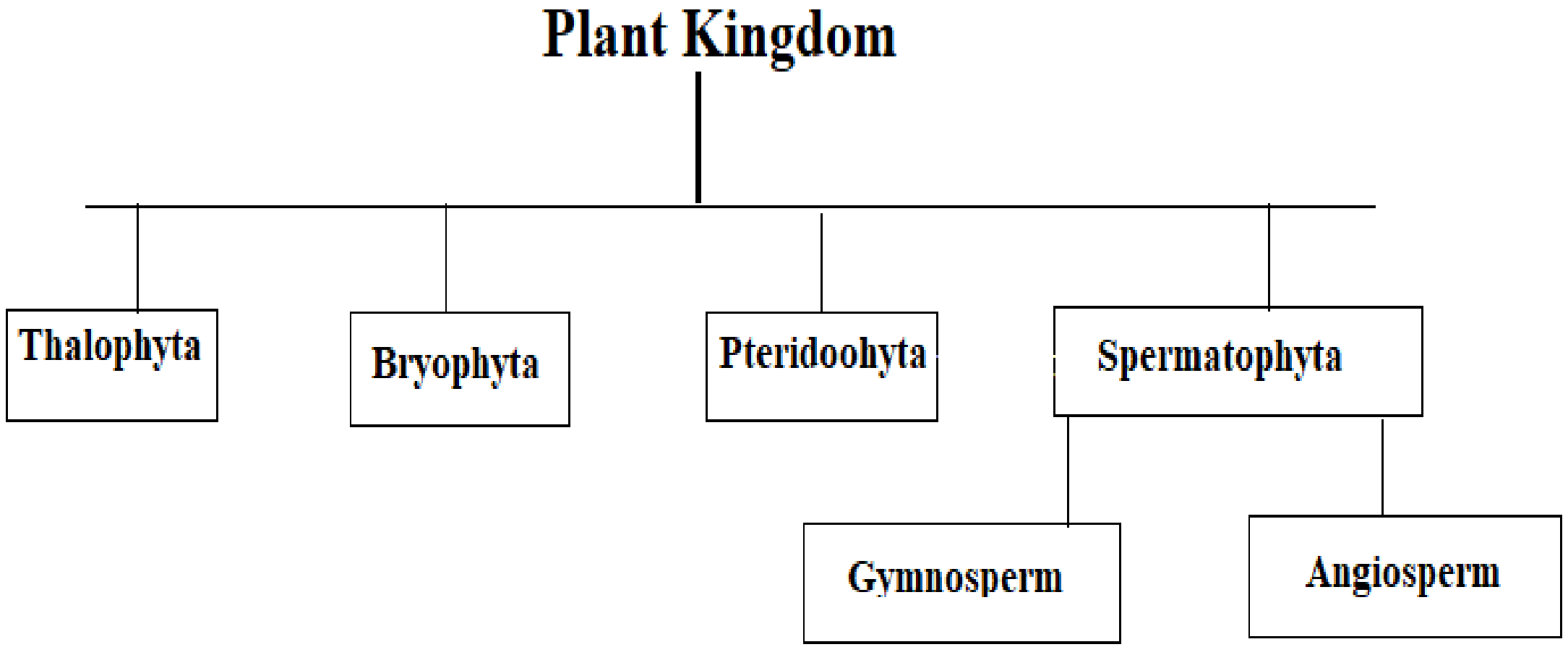

Gymnosperm


Plant Kingdom
Thalophyta
Bryophyta
Pteridoohyta
Spermatophyta
Gymnosperm
Angiosperm

Gymnosperm

Characteristics……

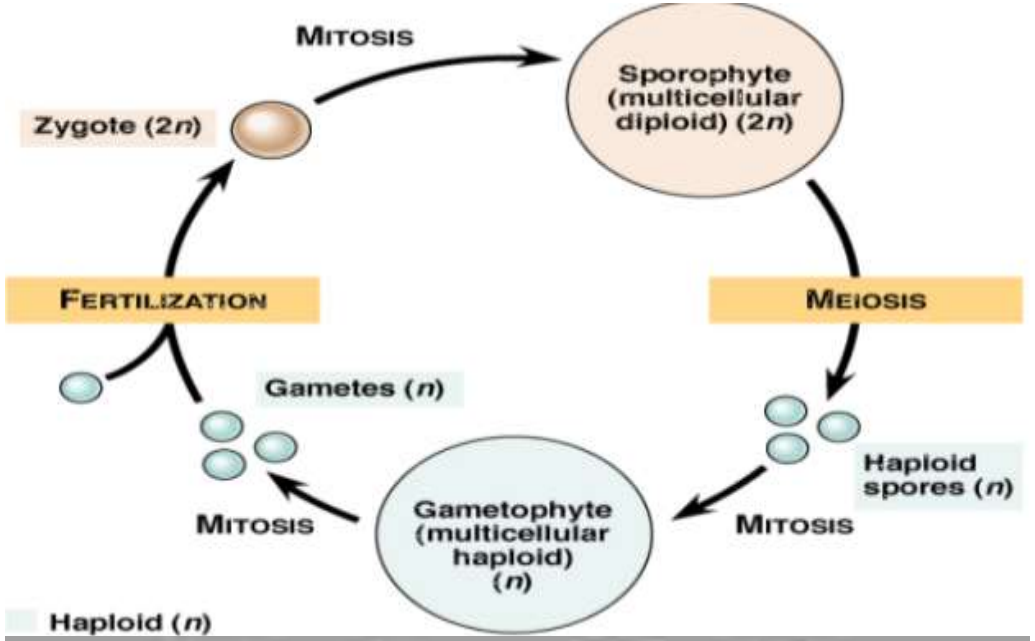
❑ Plants are sporophytes; majority are tall woody perennial and evergreen trees; rarely shrubs. Plants are always heterosporous

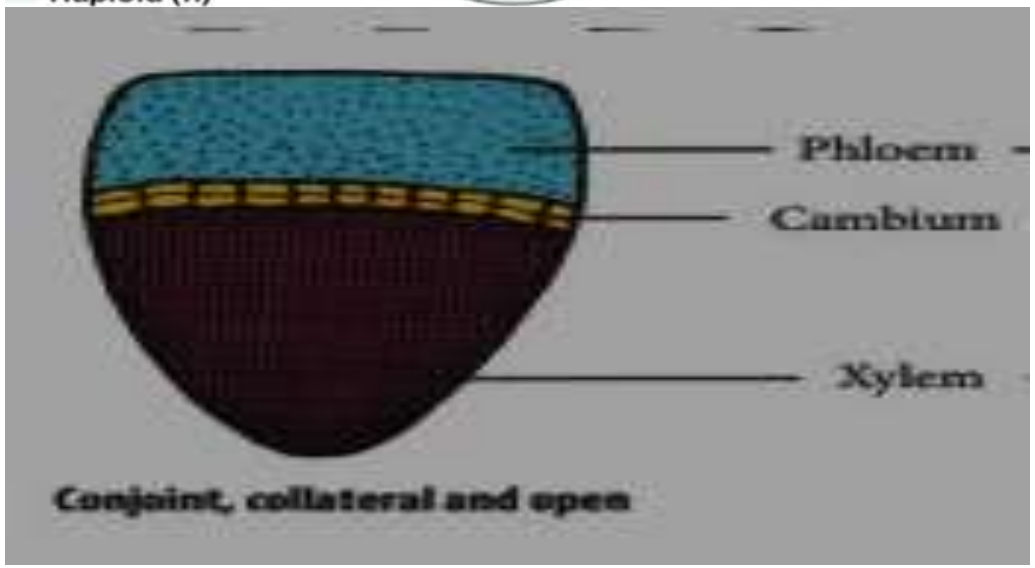
❑ Leaves are dimorphic i.e. leaves are of two types viz., a. brown scale leaves and b. green foliage leaves which are evergreen and provided with thick cuticle

