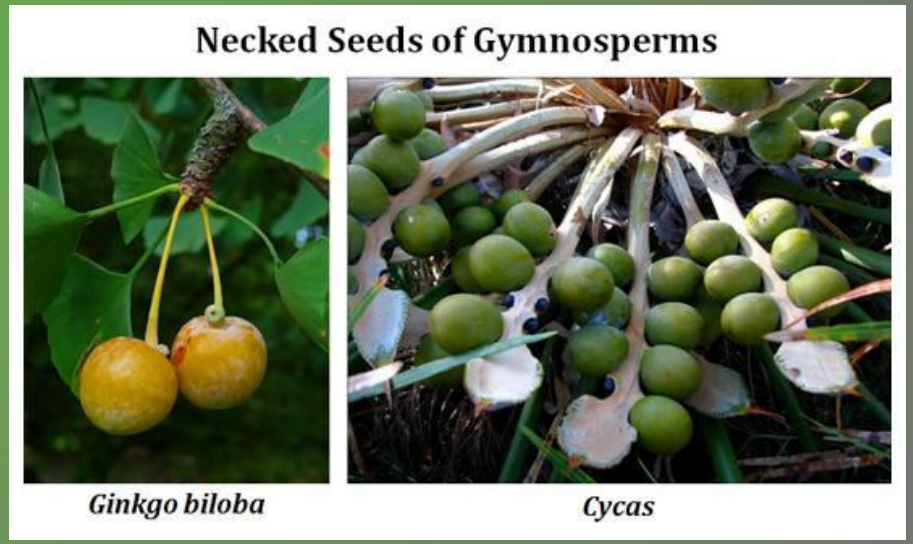
GYMNOSPERMS & EMBRYOLOGY OF ANGIOSPERMS

SEMESTER - IV
PAPER - IV

General Characters of Gymnosperms

- The word “Gymnosperm” comes from the Greek words “gymnos”(naked) and “sperma”(seed), hence known as “Naked seeds.”
- Gymnosperms are the seed-producing plants, but unlike angiosperms, they produce seeds without fruits.
- These plants develop on the surface of *scales or leaves, or at the end of stalks* forming a cone-like structure.
- Gymnosperms belong to kingdom ‘Plantae‘ and sub-kingdom ‘Embryophyta’.
- The fossil evidence suggested that they originated during the *Paleozoic era, about 390 million years ago.*
- Basically, gymnosperms are plants in which the ovules are *not enclosed within the ovary wall,* unlike the angiosperms.
- It remains exposed *before and after fertilisation* and before developing into a seed.
- The stem of gymnosperms can be *branched or unbranched.*
- The thick cuticle, needle-like leaves, and sunken stomata reduce the rate of water loss in these plants
- The family of gymnosperms consist of conifers, the cycads, the gnetophytes and the species of Gynkgophyta division and Ginkgo biloba.



General Characters of Gymnosperms

DISTRIBUTION

- ★ Ancient group of seed plants consisting of 83 genera and 1080 species.
- ★ Distributed in temperate and tropical regions
- ★ Were originated in Paleozoic era (541 - 252 million years ago)
- ★ Dominant plants of Jurassic and Cretaceous periods of Mesozoic era
- ★ Many primitive gymnosperms were extinct.
- ★ **Examples of extinct gymnosperms:**
  Cycadofilicales, Bennettitales, Cordaitales
- ★ **Examples of gymnosperms:**
  Cycas, Pinus, Gnetum, Zamia, Ephedra, Podocarpus, Taxus, Cedrus, Abies, Araucaria

General Characters of Gymnosperms

MORPHOLOGICAL CHARACTERS

- The plant body is sporophytic (diploid) differentiated into *root, stem and leaves*
- Present day gymnosperms are *evergreen trees or shrubs.*
- Shows xerophytic characters
- Roots show symbiotic association with fungi or cyanobacteria.
- Fungi forms mycorrhizal association with roots of *Pinus*
- The mycorrhiza helps in the *absorption of minerals*
- Algae (Cycas & Nostoc) inhabited in the coralloid roots of Cycas helps in *nitrogen fixation.*

