Plant Kingdom

Division Algae

Classification within Angiosperms

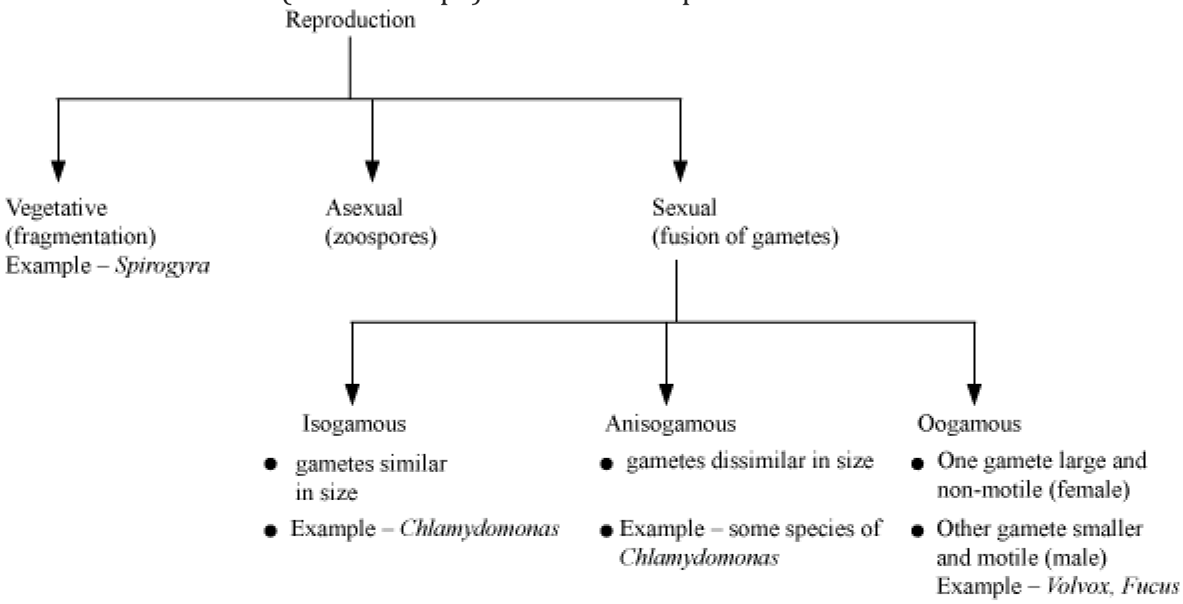
- Artificial system of classification
- Given by Linnaeus
- Based on vegetative characters or androecium structure
- Gave equal importance to vegetative and sexual characteristics
- Natural system of classification
- Based on morphology, anatomy, embryology, and phytochemistry
- Given by George Bentham and Joseph Dalton Hooker
- Phylogenetic system of classification - based on evolutionary relationship
- Numerical Taxonomy
- Based on all observable characteristics
- Numbers and codes assigned to all characters
- Easily carried out using computers
- Cytotaxonomy – Based on cytological information such as chromosome number, structure, behaviour
- Chemotaxonomy – Based on chemical constituents of plant to resolve doubts and confusions

Division Algae

- Includes chlorophyll-bearing, simple, thalloid, autotrophic, and largely aquatic (freshwater and marine) organisms
- Some occur in association with fungi (lichens) and animals (e.g., on sloth bear).

- Size ranges from microscopic unicellular forms such as *Chlamydomonas* to colonial forms such as *Volvox* and to filamentous forms such as *Ulothrix* and *Spirogyra*.

- Some marine forms (such as kelps) form massive plant-like bodies.



Economic Importance

- Carbon dioxide fixation on earth is majorly carried out by algae.

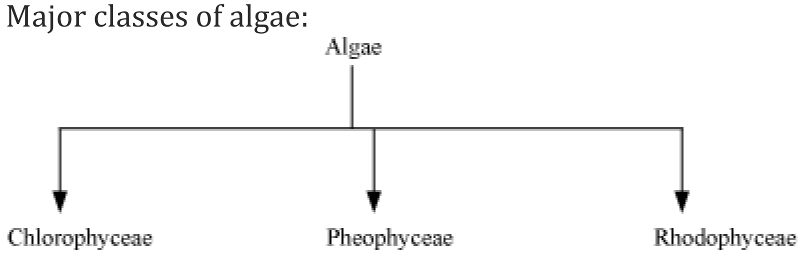
- Important as primary producers of energy-rich compounds
  Example – *Sargassum*, *Laminaria*, and *Porphyra* used as food

- Some brown and red algae species produce water-holding hydrocolloids.
  Example – Algin (brown algae) and carrageen (red algae)

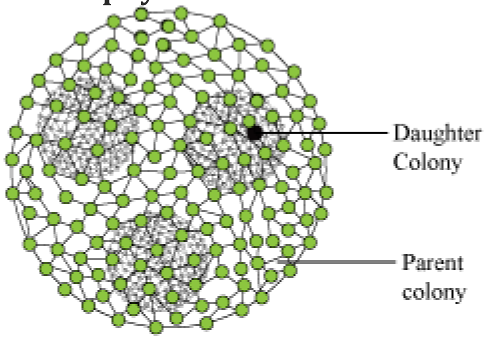
- Agar produced by *Gelidium* and *Gracilaria* is used to grow microbes and in preparation of ice creams and jellies.

- *Chlorella* and *Spirulina* are protein-rich unicellular algae, used as food supplements. They are also known as space food.

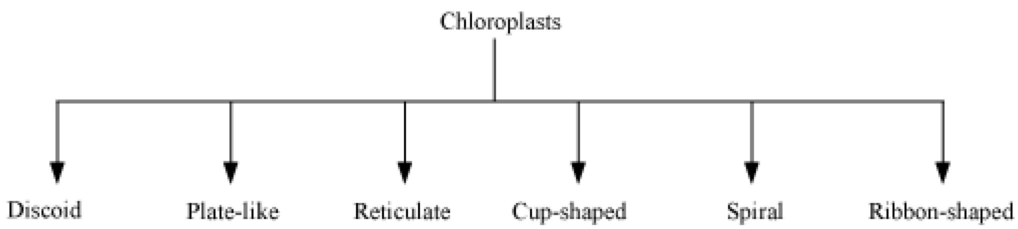
- Major classes of algae:



Chlorophyceae



- Commonly called green algae
- May be unicellular, colonial, or filamentous
- Grass green in colour due to abundance of chlorophyll *a* and *b*



- Chloroplast of most of the Chlorophyceae contains pyrenoids.
- Pyrenoids – Storage bodies containing proteins in addition to starch
- Food storage occurs in the form of oil droplets in some algae.
- Cells have rigid cell wall: inner layer made of cellulose, outer layer made of pectose
- Examples include *Volvox, Chara, Chlamydomonas*.

