Revision Notes

Class - 11 Biology

Chapter 3 - Plant Kingdom

Whittaker classified the whole living organism into five kingdoms based on the complexity of cell structure (Prokaryotic and Eukaryotic), the complexity of the body (unicellular and multicellular), and mode of nutrition (autotrophs and heterotrophs).

Classification of the plant kingdom:

All the classification systems, starting from that of Aristotle to the 20^{th} century, can be divided into three types:

1. **Artificial system:** In this system, the classification is based on few morphological characters.

   Theophrastus, Pliny, and Linnaeus used an artificial system of classification.

2. **Natural system:** In this system, the classification is based on all the important related characters. Both external and internal. Bentham and hooker, Adanson, Candolle used a natural system of classification.

3. **Phylogenetic system**: Classification based on the evolutionary relationship of plants. The use of phylogeny for classification was done by Eichler, Blessy, Whittaker, Engler, and Prantl, Hutchinson.

Numerical taxonomy: Taxonomy based on statistical methods with equal importance using computers.

Cytotaxonomy: Taxonomy that is based on cytology or structure of the cell

(chromosome number, shape, behavior, etc).

Chemotaxonomy: Taxonomy based on chemical constituents of plants (nature of the protein, DNA sequence, taste, smell, etc).

EICHLERS CLASSIFICATION: The classification of Plant kingdom depending on flowering. Divided into two-Cryptogamae (non-flowering, seedless plants) and Phanerogamae (flowering, seed-bearing plants).

Based on the plant body Cryptogamae is divided into **Thallophyta, Bryophyta, and Pteridophyta**.

➢ **Thallophyta:** The plant body is thallus-like (undifferentiated plant body).

➢ **Bryophyta:** plant body with a root-like structure, stem-like structure, vascular tissues are absent).

➢ **Pteridophyta:** The plant body is differentiated into true root, stem, and leaves. Vascular tissues are present in so-called **vascular cryptogams.**

Thallophytes again divided into:

➢ Algae (pigmented thallophytes)

➢ Fungi (non-pigmented thallophytes)

➢ Lichens: Symbiotic association between algae and fungi.

Phanerogamae is divided into two:

➢ Gymonosperma (naked seed plants) and

➢ Angiosperma (covered seeded plants)

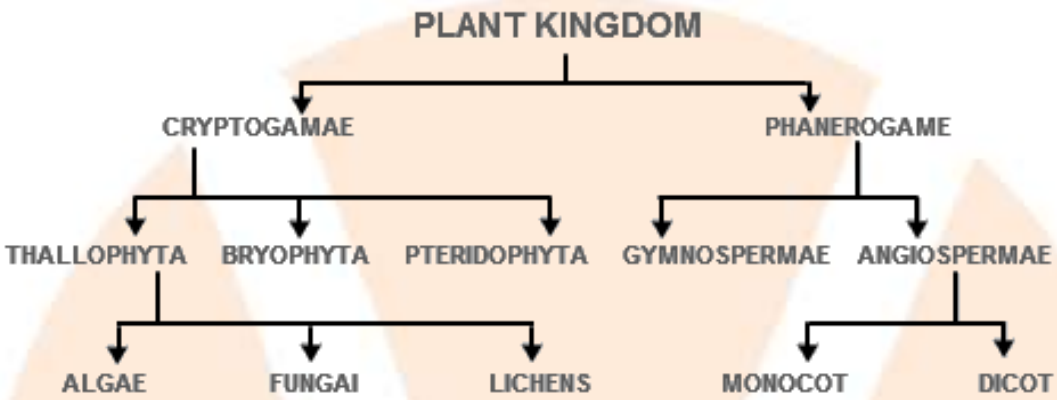
Angiosperms are again divided into two:

➢ Monocots (bearing single cotyledon, fibrous root system, and parallel venation)

➢ Dicots (have two cotyledons, taproot system, and reticulate venation).

Due to the presence of vascular tissue, the Pteridophytes, Gymnosperms, and Angiosperms are called **Tracheophytes.**

Due to the presence of embryos the Bryophyta, Pteridophyta, Gymnosperms, and Angiosperms are called **Embryophyta.**



3.1 ALGAE:

➢ **Phycology: Branch of Biology that deals with the study of algae**

Phycos = seaweed

Logos = study

➢ **Fritch – Father of phycology.**

➢ **M.O.P.Iyengar is the father of Indian phycology.**

Algal members are pigmented thallophytes.

➢ **Habitat:**

Hydrophytes: Water is their habitat. In aquatic habitat-

- Freshwater (Spirogyra) and marine (Sargassum).
- Floating- Chlamydomonas, Spirogyra

Benthophytes - These plants remain attached to the bottom of their habitat.

Example Chara (stoneworts)

Xerophytes: Their habitat is desert.

Mesophytes- They grow in medium habitats.

Epiphytes- They grow on plant body (Cladophora)

Epizoic-growing on the animal body (Trichophillus)

Lithophytes- They grow on rocks.

Halophytes- They grow in salty areas.

Moist soil-terrestrials (Fritschiella).

➢ **Plant body:**

- The vegetative plant body of algae is a haploid gametophyte.
- They may be unicellular, flagellated (Chlamydomonas), or non-flagellated (Chlorella)

Multicellular:

a) Coenobium-It is a colony with a fixed number of cells and also the division of labor is fixed. Eg: Volvox

b) Aggregation-indefinite colony. Eg: Tetraspora

c) Filamentous-unbranched.Eg: Ulothrix

d) Filamentous branches. Eg: Cladophora

e) Siphonous- multinucleate. Eg: Vaucheria

f) Parenchymatous. Eg: Ulva the,

g) Branched like higher plants. Eg: Sargassum, Chara

➢ **Nutrition**:

- Autotrophs - Photosynthetic (most of them)
- Parasitic forms (rare). Eg: Cephaleuros.

➢ **Pigments:**

- Chlorophyll- a, b, c, d.
- Carotenoids- carotene and xanthophyll-fucoxanthin are dominating pigments in brown algae.
- Phycobillins- phycocyanin and phycoerythrin.

➢ **Reproduction**:

- **Vegetative reproduction- Reproduction using the vegetative parts.**

Different types are:

1. Fission
2. Fragmentation
3. Budding
4. Tubers
5. Gemmae.

- **Asexual reproduction-without the fusion of gametes**.

Mainly by:

1. Zoospores within sporangia
2. Aplanospores
3. Akinete
4. Hypnospores
5. Endospore
6. Exospore
7. Monospore
8. Auxospore.

Palmella stage-In this stage of asexual reproduction the spores become colonial and appear like the algae named Palmella. Eg: Ulothrix, Chlamydomonas.