Foliage Leaves and Scale Leaves in *Pinus*

❑ Sporophytes are larger in size and independent. Gametophyte are very much reduced.

❑ Vascular bundles in stems are conjoint, collateral and open and often arrange in ring. Xylem is without trachea except *Gnetum* and phloem is without companion cell.





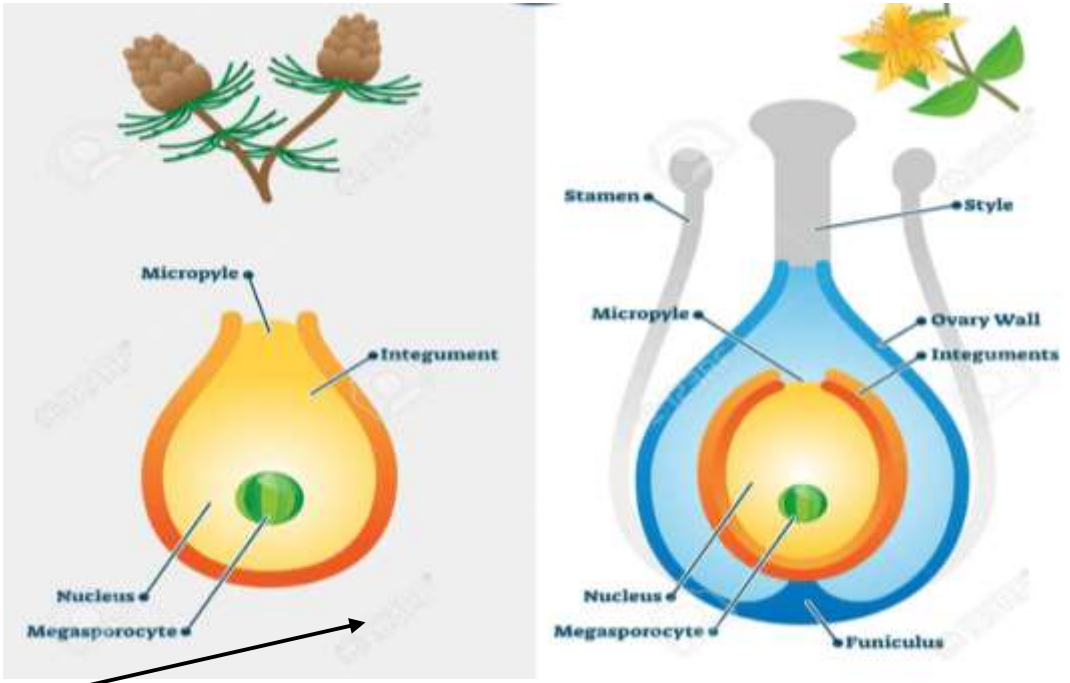
- Male gametes(sperm) either ciliated and motile as seen in some gymnosperm (*Cycus, Ginkgo* etc.) or non-ciliated and non-motile as found in other gymnosperm i.e. *Pinus* and *Gnetum.*

- Endosperm formation takes place within female gametophyte before fertilization; as such endosperm is haploid. But in *Gnetum* endosperm tissue formation takes place partly before and partly after fertilization.

- True seed are always present. Seed are borne uncovered or naked i.e. seeds are not encased within fruit

- During the pollination microspores are directly deposited at micropyle of ovule by air i.e. pollination is anemophyllous.

- True seed are always present. Seed are borne uncovered or naked i.e. seeds are not encased within fruit.



- Active cambium produces considerable amount of secondary xylem and phloem during secondary growth contributing in the formation of secondary wood

Secondary wood

Manoxylic wood: Manoxylic wood is soft, porous, relatively sparse with very wide medullary rays. More parenchymatous in nature. Commercially it is useless. Large pith and cortex with little amount of tracheids E.g. *Cycas*

Pycnoxylic wood: compact with large no. of xylem tracheid or wood and has narrow medullary rays. Small amount of cortex. Pith with little parenchyma. It is of great commercial importance as it is durable and provide best timber.
E.g. *Pinus*

Pinus

Systematic Position

Division: Coniferophyta

Class: Coiniferosida

Order: Coniferales

Family: Pinaceae

Genus: Pinus

Occurance and Distribution

- Important member of Coniferales.
- Represented by about 105 species
- Widely distribute in Northern hemisphere, commonly found in northern Europe, Northern and central America, Subtropics of North Africa, India, Myanmar, Pakistan, Afganistan and Indonesia
- Six species of Pinus occurs in India viz. *P. roxburghii*, *P. wallichiana*, *P. insularis*, *p. gerardiana*, *P. armandi* and *P. merkusii*

