

Classification of Gymnosperms

- The system of classification proposed by K.R.Sporne (1965) is outlined.
- He divided gymnosperms into three classes such as **Cycadopsida, Coniferopsida and Gnetopsida**

- **1.Class Cycadopsida**

- This class includes both fossil and living members. These are the primitive gymnosperms. They have many characters of ferns.
- They are only the small evolutionary **vestige** (a trace or remnant of something that is disappearing or no longer exists) of a large and varied group of plants that flourished in late Paleozoic and Mesozoic time.

		Eon	Era	Period	Epoch		
Younger ↑ ↓ Older	Phanerozoic	Cenozoic	Quaternary		Holocene	← Today	
					Pleistocene	← 11.8 Ka	
			Neogene		Pliocene		
					Miocene		
			Paleogene		Oligocene		
					Eocene		
					Paleocene		
						← 66 Ma	
			Mesozoic	Cretaceous		~	
				Jurassic		~	
		Triassic		~			
		Paleozoic	Permian		~	← 252 Ma	
			Carboniferous	Pennsylvanian	~		
				Mississippian	~		
			Devonian		~		
			Silurian		~		
			Ordovician		~		
			Cambrian		~		
Proterozoic	~	~	~	← 541 Ma			
Archean	~	~	~	← 2.5 Ga			
Hadean	~	~	~	← 4.0 Ga			
				← 4.54 Ga			

- **Ages** are abbreviated from Latin
- Ga (giga-annum) is a billion years
- Ma (mega-annum) is a million years
- ka (kilo-annum) is a thousand years

- They are relatively slow-growing woody plants, have stems that are mostly unbranched and are sometimes **subterranean**(found under the surface of the earth). Leaves are large and pinnately dissected.

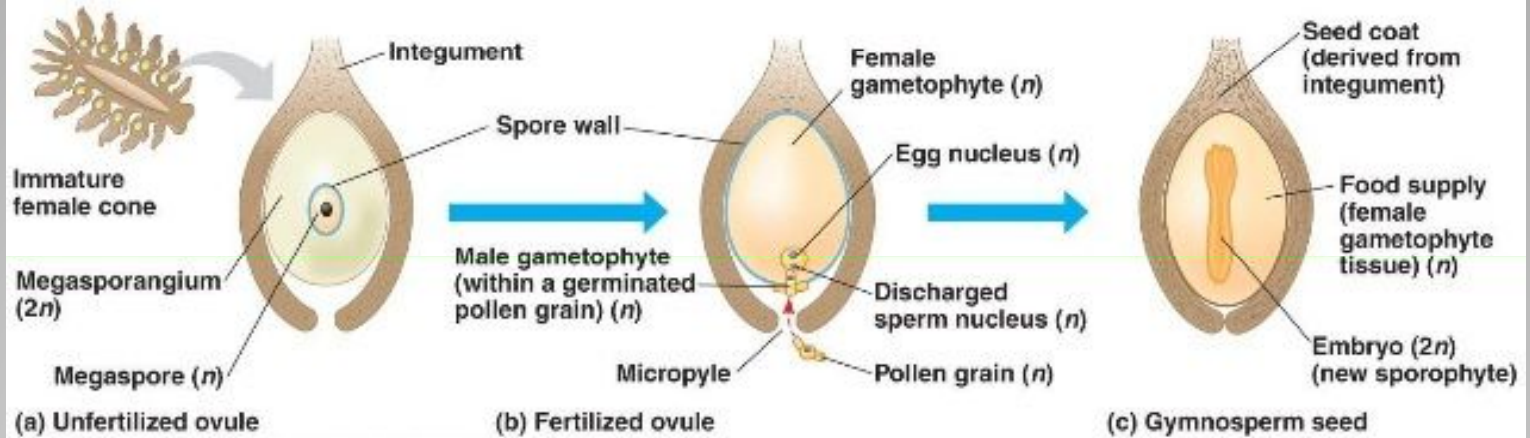
- These plants are usually dioecious (male and female reproductive structures on separate plants) with the reproductive organs borne on specialized leaves (sporophylls) which are generally arranged in cones or cone-like structures.
- The pollen grains (microspores) form within the microsporangia on the scales (sporophylls) of the male cones.



- The ovules (megaspores) develop without protective coverings on the sporophylls of the female cones. The pollen is transferred from the male cone to the ovule in the female cone by wind.
- After fertilization the seed develops without a protective pericarp on the female sporophyll. The seed has an outer fleshy layer and the embryo has two cotyledons.



