

CLASS – 11

BIOLOGY

Chapter – 3

Plantae Kingdom

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Plant Kingdome

- It is **polyphyletic group** (*i.e.it include different kind of organism and have evolved from different protist ancestors*).
- Even the lack relatedness they have many things common :
 1. All are **eukaryotic multicellular photosynthetic producers**.
 2. Have **cell wall**.
 3. All have two stage in their life cycle (*i.e. haploid gametophytic generation and diploid*

saprophytic generation which *undergoing alternation of generation*).

4. Mostly are **autotrophic** and have **photosynthetic pigment**.

Evolution and Classification

- Green algae and land plant have following thing common:
 1. Have **same kind of chlorophyll**
 2. **Cell wall** contains **cellulose**.
 3. **Carbohydrate** produces during **photosynthesis**.

4. Both **store food** in form of **starch**.
- Kingdom Plantae have the following division:

Kingdom Plantae
Algae

Chlorophyceae
(green algae)

Phaeophyceae
(Brown algae)

Rhodophyceae
(Red algae)

Bryophyta
(mosses and liverworts)

- The understanding of how plant kingdom has change over a period of time as in earlier classification *fungi, member of monera and protista* having cell wall were *put together in plants* and now these have been excluded.
- Now in kingdom Plantae included *Algae, Bryophytes, Pteridophytes, Gymnosperm and Angiosperm*.

Basis of Classification

1. **Artificial system of classification** - used gross *superficial morphological characters (i.e. habit, colour, number and shape of leaves etc)*.
2. **Natural system of classification**- based on natural affinity among the organisms which considers not *only external feature* but also *internal feature (i.e. morphology and anatomy)*.
3. **Phylogenic system of classification** – it is the present system of classification in which *phylogeny (i.e. evolutionary relationship)* is also taken along with *the natural classification*.

Numerical taxonomy:

- Based on all *observable character* which *carried out by using computer* and each character is

considered and given equal importance that help to consider hundreds of character at the same time.

Cytotaxonomy:

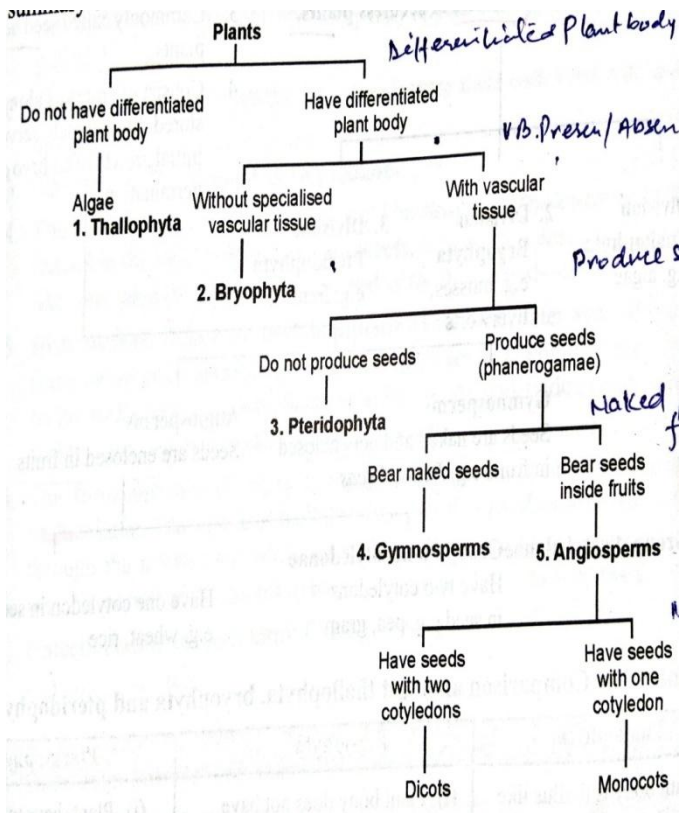
- It based on *cytological information* available about the organism (*i.e. chromosome number, structure, behavior etc.*)

Chemotaxonomy:

- It uses the *chemical constituents of plant* to classify or group them.

