Gymnosperms :

- **Gymnos :** naked, **sperma :** seeds - Seeds are naked.
- No annual and herbaceous plants
- Giant redwood tree **Sequoia** is one of the tallest tree species
- Stems are **unbranched** (**Cycas**) or **branched** (**Pinus, Cedrus**).
- Leaves may be **simple** or **compound**
- Leaves in gymnosperms are well-adapted to withstand extremes of temperature, humidity and wind.
- Ovules are not enclosed by any ovary wall and remain exposed, both before and after fertilisation.
- **Heterosporous;** they produce haploid microspores and megaspores
- **Cycas, Metasequoia** and **Ginkgo** are living fossils – **sperms ciliated**
- **Male and the female gametophytes are reduced** and do not have an independent free-living existence.
- **Araucaria** - christmas tree
- **Thuja** - myurpankh tree
- **Zamia** - smallest

Absent

- Antheridia Ovary / fruits Vessels CC ST Lateral veins in leaf

Classification : 2 class

1. Cycadopsida:

- Unbranched stem
- Compound leaf

2 orders

Cycadofilicales	Cycadales
Pteridosperms **Seed ferns** All fossils	Miniature palms **Found in tropical and subtropical regions** Produced **flagellated sperm** **Dioecious** Ex **Cycas** **Zamia**

2. Coniferopsida

- Branched stem
- Simple leaf

3 orders

Ginkgoales	Coniferales	Gnetales
Root nodules with Frankia **Ginkgo biloba**	**Largest group** Cold climate Excurrent habit **Ex** Pine - **Pinus** Common Juniper - **Juniperus** Redcedar - **Thuja** Larch- **Larix** Douglas-fir - **Pseudotsuga** Spruce - **Picea** Fir - **Abies** Hemlock - **Tsuga**	Vessels present Fore runner of angio*sperms*. **Flowers present** **Ex** **Gnetum** **Ephedra**

Some important gymnosperms :

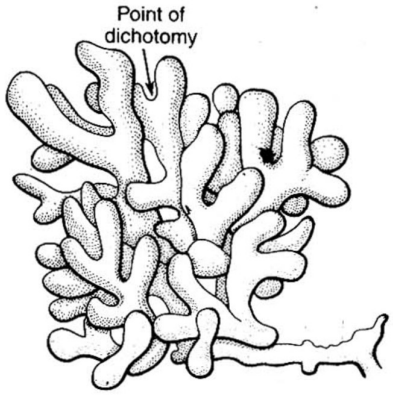
Life Cycle of Cycas :

- Cycas is an evergreen plant which looks like a palm (**arborescent habit**)
- Dioecious plant
- Also called **Sago palm** or **cocopalm** or **palm fern**
- Commonly **understorey shrubs** found in tropical and subtropical habitats

Roots : Dimorphic

- **Normal root**
  - Main tap root with lateral roots

- **Coralloid root**
  - Dichotomously branched
  - Bluish green
  - BGA - **Nostoc Anabaena Pseudomonas** in middle cortex
  - Lenticels present



Stem :

- Stem is thick, cylindrical, **columnar,** small, aerial and **unbranched.**
- It is covered with persistent leaf bases.
- At the apex of the plant is present a crown of foliage leaves.
- **Unbranched / caudex**

Leaves : Dimorphic

Brown small scale leaves or cataphylls :

- Borne in alternate whorl with the foliage leaves on young shoot apex.
- Protective

Foliage leaves or megaphylls :

- These leaves are green, **pinnately compound**
- Spirally borne at the apex of the plant forming a crown.
- **1-3 m long**
- Some leaflets at the base of rachis are modified into spines.
- The vernation of young leaflets is circinate and is a primitive ancestral fern like feature

Reproduction :

Sexual Reproduction :

- Plants are dioecious.
- Male plants are less in number and also shorter than female plants. They bear male strobilus or male cone
- The male cone is produced at the apex and is average 20 cm **(longest in plants)**
- Pruduced singly every year
- It consists of a number of **microsporophylls arranged spirally**

Microsporophylls

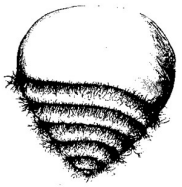
- Microsporophyll is a flattened structure, narrow below and broadened above into an expanded sterile apex - apophysis
- Triangular and hard
- **Bear sori on lower surface (500-700)**
- 2-6 sporangia in each sorus
- Sporangia – globular sac like
- It consists of a large number of microspores (pollen grains) formed from microspore mother cells, after reduction division.

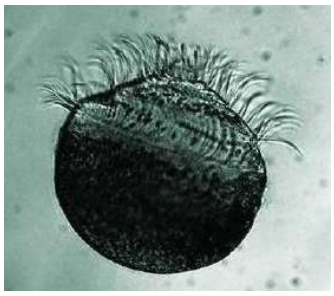
Pollen grain

- The pollen grains of Cycas are light and easily blown away by wind
- **Boat shaped**