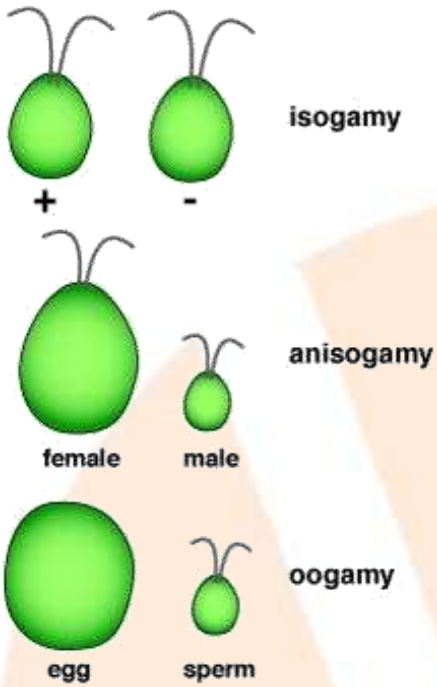
- **Sexual reproduction:**

Homogametes-similar gametes

Heterogametes-dissimilar gametes

1. **Isogamy: fusion of morphologically and physiologically similar gametes.** Isogamy- flagellated (Chlamydomonas) and non flagellated (Spirogyra).
2. **Anisogamy: fusion of morphologically or physiologically dissimilar gametes.** Morphologically dissimilar gametes' fusion occurs in Chlamydomonas. Physiologically dissimilar gametes' fusion occurs in Spirogyra.
3. **Oogamy**- It is the fusion of morphologically and physiologically dissimilar gametes that are small motile male gamete and large nonmotile female gamete.

Eg: Fucus, Volvox.



➢ **Exceptional cases:**

Unicellular antheridium and oogonium.Eg: Oedogonium.

➢ **Special reproductive structures:**

Conceptacles –Eg: Sargassum

Globule (antheridium) and nucule (oogonium) Eg: Chara

- A special type of sexual reproduction called conjugation is found in spirogyra.

The life cycle exhibits two phases-haploid and diploid and some of them exhibit **alternation of generation**. The diploid phase is alternated with the haploid phase.

➢ **Classification of algae:**

They are classified into three-

- Chlorophyceae

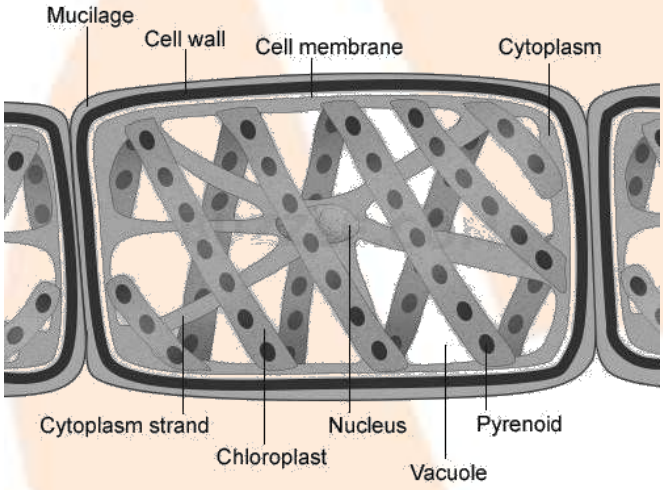
- Phaeophyceae
- Rhodophyceae.

3.1.1 CHLOROPHYCEAE:

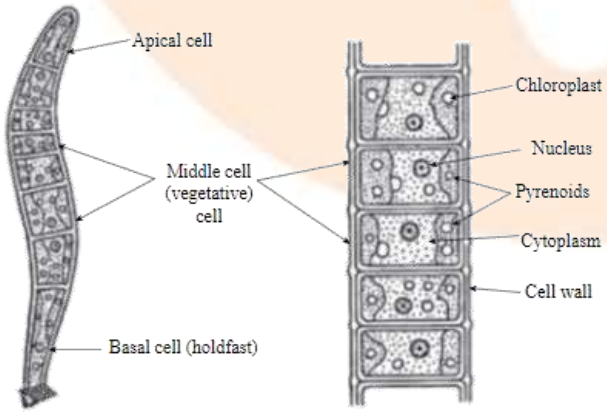
In Chlorophyceae, the plant body is unicellular as in Chlamydomonas or colonial as in Volvox or filamentous as in Spirogyra.

➢ **Different shapes for the chloroplast-**

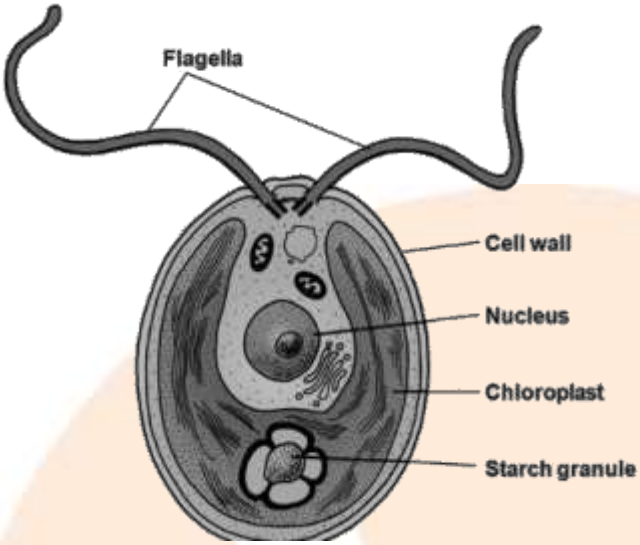
1. Ribbon shaped and spiral in Spirogyra



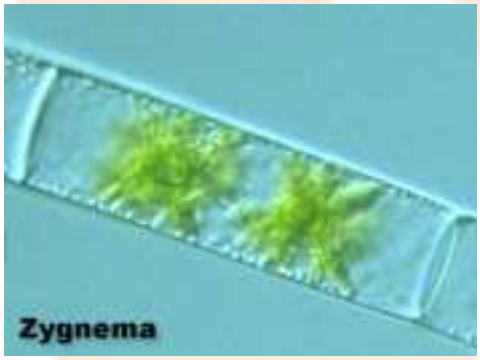
2. Girdle shaped in Ulothrix



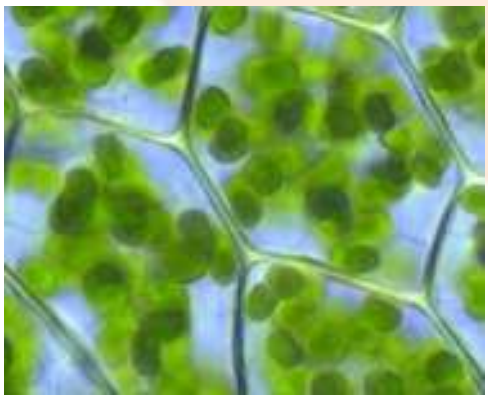
3. Cup shaped chloroplast in Chlamydomonas



4. Star-shaped in Zygnema



5. Disc-shaped in Caulerpa



6. Reticulate in Oedogonium.

- Photosynthetic pigments are chlorophyll a and b.
- Food is stored in the form of starch and some are stored in the form of oil droplets.
- Pyrenoids are present, which are the storage bodies.
- The inner layer of the cell wall is made up of cellulose and the outer layer is made up of pectose.
- The members reproduce:

  1. Vegetatively by fragmentation

  2. Asexually by flagellated zoospores

  3. Sexually by isogamy, anisogamy, and oogamy.

- Common Chlorophyceae members are:

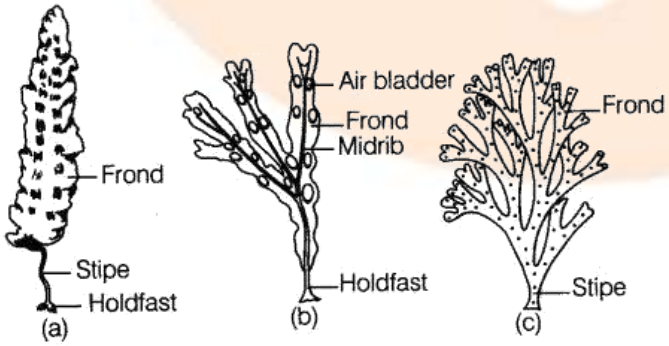
  Chlamydomonas, Chlorella, Volvox, Ulothrix, Ulva, Caulerpa, Chara, Acetabularia etc.