Phaeophyceae (Brown algae)

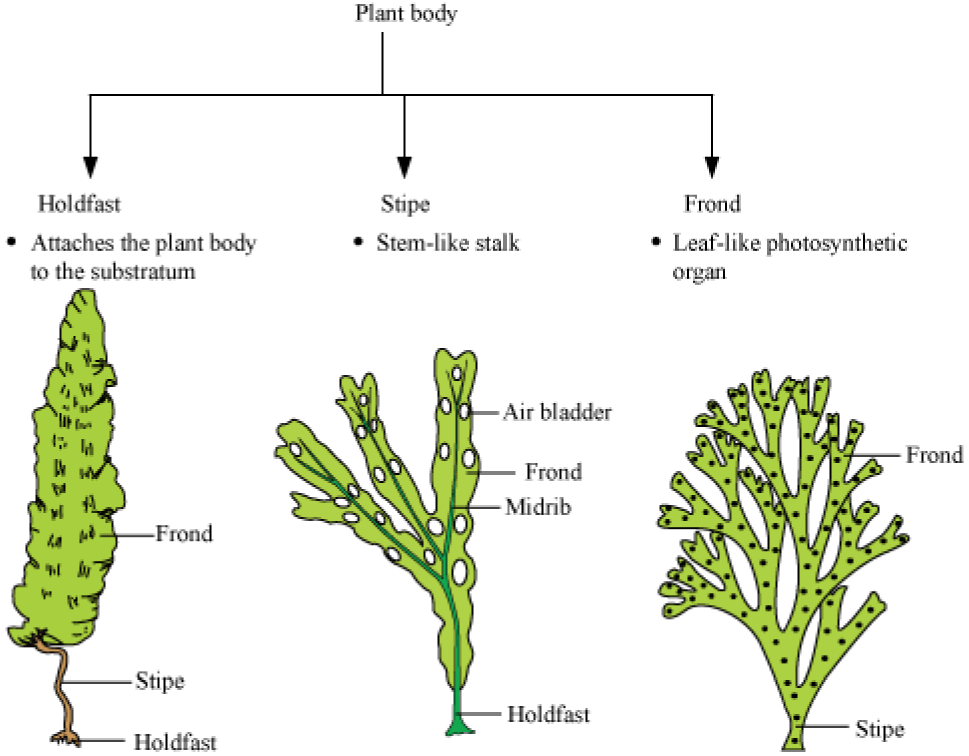
- Primarily marine forms
- Show great variation in size and form
- Range from simple-branched, filamentous forms (*Ectocarpus*) to profusely branched forms such as kelps (may reach a height of 100 m)
- Possess chlorophyll *a, c*, carotenoids, and xanthophylls

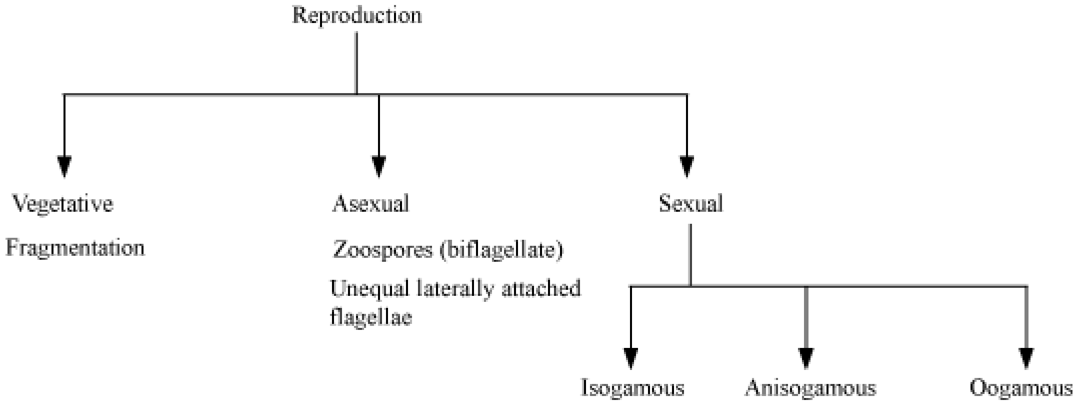
- Vary in colour from olive green to various shades of brown (depending on amount of xanthophyll and fucoxanthin)

- Food stored as complex carbohydrates such as laminarin or mannitol

- Vegetative cells have cellulosic wall covered on the outside by gelatinous coating of algin.

- Cell contains a centrally located vacuole and nucleus in addition to plastids.

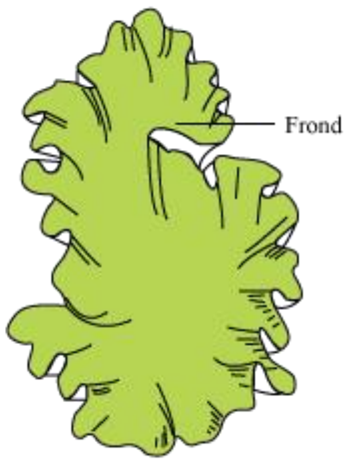


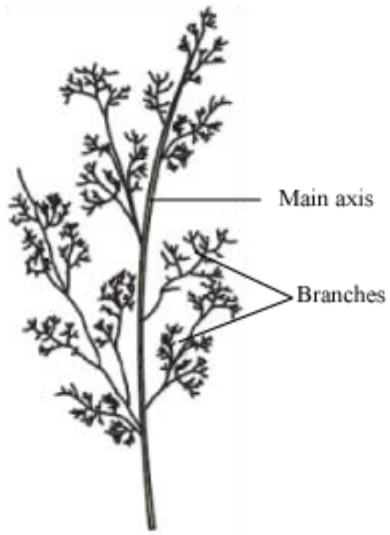


- Union of gametes takes place in water or within oogonium (oogamous species).