Classification of Kingdom Plantae

- It based on following important features:
 - ☐ First level of classification depend on wither the plant *body is well differentiated or not*.
 - ☐ Next level is based on *tissue for transport of water and other substance*.
 - ☐ Third level is based on the *ability to bear seed or not*.
 - ☐ And lastly is categories on the basis of either seed are *naked or enclosed within fruits*.



Eichler Classification of plant

- According to **Eichler (1883)** plant kingdom is divide into two main subkingdoms:
 - Cryptogamae:** include those having reproductive organs and divide into three division –
 - Thallophyta – Algae**
 - Bryophyta – Mosses, Lichens**
 - Pteridophyta – Fern**
 - Phanerogamae:** include those having differentiated reproductive tissue or organs and placed into two subdivision –
 - Gymnosperm (i.e. seedless plant) – Pinus, Cycas**
 - Angiosperm (i.e. seed enclosed in fruits) – Dicotyledonae, Monocotyledonae**

Algae

- They are **chlorophyll bearing autotrophic thallophytic** (i.e. having thalloid structure).
- Cell wall made-up of cellulose** and their **body** could be simple colonial in the form of **filament and sheet**.
- Distribution-** mainly aquatic, some grow attached to rock and some found on the bark of trees and surface of moist soil and known as seaweeds.
- Form and size of algae is highly variable like **Chlamydomonas** – unicellular microscopic, **Volvox** – colonial form, **Ulothrix and Spirogyra** – filamentous form and **Laminaria and Fucus** – giant kelp.
- Reproduction:**
 - Vegetative** - by fragmentation
 - Asexual reproduction by zoospore** (i.e. flagellated motile)
 - Sexual reproduction:** by fusion of gamete in which gamete could be **isogametes** (i.e. male and female gamete are similar in morphology) and their fusion is known as **isogamy**; some are flagellated or non-flagellated.

Example – Chlamydomonas – (i.e. gamete are similar and flagellated) and **Spirogyra** (i.e. similar and non-flagellated).
- Some are dissimilar like **Anisogametes** and their fusion is known as **Anisogamy**

Example: chlamydonmonas
- Some times the gamete are dissimilar like **female gamete** are larger and non-motile while **male gamete** are smaller and motile and their fusion is known as **oogamy**.

Classification

Algae

Chlorophyceae

Phaeophyceae

characteristics	Chlorophyceae	Phaeophyceae	Rhodophyceae
Common Name	Green algae	Brown algae	Red algae
Major pigments	Chlorophyll a, b	Chlorophyll a, c fucoxanthin	Chlorophyll a, d phycoerythrin
Stored food	Starch	Mannitol, laminarin	Floridean starch
Cell wall	Cellulose	Cellulose and alginic acid	Cellulose
Flagella number and position of insertion	2-8 equal apical	2, unequal lateral	Fresh water , brackish water, salt water
Habitat	Freshwater brackish water , salt water	Fresh water , brackish water, salt water	Freshwater, brackish water salt water

Class Chlorophyceae (Green Algae)

- It occurs in various shape and size like *Chlamydomonas* (unicellular, flagellated, microscopic), *Chlorella* (unicellular, non-flagellated microscopic) *Volvox* (colonial, flagellated) *Ulothrix*, *Spirogyra* (filamentous, non-branching) etc.
- Occurrence:** mostly **freshwater and very few are marine**, few **epiphytic** (i.e. live on other plants), **some parasitic** (e.g. *Cephaleuros*) and **epizoic** (i.e. grow as symbionts on animals like shell of molluscs and other vertebrates).
- Usually green contain **chlorophyll a and b** and also contain small amount of **carotenoids**.
- Most of member has one or more **pyrenoids** (i.e. store bodies) that contain protein beside starch.