Algal Zone in the Coralloid Roots of *Cycas*

General Characters of Gymnosperms

- The stem is usually *erect, branched and woody.*
- Stem is usually **unbranced in Cycas** and it is underground in Zamia.
- Presence of **leaf scar** - Characteristic feature.
- Leaves are usually dimorphic (two types of leaves in the same plant)
- They are **a) Foliage leaves** **b) Scale leaves**
- The foliage leaves are *green, simple, needle shaped* or pinnately compound
- Scale leaves *minute and deciduous*
- Cycas shows **circinate vernation** (Young leaves curved inward)
- Presence of circinate vernation in Cycas is a strong evidence of pteridophytic origin of Gymnosperms.
- Cycas acts as a connective link between pteridophytes and gymnosperms.

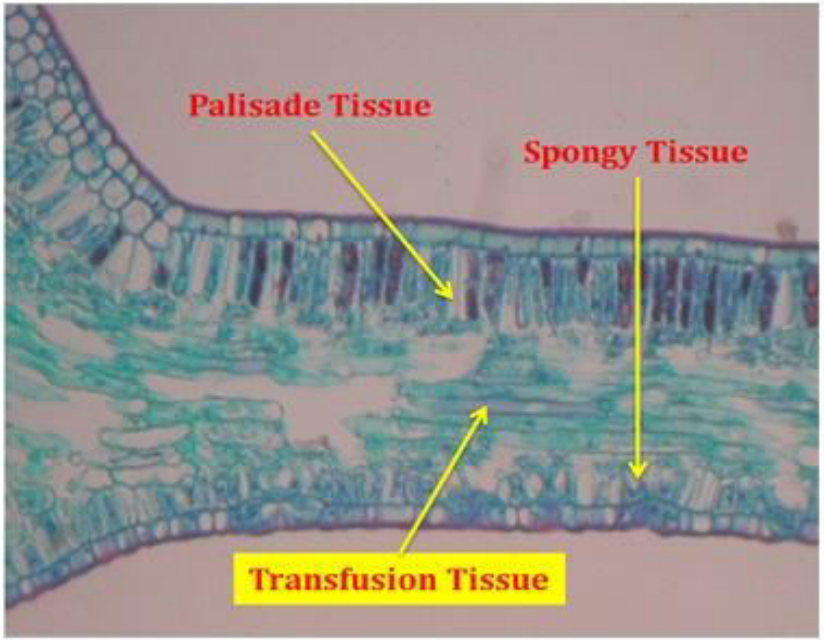
Foliage Leaves and Scale Leaves in *Pinus*


Circinate Vernation (*Zamia*)

General Characters of Gymnosperms

ANATOMICAL CHARACTERS

- The leaves of gymnosperms have very **thick cuticle.**
- Mesophyll is differentiated into **palisade and spongy tissue.**
- Mesophyll is *undifferentiated in Pinus.*
- Leaves do not have **lateral veins.**
- Lateral translocation of nutrients takes place through **transfusion tissue.**
- Stomata usually *sunken type* (to reduce transpiration)
- Gymnosperms possess well developed vascular system.
- Vascular bundles are **collateral and open**
- The vascular system consist of *xylem and phloem.*