3.1.2 Brown algae or Phaeophyceae:

- They are marine.
- Simple branched and filamentous as in Ectocarpus, or flat ribbon-shaped in Sargassum, Laminaria, Fucus, etc.
- The giant brown algae Kelps are the largest sea plants, some are free-floating as in Sargassum and some are epiphytes on other plants like Ectocarpus.

➢ **The plant body has three parts** -

1. Fixing structures called a holdfast
2. The stalk-like structure called a stipe
3. The leaf-like structure is called a frond.



- Pigments present in brown algae are chlorophyll a, c, carotenoids, and xanthophylls.

- Food is stored as **laminarin and mannitol**, which are complex carbohydrates.
- The cell wall is made up of cellulose and it remains covered by a gelatinous coating **algin** on the outer part. Algin is a phycocolloid (hydrocolloid) that helps the thallus stay moist during low tide.
- The cell consists of cell organelles in which vacuole is placed which helps the thallus in floating.
- Vegetative reproduction occurs by the process of Fragmentation
- Asexual reproduction occurs by biflagellated zoospores which are pear in shape with two flagella attached laterally.
- Sexual reproduction occurs by the process of fusion of gametes. It includes:

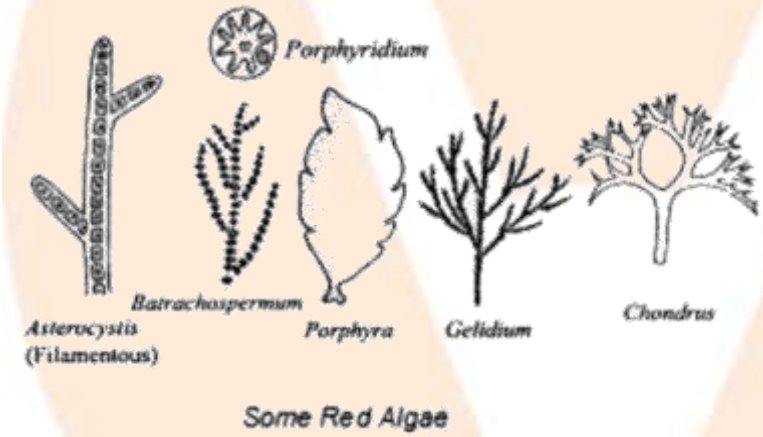
  1. Isogamy,
  2. Anisogamy
  3. Oogamy.

- Gametes are pear-shaped having two laterally attached flagella.
- The most common brown algae are Ectocarpus, Laminaria, Dictyota, Sargassum, and Fucus.

3.1.3 RHODOPHYCEAE (Red Algae):

- Commonly called red algae.
- They are mostly marine and rarely freshwater. Eg: Betrachospermum.
- They occur in the well-lighted region and also in the depths of oceans.
- The thallus is multicellular.
- Pigments present in red algae are chlorophyll a, d and phycoerythrin.

- Due to the presence of red pigment **r-phycoerythrin,** the color of algae is red.
- Food is stored in the form of **floridean starch** which is similar in structure to **amylopectin** and **glycogen**.
- Vegetative reproduction by fragmentation
- Asexual reproduction by nonmotile spores
- Sexual reproduction by the process of Oogamy and bears complex post-fertilization developments.
- The commonly found red algae are Polysiphonia, Porphyra, Gracilaria, Gelidium, Betrachospermum, etc.



Some Red Algae

➢**Economic Importance of algae:**

- In the food chain algae are the primary producers. The basis of the food cycles of all aquatic animals is formed by the algae.
- On earth, half of the total carbon dioxide fixation is carried out by algae through the process of photosynthesis.
- In the purification of air and water it plays a very important role.
- Some algae are edible. Eg- Chlorella, Laminaria, Porphyra, Sargassum, Ulva, Spirulina.

- Some algae are used as fodder. Eg; Laminaria, Sargassum, Fucus.
- It also acts as a food supplement for space travelers. Eg. Chlorella, Spirulina.
- From red algae, algin and carrageenan are obtained which are water-holding substances or hydrocolloids.
- Agar is obtained by Gelidium and Gracilaria. It is used to grow microorganisms.
- Used in the preparation of culture medium in tissue culture experiments.
- It has medicinal values as antibiotics are prepared from them.
  Eg: Chlorella, Polysiphonia.
- Also used as a source of minerals- Polysiphonia, Laminaria
- Has importance in biological research: Chlorella, Acetabularia.

➢ **Common names of algae:**

- Water silk-Spirogyra
- Sea lettuce- Ulva
- Umbrella plant-Acetabularia (Largest unicellular algae)

3.2 Bryophytes:

- Simplest non-vascular land plants with undifferentiated plant bodies.
- **Bryology-Study of Bryophytes**
- **Hedwig- Father of bryology**
- **S.R.Kashyap-Father of Indian bryology**
- The bryophytes are also called the amphibians of the plant kingdom due to their unique characteristics.

- Bryophytes grow in dense patches on moist shady places like walls, damp soil, tree trunks, etc.

➢ **Features:**

- Habitat: Mainly terrestrial but some are aquatic. E.g- Riccia fluitans
- Epiphyllous –E.g: Radula
- Plant body-Thallus and Prostate. Eg: Riccia, Anthoceros, Marchantia or Erect. Eg- Moss.
- Root-like structures called **rhizoids** helps in fixing them in the soil.
- The body of the plant is differentiated into stem-like and leaf-like structures.
- Vascular tissues are absent.
- Vegetative reproduction occurs by fragmentation, budding, tubers, etc.
- Asexual reproduction occurs by Gemmae- asexual buds in liverworts.
- Sexual reproduction occurs. The vegetative plant body acts as the gametophyte and all the members are homosporous.
- Multicellular sex organs are present that are found in clusters.
- The club-shaped antheridium is the male reproductive organ and it produces biflagellate antherozoids which are motile too.
- The flask-shaped archegonium is the female reproductive organ and it produces the egg.
- To form the zygote the antherozoid fuses with the egg.
- The sporophyte is not free-living and it derives nutrients from the photosynthetic gametophyte.
- After meiosis, the haploid spores are formed in the sporophyte and the spore germinates to form the gametophyte.

- Alternation of generation is present where the haploid phase alters with the diploid phase.
- Both the phases are multicellular.
- The gametophyte is the dominant photosynthetic free-living stage.
- The sporophyte is short-lived and it highly depends on the gametophyte.
- For fertilization, water is very much essential.