- Have **rigid cell wall** made up of **inner layer** (i.e. made up of cellulose) and **outer layer** (i.e. made-up of pectose).
- Stored food material **starch** and some store in the form of **oil droplets**.
- Reproduce vegetative** by fragmentation, **asexual reproduction** by flagellate zoospore (i.e. produce in zoosporangia) and by **sexual reproduction** show considerable variation in the type and formation of sex cells like **isogamous, anisogamous, or oogamous**.

Example: *Chlamydomonas*, *Ulothrix*, *Spirogyra* and *Volvox* etc.

Class Phaeophyceae (Brown Algae)

- Occurrence:** mainly **cooler seas** but genus *Sargassum* grows in **shallow tropical water** and all are **multicellular**.
- Body in form of simple **branched filament** (e.g. *Ectocarpus*) or **complex profusely branched structure** (e.g. *Laminaria*).
- Have **holdfast** (i.e. anchor them to the substratum) and **fronds** (large flattened leaf like photosynthetic organs).
- Cell wall** is **cellulosic** which also have outer **covering of algin** (i.e. mixture of polysaccharide).
- Protoplast contains **chlorophyll a and c, Xanthophylls and carotenoids and fucoxanthin** (i.e. responsible to owe their colour to golden brown pigment).
- Store food material **laminarin starch or mannitol** and some store **fat** as well.
- Reproduction:** by
 - Vegetative** through **fragmentation**
 - Asexual reproduction** by **biflagellate zoospores** (i.e. pear shape having two unequal laterally attached flagella).
 - Sexual reproduction** may be **isogamous, anisogamous or oogamous**.
- Adaptation :** have **dichotomous branching** that reduce the resistance to water, fucus possess **air**

bladders for bouyancy, **fucoxanthin** (*i.e. photosnthetic pigment*) help to photosynthesis absorbing blue light, **phycocolloids** (*i.e. present in cell wall*) prevent drying or freezing in winter as they can retain water.

Class Rhodophyceae (Red Algae)

- All are **marine** and have typical **eukaryotic cell structure**.
- **Cell wall** is **cellulosic** and also contains **phycocolloids** and **some contain sulphur**.
- **Storage food** in form of **floridean starch**.
- **Coralline algae** have **calcium carbonate** in their walls which form coral like structure.
- **Pigmentation**: have **chlorophyll**, **phycoerythrin** and **anthocyanin**.
- Do not have flagellated stage at any stage.
- **Reproduce**
 1. **Vegetative**: **fragmentation**,
 2. **Asexually reproduce** by **non-motile spore**.
 3. **Sexually** they produce by **forming non motile gamete which carried away by water current and fertilized the female gamete**.
- **Adaptation**: have **red and blue pigment** so they can **absorb blue green light that can go into the water**.

Bryophytes

- It is **simplest multicellular** land plant and also known as **amphibians of plant kingdom** (*because they live in soil but are dependent on water for sexual reproduction*).
- Plant body is **thallus** like which are **prostrate** (*e.g. liverworts*) or **erect** (*E.g. mosses*) and attached to the substratum by **unicellular or multicellular rhizoids**.
- Have **no specialized tissue like xylem and phloem** for conduction of water and other substance.

- Main plant body of bryophyte is **gametophyte** (*i.e. haploid and dominant phase of life cycle*).
- **Sporophyte** is attached and dependent on the gametophyte that produces **spores**.
- **Reproduction**: it shows alternation of generation between **gametophytic** and **sporophytic** generation.
- During life cycle the gametophyte bear **archegonia** (*female sex organs, flask shaped structure*) and **antheridia** (*i.e. male sex organs*) produce **antherozoids** (*i.e. biflagellate*) which release in water and come in contact of archegonia containing a single egg and produce **zygote** that produce **sporophyte**.
- Sporophyte undergoes **meiosis** and result **haploid spores** which germinate and develop into **gametophyte**.

