

THE PLANT KINGDOM

The Plant Kingdom is characterised by:

- The presence of Chlorophyll a & b, and Carotenoid pigments
- An alternation of generations (Gametophyte --> Sporophyte --> Gametophyte)

The green algae share these characters, and all land plants are considered to have a single origin from a green algae ancestor. RED ALGAE and BROWN ALGAE are very different evolutionary lineages, as are Diatoms, Dinoflagellates etc.

LIVERWORTS, HORNWORTS and MOSSES (22,000 species)

- No vascular system
- A prominent Gametophyte and diminutive Sporophyte

FERNS Pterophyta (8,600 species)

- Vascular system of tracheids
- Gametophyte (Prothallus) small, Sporophyte conspicuous (fern plant)

FERN ALLIES (900 species)

Similar to Ferns, but some, e.g. *Selaginella* have mega- and micro-spores. This is equivalent to the development of an embryo sac (Megaspore) and Pollen grains (microspore) of higher plants.

1. Whisk ferns - Psilotophyta
2. Club Mosses - Lycophyta
3. Horsetails (Equisetum) - Sphenophyta

GYMNOSPERMS (Pines, Cycads etc.)

- Seeds: Endosperm containing an embryo.
- Gametophyte of 2 types: Megagametophyte contained within sporophyte (Embryo sac)
- Microgametophyte= Pollen Grain

Gymnosperm (=naked seeds). Most primitive seed plants. Distinguished from ferns by fibres, dependent gametophyte, seeds. Distinguished from flowering plants by: naked seeds (No carpels); Lack of vessels. A varied group, not of a common origin - characterised by a shared 'primitive' state.

- 1 Cycads (Cycadophyta) 160 spp.
- 2 Conifers (Pinophyta) 700 spp.
 - 2.1 Pinales: Pinaceae
 - 2.2 Cupressales: Cupressaceae, Taxodiaceae (redwoods) Podocarpaceae Araucariaceae
 - 2.3 Taxales: Taxaceae
- 3 Ginkgo (Ginkgophyta) 1 spp.
- 4 Gnetum, Ephedra, Welwitschia (Gnetophyta) 70 spp.

ANGIOSPERMS (Magnoliophyta - Flowering plants)

- Ovules hidden within a carpel: pollen germinates on a stigma.
- Flowers
- Seed not developed until after fertilisation

Two classes are recognised, based on the number of cotyledons:

- The DICOTYLEDONS (Magnoliopsida) 320,000 spp.
- The MONOCOTYLEDONS (Liliopsida) 80,000 spp.

DIVISIONS (PHYLA) of the PLANT KINGDOM

The divisions of the plant kingdom approximate to a pseudo-evolutionary sequence. That is the earlier divisions represent a life style that might be considered 'primitive', but we must remember that all living plants are equally 'modern'. All the members exhibit a characteristic alternation of generations, and have chlorophyll a & b (in approximately equal quantities), and carotenoids, and store their food as starch.

*I-VII are sometimes called **Cryptogams** (hidden marriage), because they reproduce by spores. The male gametes are motile and are called sperm.*

I.	HEPATICOPHYTA	(Liverworts)	8,300
II.	ANTHOCEROTOPHYTA	(Hornworts)	350
III.	BRYOPHYTA	(Mosses)	13,500

*I-III have a very basic vascular system, which prevents them forming tall, branching plants. In all 3 the haploid generation (gametophyte) is the conspicuous generation. In divisions IV-XII a vascular system is present, and these plants are sometimes called **Tracheophytes** (Vascular plants). The diploid generation (sporophyte) is conspicuous.*

IV.	PSILOTOPHYTA	(Whisk ferns)	3
V.	LYCOPHYTA	(Club mosses)	850
VI.	SPHENOPHYTA	(Horsetails)	25
VII.	PTEROPHYTA	(Ferns)	8,600

*In divisions VIII-XII the gametophyte is not independent and is borne within the tissues of the sporophyte. These plants reproduce by seeds, and are therefore sometimes called **Spermatophytes** (Seed plants) or **Phanerogams** (visible marriage). In some books you will find all Gymnosperms in one Division (Pinophyta) with 4 sub-divisions (Cycadophytina, Pinophytina, Ginkgophytina and Gnetophytina). Divisions VIII-XI have seeds in a cone, but the ovule is not contained in an ovary, and are called **Gymnosperms** (Naked seeds).*

VIII.	CYCADOPHYTA	(Cycads)	160
IX.	PINOPHYTA	(Conifers)	700
X.	GINKGOPHYTA	(Ginkgo)	1
XI.	GNETOPHYTA	(Gnetum, Ephedra, Welwitschia)	75

