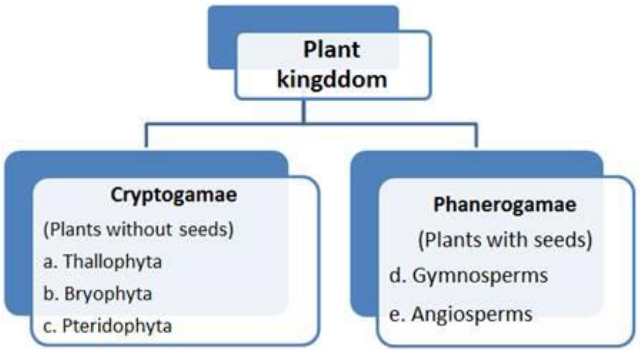
Plant Kingdom

- Eukaryotic, multicellular, chlorophyll containing and having cell wall, are grouped under the kingdom Plantae.

Earliest Classification (within Angiosperm):

- **Artificial Classification** (by Linnaeus).**:** Classification based on vegetative characters and gives equal weightage to sexual & morphological characteristics .
- **Natural classification systems** (by G Bentham and J Hooker): Classification based on both internal & external factors like anatomy, embryology and phytochemistry etc.
- **Phylogenetic Classification** : System based on evolutionary relationship is presently used for classifying plants.
- **Numerical Taxonomy** use of computer by assigning code for each character and analyzing the features.
- **Cytotaxonomy** is based on cytological information like chromosome number, structure and behaviour.
- **Chemotaxonomy** uses chemical constituents of plants to resolve the confusion.



Thallophytes

These include Algae the simplest plants which possess undifferentiated or **thallus like forms** & bears chlorophyll.

Characteristic of Algae

- Plant body is thallus (body not divided into root shoot & leaves), which may be unicellular, colonial, filamentous or parenchymatous.
- Usually aquatic but a few are also found in moist terrestrial habitats like tree trunks, wet rocks, moist soil, in association with fungi (lichen) and animals (e.g., on sloth bear).
- Vascular tissues and mechanical tissues are absent.
- Algae may be Unicellular (Chlamydomonas), colonial (Volvox) or filamentous (Ulothrix).
- Reproduction by:
  - Vegetative (fragmentation)- Spirogyra
  - Asexual spore -**Zoospores** (flagellated)
  - Sexual reproduction by fusion of two gametes
    - Flagellated & Isogamous -Ulothrix
    - Non-flagellated & isogamous- *Spirogyra*
    - Anisogamous - Eudorina
    - Oogamous (Large nonmotile & small motile) -*Volvox*.
- Life cycle is various- haplontic, diplontic or diplohaplontic.

Economic importance-

- A number of brown algae (Porphyra, *Laminaria, Sargassum*) are used as food in some countries.
- Fucus and Laminaria are rich source of Iodine.
- Laminaria and Ascophyllum have antibiotic properties.
- Alginic acid is obtained from Fucus and Sargassum, which is used as emulsions.
- Carryout a half of the total carbon dioxide fixation on earth.
- Form hydrocolloids (water holding substances), e.g., algin (brown algae) and carrageen (red algae)
- Agar (Gelidium and Gracilaria) used in ice-creams and jellies.
- Chlorella & Spirulina (unicellular alga) rich in proteins is used as food supplement by space travellers.

Chlorophyceae (Green Algae)	**Phaeophycean (Brown Algae)**	**Rhodophyceae (Red Algae)**
Fresh water, Brackish water & Salt Water	Marine Habitat, Fresh water (rare) Brackish Water	Fresh Water (Some), Brackish Water, Mostly marine. Found in the warmer areas., near surface & great depth.
Plant body Unicellular (abundant) Colonial, filamentous	Unicellular species are absent.	Unicellular species fewer.

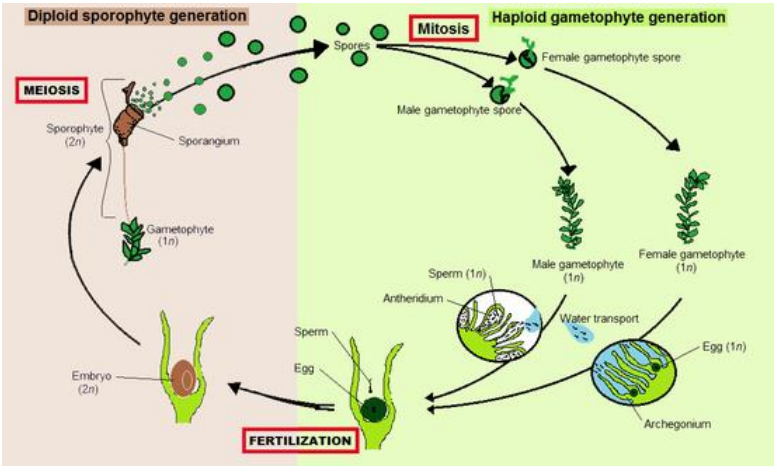
Grass green due to Chlorophyll a and b.	Olive green to various shades of brown due to Chlorophyll a, c, carotenoids, xanthophyll p & **Fucoxanthin**	Chlorophyll a, d & **r-Phycoerythrine**
Storage Body Pyrenoids contain protein & starch	Reserve food is Mannitol, laminarin.	Reserve food is **Floridean starch** (similar to amylopectin and glycogen)
Cell wall is of cellulose (outer layer of pectose)	Cell wall contains cellulose and outside by a gelatinous coating of algin.	Cell wall contains cellulose, pectin and poly-sulphate esters.
2-8, equal, apical flagella.	Plant body attached to substratum by holdfast, and a stalk, the stipe and leaf like photosynthetic organ – the frond.	Flagella Absent.
Zoospores present & Sexual Spores may be isogamous, anisogamous or oogamous	Pear shaped Zoospores (2 unequal lateral flagella) present. Sexual Spores may be isogamous, anisogamous or oogamous	Zoospores absent. Sexual reproduction is oogamous.
Chlamydomonas, Ulothrix, spirogyra.	Kelps (profusely branched-100m), Focus, Sargassum, Ectocarpus (Branched & filamentous)	Polysiphonia, Gelidium, Porphyra etc.