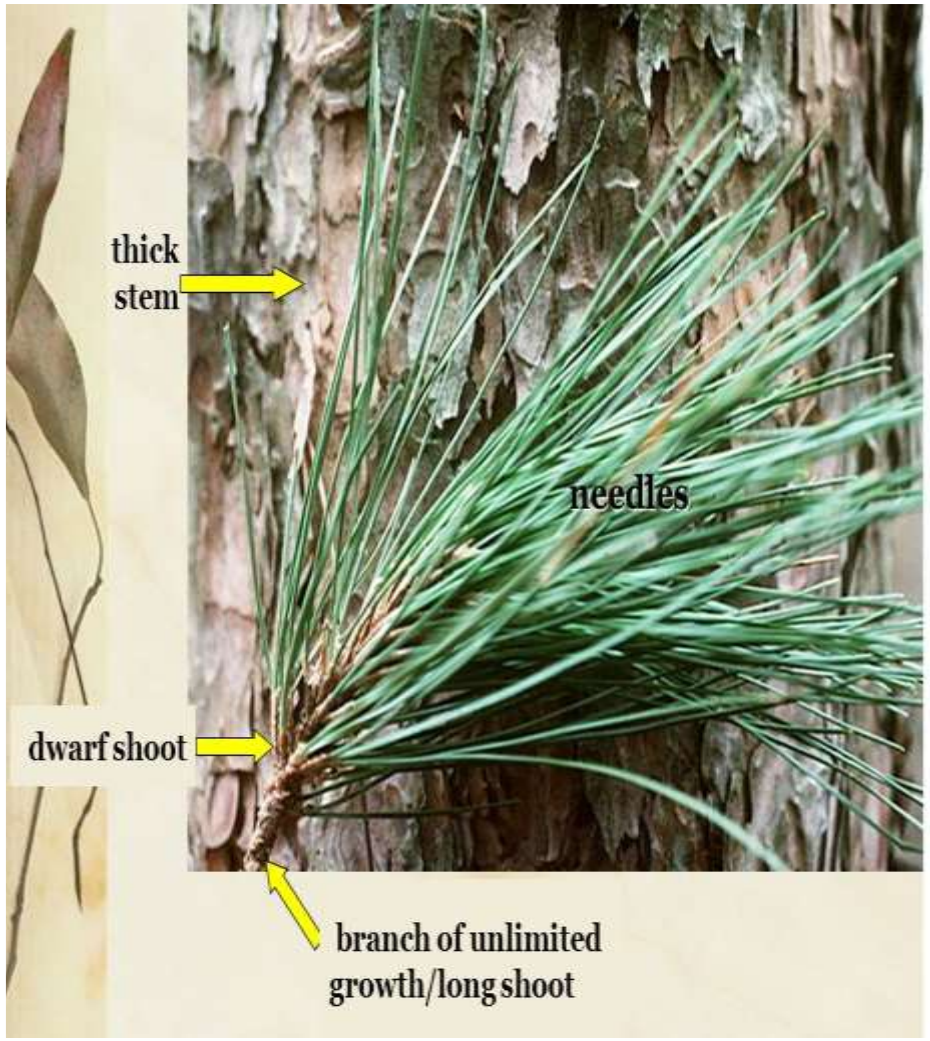
Sporophytic Structure

- Root : A strong tap root system is present in young plant which is replaced by lateral root at later stages. Roots make symbiotic association with fungi called mycorrhizae where the fungi does not affect the plant root but provide soil nitrogen and phosphate and other minerals from root to the root .

Stem: The stem is erect, stout, cylindrical and pyramidal shape with dimorphic branches. The branches are restricted in the apical region. The stem is covered with bark. There are two types of branches:

Long Shoot: Shoot which grows indefinitely with the help of apical bud. Also called branches of unlimited growth. Develops as lateral buds in the axil of scale leaves on main stem. Gradually becomes shorter and give the plant pyramidal shape.

Dwarf shoot are devoid of any apical bud and thus are limited in
their growth. They arise on the long shoot in the axil of scaly leaves. A dwarf shoot has two scaly leaves called prophylls, followed by 5-13 cataphylls . Dwarf shoot along with needles is also called a spur .



Spur with only one leaf……..Unifoliar (P. monophyla)
Two leaves……Bifoliar (P. sylvestris)
Three leaves……Trifoliar (P. gerardiana)
Four……Quadrifoliar (P. quadrifolia)
Five……..Pentafolia (P. wallichiana)

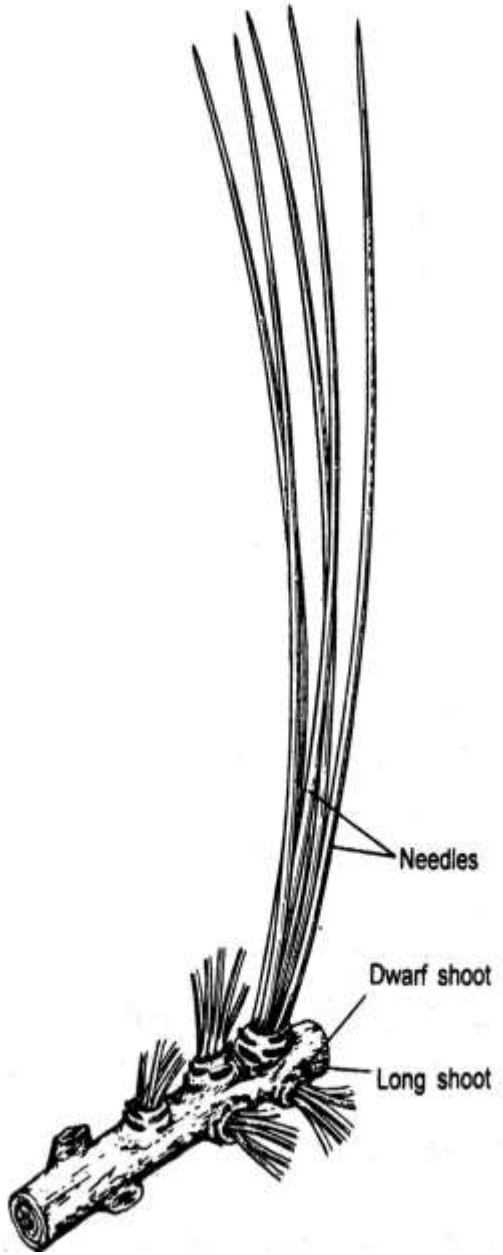
Leaves :-

(a) Foliage leaf :-

- leaves are long narrow ,green and look like needles .
- They occur in groups of 2-5 in different species on the tip of dwarf shoots. The dwarf shoot along with needles is also called a spur.
- Needles are acicular in *P. monophyla*, semicircular in *P. sylvestris*, triangular in *P. longifolia* and *P. gerardiana*