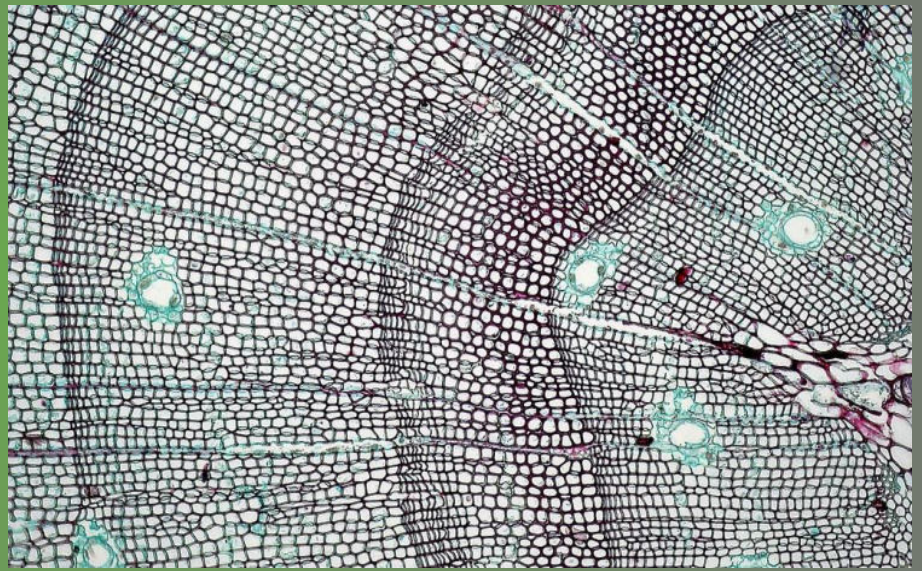


Transfusion Tissue in Gymnosperms (*Cycas*)

General Characters of Gymnosperms

XYLEM

- ★ Xylem consists of Tracheids and Parenchyma
- ★ Vessels are absent in the Xylem
- ★ Vessels present in the xylem of Gnetum
- ★ Presence of vessels in the wood of Gnetum is a strong evidence of gymnospermic origin of angiosperms.
- ★ Gnetum is connecting link between Gymnosperms and Angiosperms.



PHLOEM

- ★ Phloem consists of sieve tubes & Phloem parenchyma
- ★ *Companion cells are absent* in Gymnosperms.
- ★ Stem shows *secondary growth.*
- ★ The wood may be manoxylic(Cycas) or pycnoxylic (Pinus)
- ★ *Tanniniferous cells* are present in the cortex
- ★ Roots are diarch (2 vascular bundles) to polyarch (many vascular bundles)

General Characters of Gymnosperms

REPRODUCTION IN GYMNOSPERMS

- Gymnosperms are **heterosporous**
- Megasporangia are produced in **megasporophylls.**
- Microsporangia are produced in **microsporophylls**.
- Sporophylls aggregated to form ***cones or strobili.***
- Cones/strobili are mono-sporangiate.

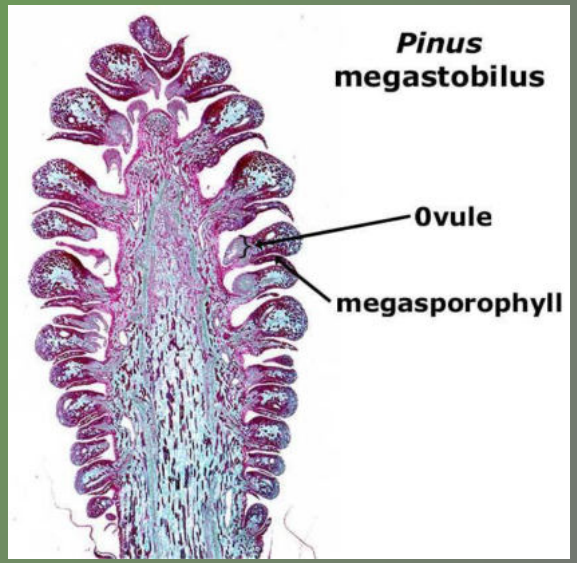
MALE CONE, MICROSPOROPHYLLS & MICROSPORES

- Male cone in gymnosperms are ***short lived*** whereas female cones ***live for many years.***
- Microsporangia are formed on the ***abaxial side of microsporophyll.***
- Microsporangial development is eusporangiate type

General Characters of Gymnosperms

FEMALE CONE, MEGASPOROPHYLL & OVULE

- Female cone is formed by **aggregation of megasporophylls.**
- The megasporophyll may be *foliar* as in cycas or *cauline (woody)* as in pinus
- The megasporangium is better known as the **ovule.**
- Ovules are **orthotropous** and **unitegmic.**
- Ovular integument in gymnosperms in differentiated into *three layers.*