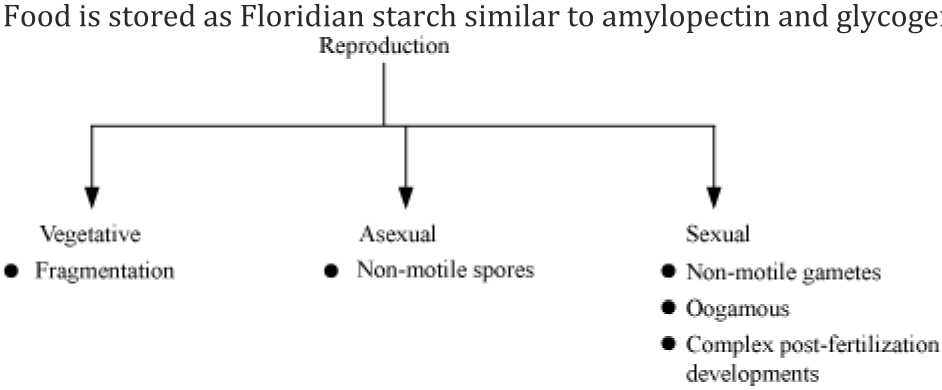
- Gametes are pyriform (pear-shaped).
  Example – *Ectocarpus*, *Dictyota*, *Laminaria*, *Sargassum*, and *Fucus*

Rhodophyceae (Red algae)





- Commonly called red algae due to the presence of red pigment, *r*-phycoerythrin
- Mainly marine forms with bulk mass inhabiting warmer areas
- Occur in well-lighted regions i.e., close to the surface of water and also in deeper areas
- Red thalli of most of these species are multicellular. Some have complex body organization.
- Food is stored as Floridian starch similar to amylopectin and glycogen in structure.

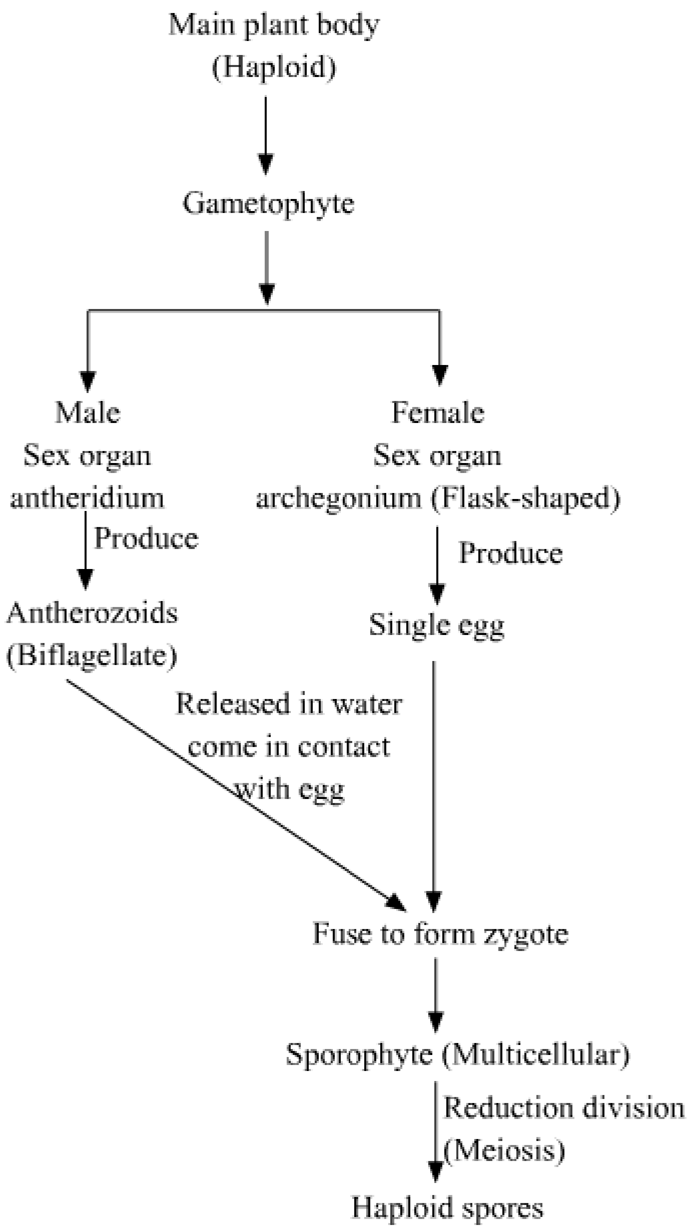


Example – *Polysiphonia*, *Gelidium*, *Gracilaria*, *Porphyra*

Division Bryophyta

- Known as amphibians of plant kingdom since they live on land, but depend on water for sexual reproduction
- Usually occur in cool, damp, and shady areas
- Play an important role in plant succession on bare rocks/soils

- Plant body more differentiated than algae
- Thallus-like plant body is attached to substratum by unicellular or multicellular rhizoids.
- Lack true roots, stem and leaves; may possesses root-like, stem-like, and leaf-like structures



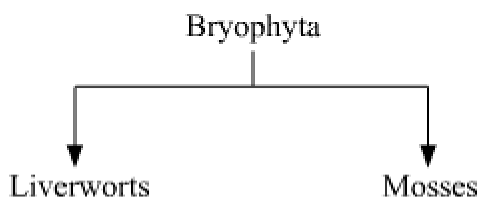
- Sporophyte is dependent on gametophyte for food. Hence, it remains attached to the gametophyte.

- Few cells of sporophyte undergo meiosis to produce spores (haploid).
- Spores germinate to form gametophyte.

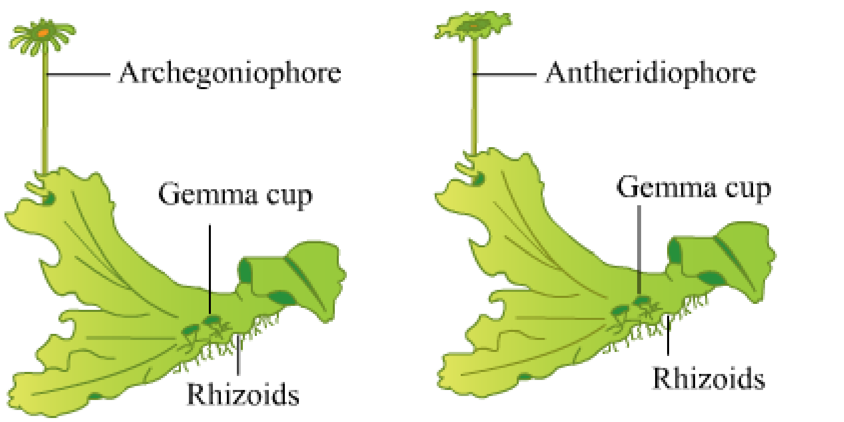
Economic Importance

- Provide food for herbaceous mammals, birds, and insects
- Peat provided by *Sphagnum* is used as fuel.
- *Sphagnum* is also used as packing material in trans-shipment of living material because of its water-holding capacity.
- They form dense mats on the soil and hence prevent soil erosion.
- Mosses along with lichens form the pioneer community in land and desert succession.