(b) Scaly leaves :-

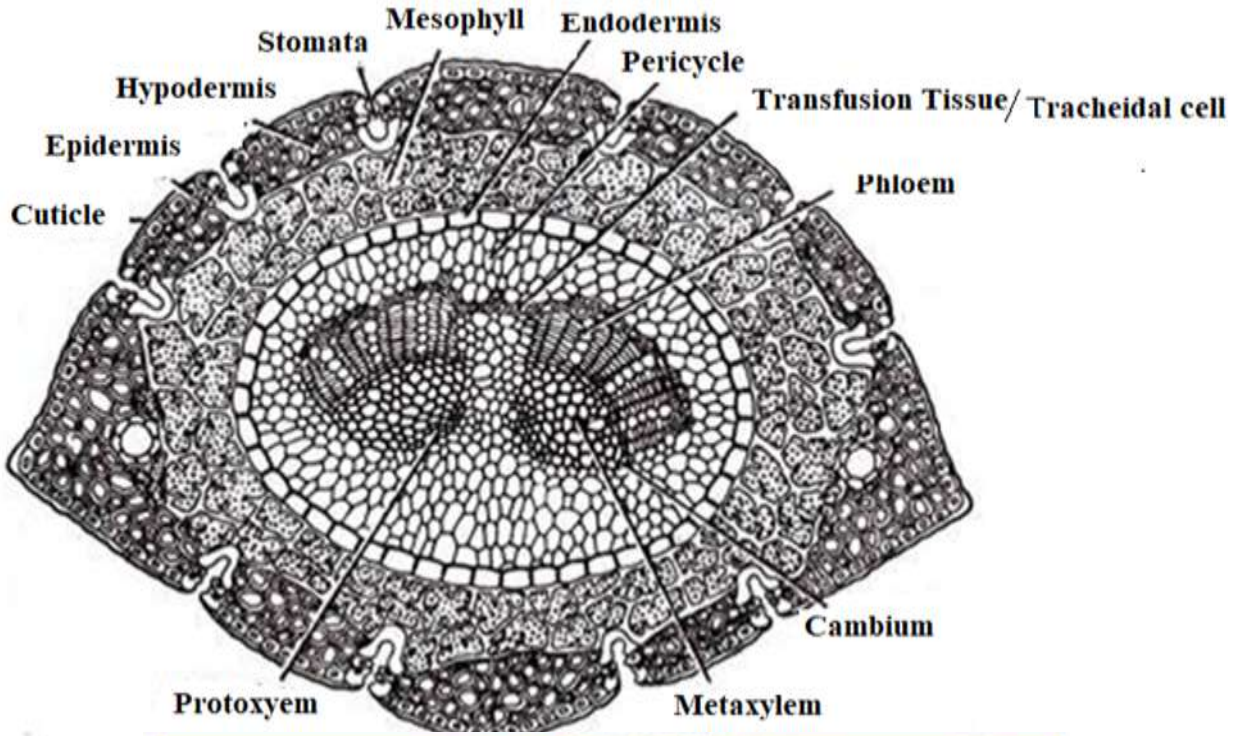
They are small brown and membranous .Scale leaves occur on both long shoot as well as on dwarf shoots .

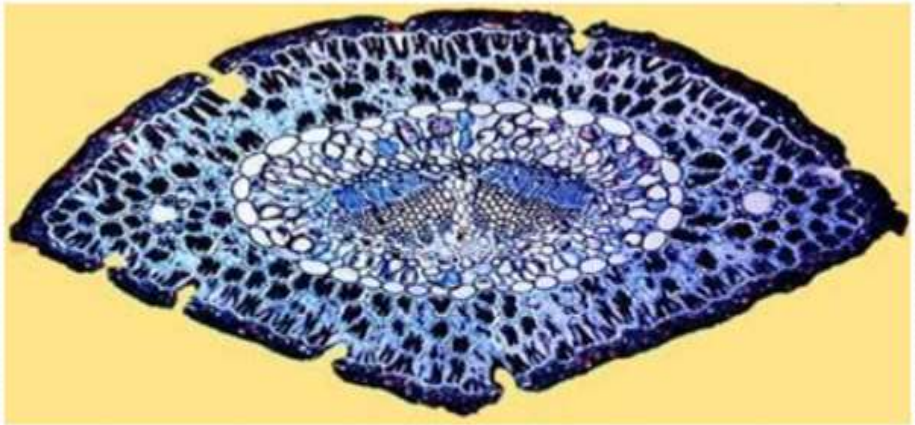


Anatomy

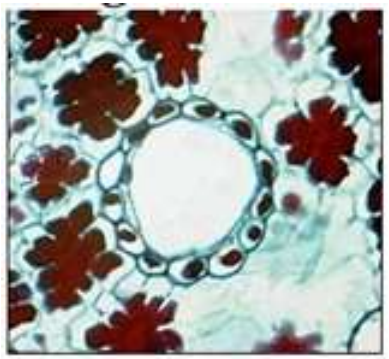
Leaf:

- Epidermis
- Hypodermis
- Mesophyll tissue
- Endodermis
- Pericycle
- Vascular bundle





Pinus – T.S. Needle



Resin Duct

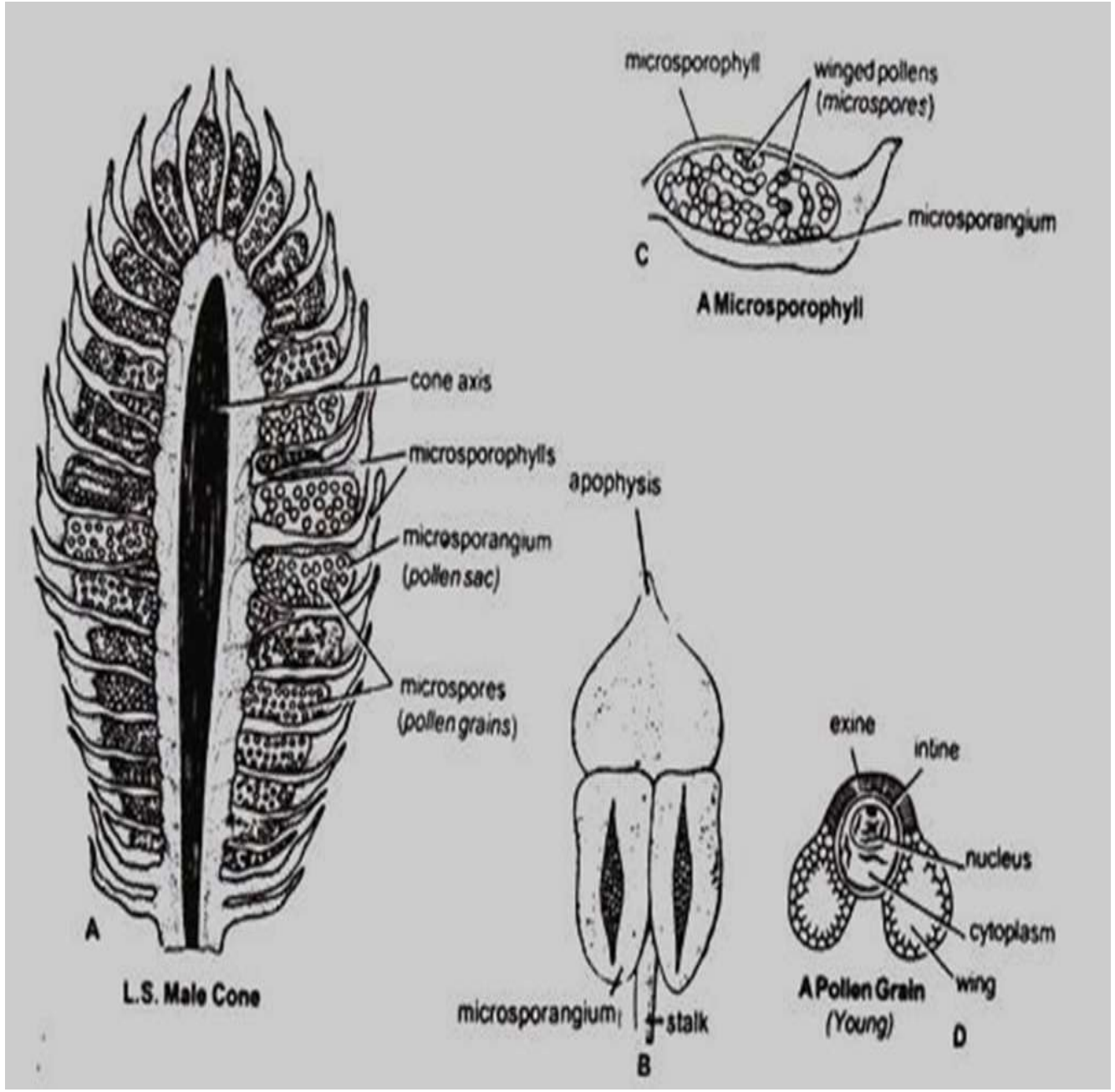
Reproduction

- Takes place by means of male spore(microspore) and female spore(megaspore)
- No vegetative reproduction
- Male and female reproductive structure as cone develop on separate branches of same plant, hence Pinus is monoecious

