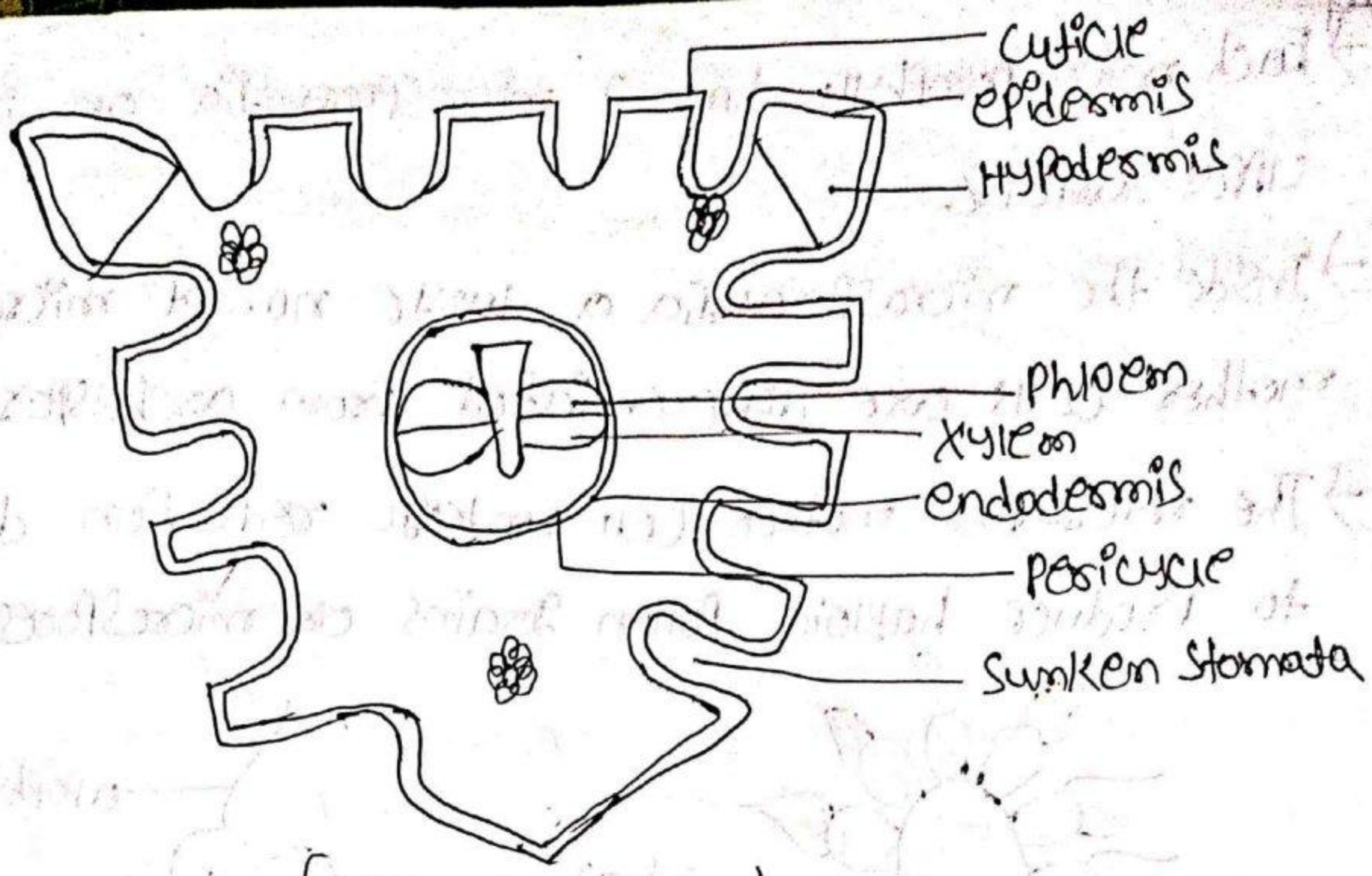
→ Each 'needle' is semicircular in cross section.

→ The outermost layer epidermis is covered with a thick cuticle

→ Just below the epidermis is present 1-2 layer hypodermis.

→ Two-centrally situated vascular bundles are surrounded by multi layered pericycle & a well-marked endodermis.

→ The vascular bundles are conjoint, collateral & open.