Classes of bryophytes



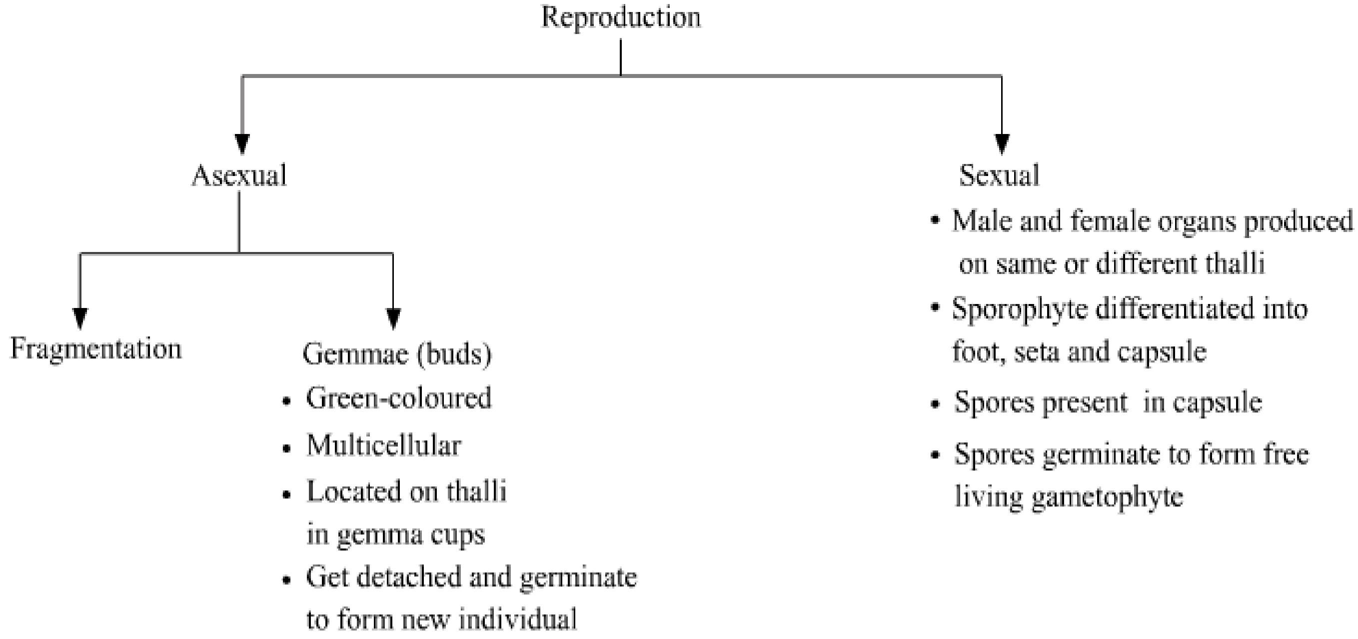
Liverworts



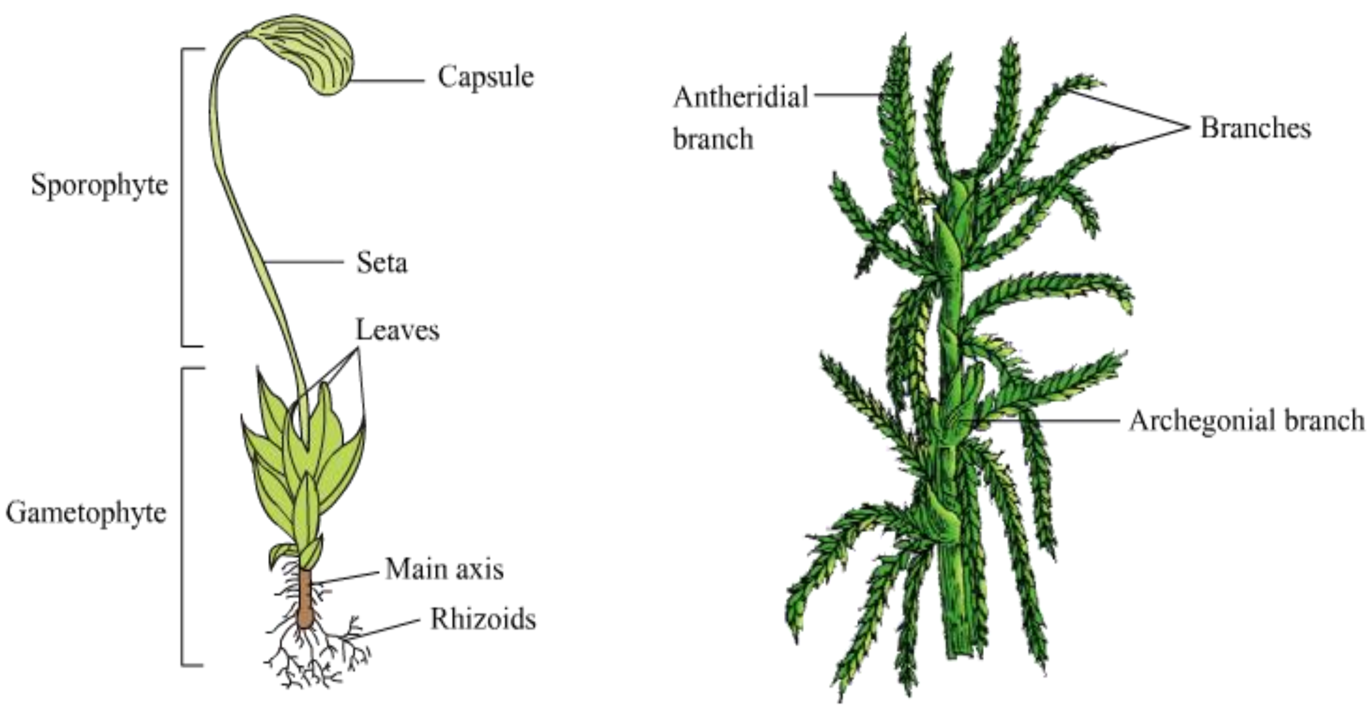
(a) Female thallus of *Marchantia* (b) Male thallus of *Marchantia*

- Grow in moist, shady habitats
- Plant body is thalloid.