Male Cone

- Develops in cluster in the axil of scale leaves on long shoot
- Replace the dwarf shoot at the tip of long shoot
- Has large no. of microsprophyll arranged spirally on the central axis

- Each microsporophyll is small, membranous, brown-coloured structure
- Two pouch-like microsporangia (= pollen sacs) are present on the abaxial or undersurface of each microsporophyll. In each microsporangium are present many microspores (= pollen grains).
- it consists of a stalk (=filament)with a terminal leafy expansion (= anther), the tip of which is projected upwards and called apophysis.

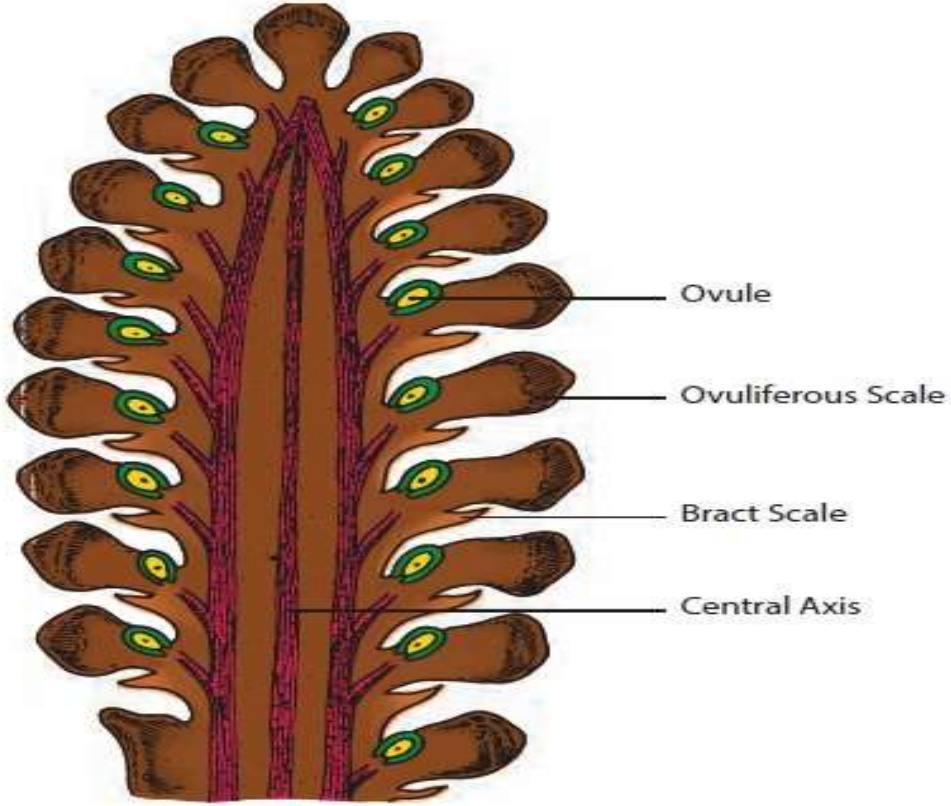


- Each microspore or pollen grain is a rounded and yellow coloured, light, uninucleate structure with two outer coverings, i.e., thick outer exine and thin inner intine
- The exine protrudes out on two sides in the form of two balloon shaped wings.
- A few microsporophylls of lower side of cone are sterile. Sporangia are also not present on the adaxial surface of each microsporophyll of the male cone.
- At the time of dehiscence, huge quantities of microspores form yellow clouds around the pine forests. It's called the "Shower of sulphur dust". It occurs during ***spring.***

Female cone

- Each female cone is an ovoid, structure when young but becomes elongated or cylindrical at maturity
- develop in the axil of scaly leaves on long shoots like male cones.