Classification

- Bryophytes classified into **Hepaticae** (*i.e. liverworts*) and **musci** (*i.e. mosses*)

Liverworts:

- It grows usually in **moist and shady** habitats.
- Plant body is **thalloid** which is **dorsiventrally flattened** and closely attached to substrate.
- **Asexual reproduction** takes place by **fragmentation** and **formation of gemmae** (*i.e. green multicellular asexual bud*) that develop in **gemma caps** (*i.e. present on thalli*) which get detached from the parent body and germinate to form new individual.
- **Sexual reproduction** occurs by the formation of male and female organs which are produce either on the same or on different thalli.

Example: Riccia , Marchantia

Mosses:

- The dominant stage of the life cycle in mosses is the **gametophyte** which consist of two stages:

1. **Protonema stage** (i.e. creeping green branched and frequently filamentous stage) that **develop directly from spore**.
 2. **Leafy stage** (i.e. upright, slender axis bearing spirally arranged leaves) that **develop from secondary protonema as a lateral bud**.
- Sex organs are **antheridia** and **archegonia** which produce at the apex of leafy shoot and after fertilization **zygote** develop into the **sporophyte** (i.e. contain foot seta and capsule) that produce **spore in capsule after meiosis** which undergo germination and formed **gametophyte**.
 - **Vegetative reproduction** is by **fragmentation and budding** of **secondary protonema**.

Example: *Funaria*, *Polytrichum*, *sphagnum* etc.

Pteridophytes

- They are basically **land plant** that grows well in **moist, shady, and cool place** with **differentiated true root, stem and leaves**.
- They have well developed **specialized tissue for conduction** (i.e. **Phloem**- for translocation of food and **Xylem** – for transport water).
- Main plant body is **sporophyte** which has **true root stem and leaves with vascular tissue** and **gametophyte** is reduced to a **simple small prothallus**.
- Plant exhibit **alternation of generation** with **sporophyte being dominant**.
- The stem of the most fern except tree fern is an underground horizontally growing **rhizome**.
- **Rhizome** produce **adventitious roots** like *Adiantum* leaf when touches the soil surfaces it **give out adventitious root** so that they may also known as **walking fern**.
- The size of leaf in pteridophytes varies like in *Selaginella* – have **microphylls** (i.e. leaves are very small) and **ferns** have **macrophylls** (i.e. leaves are large).

- Fern may have different types of fronds – leaves like **simple leaves**, **pinnately leaves**, **unipinnate**, **bipinnate**, **tripinnate leaves**.