➢ **Classification of Bryophytes:** It has three classes:

1. Hapticospida (liverworts)
2. Anthocerotopsida (Hornworts)
3. Bryopsida. (Moss)

3.2.1 Hepaticopsida or Liverworts:

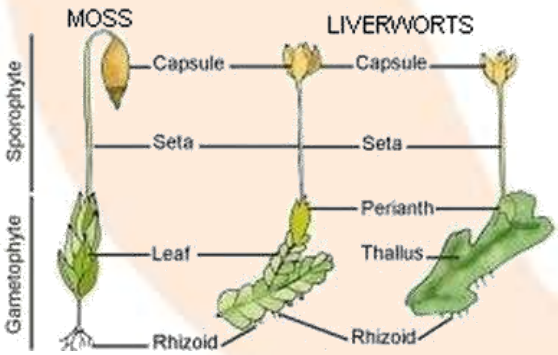
- The plant body is photosynthetic, flat, and have dorsiventral thallus .E.g.: Riccia, Marchantia
- The rhizoids are present that help the thallus to remain attached to the soil.
- Vegetative reproduction is by the process of fragmentation. E.g.: Riccia, Marchantia
- In some bryophytes, the reproduction occurs by the gemmae formation. E.g.: Marchantia

- **Gemmae develop into small receptacles which are called gemma cups and are green multicellular, asexual buds.** To form the new thallus the gemma gets detached from the parent body and germinates.
- Sexual reproduction: Sex organs present are **antheridia and archegonia**. They are formed either on the same thalli or different thalli.
- The sporophyte can be differentiated into three parts-**foot, seta,** and **capsule.** Meiosis takes place in the capsule to form the haploid spores which germinate into free-living thalloid gametophytes.

➢ **Anthoceropsida or Hornworts**: E.g.: Anthoceros, Notothylas.

- **Anthoceros is commonly known as hornworts**
- They contain pyrenoids.
- Symbiotic nitrogen fixation is present.

3.2.2 Bryopsida (Moss):



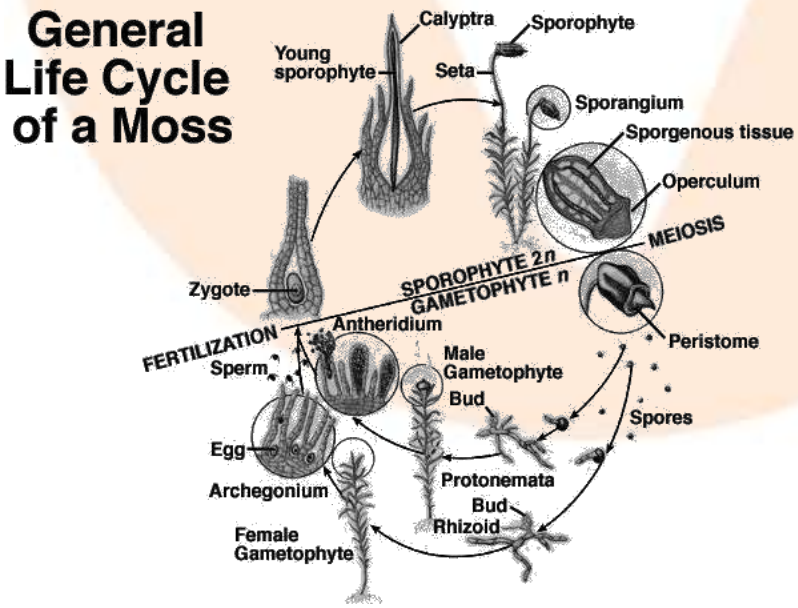
- They are higher bryophytes
- The gametophyte consists of two stages - **protonema and the leafy stage**.
- **Protonema** is green filamentous, branched, creeping structures that directly develop from the spore on germination and they also bear branched rhizoids and lateral buds.
- The **leafy stage** is developed as a lateral bud from the secondary protonema.

- The plant body consists of root-like, stem-like, and leaf-like structures. Eg: Funaria.
- Rhizoids are multicellular and branched also.
- The leafy stages bear the sex organs.
- Vegetative reproduction occurs by the process of fragmentation and budding in the secondary protonema.

A typical moss protonema with buds (magnified)

- In mosses the spore dispersal mechanism is elaborate.

Eg: Funaria, Polytrichum, Sphagnum etc.



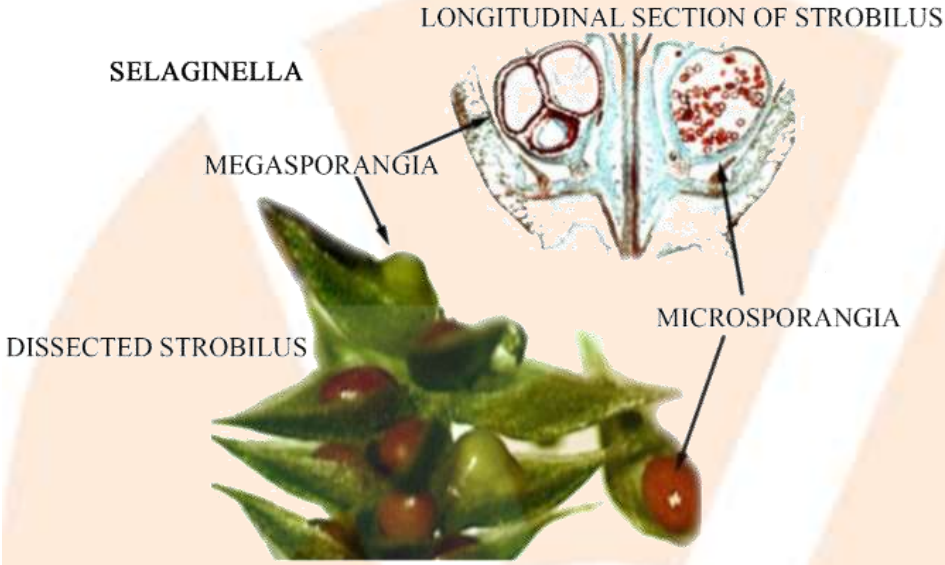
➢ **Economic Importance**

- They are used as food by herbaceous animals.
- Sphagnum (Moss) occurs in the form of peat and is used as fuel.
- Because of its water holding capacity, the mosses are also used for the trans-shipment of living material
- Moses also prevents soil erosion.
- They are the first colonizers on barren rocks along with lichens.
- For the growth of the higher plants or succession, they decompose rocks for making substrate.

3.3 PTERIDOPHYTES:

- They are the first terrestrial plant to bear vascular tissue such as **xylem** and **phloem**. So they are also called vascular cryptogams.
- Commonly known as a botanical snake.
- The plant body is differentiated into true root, stem, wind-needle-like, and leaf.