Bryophytes **(Amphibians of Plant Kingdom)**

They are non-vascular plant whose body is divided into root like, shoot like and leaf like structure & that grow in moist shady region. These plants live on soil but dependent on water for sexual reproduction.

Characteristic features-

- Live in damp and shady habitats, found to grow during rainy season on damp soil, rocks, walls, etc.
- The dominant phase or plant body is free living gametophyte.
- Roots are absent but contain rhizoids.
- Vegetative reproduction is by fragmentation, tubers, gemmae, buds etc. sex organs are multicellular and jacketed.
- The male sex organ is called **antheridium.** They produce biflagellate antherozoids.
- The female sex organ called **archegonium** is flask-shaped and produces a single egg.
- The main plant body is Gametophyte (n). Gametophytes after fertilization forms Zygote.
- Zygote do not undergo meiosis immediately, It produces multicellular body Sporophyte. Sporophyte is not free living but attached to gametophyte dependent on it for nourishment.
- Sporophytes undergo meiosis to produce spores. These spores germinates to form Gametophyte.

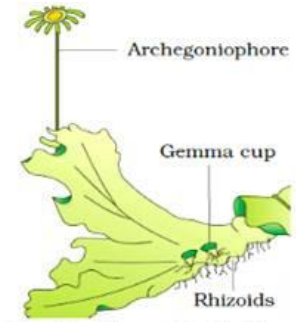


Economic Importance

- Food for herbaceous mammals, birds etc.
- Sphagnum (a moss) provide peat (fuel).
- It has water-holding capacity hence used as packing material for trans-shipment of living material.
- Play major role in plant succession on bare rocks. Mass along with lichens decompose rock making substrate suitable for growth of higher plants.
- Prevent soil erosion.

Hepaticopsida (Liverworts)

- The plant body of a liverwort is thalloid (dorsiventral and closely appressed to the substrate), e.g., Marchantia.
- Asexual reproduction in liverworts takes place by fragmentation, or by the formation of **gemmae.**
- Gemmae are green, multicellular, asexual buds, which develops in small receptacles called gemma cups. The gemmae becomes detached from the parent body and germinate to form new individuals



Marchantia male thallus

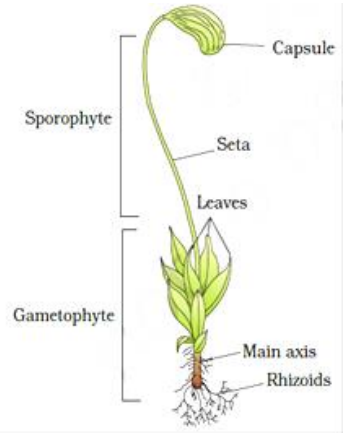
Marchantia female thallus

- During sexual reproduction, male and female sex organs are produced either on the same or on different thalli.
- The sporophyte is differentiated into a foot, seta and capsule. Spores produced within the capsule germinate to form free-living gametophytes.

Bryopsida (Mosses)

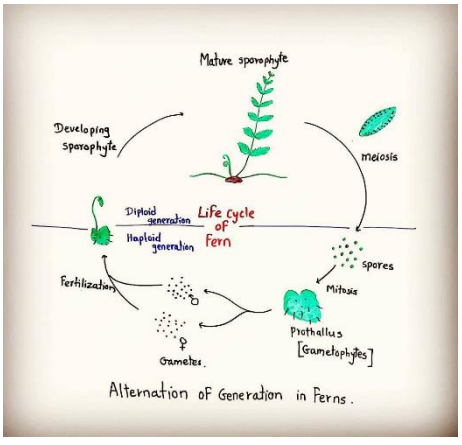
The gametophyte of mosses consists of two stages-

- **Protonema stage** the first stage is , which develops directly from spores. It is creeping, green and frequently filamentous.
- **Leafy stage** The second stage , which develops from secondary protonema as lateral bud having upright, slender axes bearing spirally arranged leaves.
- Vegetative reproduction is by the fragmentation and budding in secondary protonema.
- In sexual reproduction, the sex organs antheridia and archegonia are produced at the apex of the leafy shoots.
- Sporophytes in mosses are more developed and consist of foot, seta and capsule.
- Common examples are *Funaria, Polytrichum, Sphagnum* etc.