Classification of Pteridophytes

Pteridophytes

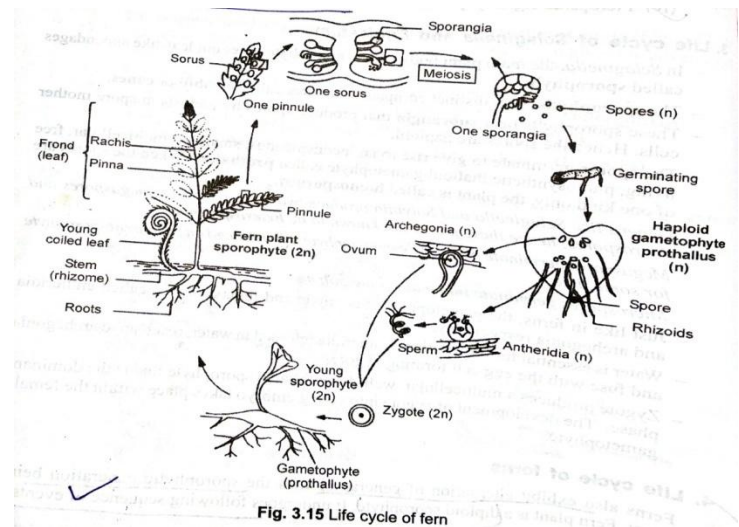
Psilopsida

E.g. *Psilotum*

Lycopsida

E.g. *Selaginella*,
Lycopodium

Life cycle of Ferns



Gymnosperm

- They are abundant in the **Mesozoic era** especially the **Jurassic period**.
- Ovule is **not enclosed in ovary wall** and **remains exposed before and after fertilization**.
- They have well developed **xylem tracheids** and do **not bear fruit** as there is no ovary.
- All are **perennials**, having **tap root** and some are **present with the fungal associations** (i.e. *Pinus* with *Mycorrhiza* and *cycas* with *nitrogen fixing bacteria*).

- Stem are **branched** (*cycas*) and **unbranched** (*Pinus*) and leave may be **simple or compound** like *cycas have pinate leave* while *pinus have needle like leaves*
- Plants are **heterosporous** i.e. give rise two type of spores – **microspores** and **megaspores**.
- Cone bears the **sporophylls** which bear **sporangia** in which **spores** develop.
- Sexual reproduction does not required water as **pollen grains are carried away by wind**.

Classification of Gymnosperm

Gymnosperm

Cycads

E.g. Cycas

Conifers

E.a. Pinus

Grow mainly in tropical and subtropical region of world.

Thrive well in cold climate in the world but some also seen in warm region.



(a) Cycas



(b) Coniferous tree

Formation of seed

- All gymnosperm are **heterosporous** (i.e. produce two type of seed - microspore and megaspores).
- Spores are produce by **sporangia** that formed on **sporophylls** (i.e. leaf like structure) that arranged spirally along the axis to **cones or strobili**.
- The strobili bear **microsporophyll** and **microsporangia** are called **male strobili or male cone** and strobili or cones bearing

megasporophylls and **megasporangia** is called **female strobili or female cone**.

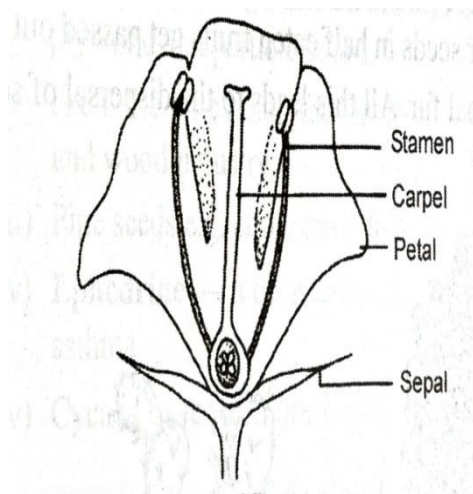
- Male cone and female cone present in **same tree in Pinus** or on **different tree as in cycas**.

Sporophylls	
Microsporophyll	Megasporophyll
Bear microsporangium called <i>pollen sac</i>	Bear megasporangium called <i>ovule</i>
It produces numbers of <i>microspore</i> or <i>pollen grain</i> and each pollen grain contain 2 male gamete.	Each ovule have <i>megaspore mother cells</i> which divide <i>meiotically</i> and give rise to 4 megaspores which develop in to female gametophyte called embryo sac . Each embryo sac has <i>one or more female gamete or ova</i> .

- The **pollen grain** carrying **male gamete** fertilized by **egg cell** and formed **zygote** which develops into **ovule** in which **ovule wall forms seed coat**.

Angiosperm

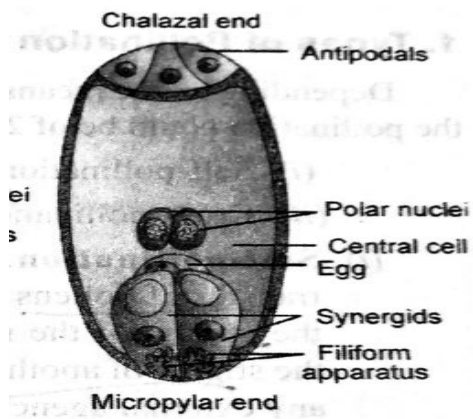
- Seed** are enclosed in **an ovary**.
- Flower is present** instead of cones.
- They have adapted to **different habitat** like some find in fresh water and few in salt water.
- Well develop conducting system** is present.
- During the formation of fruit** *ovule forms seed* and *ovary forms fruit* in which fruit *also help in seed dispersal*.