L.S. of Female cone

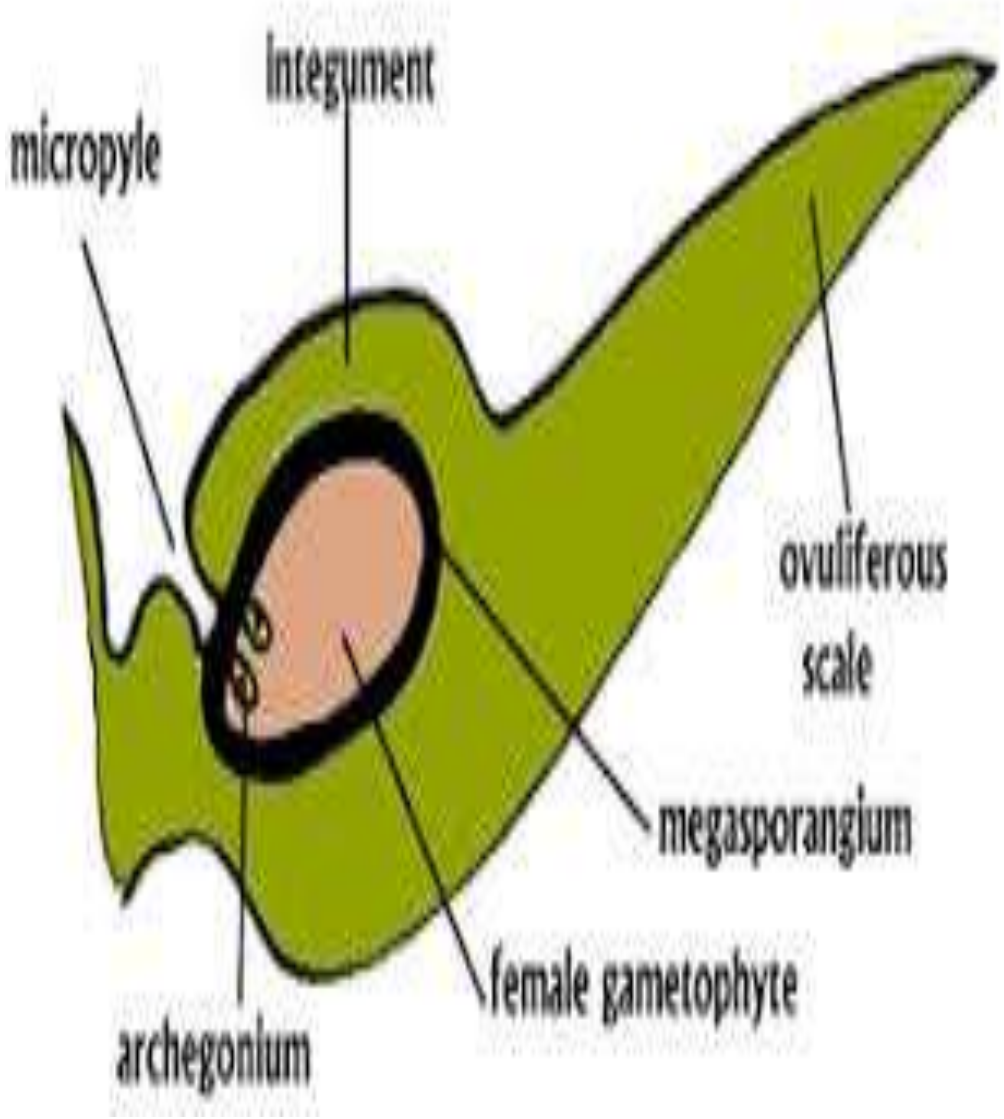


- In the centre is present a cone axis
- Many megasporophylls are arranged spirally on the cone axis.
- A few megasporophylls, present at the base and at the apex of strobilus, are sterile.

Each megasporophyll consists of two types of scales, known as bract scales and ovuliferous scales.

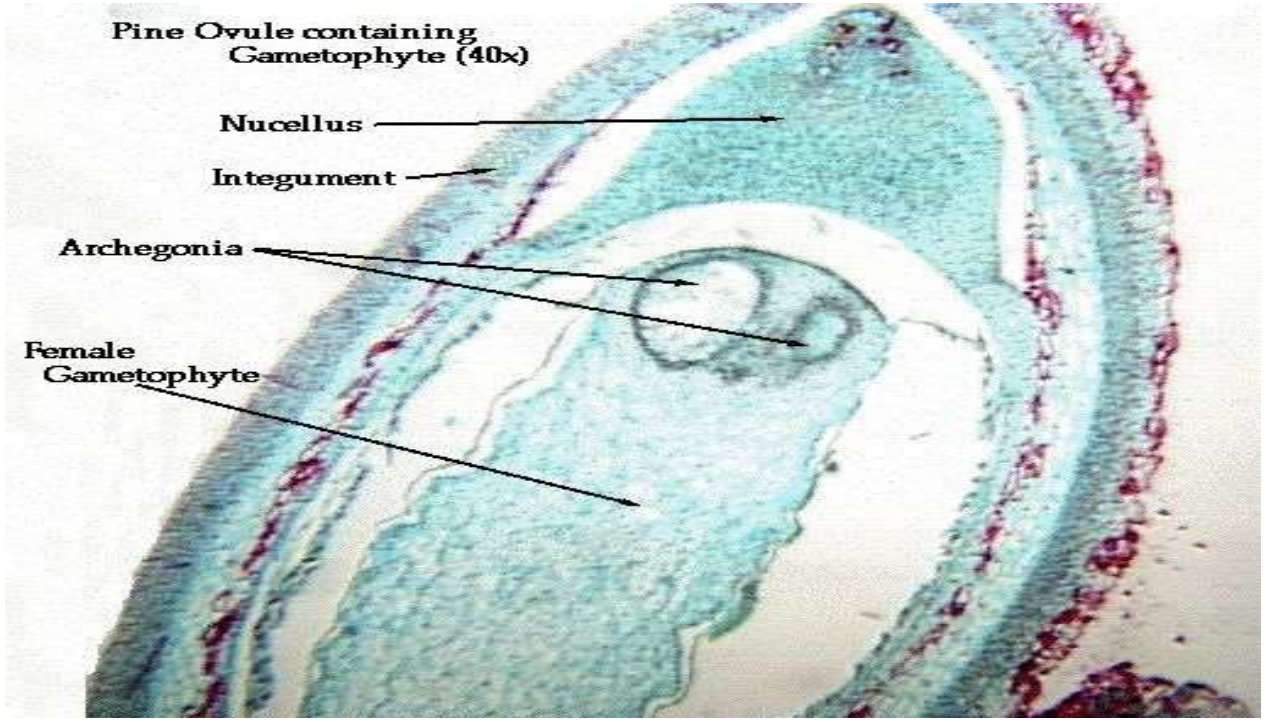
Bract scale: Bract scales are thin, dry, membranous, brown- coloured structures having fringed upper part. These are also called carpellary scales.

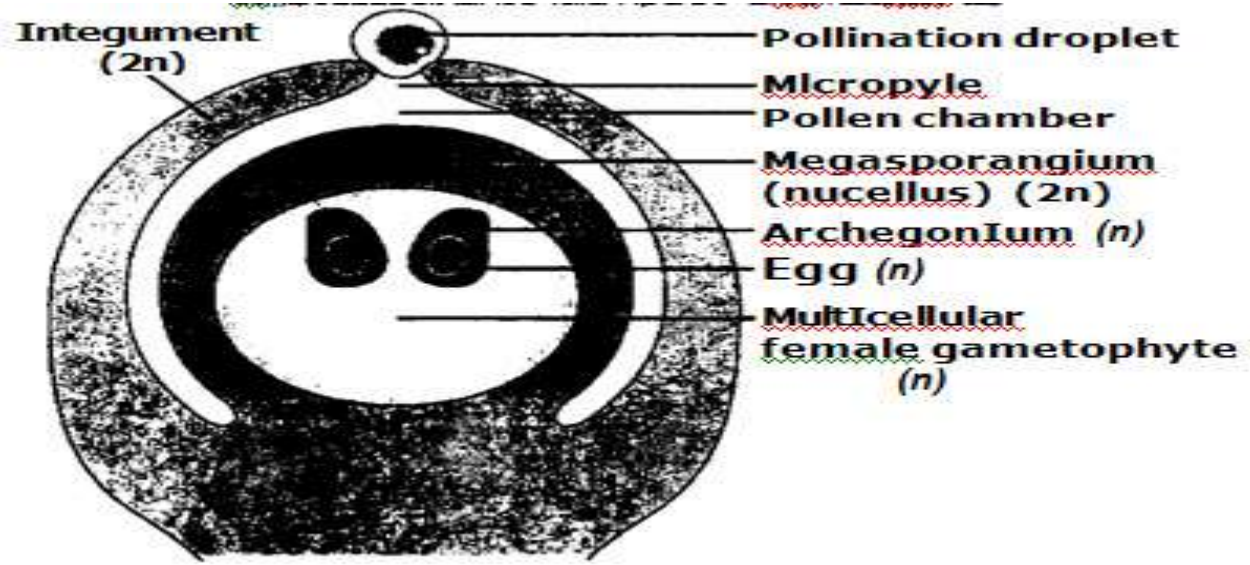
Ovuliferous scale: An ovuliferous scale is present on the upper surface of each bract scale. ovuliferous scale is woody, bigger and stouter than bract scale and it is triangular in shape. A broad sterile structure, with pointed tip, is present at the apex of these scales. This is called apophysis.
At the base of upper surface of each ovuliferous scale are present two sessile and naked ovules



Ovule

- Each ovule is **Orthotropous**, and it remains surrounded by a single integument, consisting of an outer fleshy, a middle stony and an inner fleshy layer. It opens with a mouth opening called micropyle.
- Integument surrounds the megasporangium or nucellus.
- Just opposite the micropyle is present a pollen chamber. In the endosperm or female gametophyte are present 2 to 5 archegonia.