General Characters of Gymnosperms

POLLINATION & FERTILIZATION

- ★ All gymnosperms are **wind pollinated (Anemophily)**
- ★ Microspores are liberated at various stages of the male gametophyte.
- ★ Pollens deposited in the ***wet pollen chamber.***
- ★ Fertilization **siphonogamous** (with the help of pollen tube)
- ★ The pollen tube functions as the ***sperm carrier.***
- ★ Male gametes are ***non - motile except in Cycas*** and Ginkgo.
- ★ Number of archegonia in the female gametophyte varies.
- ★ There are **several archegonia in cycas** whereas only **one in pinus.**
- ★ Archegonium has ***single egg and a venter canal cell.***
- ★ Archegonium in Gnetum is represented by ovum only.
- ★ Neck canal cell are **absent in Gnetum.**
- ★ Embryo development is **meroblastic** (embryo develops from some part of zygote. Angiosperms also show meroblastic development)

General Characters of Gymnosperms

POLLINATION & FERTILIZATION

- ★ Endosperm is present in the seeds of gymnosperms.
- ★ The development of endosperms takes place before the fertilization.
- ★ Endosperm in gymnosperm is haploid (since it is a part of female gametophyte)
- ★ Polyembryony is very common in Gymnosperms.
- ★ Polyembryony may arise by a) fertilization of more than one egg or b) division of zygote
- ★ Seed coat present. Integument of the ovule forms the seed coat.
- ★ Seeds are *winged and light - weight* in Pinus (for wind dispersal)
- ★ Number of cotyledons in the seeds may be one or two or many.
- ★ Gymnosperm seeds usually have a resting period
- ★ Distinct alternation of generation is present in Gymnosperms.
- ★ Diploid sporophytic generation is the dominant phase.
- ★ Haploid gametophytic stage is highly reduced.
- ★ Gametophytic phase is dependent on sporophytic phase.

Economic Importance of Gymnosperms

1. Ornamental value:

A number of gymnosperms are grown as ornamental plants, e.g., Cycas, Araucaria, Thuja etc.

2. Food Value:

i. 'Sago' starch obtained from pith and cortex of stem of C. revolute, C. rumphi etc.
ii. 'Seed starch' obtained from seeds of Cycas rumphii, Dioon edule etc. It is prepared into flour and cooked before eating.
iii. Seeds of Pinus gerardiana (chilgoza) are edible.
iv. 'Kaffir bread' prepared from the stem pith of Encephalartos.
v. Young leaves of Cycas cooked as vegetables.

3. Medicinal value:

i. Ephedrine (alkaloid) extracted from Ephedra used in treating asthma, cough, cold, bronchitis etc.
ii. Tincture of Ephedra is a cardiac stimulant.
iii. The juice extracted from young leaves of Cycas revoluta is used for curing blood vomiting and flatulence.

Economic Importance of Gymnosperms

4. Industrial Use:

i. Gum-Cycas gum used as adhesive, antidote for snake bites and using malignant ulcers.
ii. Tannins – Tannins extracted from bark of Araucaria, Pinus, Sequoia etc. used in leather industry.
iii. Canada balsam – It is turpentine obtained from Abies balsamea and used as a mounting medium in biological preparations.
iv. Amber (fossil resin) – obtained from Pinus succinifera. Wood of Pinus is used for doors, poles, beams, railway wagon flooring etc.
v. Plywood prepared from Podocarpus.
vi. Papers like newsprints, writing and printing papers are being prepared from the wood pulp of Pinus, Picea,Abeis, Gnetum etc.
vii. The leaves of cycads are used for preparing baskets, mats, hats, brooms etc.
viii. The fibres obtained from the leaves of Cycas and Macrozamia are used for stuffing pillows and making mattresses.

5. Source of oils:

i. Oils extracted from seeds of C. revoluta, Macrozamia reidlei, Pinus cembra and Cephalotaxus drupacea are used as edible oils.
ii. Red cedar wood oil extracted from the heart wood of Juniperus virginiana is used for cleaning microscopic preparations and for oil immersion lenses.
iii. Oils obtained from Cedrus deodara, Ciyptomeria japonica and Cupressus serm-perivirens are used in preparations of perfumes.