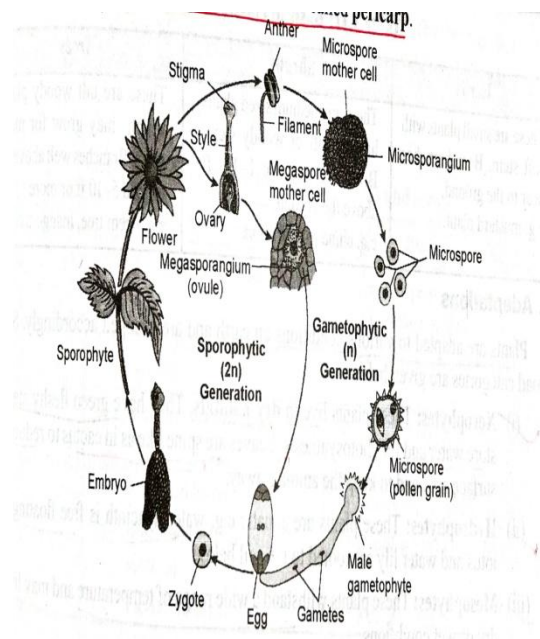
- Flower has distinct structure of the angiosperm which categories into **reproductive structure** (i.e. male sex organ is stamen female sex organ is pistil or carpel) and **accessory parts** (i.e. sepals and petals).

Formation of seed

- Each flower have cell of embryo sac and each embryo sac has 8 cells



- At **micropylar end 3 cells are present** in which **2 are synergids** and **one is egg cell**.
 - 3 antipodal cells at chalazal end**.
 - 2 polar nuclei at center**.
- Polar nuclei fuse and form **secondary nuclei**.
 - After pollination** pollen grain germinates on stigma and forms pollen tube which passes through the style and reaches up to ovary.



- After reaching pollen tube **release two male gametes into embryo sac of ovule** in which **one male gamete fuse with egg cell** and produce **zygote** while **another male gamete fuses with secondary diploid nucleus** and produce **triploid primary endosperm nucleus (PEN)**.
- After this the embryo develops into an embryo and PEN develops into endosperm which provides nourishment to the developing embryo.

synergids and antipodal degenerate after fertilization.

Kind of Angiosperm

Annual	Biennials	Perennials
They complete the life cycle from germination to seed production in one year.	Complete their life cycle in two year	They live for many years.
Wheat rice etc	Sugar beet carrot radish	Mango tree

Classification of Angiosperm

- Dicotyledonae:**
 - It have two cotyledon in the seed
 - flower bear five petals or in multiple of five

- tap root and leaves have reticulate venation.

Example: Mustard, Pea, Gram.

2. Monocotyledonae:

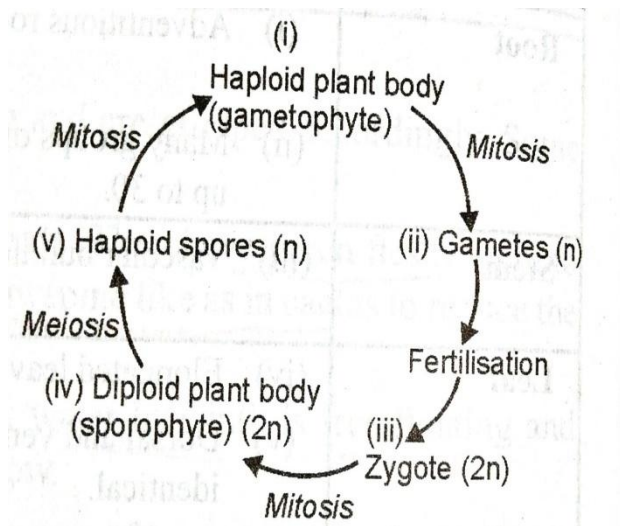
- It has one cotyledon in the seed flower bear three petals or multiple of three
- They have fibrous root and leaves show parallel venation.