- Thallus is dorsiventral and closely appressed to the substrate.
- Leafy members have tiny leaf-like appendages on stem-like structures



Mosses



(a) *Funaria* – Gametophyte and sporophyte (b) *Sphagnum* gametophyte

Gametophyte

- Predominant stage

Gametophyte

- Protonema
  - Develops directly from a spore
  - Creeping, green, filamentous and branched
- Leafy stage
  - Develops from secondary protonema as a lateral bud
  - Consists of upright, slender axes bearing leaves
  - Attached to soil by multicellular branched rhizoids
  - Bears sex organs

Reproduction

- Vegetative
  - Fragmentation
  - Budding in secondary protonema
- Sexual
  - Sex organs at apex of shoots
    - Antheridia
    - Archegonia
  - After fertilization, zygote develops into sporophyte

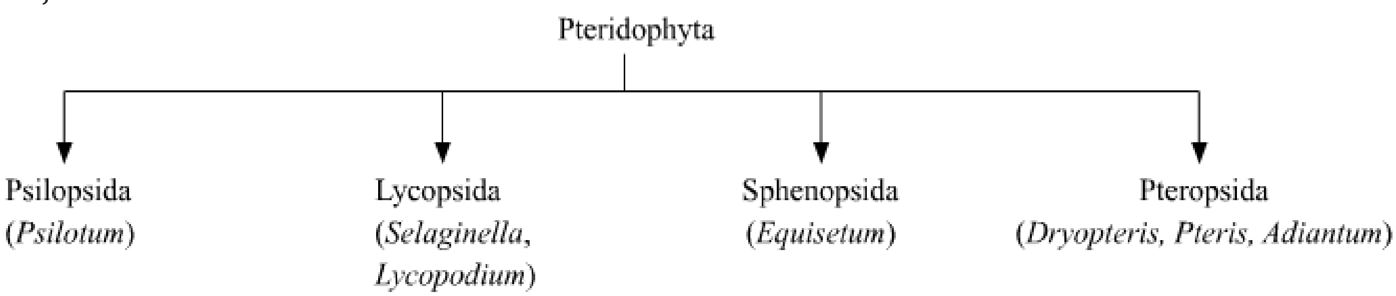
Sporophyte

- More elaborate than liverworts
- Consists of foot, seta, and capsule
- Capsule contains spores.
- Spores are formed by meiosis.
- Elaborate mechanism of spore dispersal
  Example – *Funaria*, *Polytrichum*, and *Sphagnum*

Division Pteridophyta

General Characteristics

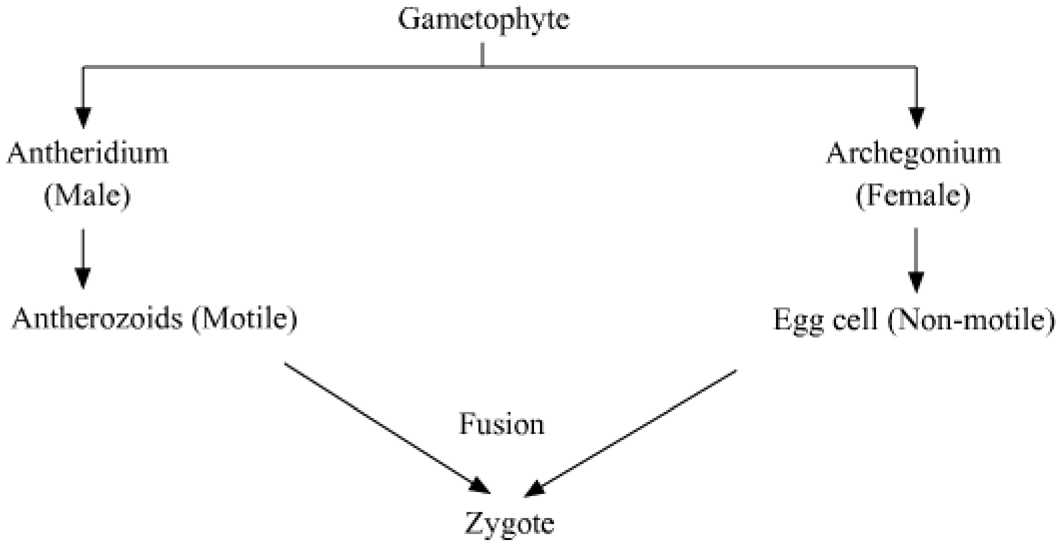
- The dominant plant body is sporophyte.
- First terrestrial plants to possess xylem and phloem
- Found in cool, damp, shady places
- Have well-differentiated true stem, leaves, and roots
- Leaves may be microphylls as in *Selaginella* or macrophylls as in ferns.
- Sporophytes bear sporangia, which develop in association with leaves called sporophylls.
- In some pteridophytes, sporophylls form distinct, compact structures called strobili or cones (*Selaginella, Equisetum*).
- Sporangia produce spores by meiosis in spore mother cells.
- Spores germinate to form small, multicellular, free-living, mostly photosynthetic thalloid gametophytes called prothallus.
- Major classes:



Gametophyte

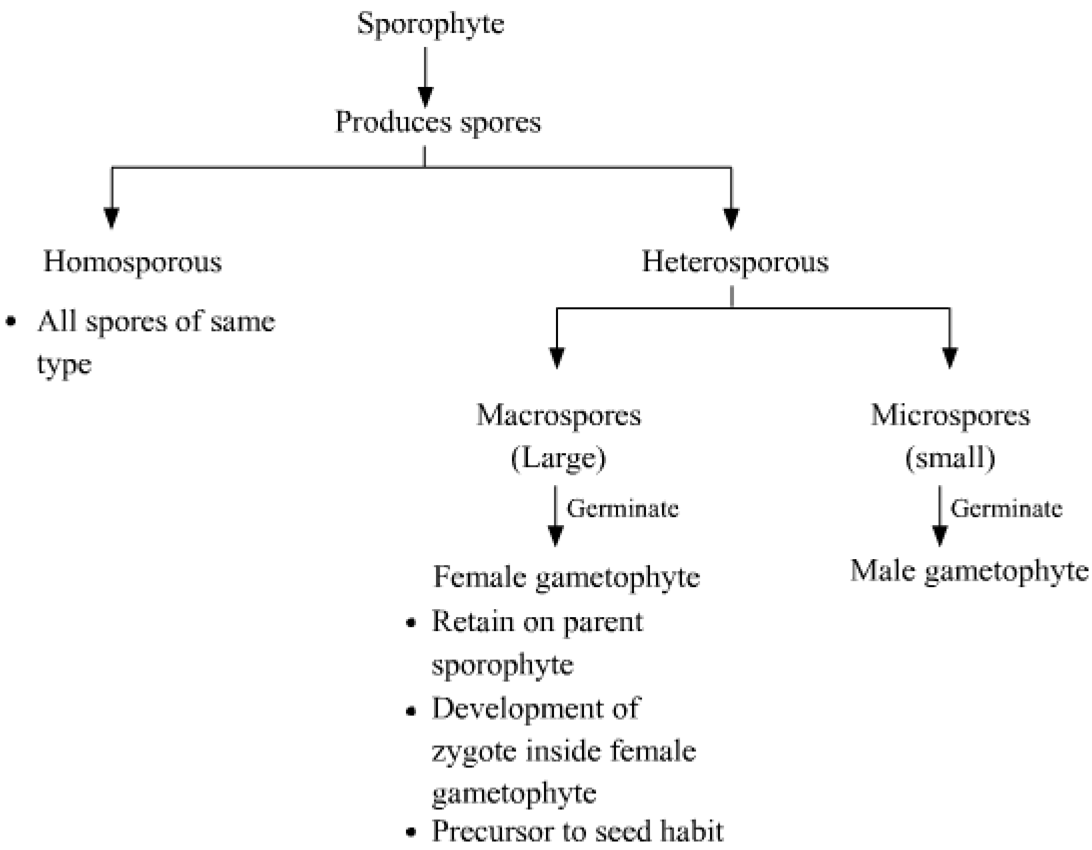
- Require cool, damp, shady places to grow