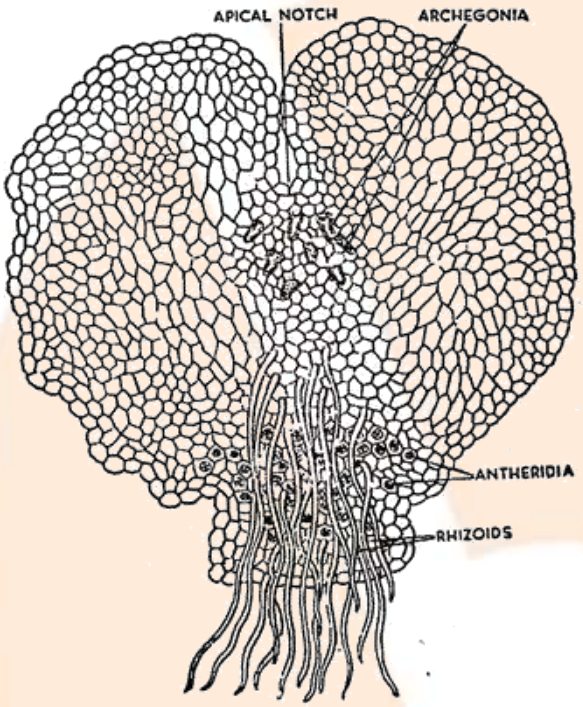
- The plant body is the sporophytic generation**.**
- The stem is rhizomatous and they regenerate when aerial parts are destroyed.
- Leaves may be small known as **microphyll** as in Selaginella or large known as **macrophyll** as in ferns.



- **Coiling of young leaves - Circinate vernation is seen in pteridophytes**.

- Two types of leaves are found vegetative and fertile.
- Fertile leaves are spore-bearing leaves called sporophylls.

- Spores are formed inside the sporangia. In Sporangia, the spore mother cells give rise to spores after the process of meiosis.
- **Spores germinate to form a haploid gametophytic, photosynthetic heart-shaped multicellular structure called prothallus which bears antheridia and archegonia.**

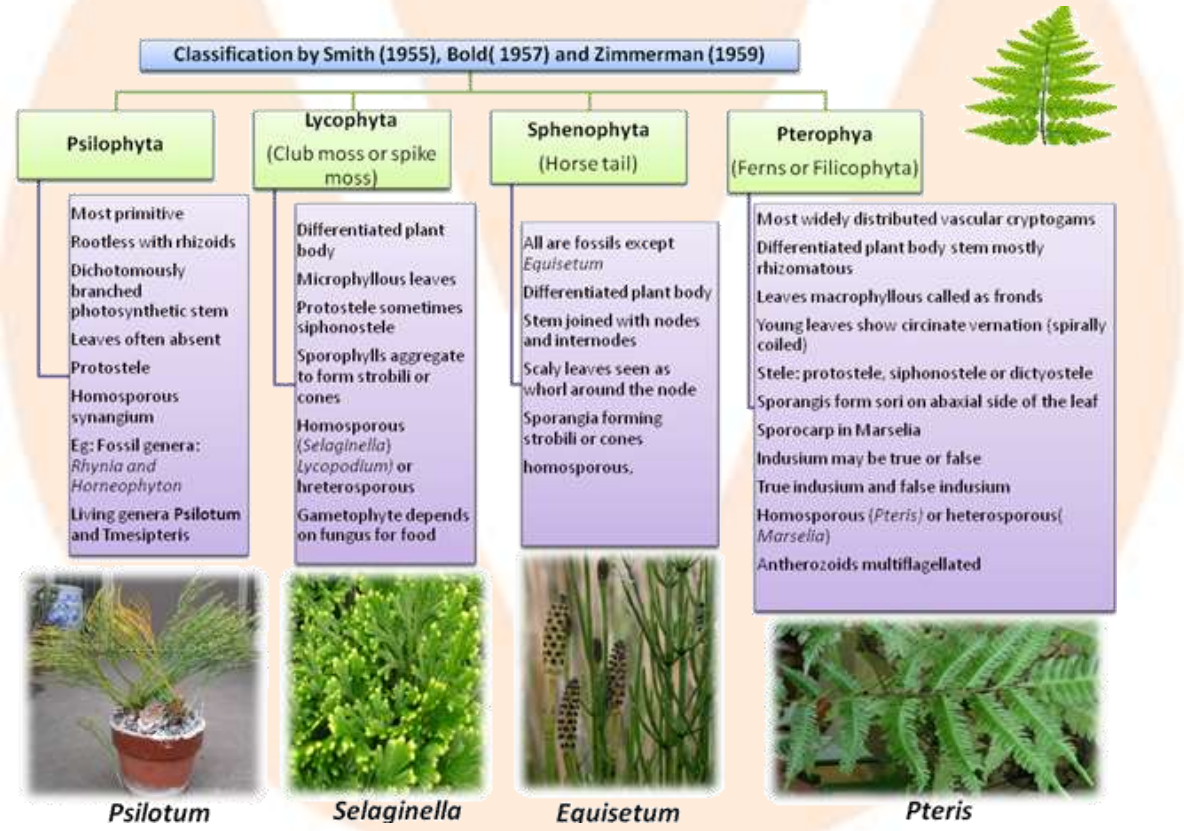


- For growth, prothallus requires cool, damp, and shady areas whereas water is essential for fertilization.
- The antheridia bear **antherozoids** and archegonia bear the **egg cell** respectively which on fertilization form zygote which on germination forms the sporophyte.
- Most of the pteridophytes form similar kinds of spores, therefore, called **homosporous.** Two kinds of spores, macro or large spores and small or microspores, which are, **heterosporous** are produced by the genera like Selaginella and Salvinia. Male and female gametophytes are produced when microspores and macrospores germinate.
- In heterosporous conditions the female gametophyte is not free-living, it is

retained in the parent sporophyte till the beginning of the embryo development.

- Seed-bearing plants are evolved from heterosporous pteridophytes.
- Pteridophytes are further classified into four classes:

1. Psilopsida (Psilotum)
2. Lycopsida (Selaginella)
3. Sphenopsida (Equisetum)
4. Pteropsida (Pteris).



➢ **Economic importance:**

- Some members are Medicinal- Dryopteris
- Helps in Soil binding

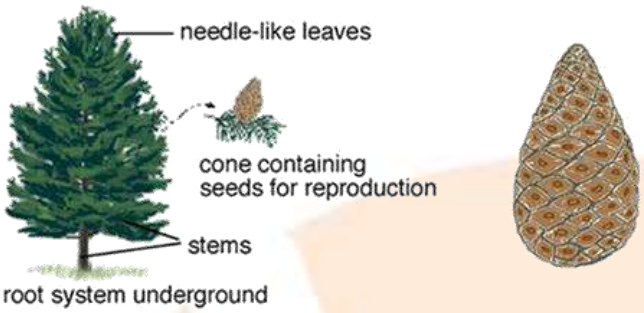
- Used as Ornamental plants
- Edible plants- Marcelia
- Used in Crop rotation- Azolla
- Helps in Symbiotic nitrogen fixation.
- Play an important role in the succession of plants on bare rocks or soil.
- Sphagnum is used to keep seedlings in gardens and also in keeping cut plant parts moist during transportation and propagation.