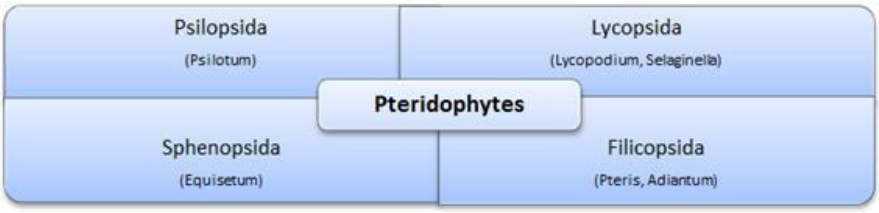


Pteridophytes

- They are seedless vascular plants that have sporophytic plant body and inconspicuous gametophyte.
- Sporophytic plant body is differentiated into true stem, roots and leaves.
- Vascular tissue are present but vessels are absent from xylem and companion cells and sieve tube are absent.
- Small Leaves – Microphylls. Eg- Selaginella. Large leaves- Macrophylls. Eg- Fern.
- Sporophytes bear sporangia that are subtend by leaf like appendages- **sporophylls**. In some plants (*Selaginella*) compact structure called strobili or cone is formed.
- Sporangia produce spores by meiosis in spore mother cells. Spores germinate to produce multicellular thalloid, **prothallus.**
- Gametophyte bears male and female sex organ called antheridia and archegonia. Water is required for fertilisation.



- **Homosporous –** Most pteridophytes
- H**eterosporous** - *Selginella* and *Salvinia*, megaspore (larger spore) produce female gametophyte & microspore (smaller) produce male gametes.
- **Economic importance:** Medicinal Purpose, Soil binders, Ornamentals etc.



Gymnosperms (Nacked Seeds)

- Gymnosperms are those plants in which the ovules are not enclosed inside the ovary wall and remain exposed before and after fertilisation.
- They are perennial and woody, forming either bushes or trees. Some are very large like Giant Redwood Tree (*Sequoia sempervirens*) and others are very small (*Zamia pygmia*).
- Stem may be unbranched(Cycas) or branched(Pinus).
- Root is taproot. Some Genera has Fungal association- Mycorrhiza eg: Pinus. Some Has coralloid root (associated with N_2- fixing cynobacteria)
- Leaves may be simple or compound. Pinnate leaves in Cycas.
- Some leaves have needle shape as in Conifers (Pinus)- reduced surface area, thick cuticle & sunken stomata to prevent water loss in extreme condition.
- The male and the female gametophytes do not have an independent free-living existence they remain within the sporangia retained on the sporophytes
- Sporophylls bears sporangia in which spores are produced. They are heterosporous i.e. Microsporophylls- , produce haploid **microspore** (in male strobili) & Megasporophylls- haploid **megaspore** (in female strobili)
- Microspore develop into Pollen grain & Megaspore develop into ovule and it also consist a body called nucellus that protects by envelopes.
- The ovules are borne on megasporophylls which may be clustered to form the female cones. The megaspore mother cell divides meiotically to form four megaspores. One of the megaspores enclosed within the megasporangium develops into a multicellular female gametophyte that bears two or more archegonia or female sex organs
- Pollination occurs through air and zygote develops into embryo and ovules into seeds. These seeds are naked.
- Example- Pines, Cycus, Cedrus, Ginkgo, etc.

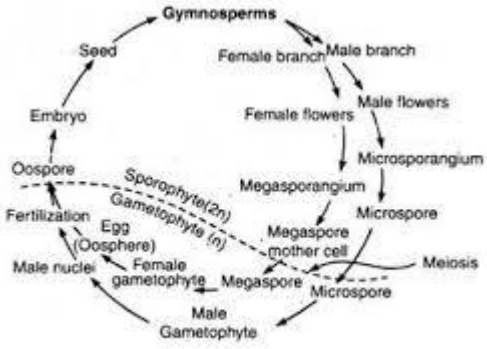


Fig. 1.2. Graphic life cycle of Gymnosperm.

Angiosperms (Flowering Plants)

- Pollen grain and ovules are developed in specialized structure called flower. Seeds are enclosed inside the fruits.
- Size varies from almost microscopic Wolfia (0.1cm)to tall tree Eucalyptus (more than 100m
- The male sex organs in a flower is the stamen. It contains pollen grain.
- The female sex organs in a flower is the pistil or the carpel. Pistil consists of an ovary enclosing one or many ovules.
- **Angiosperms are further classified into:**

Monocotyledons	Dicotyledons
1. Single cotyledons. 2. Parallel venation. 3. Fibrous root system. 4. Closed vascular bundle. 5. More number of vascular bundles. 6. Banana, wheat, rice.	1. Two cotyledons. 2. Reticulate venation. 3. Tap root system. 4. Open vascular bundle. 5. Less number of vascular bundles. 6. Gram, mango, apple.