Gymnosperm Seed



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- The life cycle of cycads has two distinct phases but the gametophyte stage is microscopic and enclosed within the microspores and megaspores. This class is divided into four orders such as **Pteridospermales, Bennettitales, Pentoxylales and Cycadales.**

- **Order Pteridospermales**

- The pteridospermales or the seed ferns have fern like foliage. The seeds were unprotected.
- It is a very large order that includes a heterogenous assemblage of tree like or reclining (lean or lie back) or sprawling (sit or lie) plants.

- They came into existence during the upper Devonian and lived through Carboniferous and Permian periods and reached their climax in the Mesozoic era.
- The plants have erect, slender or weak stems.
- The leaves are large, pinnately compound (a row of leaflets found on either side of the rachis) and the secondary wood was manoxylic-

- **Manoxylic:** In cycads (cycas) cambial activity is short lived as a result pith and cortex are well developed and parenchymatous rays are present. It is porous, soft and commercially less important.
- **Pycnoxylic:** In Pinus and Taxus the cambial activity is pronounced (prominent) leading to the formation of much reduced pith and cortex and less parenchymatous rays. This type of wood is commercially more valuable.

- The seeds are unprotected and borne on the modified foliage. The ovules have integuments either free or fused with the nucellus.
- It has a distinct pollen chamber and a micropyle.

- The pollengrains lacked pollen tubes and male gametes were motile. This order includes seven families such as **Lyginopteridaceae, Medullosaceae, Calamopityaceae, Glossopteridaceae, Peltaspermaceae, Crystospermaceae, Caytoniaceae.**

- **Order Bennettitales**

- It is an extinct order of seed plants that first appeared in the Triassic period and became extinct in most areas toward the end of the Cretaceous.
- The stems are upright, columnar forms of conical shape, height usually below one meter. The leaves are pinnately compound with parallel venation. The stem have large pith surrounded by a ring of collateral, conjoint (xylem and phloem on the same radius), endarch (the protoxylem is directed towards the centre) and open primary vascular bundles (a layer of cambium will be present between the xylem and phloem).

- The reproductive organs are bisexual. The ovules and the seeds are stalked.
- The flowers are surrounded by numerous hairy bracts that arise from the base of the receptacle.=

- The pollen grains are borne in bilocular **synangia** –sporangia united into a compound structure.
- The seed possess two cotyledons. This order includes three families such as Williamsoniaceae, Wielandiellaceae, Cycadeoideaceae

- **Order Pentoxylales**

- The plants were probably shrubs or small trees. The branches were of two types a) long shoots and b) dwarf shoots.
- The leaves were spirally arranged. The stems were polystelic (the central core of the stem and root of a vascular plant, consisting of the vascular tissue) with five primary steles, hence the name pentoxylales.

- The leaves were simple, lanceolate and thick. The venation is open, rarely reticulate.

- The reproductive organs were unisexual. The male organs consist of a whorl of branched sporangiophores (a specialized hypha bearing sporangia) fused at the base into a disc. The female reproductive organs lacked **interseminal** (integument surrounded by a structure) scales.
- The ovules were attached to a thick central axis in a spiral manner. The ovules were sessile. This order includes only one family i.e pentoxylaceae

- **Order Cycadales**

- This order includes both living and extinct forms. The fossil forms lived during the Jurassic and Cretaceous periods.
- Cycads originated in Pangaea (supercontinent that incorporated almost all the landmasses on Earth) during the early Permian and reached their greatest abundance and diversity during the Jurassic, declining sharply during the Cretaceous period. =

- They are woody, long-lived, unisexual plants. Main roots thickened, fleshy, often tuberous.
- All species have coralloid roots that are N-fixing due to symbiotic blue-green algae. Stems may be underground or **emergent** (taller than surrounding vegetation).

- In most species, leaves are once-pinnate and form a palm-like crown. Reproductive structures are cones. Cycads also reproduce vegetatively by means of bulbils.
- This order includes two families a) Cycadaceae and b) Nilssoniaceae.

- **2.Class Coniferopsida**

- This class includes both fossil and living gymnosperms.
- Gymnosperms of this group have stems that are highly branched. They are divided into long and short shoots.
- The leaves are simple (often needle-like) or reduced and scale-like and are either **spirally** (alternatively arranged leaves, each succeeding stem node rotated slightly from the nodes below) arranged or opposite and decussate.



- The plants are usually dioecious with the reproductive organs borne on specialized leaves (sporophylls) which are usually arranged in cones or cone-like structures.
- The wood is **pycnoxylic**. The pith and cortex are narrow. The cambium is active and forms an extensive secondary wood. The seeds and ovules are bilaterally symmetrical. This class includes orders such as **Cordaitales, Coniferales, Taxales and Ginkgoales.**

- **Order Cordaitales**

- This order includes only fossil plants which lived during Devonian and Carboniferous periods.
- The plants were tall trees with slender and branched stems, leaves simple and spirally arranged with parallel venation.