➢ **Common names:**

- Creeping pine/Club moss- Lycopodium
- Spike moss(Resurrection plant- Selaginella
- Water fern- Azolla (smallest pteridophyte)
- Walking fern (Maiden hall fern)- Adiantum
- Adder's tongue fern- Ophioglossum
- Fossil pteridophyte- Cooksonia
- Leafless Pteridophyte- Psilotum
- Horsetail- Equisetum

3.4 GYMNOSPERMS:

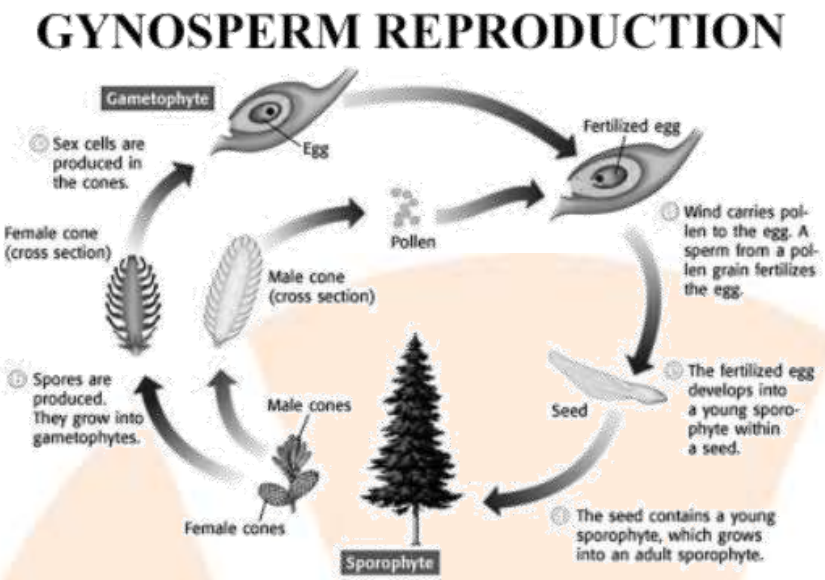
Gymnosperms



- Have naked seeds because the ovules are not enclosed within or by any ovary wall and they remain exposed (no fruit covering). Flowerless seed-bearing plants.
- Ovules are also not enclosed by the wall of the ovary.
- Dominant plants during the Jurassic period.
- Gymnosperm includes trees which are medium-sized or taller and also the shrubs.
- Taproot system is generally present. They are also associated with mycorrhiza that is the association between fungus and roots of higher plants.
  Eg: Pinus. Coralloid roots bearing nitrogen-fixing bacteria as in Cycas.
- The stem is branched (Pinus), or unbranched (Cycas).
- Leaves are adapted for extreme temperature, humidity, and wind-needle-like leaves with thick cuticles, sunken stomata. Eg: Pinus.
- Leaves may be simple or compound.
- The stem is unbranched as in Cycas
- Branched in Pinus and Cedrus
- Well-developed vascular system –**xylem without vessels.**

➢ **REPRODUCTIONS:**

- Sporophylls are aggregated to form stromboli or cones. They are generally monosporangiate or of two types male and female cones.
- Male cones are short-lived whereas female cones are long-lived.
- **Male strobili or male cone** – **microsporophylls** which bear **microsporangia** having microspores which develop into reduced gametophyte called a **pollen grain**.
- **Female cone or female strobili** –**megasporophylls** which bear **megasporangium** having **megaspores** which are enclosed within the **megasporangium** (Nucellus).
- One megaspore develops into a female gametophyte bearing two or more **archegonia.** Pollen grains are carried by the wind and they reach the ovules.
- They form a pollen tube that reaches the archegonia and releases male gametes into the ovule. Fusion of the gametes takes place and the zygote is formed which produces embryos. Ovules develop into seeds that are not covered.
- The endosperms in gymnosperms are like, and a pre fertilization product and haploid in nature.
- The dominant photosynthetic independent stage is the sporophyte.
  The gametophyte ranges from single to few celled but is not free living.



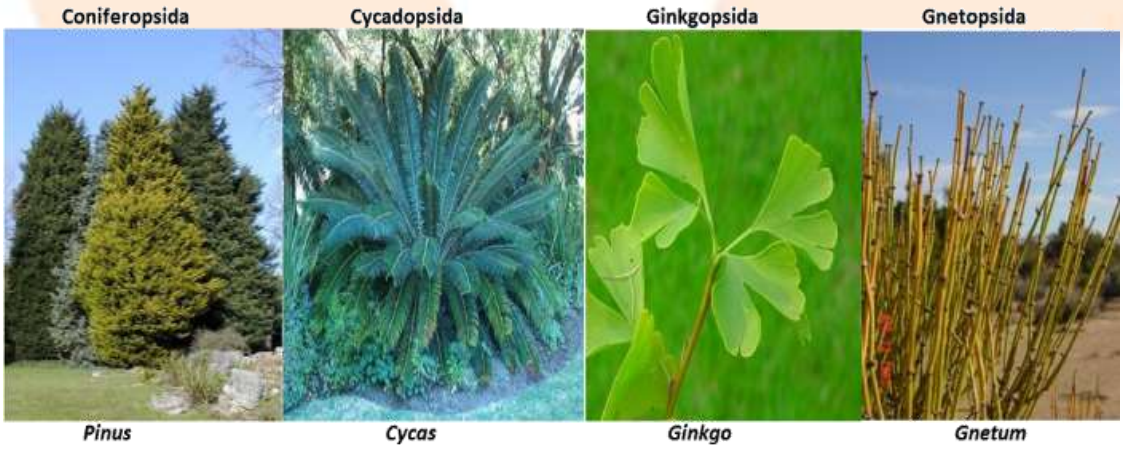
➢Classified into four classes:

1. Cycadopsida Eg: Cycas

2. Coniferopsida eg: Pinus

3. Gnetopsida: Eg: Gnetum.

4. Gingopsida- Ginko



➢**Economic importance:**

- Timbers for furniture, Pulpwood, Pencil box, Musical instruments, etc.

- Production of resins, Turpentine etc.-E.g.-Pinus
- Edible seeds: Eg- Cycas, Pinus, Ginkgo.
- Medicinal Eg: Ephedrine from Ephedra are used in treatment for respiratory problems
- Taxol – from Taxus species are extracted to freeze cancer cells.