(T.S of needle)

## Repⁿ

→ Pinus reproduces by asexual spores which are produced in sporangia, born on specialized stᵏ - the sporophyll which are aggregated together into cones.

→ Cones are of 2 types i.e. male cone & female cone.

→ Pinus is monoecious as it bears both types of cones on the same tree on separate branches.

→ Male cone occurs in clusters near the ends of long branches.

→ The female cones are produced laterally in the axils of scale leaves.

### Male Cone

→ Each male cone usually has 60-100 spirally arranged microsporophylls.

→ The microsporophylls arise from the central axis & pass out horizontally.

Lavish

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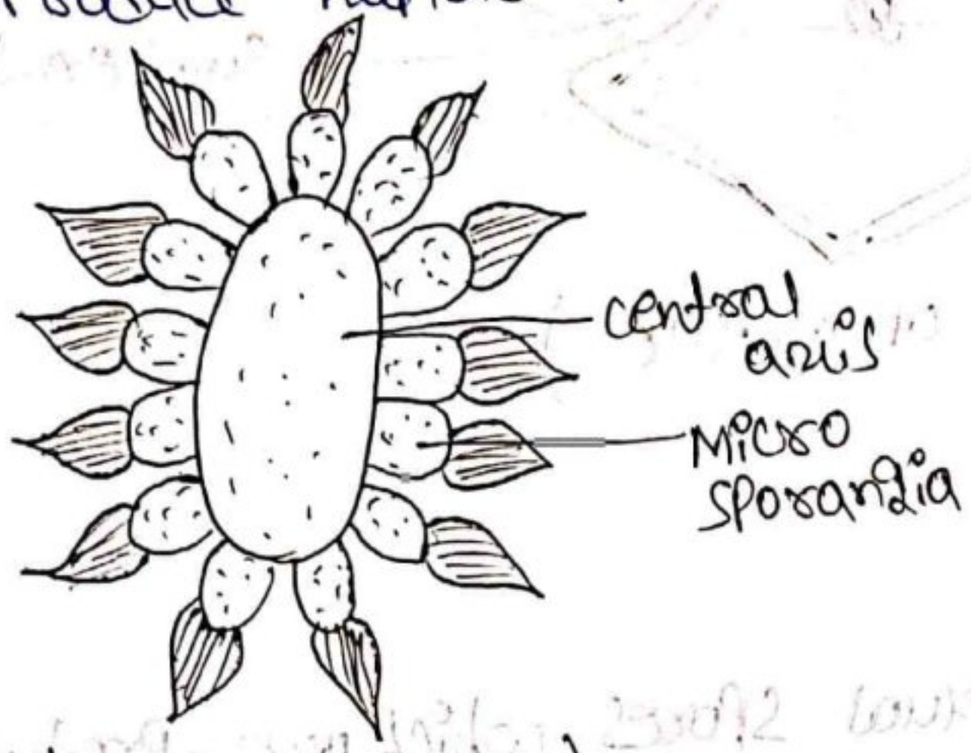
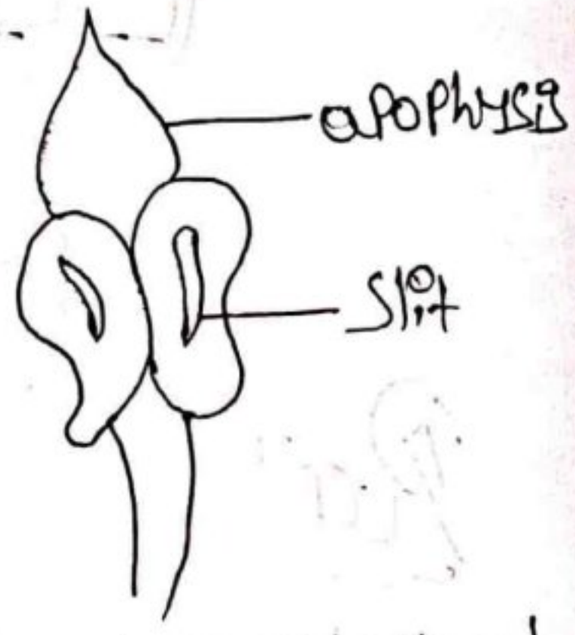
→ Each microsporophyll has 2 microsporangia on its upper surface.

→ Inside the microsporangia a large no. of microspore mother cells are differentiated from archesporial tissue

→ The microspore mother cell undergo reduction div^n to produce haploid pollen grains or microspores.