- Megasporophylls bore four ovules. Microsporophylls bore 4-6 microsporangia. The ovules had endospermic beak. They are divided into three families such as **Erytrophytaceae, Cordaitaceae and Poroxylaceae**

- **Order Coniferales**

- It has many extinct and living forms. The fossil forms lived in late Jurassic and early Cretaceous.
- The conifers have highly branched root and shoot systems.
- The branches are of two types; the dwarf shoot and the long shoot.
- Long shoots contain apical bud and grow indefinitely. Many scaly leaves are present on the long shoot. Dwarf shoots 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.
- Two types of leaves are also present, the scale leaves and the foliage leaves.

- The wood is pycnoxylic. Resin canals are found throughout the internal structure.
- Male and female cones are compact. The male gametes are non motile. This order includes nine families such as **Lebachiaceae,** **Voltziaceae,** **Palissyaceae, Pinaceae, Taxodiaceae,** **Cupressaceae,** **Podocarpaceae,** **Cephalotaxaceae,** and **Araucariaceae.**

- **Order Taxales**

- The plants are small trees or shrubs that branch extensively. Leaves are simple, solitary, flat and spirally arranged.
- Wood is pycnoxylic with **homogenous rays** (a sheet of vascular tissue separating vascular bundles). Trees are mostly unisexual.
- Ovules are single, borne terminally on a dwarf shoot.

- A distinct **aril** (brightly coloured cover of a seed) is present at the base of the ovule. The male cone bears peltate sporangiophores with 6-8 pendulous sporangia.
- Seeds are endospermic. This order includes a single family Taxaceae.



STROBILUS



SPORANGIOPHORE

CAP

SPORANGIA



- **Order Ginkgoales**

- It includes several fossils and a single living member *Ginkgo biloba* (referred often as living fossil)
- They came to existence during Permian and achieved luxuriance during the Triassic and Jurassic periods.
- The plants are tall trees having **excurrent habit** (having the axis prolonged as to form an undivided main stem or trunk) with tap root systems.

Ginkgo leaves and fruits



Photo by Phil Barrie

Ginkgo



Ginkgo biloba

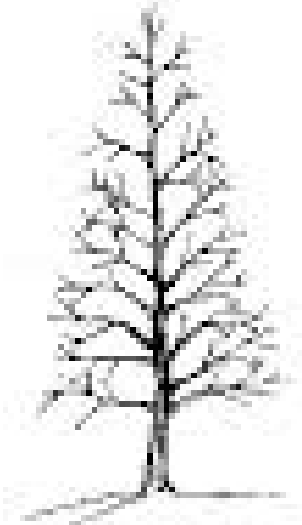




Growth habit determines training objectives.

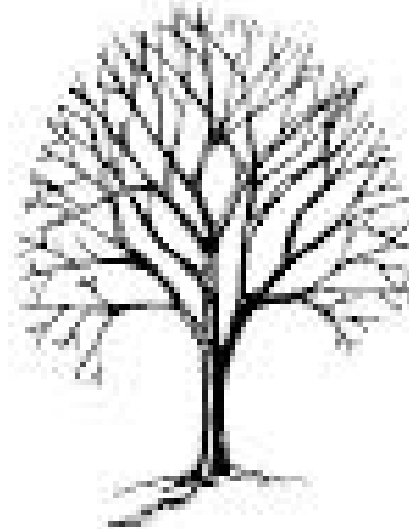
Excurrent

Central leader trees



Decurrent

Multiple scaffold branches



- The leaves are fan shaped and deciduous with open dichotomous venation.
- The inflorescence is catkin like and each microsporangiophore bear two to twelve pendent microsporangia. The ovules arise in groups. The male gametes are motile.



- **3. Class Gnetopsida**

- This class consists of living members. These are highly advanced. The members of this class have vessels in the secondary xylem.
- The flowers are arranged in compound strobili and are unisexual. The male flowers are surrounded by several envelopes.
- The micropylar tube is extremely elongated. The embryo has two cotyledons. This class has only one order

Gnetales

- **Order Gnetales:**

- The sporophytes may be shrubs, trees or even woody climbers. In *welwitschia* the stem is turnip-like and is partly subterranean. The leaves are simple and may be scale like, strap shaped or even ovate or elliptic. In *welwitschia* they become long and woody
- The secondary wood has vessels. These vessels unlike those of angiosperms are derived from tracheids with pitted thickenings. There are no resin canals

- The flowers are unisexual and the trees are dioecious except in some species of *Gnetum*
- The reproductive organs are organised into compound strobili or inflorescence. The male flowers are surrounded by sterile perianth scales and the ovule is also surrounded by extra envelopes. They have three families such as *Gnetaceae*, *Ephedraceae* and *Welwitschiaceae*