➢ **Common names:**

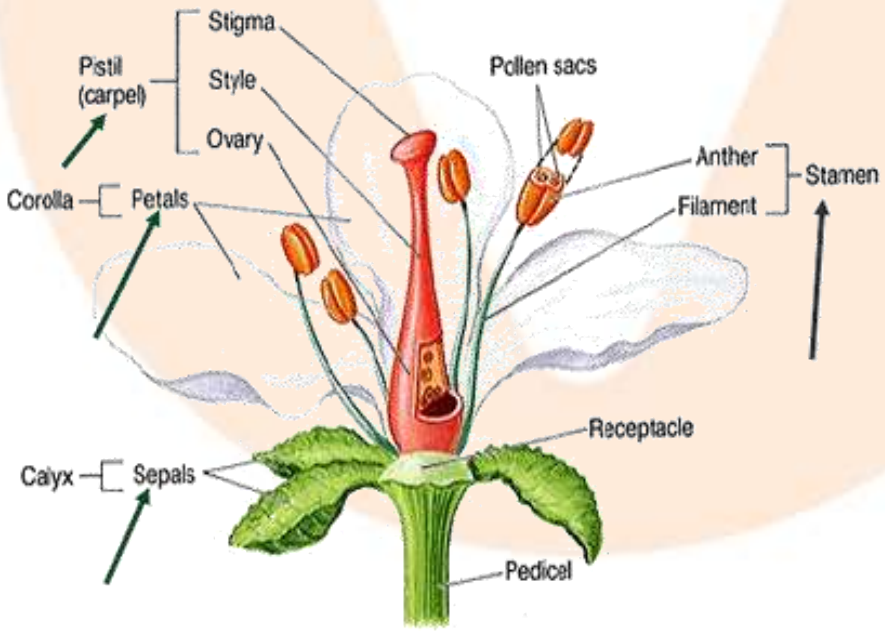
- Maidenhair tree- Ginkgo
- Sago palm are called the Panda of the plant kingdom- Cycas
- Largest gymnosperm- Sequoia
- Smallest gymnosperm- Zamia
- Gymnosperm with xylem vessels- Ephedra, Gnetum.

3.5 ANGIOSPERMS:

- Angiosperms are also known as flowering plants and they are having **covered seeds**.
- They are divided into two classes –

  1. Dicotyledons (have two cotyledons)

  2. Monocotyledons (have one cotyledon).
- Smallest angiosperm: **Wolfia** (microscopic).
- Large tree: **Eucalyptus** over 100 meters.
- Reproductive organs are developed in **flowers**.
- The Male sex organs present in a flower are called **stamens** or androecium.
- It has **filament** and **another**. Anthers on meiosis produce **pollen grains**. Pollen grains have two male gametes. The female reproductive part in the flower is called the pistil or gynoecium. It has **stigma**, **style,** and **ovary**.



- The ovary has one or many ovules in which female gametophyte (**embryo sac**) develops by meiosis. 7 cells and 8 nuclei are present in the embryo

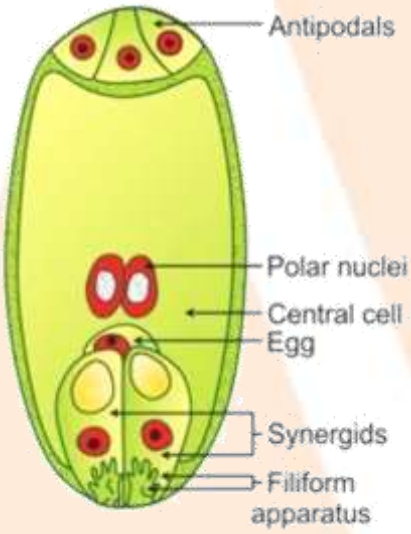
sac. They are:

1. One (1) egg cell

2. Two (2) synergids

3. Three (3) antipodal

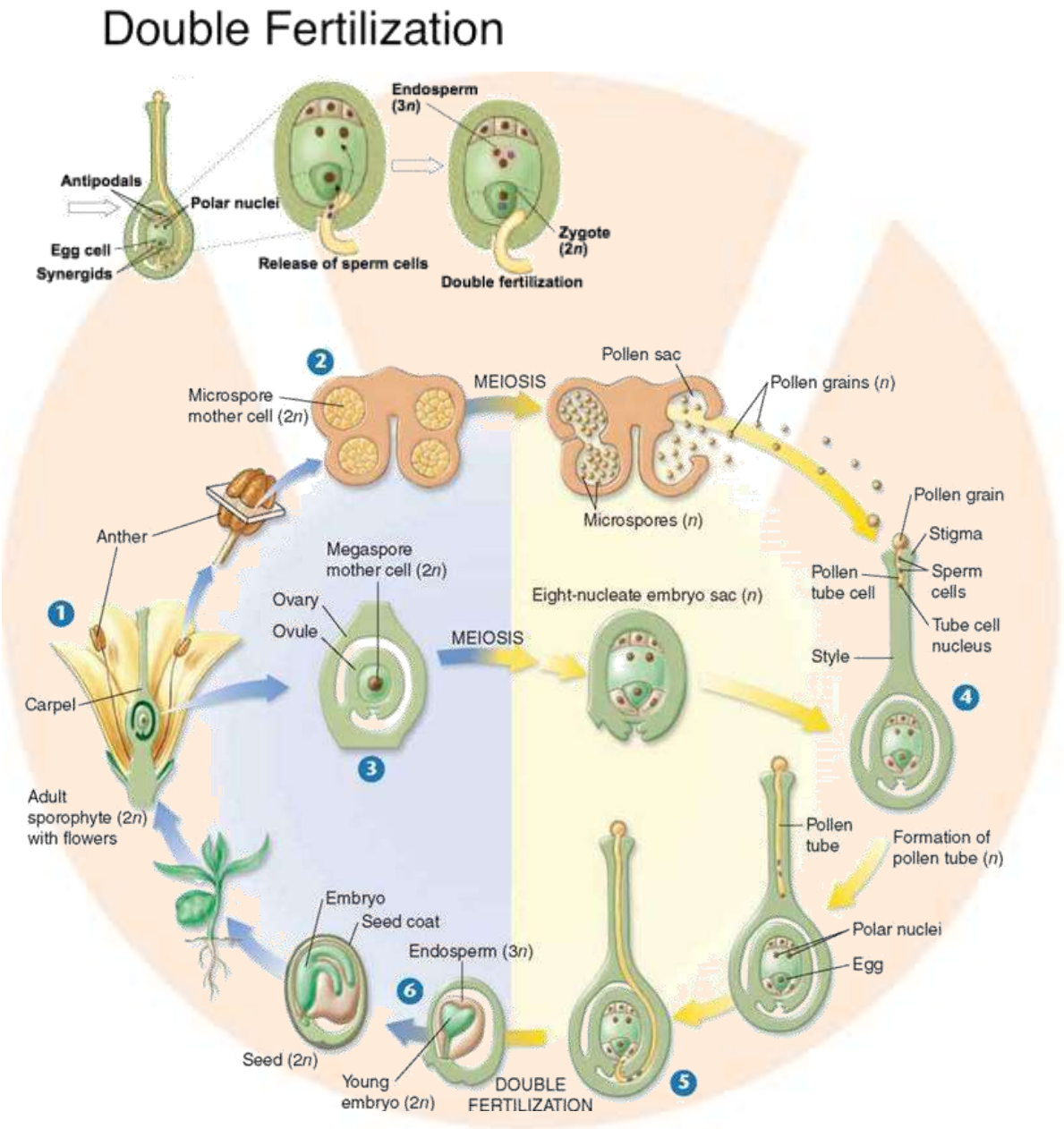
4. One (1) central cell having two polar nuclei.



Mature Embryo Sac

- The pollen grain is carried by various agents like wind, water, birds, insects, etc., and reaches the stigma.
- Pollen grains produces a pollen tube that contains two male gametes and enters into the embryo sac.
- One male gamete fuses with the egg cell to form a zygote and is called **syngamy** which develops into an embryo.
- Other male gamete fuses with the secondary nucleus that is formed by fusion of two polar nuclei and produces triploid primary endosperm nucleus (PEN) and is called **triple fusion.**
- PEN develops into an endosperm that nourishes the developing embryo. As two fertilizations, namely syngamy and triple fusion, occur inside the embryo sac simultaneously, it is called double fertilization.