(LS of male cone)




(A microsporophyll)

## Development of the male gametophyte

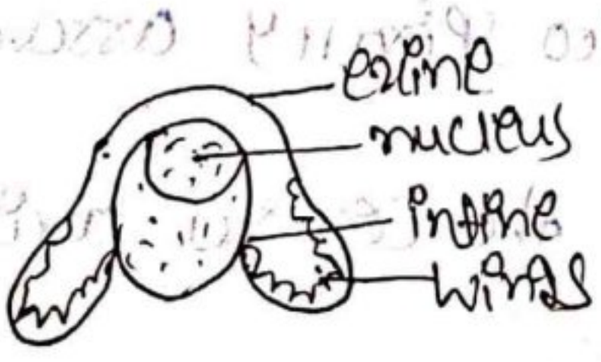
### before Pollination

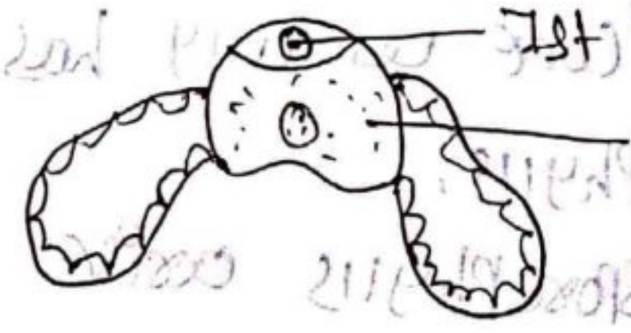
→ The pollen grains have prominent 3 layered coat.

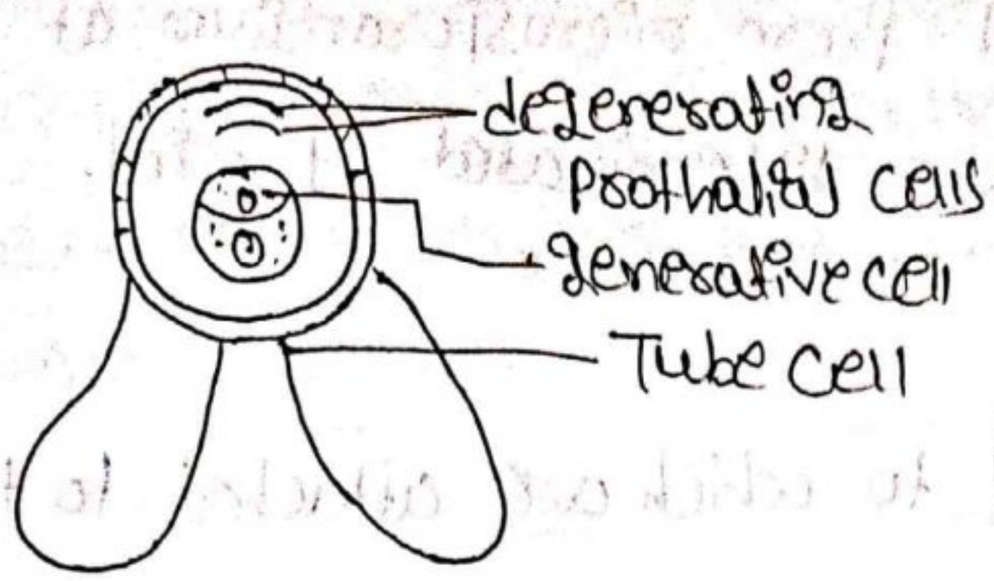
→ The outermost layer exine, middle layer completely surrounds the spore & forms two ballon shaped, wings on either side.