- Also require water for sexual reproduction

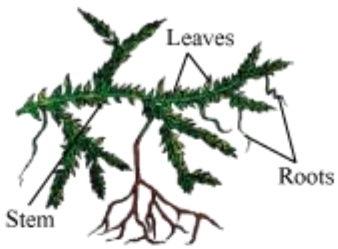


- Zygote produces well-differentiated, multicellular sporophyte.

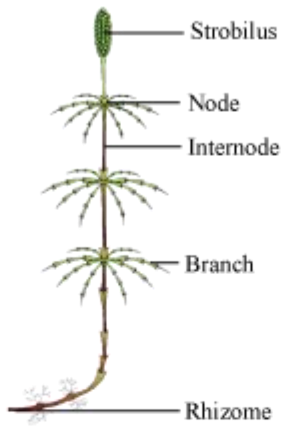
Sporophyte



- Example of heterospory – *Selaginella* and *Salvinia*



Selaginella



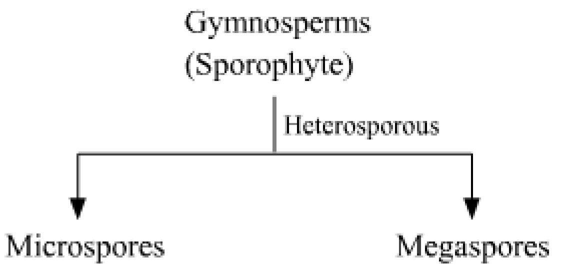
Equisetum

Division Gymnospermae

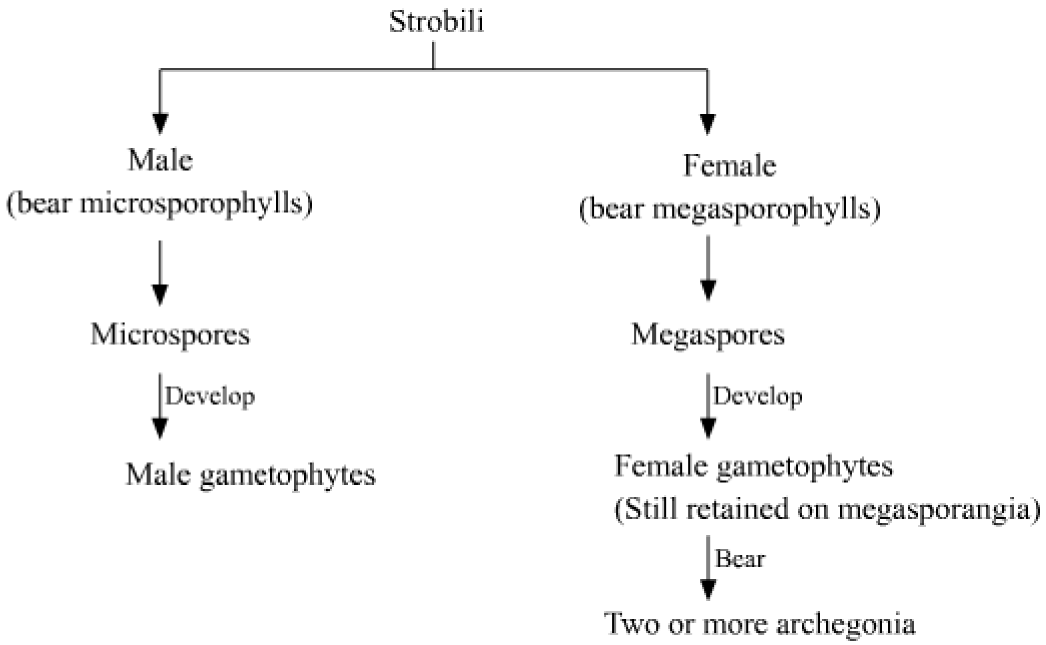
- Word gymnosperms, *gymnos* – naked, *sperma* – seeds
- Ovules not enclosed by any ovary wall
- Seeds formed after fertilization are not covered (i.e., naked).
- Include medium-sized trees, shrubs, and tall trees
- Contains the world's tallest tree *Sequoia* - the giant redwood tree
- Plants have tap roots. Roots in some genera show symbiotic associations.
- Mycorrhiza shows association of fungi with *Pinus* roots.
- Coralloid roots of *Cycas* show association with N_2-fixing Cyanobacteria.

- Stem
  - Branched (*Pinus*, *Cedrus*)
  - Unbranched (*Cycas*)
- Leaves
  - Simple (*Pinus*)
  - Compound (*Cycas*)

- Leaves are well-adapted to withstand extreme conditions. In conifers, needle-like leaves with thick cuticle and sunken stomata reduce surface area and water loss.



- Spores produced within sporangia, borne on sporophylls, which form strobili or cones



- Male and female strobili may be borne on same tree (*Pinus*) or on different trees (Cycas).

- Megaspore mother cell divides mieotically to form four megaspores.

- Megaspore mother cell is a differentiated cell of nucellus. Nucellus protected by envelopes is known as an ovule.

- Male and female gametophytes do not have independent existence, hence remain within sporangia.