*The last division XII is the **Angiosperms** (Hidden seeds) in which the ovule is enclosed in a carpel, flowers are present and fruits.*

XII.	MAGNOLIOPHYTA	(Flowering plants)	
	CLASS: Magnoliopsida	(Dicots)	320,000
	CLASS: Liliopsida	(Monocots)	80,000

GYMNOSPERM differ from **FERNS** by:

<u>WOOD</u>	They have <u>Fibres</u> , and develop <u>Wood</u> . (Fern trunks are erect rhizomes, roots and leaf bases).
LEAVES	Ferns have branching leaves of indeterminate growth Gymnosperms have simple or pinnate leaves .
GAMETOPHYTE	2 types: “ Embryo sac ” (Mega-sporangia) Pollen Grain (Micro-sporangia) Not independent of Sporophyte, being contained in “cones” on the sporophyte. “Embryo sac” contained within an Ovule Male gametes motile in ferns, Cycads, and Ginkgo, but in other Gymnosperms nuclei in tubes. <u>Not dependent on external water</u> .
<u>SEEDS</u>	Embryo contained within an endosperm, and surrounded by a seed coat.

ANGIOSPERMS differ from **GYMNOSPERMS** by:

WOOD	Tracheids in Gymnosperms, <u>Vessels</u> in Angiosperms(rare in Winteraceae) Phloem Companion cells Herbaceousness Epicormic buds
LEAVES	More efficient water supply in Angios leads to Larger, broad leaves Deciduousness
<u>FLOWER</u>	Unique to Angiosperms. Bisexual ‘Angiospermy’ (seeds hidden): Carpel & Stigma Economy of Double fertilisation
<u>FRUIT</u>	Flowering & <u>Fruiting</u> (Gymnosperm endosperms develop <u>prior</u> to fertilisation, in Angios flowering and fruiting occurs <u>sequentially</u>) <u>Efficiency</u> : Pollination & Dispersal

GYMNOSPERMS

Gymnosperms are the most primitive of the 'seed plants'. The Ovules are 'naked', which means they are exposed to the outside world through the narrow scale openings, and the pollen grain has to land on the micropylar opening of the integuments - there is no stigma. The micropyle exudes a drop of fluid - the pollination droplet - in most Gymnosperms.

1. Gametophyte generation wholly enclosed by Sporophyte generation: does not exist independently.
2. Female gametophyte (Megasporangia) is contained in an 'Ovule' in which the spore grows into the embryo sac [=Megasporangia or Female gametophyte]. Gametophyte develops into a large endosperm (many thousands of haploid cells) prior to fertilisation. Each megasporangia develops several archegonia (2-5), if more than one is fertilised, then competition between embryos usually results in only one developing.
3. Male gametophyte (Microsporangia) is enclosed in a Pollen grain (3 nuclei are present, one of these is the generative nucleus, and will form a motile 'sperm' or travel along a pollen tube)
4. After fertilisation, the Embryo develops within an endosperm (haploid in Gymnosperms), and the integuments develop into a hard seed coat.

Gymnosperms are very varied, they do not have a single evolutionary origin, and four divisions are usually recognised:

CYCADS (CYCADOPHYTA) Rarely-branched trunks with soft pithy wood. **Dioecious** (separate male and female plants).

Leaves compound.

Male gametes multi-ciliated, released from the male gametophyte after several months, sometimes after the seed has fallen.

GINKGO (GINKGOPHYTA) Only 1 living species - *Ginkgo biloba*, probably native to China; widely cultivated in temperate areas. A "living fossil" with no close relatives (more diverse in the Jurassic). Well branched, deciduous, **dioecious** (male & female) tree.

Leaves alternate, simple, fan-shaped with dichotomous venation.

Female gametophyte large, photosynthetic; male gametophyte producing 2 large swimming sperm (multiflagellate) within the pollen tube.

Embryo with 2 cotyledons

PINES, CYPRESSES, REDWOODS, YEWS etc. (PINOPHYTA: with 3 orders: Pinales, Cupressales, Taxales). Branched, woody trees, mostly **monoecious**. Resin canals in wood. Vascular system lacks vessels (Tracheids only).

Pollination occurs 12 months prior to fertilisation. Pollen tube, and non-motile gamete.

Embryo with 6 or more cotyledons.

GNETUM, EPHEDRA, WELWITSCHIA (GNETOPHYTA: 3 orders: Ephedrales, Gnetales, Welwitschiales) Plants of very diverse growth forms. All have vessels in the xylem, but this has probably evolved independently of Angiosperms.

Pollen tubes with non-motile gametes.