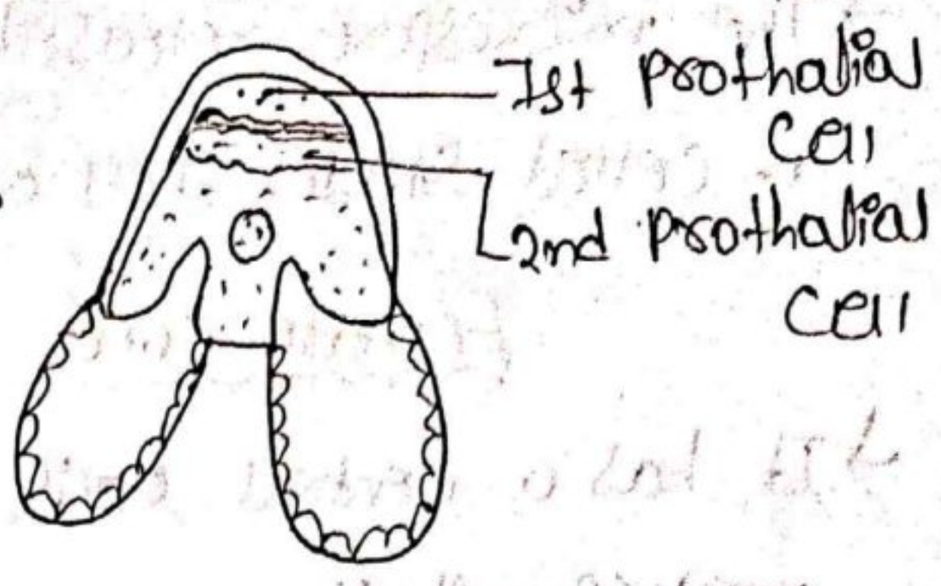
→ Pinus is wind pollinated.

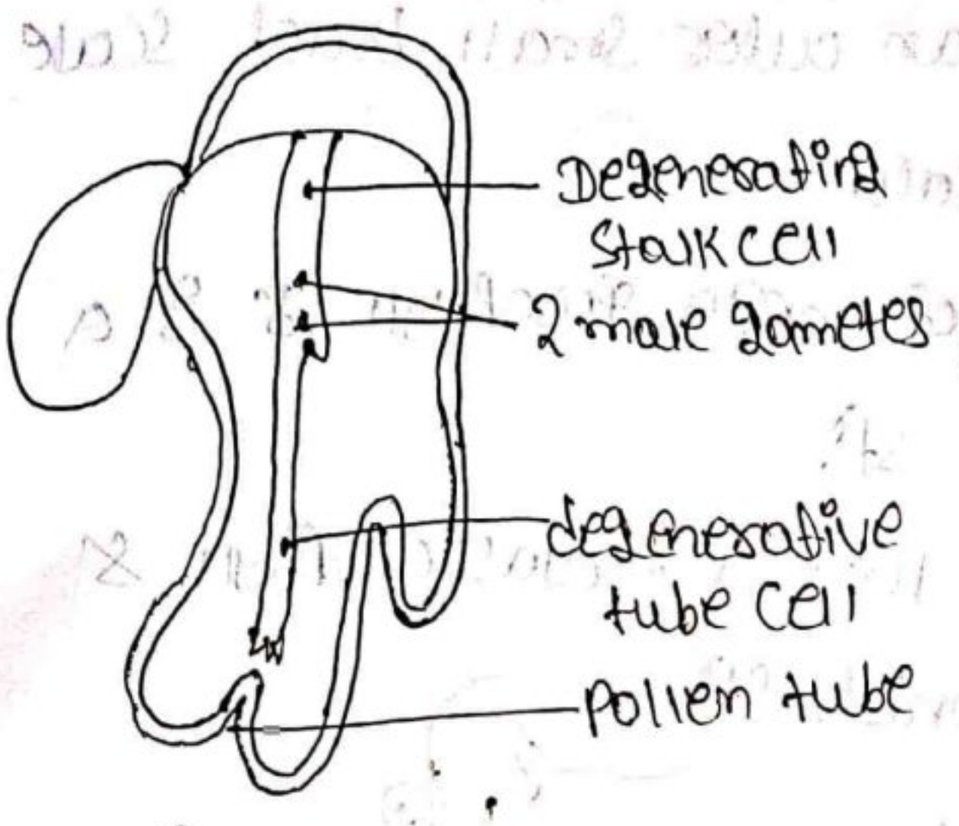
→ The innermost layer, intine.