- Steps in fertilization:

Pollen grain released from microsporangium

↓

Carried by air currents

↓

Come in contact with ovules

↓

Discharge of pollen content on mouth of archegonia

↓

Fertilization

↓

Formation of zygote

↓

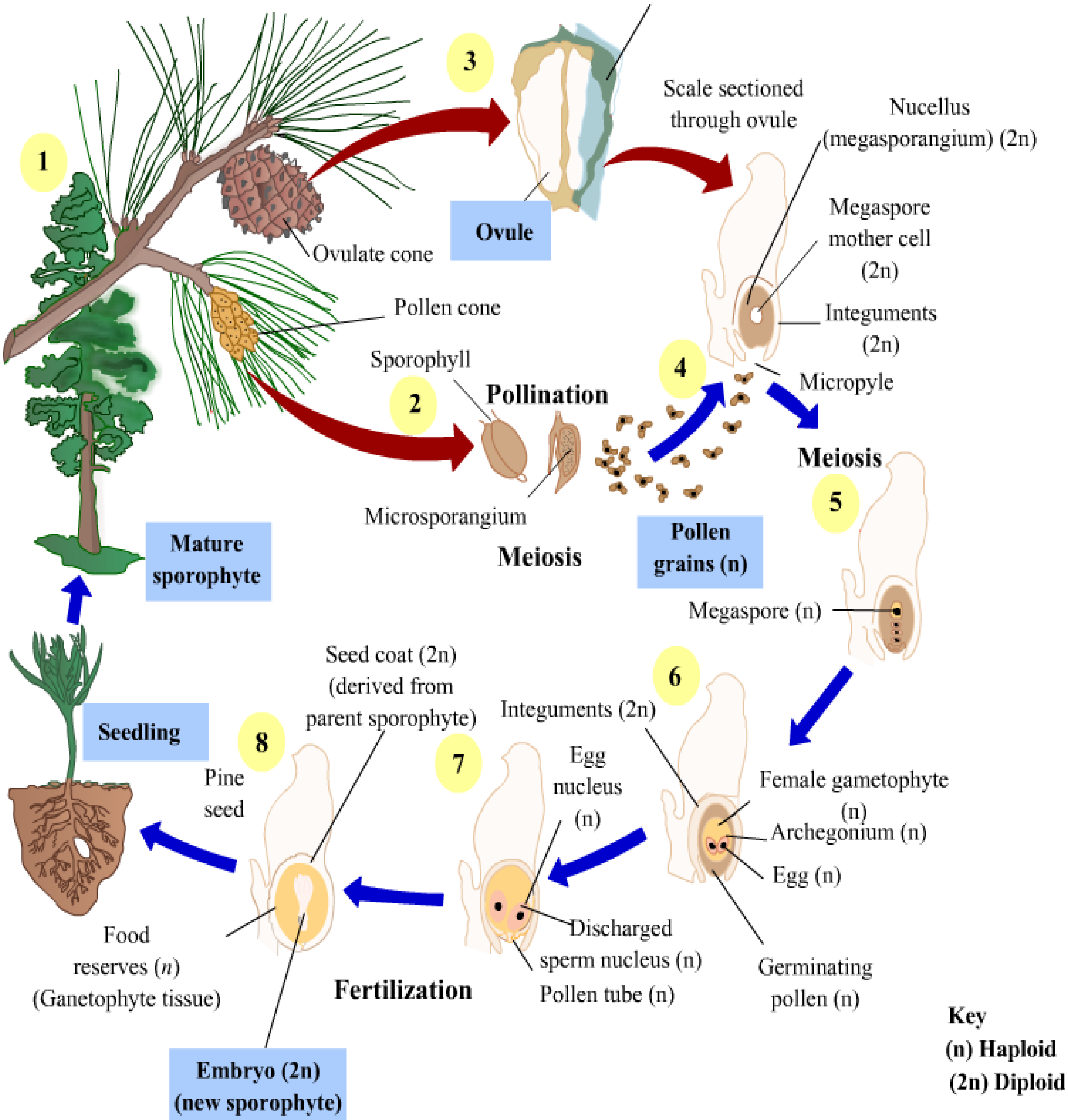
Development of zygote into embryo and ovules into naked seeds

- For Example – *Pinus* and *Cycas*

Pinus

Cycas

The lifecycle of a gymnosperm can be depicted as follows;

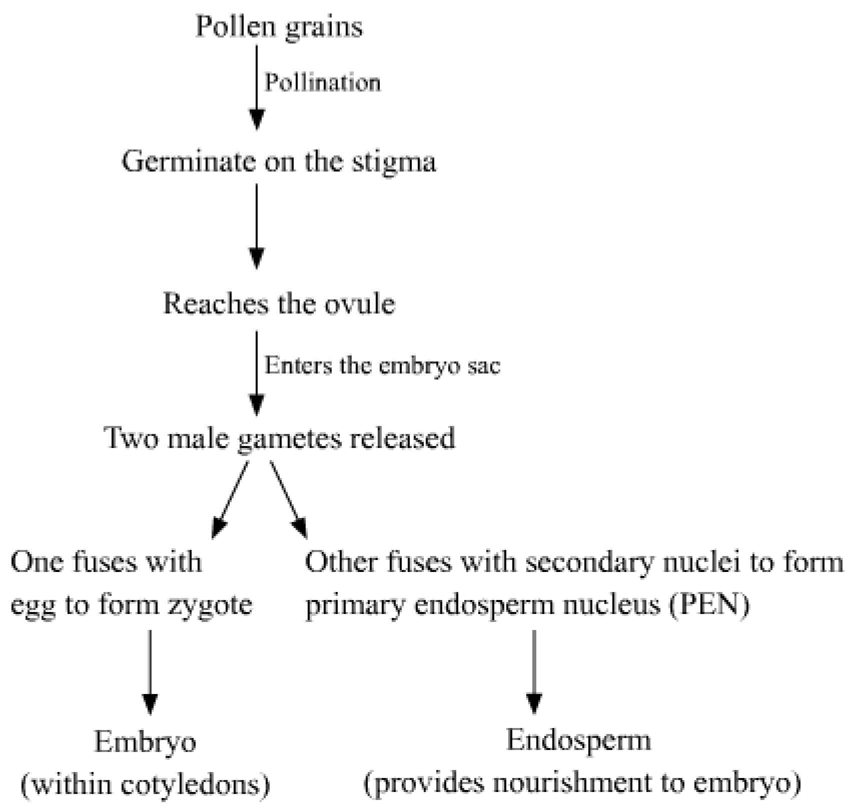


Division Angiosperms

- Large group of plants inhabiting a wide range of habitats
- The pollen grains and ovules are developed in structures called flowers.