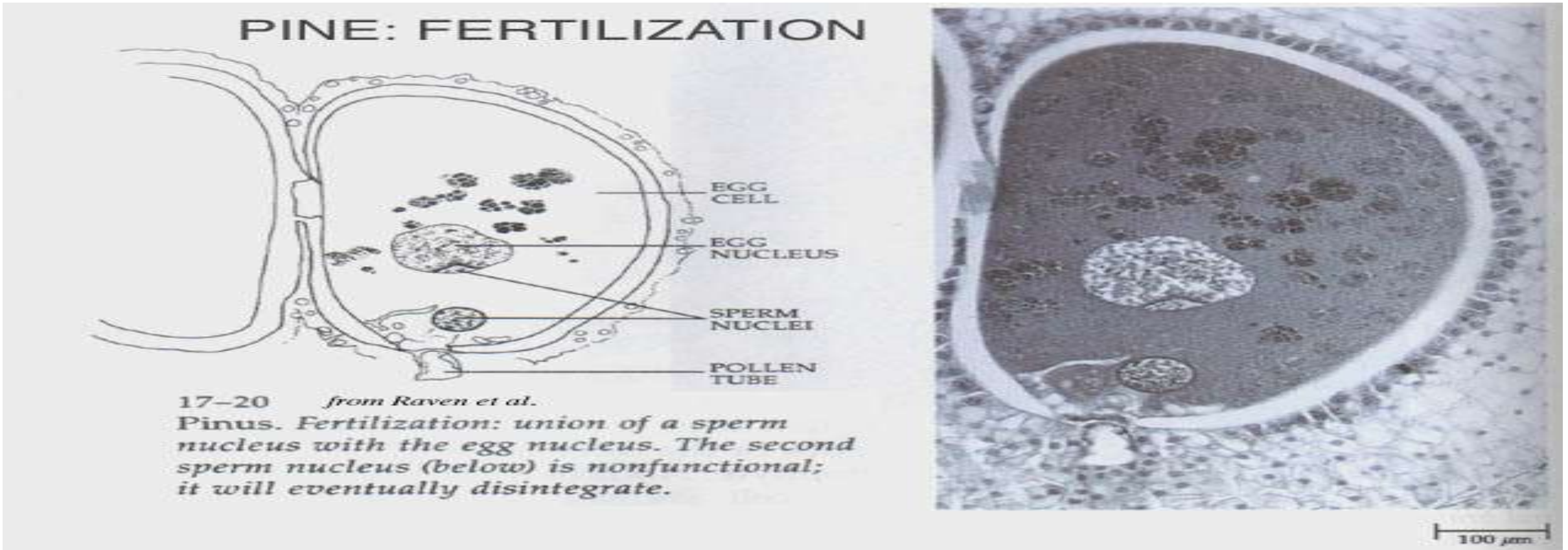


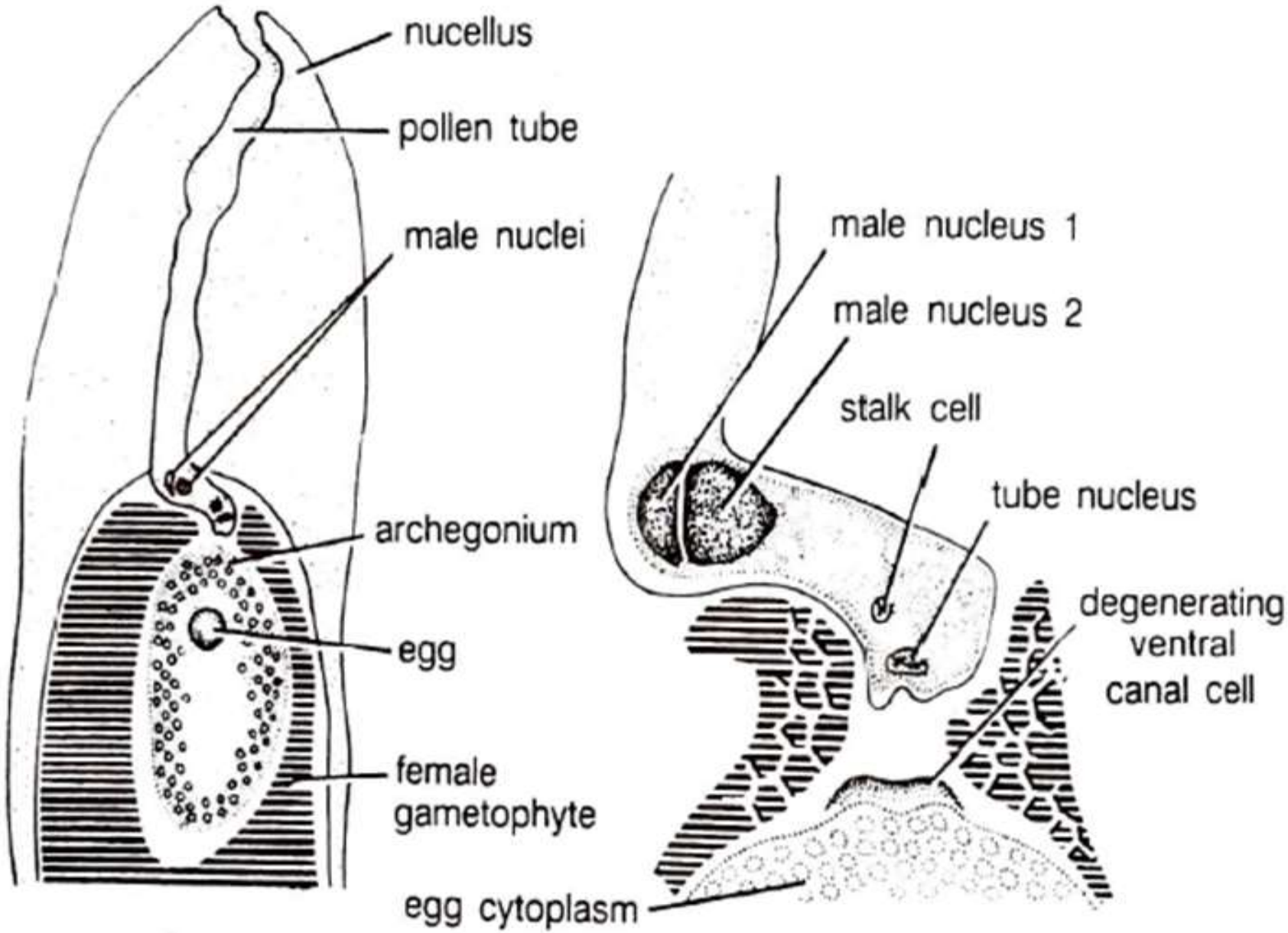


Sl. No.	*Cycas* Ovule	*Pinus* Ovule
1	Large in size	Comparatively smaller
2	Nucellar beak is present	Absent
3	Prominent pollen chamber is present	Not so prominent
4	Three integument layers are quite distinct	Not clearly marked
5	Vascular supply is well developd	Poorly developed

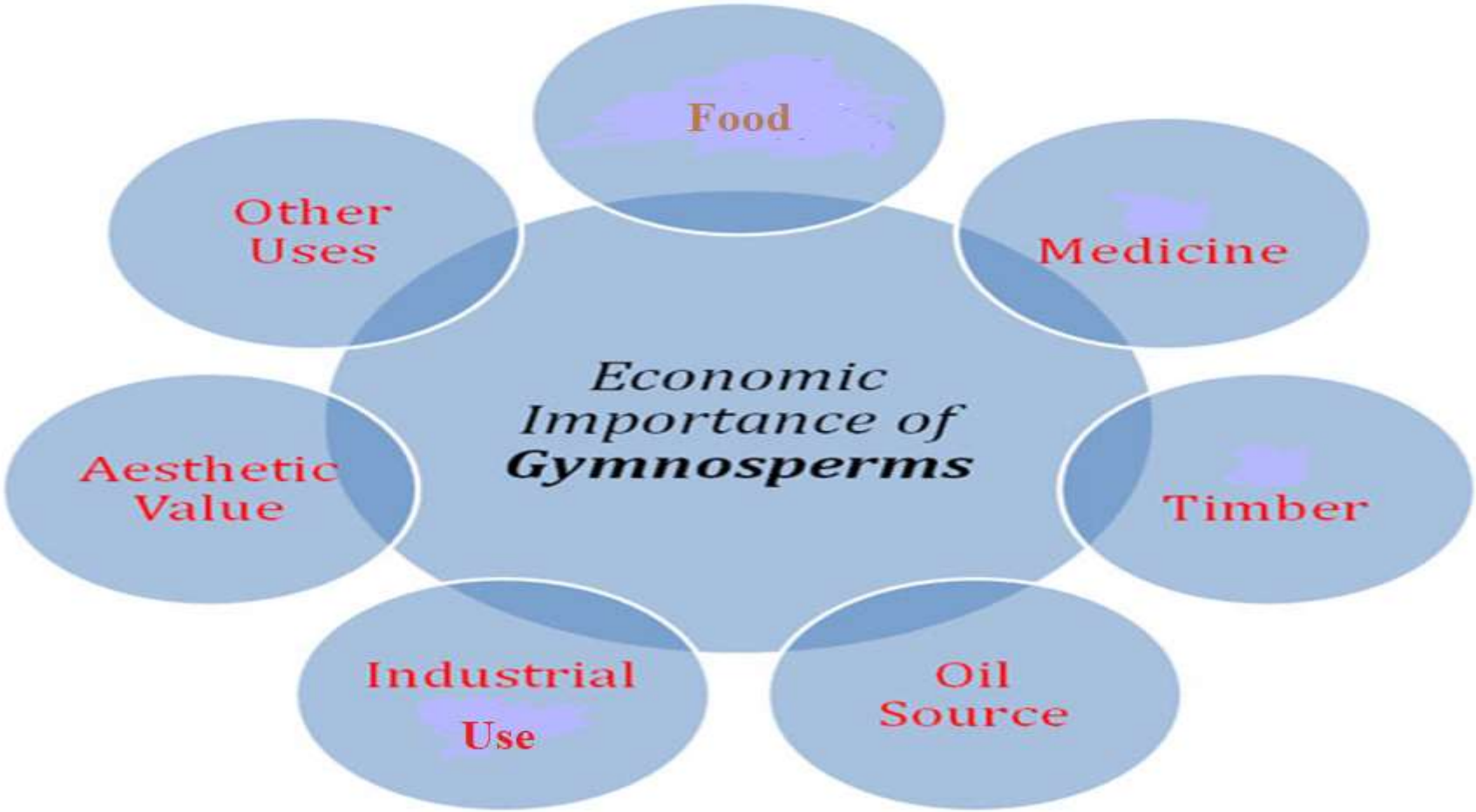
Pollination

Each ovule secretes mucilaginous drop at the picropylar end, it forms a passage for the entry of pollengrains. mucilaginous drop entangles pollen grain and thereby carried through the micropyle to the surface of nucellus.




nucellus
pollen tube
male nuclei
archegonium
egg
female gametophyte
male nucleus 1
male nucleus 2
stalk cell
tube nucleus
degenerating ventral canal cell
egg cytoplasm

Economic Importance of Gymnosperm



1. Gymnosperm as Timber: *Pinus, Abies, Cedrus*

2. As Source of Resin:

Resins are coniferous plant exudates, which are only soluble In organic solvents.

Oleoresin and Rosin: *Picea abies.*

Copal: *Agathis australis*

Sandarac: *Tetraclinis articularia*

Canada Balsam: *Abies balsamea*

3. Gymnosperms as sources of essential oils:

The **'Cedar oil'** is obtained from *Cedrus deodara* and *Juniperus virginiana*

'Cedarwood oil' obtained from *Juniperus mexicana*

4. Gymnosperms as sources of papers: manufactured from the Wood of *Picea*, *Abies*, *Larix* and *Tsuga*,

5. Gymnosperms used as ornamental plants(Aesthetic) : Gymnosperms such as Pinus, cedar, Cycas are widely planted as ornamental plants

6. Gymnosperms used as food: The stem(pith) starch called '**sago**' is obtained from the Species of *Cycas* (C. *revoluta*, *C. rumphii*, and *Circinalis*)

The seeds of_*Cycas* spp. , *Pinus gerardiana*, *P. pmea*, *P. edulis*, *Praucaria araucana*, *Ginkgo biloba*, are edible

7. Gymnosperms used as drugs and Medicine: *Ephedra* (e.g. *E. sinica*, *E. gerardiana*, *E. equisetina)* are important sources of alkaloid, **ephedrine** which has been used as bronchodilator in cough mixture for the treatment of bronchial asthma .