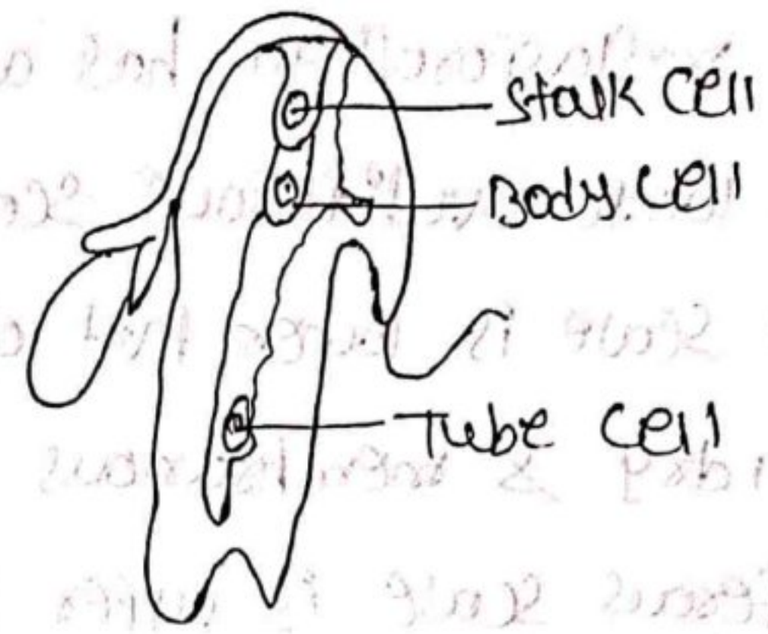





Development of male gametophyte

→ The nucleus of the microspore divide into two cells, a smaller cell called first prothalial cell & a larger cell called apical cell.

→ first prothalial cell does not divide further.

→ The apical cell again divides & forms a small second prothalial cell & large antheridial cell.

→ The 2nd prothalial cell does not divide further.

→ The antheridial cell divided to form a generative cell & a large tube cell.

→ At this stage the male gametophyte has four cells first & second prothalial cell, a generative cell & a tube cell.

→ The microspore released from microsporangium at 4-celled stage. They are disseminated by wind.