- The endosperm is triploid**.**
- Ovules get to develop into seeds whereas ovaries into fruits.

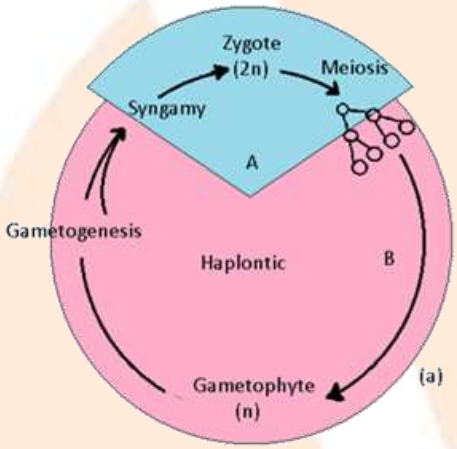


3.6 Alternation of generation:

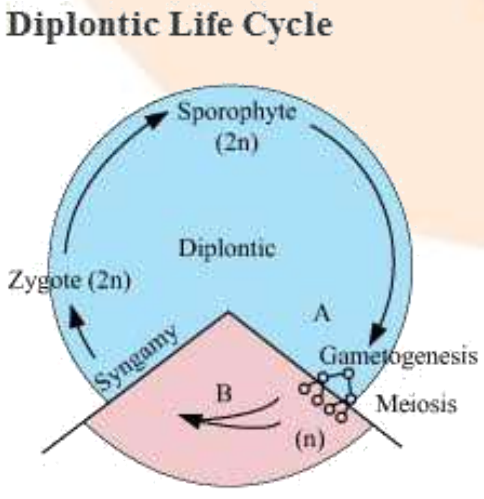
There exists an alternation of a haploid gamete which is producing gametophytic and spore-producing sporophytic generation.

Three types:

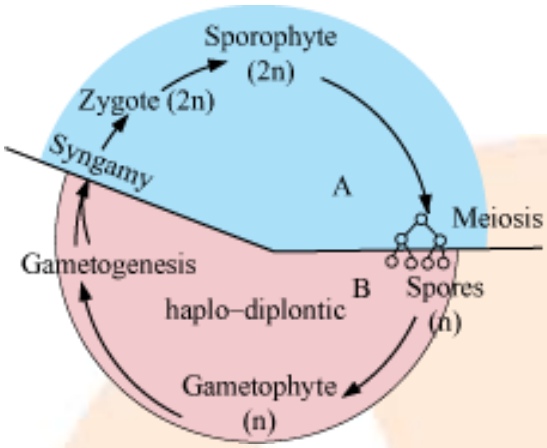
1. **Haplontic life cycle:** In this type of lifecycle, the dominant, photosynthetic phase is a free-living gametophyte produced by haploid spores. The gametophyte produces gametes by the process of mitosis and the gametes fuse to form the zygote which represents the sporophytic generation. The zygote undergoes the process of meiosis to form haploid spores. **Here the Gametophytic phase is dominant**. e.g., Chlamydomonas.



2. **Diplontic life cycle**: Here the diploid sporophyte is the photosynthetic independent phase of the plant which is dominant too. The gametophytic phase is represented by one to a few celled haploid gametophytes nourishes. Here the sporophytic **phase is dominant**. e.g., Angiosperms and Gymnosperms.



3. Haplo-Diplontic life cycle: Both haploid and diploid phases are multicellular and mostly free-living in this type. Bryophytes and pteridophytes are examples.



Although haplontic life cycle has been shown by most algal genera some of them are Ectocarpus, Polysiphonia, Kelps, etc. But some also exhibit haplo-diplontic life cycle. Fucus, a brown alga, exhibits a diplontic life cycle.

FAST TRACK REVISION:

1. The Plant Kingdom Divided into two-Cryptogamae (non-flowering seedless plants) and Phanerogamae (flowering, seed-bearing plants).
2. Based on the plant body Cryptogamae is divided into Thallophyta, Bryophyta, and Pteridophyta.
3. Thallophytes again divided into
    1. Algae (pigmented thallophytes)
    2. Fungi (non-pigmented thallophytes)
    3. Lichens: Bears symbiotic association between algae and fungi.
4. Phanerogamae is divided into two
    1. Gymonosperma (naked seed plants) and

2. Angiosperma(covered seeded plants)

5. Angiosperms are again divided into two

1) Monocots are having a single cotyledon, fibrous root system, and parallel venation in leaves.

2) Dicots are having two cotyledons, a taproot system, and reticulate venation in leaves.

6. Algae are very simple, thalloid, autotrophic also, and mainly aquatic organisms.

7. Algae are classified into three classes: Chlorophyceae, Phaeophyceae, and Rhodophyceae depending on the type of pigment possessed and the type of stored food.

8. Vegetative reproduction by fragmentation, asexual reproduction by the formation of different types of spores, and sexually reproduced by the formation of gametes which show isogamy, anisogamy, and oogamy.

9. Bryophytes are plants that can live in soil but for sexual reproduction they are dependent on water. Their plant body is more differentiated as compared to the algae.

10. Rhizoids have a thallus-like plant body, which is prostrate or erect, and have fixing structures. They bear root-like, leaf-like, and stem-like structures.

11. The bryophytes are divided into liverworts, hornworts, and mosses.

12. Liverworts have a thalloid plant body and dorsiventral.

13. Mosses bear spirally arranged leaves and have upright and slender axis.

14. The plant body is a gametophyte and after fusion of the gametes, the zygote produces a multicellular body called the sporophyte.

15. In pteridophytes, the plant body is a sporophyte with root, stem, and leaves.

16. The sporophyte in Pteridophyte bears sporangia which produce spores which on germination form gametophyte.

17. In Pteridophyte the gametophyte possesses both male and female sex organs called antheridia and archegonia respectively.

18. For fertilization water is essential.

19. The gymnosperms are the plants producing naked seeds and after fertilization, the seed remains exposed.

20. Gymnosperms produce microsporophyll and megasporophyll. Microsporangia and Megasporangia are born on the sporophylls.

21. Sporophylls-Microsporophyll and megasporophyll.

22. The pollen tube made by the pollen grain releases the male gamete into the ovule. In ovule it fuses with the egg cell in archegonia. Following the process of fertilization , the zygote develops into an embryo and finally the ovules into seeds.

23. In angiosperms, the male sex organs the stamen, and the female sex organ the pistil are present in a flower.

24. The stamen consists of anther and filament.

25. Pistil contains ovary, style, and stigma.

26. The pollen grain produces two male gametes. One male gamete fuses with the egg and is called syngamy and forms a zygote which develops to form the embryo.

27. The other male gamete fuses with the polar nuclei and is called triple fusion and forms the primary endosperm nucleus which develops to form the endosperm which nourishes the developing embryo.

28. As two fertilizations are taking place inside the embryo sac simultaneously – syngamy and triple fusion, it is called double fertilization.

29. Angiosperms are divided into two classes namely monocotyledons and dicotyledons.