Sperm

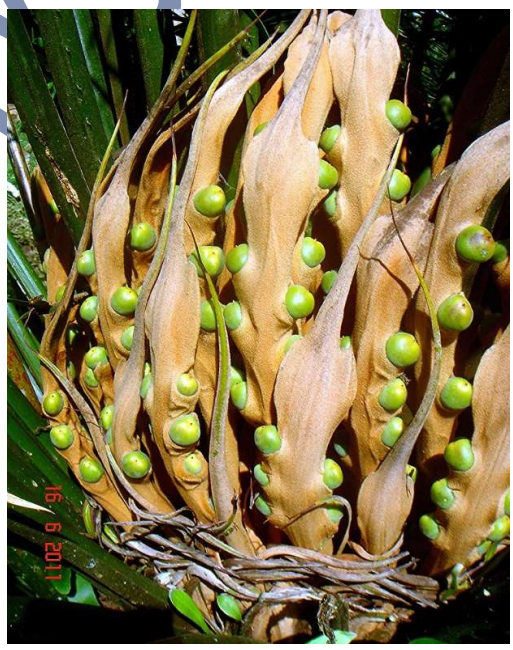
- Largest in plant kingdom
- 4-5 spiral band of cilia at anterior half
- Top shaped
- Visible





Female reproductive structures :

- The female reproductive structure is **rosette of megasporophylls** loosely arranged on the stem apex of female plant.
- Each megasporophyll resembles a reduced foliage leaf.
- The apical part of megasporophyll is leafy, sterile, pinnately divided part and just below it a fertile stalk which bears **2-4 pairs of ovules** (megasporangia) attached laterally. Ovules covered by wooly hairs.
- Ovules are **orange red colour and largest in plants kingdom**



- Megasporophylls not gathered in cones – loosely arranged
- **Apical part leafy and sterile**
- **Fertile stalk with 2-4 pairs of ovules**
- **Ovules orange red colour / 6 cm. / largest in plants**
- **Largest egg in plant kingdom**

- Most abundant trees in the Northern Hemsisphere
- **Evergreen tree - 30-50 m**
- **Excurrent habit – conical /pyramidal shape due to apical dominance**
- **Xerophytic – needle leaf ,sunken stomata ,early bark formation,**
- **Pines are monoecious**

Roots

- **Ectomycorrhiza with Boletus**

Stem

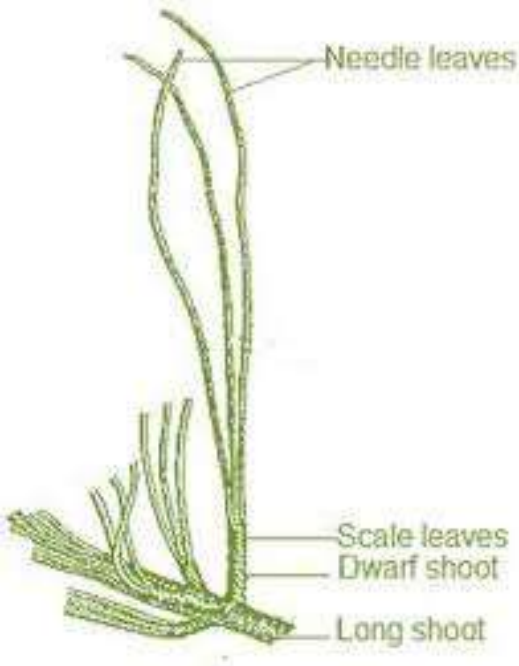
- **Branched**
- Spiral arrangement of branches
- **Resin canals in cortex**
- **Dimorphic branches**

Long shoots

- Unlimited growth

Dwarf shoots / Spur

- Limited growth
- Has needles at apex
- Covered with spirally arranged scales
- Needle-bearing fascicles are shed a few at a time, usually every 2-5 years



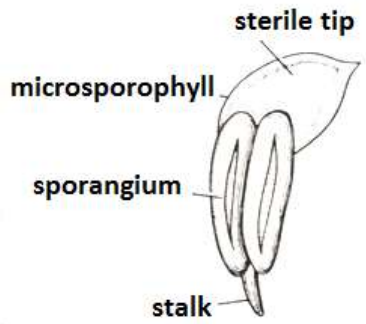
Leaves

- Dimorphic
- **Cataphylls** – conserve water, on both types of shoots
- **Needles**
  - **Green Acicular Grow continuously**
  - **Simple leaf**
  - **generally 2 to 5 needles**

Male Cone :

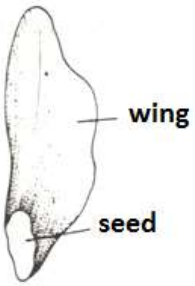
- Arise in place of dwarf shoot in **clusters 15-40**
- Small size 3- 4 cm

- They are homologous to male flower of angiosperms.
- **Microsporophylls are** brown triangular scaly & spirally arranged
- Each m**icrosporophylls** has 2 elongated sporangia
- **Pollen grains are winged**
- 1-2 million pollen grains per cone
- **S dust / shower** in march -may



Female Cone :

- Arise singly in place of long shoots
- They are equivalent to female inflorescence of angiosperms.
- **Megaosporophylls has 2 parts -** Spirally arranged **ovuliferous scales** , each of which is subtended by a **bract scale**
- **Ovuliferous scales are s**tout, woody, brownish which **bear 2 ovules**
- **Bract scale** are small, dry and membranous



Seeds

- **Winged**
- Embryo straight with 3-18 cotyledons
- 3 years to complete development
- **P gerardiana** – chilgoza

Ginkgo :

- Only living representative is **Gingko biloba**
- Also called **Pagoda tree**
- Cultivation in temples in China Japan

Gnetophytes are the most distinctive of gymnosperms because of their similarities with angiosperms.

Gnetum :

- Have Reticulate venation
- Archegonia absent

Ephedra

- Contains chemicals similar to those of human neurotransmitters called ephedrine, a drug used for the relief of allergic symptoms
- Also a heart stimulant