Example: Rice, Wheat, Grass etc.

zygote which undergoes **meiosis** and forms **haploid spore**.

Plant life cycle and alternation of generation

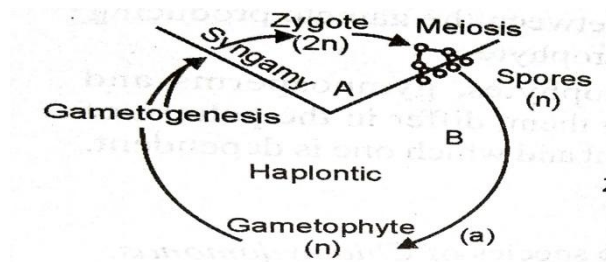
- Haploid plant body represents **gametophyte** which produces **gamete** by **mitosis**.
- These male and female gametes followed the **fertilization** and results **zygote** which divide by **mitosis** to produce a **diploid sporophytic plant body**.



- These sporophytic plant body **produce spore by meiosis** which in turn **divide by mitosis** to produce a **haploid gametophyte plant body** again.

Haplontic life cycle

- It occurs mainly in **algae volvox, spirogyra and some species of chlamydomonas**.
- In this the **dominant phase** is gametophyte and **sporophyte generation represents only one cell**

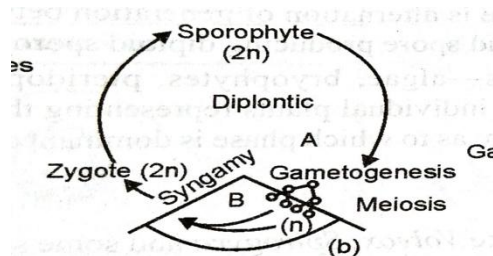


- Haploid spore divide mitotically and form **gametophyte**.

in this plant is basically in the haploid gametophytic phase hence it is called haplontic life cycle.

Diplontic life cycle

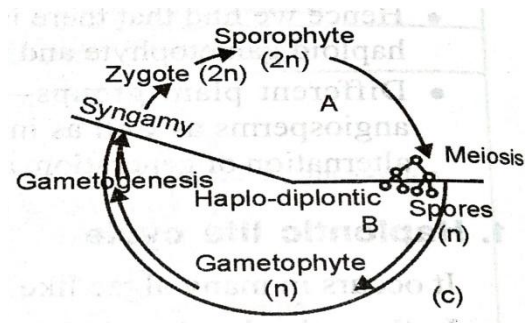
- It occurs in seed bearing plants *like gymnosperm and angiosperm*.
- Dominate phase of life cycle is **diploid sporophytic phase**.



- **Sporophyte** is **dominant, photosynthetic independent phase** of plant.
- **Gametophytic phase** is represented by **single to few celled haploid gametophyte**.

Haplo-diplontic life cycle:

- Occurs in **bryophyte and pteridophytes**.
- It is **intermediate condition of haplontic and diplontic condition** in this both phase are multicellular but they differ in their dominant phases.



- In **bryophytes** the **dominant phase** is haploid **gametophyte** which is **independent photosynthetic thalloid or erect phase**.
- **Sporophytic phase** is **short lived multicellular, totally or partially dependent on the gametophyte**.

- In **ptedridophyte** *dominant phase* is **sporophyte** which is *independent photosynthetic vascular plant body* and **gametophytic phase** is *short live multicellular and autotrophic independent phase*.