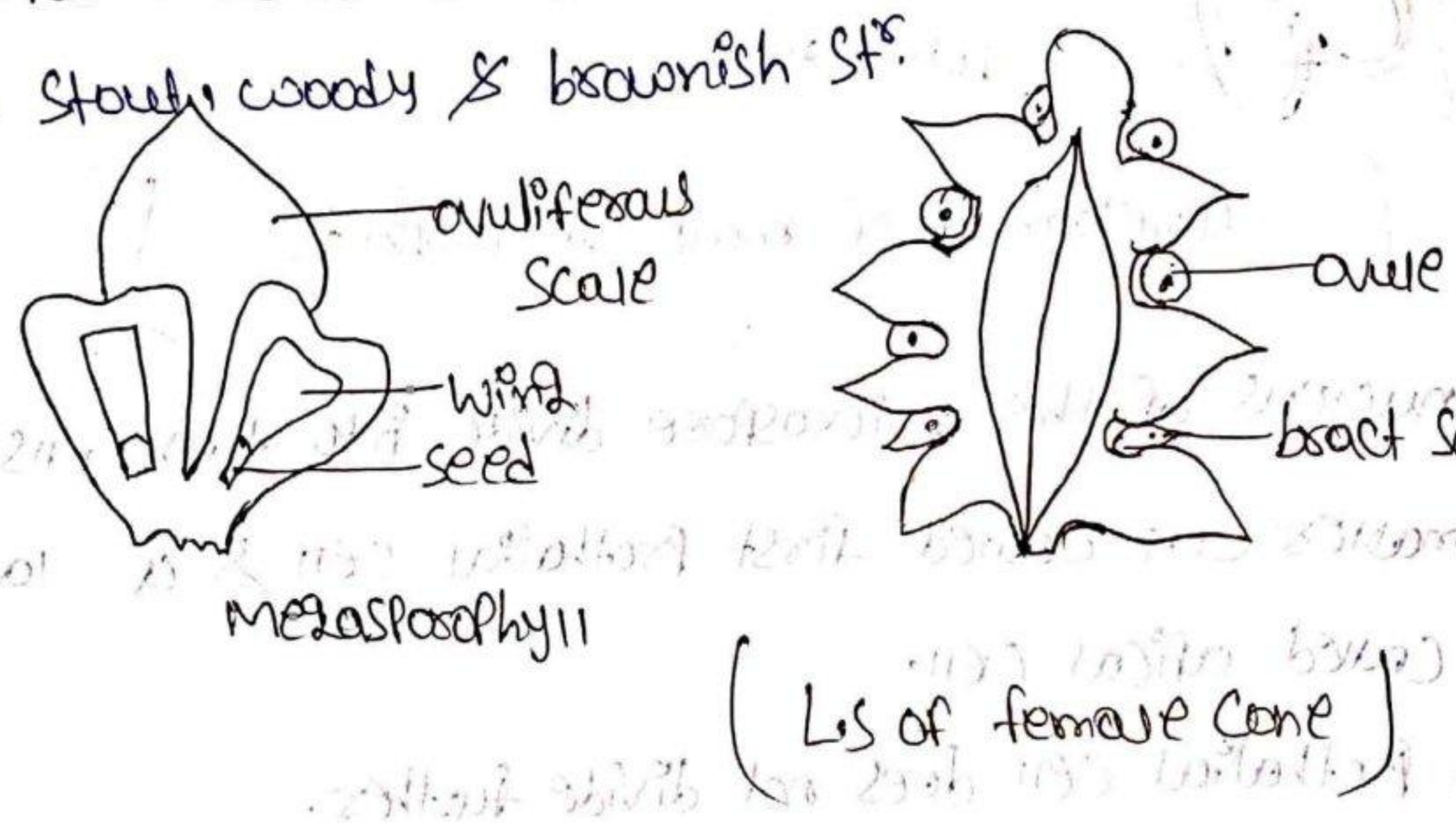
## Female cone

→ It has a central axis to which are attached to the megasporophyll.

→ Each megasporophyll has an outer small bract scale & a large ovuliferous scale.

→ Bract scale is lower part of mega sporophyll & is a small, dry & membranous str.

→ ovuliferous scale is upper part of megasporophyll & is a stout, woody & brownish str.




(L.S of female cone)

## Development of female Gametophyte & Archegonium

→ The megaspore is the mother cell of the female gametophyte.

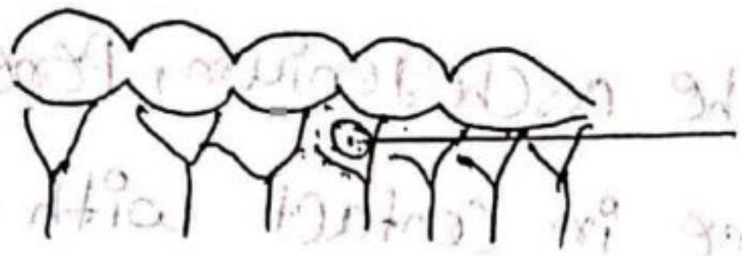
→ All the superficial cells at the micropylar end of the female gametophyte have the capacity to develop into archegonia but only a few cells differentiated into archegonial initials.