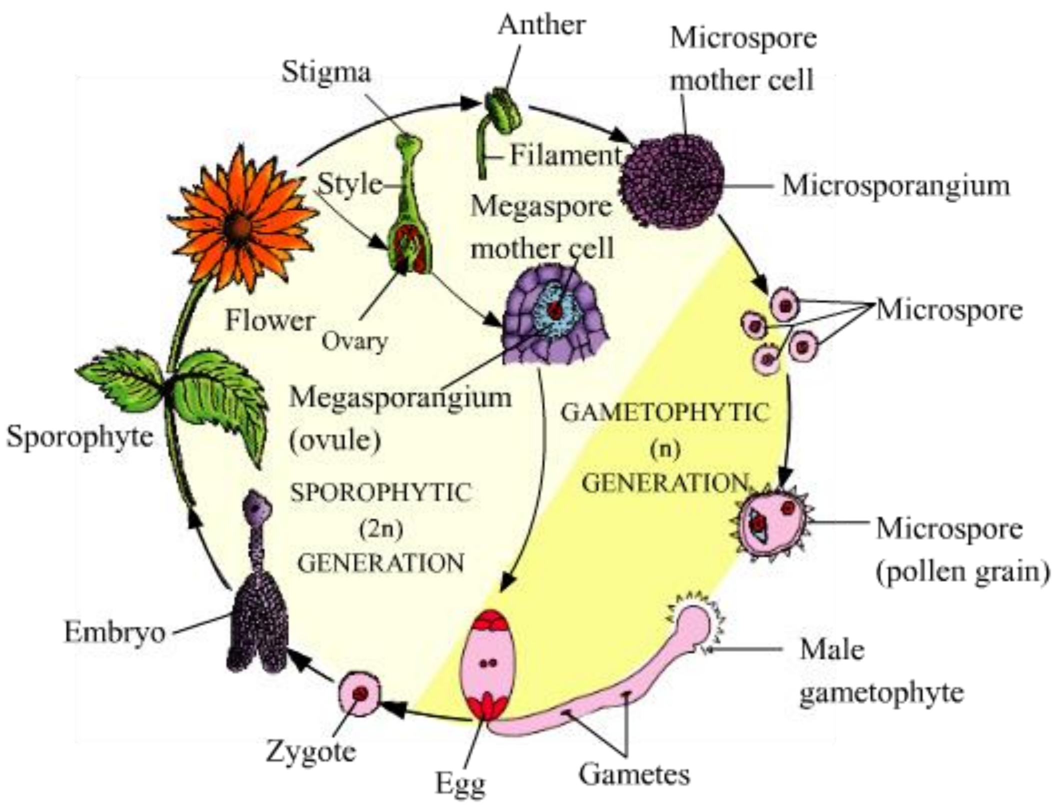
- Seeds enclosed by fruits
- Range from tiny, almost microscopic *Wolfia* to tall trees like *Eucalyptus*
- Two main groups are:
- Monocotyledons – having one cotyledon in their seeds
- Dicotyledons – having two cotyledons in their seeds
- The male sex organ in a flower is a stamen.
- Each stamen consists of:
- a slender filament
- an anther at the tip
- The anther produces pollen grains by meiosis.
- The female sex organ is a pistil or carpel
- Each pistil consists of:
- an ovary
- a style
- a stigma
- The ovary encloses one or more ovules.
- Within the ovule (the highly reduced female gametophyte) embryo sacs are present.
- Embryo sac is a seven-celled, eight-nucleated structure. Embryo sac contains
- One egg cell
- Two synergids
- Three antipodal cells
- One central cell

- The polar nuclei fuse to form a secondary nucleus (diploid).
- Pollen grains, after dispersal from anthers are carried by the wind or other agents to the stigma of the pistil; termed as pollination



- Fertilisation in angiosperms is termed as double fertilisation.
- The synergids and antipodals degenerate after fertilisation.
- The ovules develop to form seeds, and the ovaries develop into fruits.

LIFE CYCLE OF AN ANGIOSPERM

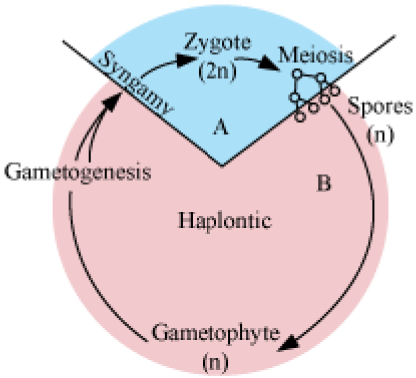


Plant Life Cycles

- There is alternation of generations between haploid gametophyte and diploid sporophyte in the life cycle of a plant.
- In plants, both haploid and diploid cells can divide by mitosis.
- Hence, there are two different plant bodies – haploid and diploid.
- The haploid plant body produces gametes by mitosis and represents a gametophyte.
- Mitotic division is encountered in diploid cells when zygote divides by mitosis to produce sporophytic plant body after fertilization.
- This sporophyte produces haploid spores by meiosis.
- Spores in turn undergo mitosis to form haploid plant body.

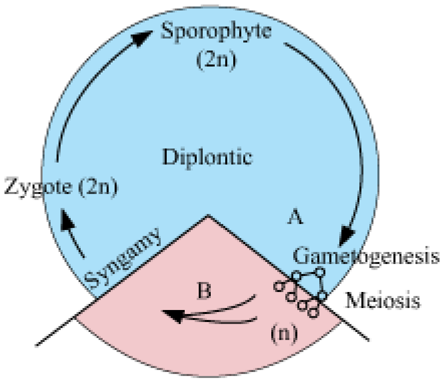
Types of Life Cycles in Plants

Haplontic Life cycle



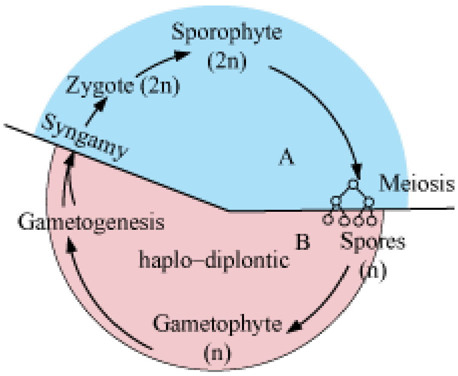
- In this, sporophyte is represented by one-celled zygote.
- There is no free living sporophyte.
- Zygote undergoes meiotic division to produce spores, which divide mitotically and form gametophyte.
- Gametophyte is the dominant phase in this life cycle as it is dominant, free living, and photosynthetic.
- Algae such as *Spirogyra* and some species of *Chlamydomonas* have this type of life cycle.

Diplontic Life Cycle



- In this case, diploid sporophyte is the dominant phase as it is free living and photosynthetic.
- Gametophyte is single to few-celled.
- Example – All seed-bearing plants, gymnosperms, and angiosperms, some algae-like *Fucus*

Haplodiplontic Life Cycle



- Intermediate condition
- Both gametophyte and sporophyte are free-living and multicellular, but have different dominant phases.
- In bryophytes, haploid gametophyte is dominant, independent, and photosynthetic. It alternates with short-lived multicellular sporophyte totally or partially dependent on gametophyte for nutrition and anchorage.
- In pteridophytes, diploid sporophyte is dominant, independent, and photosynthetic. It alternates with short-lived haploid gametophyte, which is independent of sporophyte.