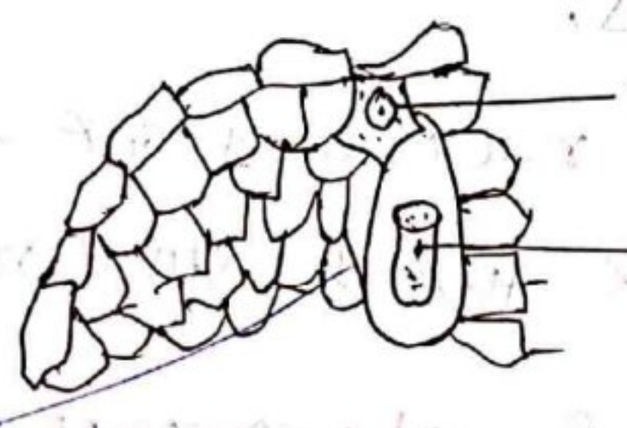
Lavish

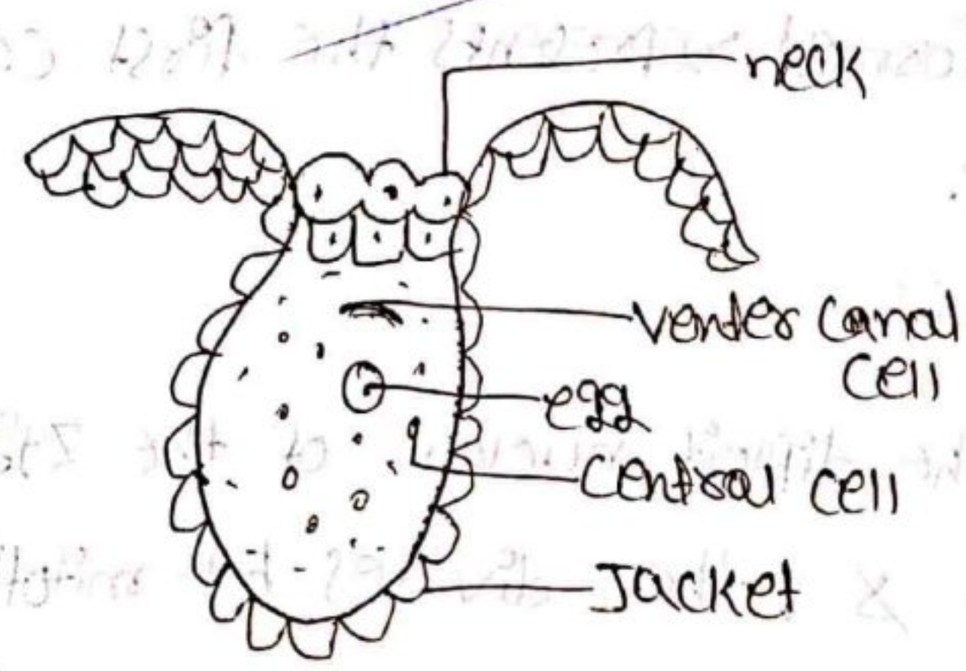
→ The archegonial initial divided into a upper smaller primary neck cell & a lower larger central cell.

→ The neck cell divided into four cell which are again divided into eight neck cell.

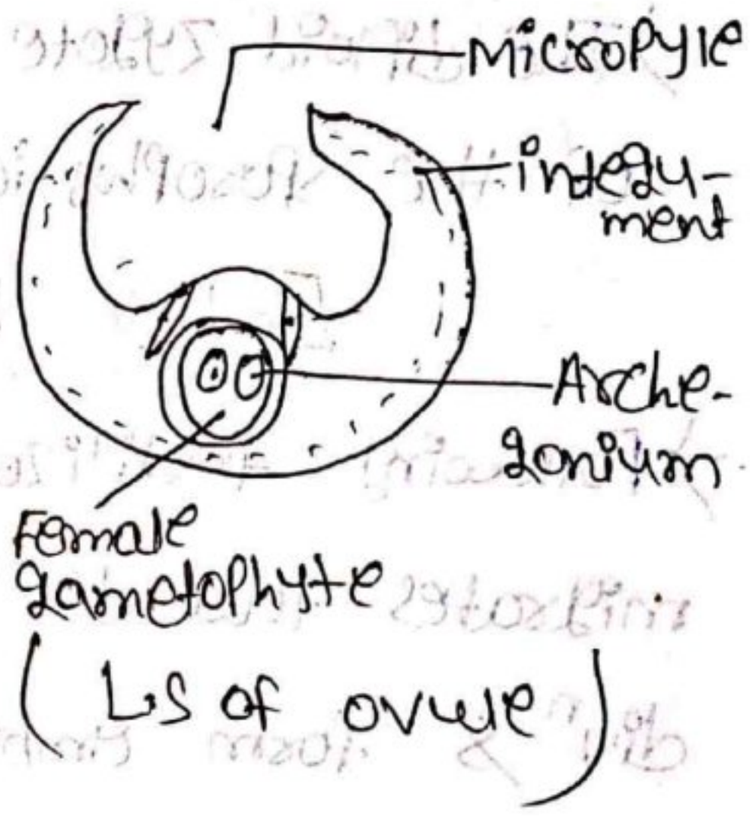
→ The central cell divides to form a upper smaller vender canal cell & a large egg.




(Dev. of Archegonium)




(L.S of ovule)

## Pollination

→ Pinus is wind pollinated.

→ At the time of pollination a secretion oozes out from the micropyle of the ovule which entangles pollen grains disseminated by wind.

→ This secretion is generally given out at night & remains at the tip of the micropyle till morning.

→ In Pinus the pollen grains are formed in enormous quantity but only a few are utilized for fertilization.

## Fertilization

→ Fertilization takes place after about one year on pollination.

→ The pollen tube, containing four nuclei elongated & reaches near the tip of the archegonium, penetrates neck cells & when it come in contact with the egg it releases its contents.

→ out of the two male nuclei only one fuses the egg & other male nuclei & tube & stalk nuclei degenerate.

→ The diploid zygote thus formed represents the first cell of the sporophytic phase.

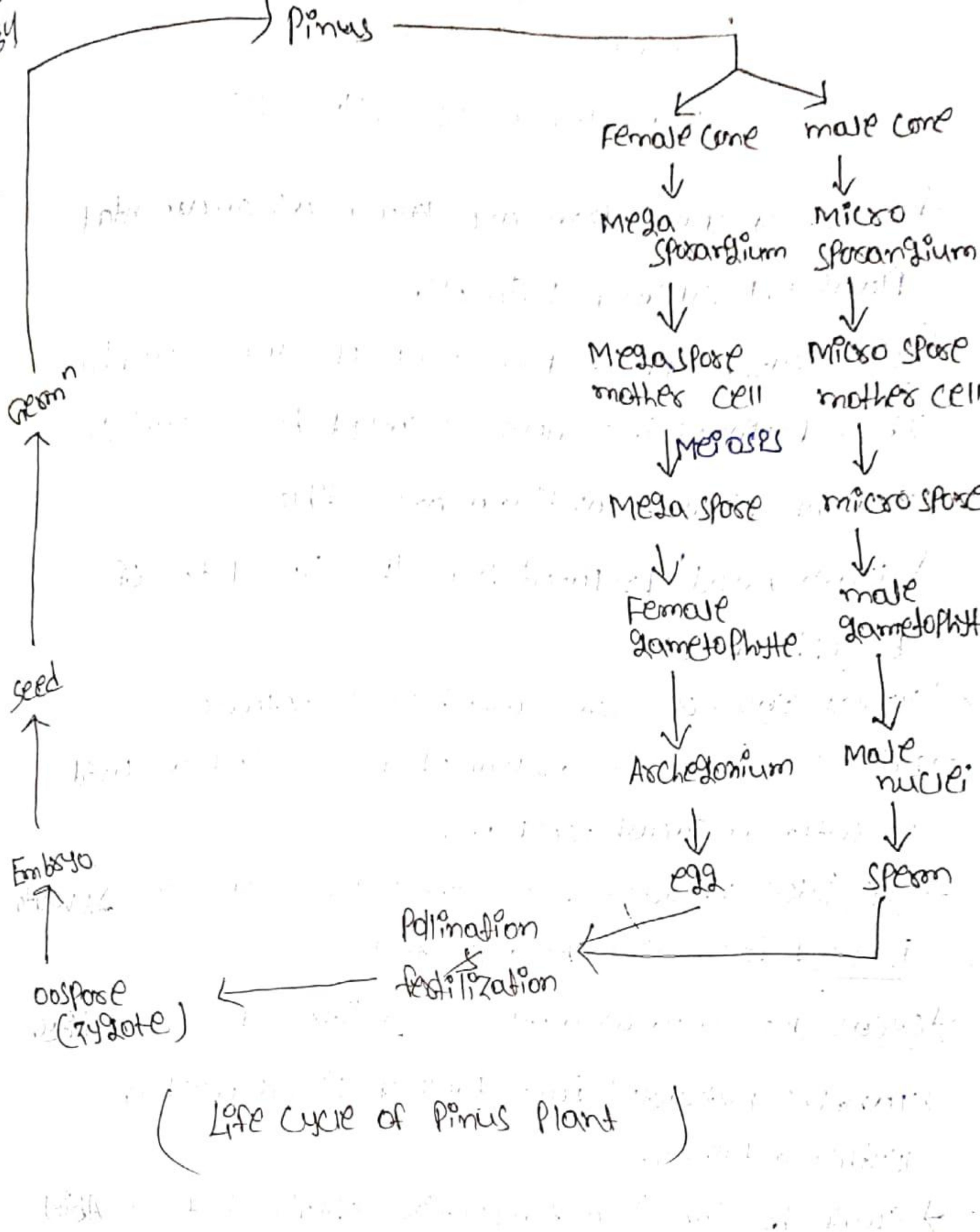
## Embryo development

→ Following fertilization, the diploid nucleus of the zygote migrates towards its base & then divides by mitotic div$^{n}$ & form embryo.

→ Embryo then develops into seed.

→ seed germ$^{n}$ takes, here germination is epigeal i.e. cotyledons come outside of the soil.

→ seed germinates & give rise to new Pinus Plant.




( Life cycle of Pinus Plant )

Lavish