3. Kingdom Plantae

Can you recall?

1. Why do we call plants as producers on land ?
2. What are differences between sub-kingdoms Cryptogamae and Phanerogamae?
3. Differentiate between Thallophytes and Bryophytes.
4. Give any two examples of Pteridophyta.

3.1 Kingdom plantae :

In earlier chapter, we have studied different aspects of classification.

Kingdom Plantae is further classified on the basis of characteristics like absence or presence of seeds, vascular tissues, differentiation of plant body, etc.

- Phanerogamae are commonly called seed producing plants. They produce special reproductive structures that are visible (Phaneros – visible)
- Cryptogamae are spore producing plants and do not produce seeds and flowers. They reproduce sexually by gametes but sex organs are concealed (kryptos : hidden, gamos : marriage).

Classification of Kingdom Plantae is represented as follows :

Observe and Discuss

Collect different water samples of fresh water. Mount them on a glass slide and observe under a compound microscope. Try to identify the organisms which are visible under it.

3.2 Salient features of major plant groups under Cryptogamae :

A. Division : Thallophyta - Members are mostly aquatic, few grow on other plants as epiphytes. Some grow symbiotically and epizoic i.e. growing or living non-parasitically on the exterior of living organisms. Aquatic algae grow in marine or fresh water. Most of them are free living while some are symbiotic.

Plant body is thalloid i.e. undifferentiated into root, stem and leaves. They may be small, unicellular, microscopic like *Chlorella* (non-motile), *Chlamydomonas* (motile). They can be multicellular, unbranched, filamentous like *Spirogyra* or branched, filamentous like *Chara. Sargassum,* a huge macroscopic sea weed which measures more than 60 meters in length is also an alga.

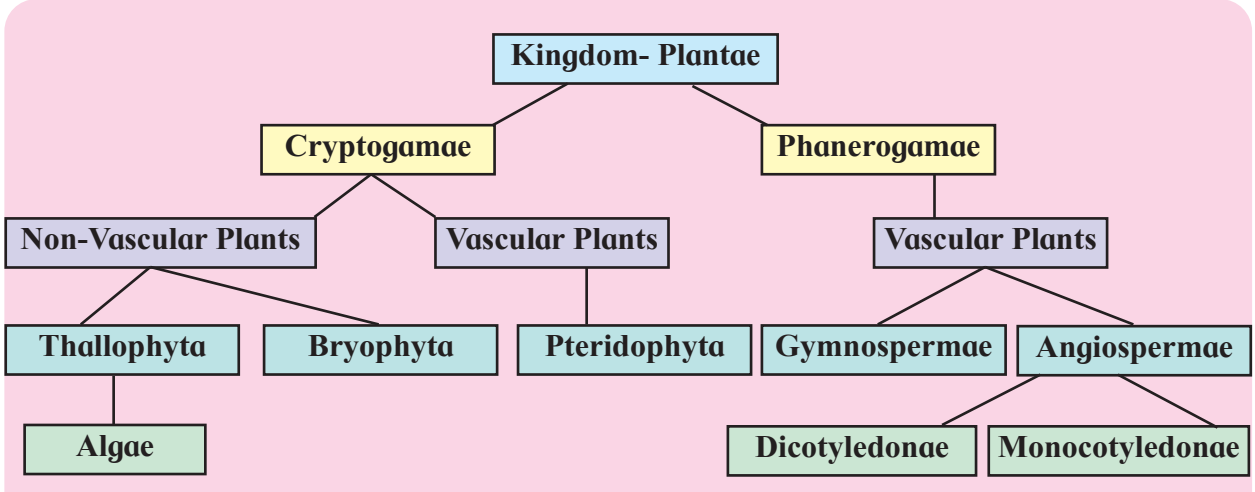


Chart 3.1 Classification of Kingdom Plantae

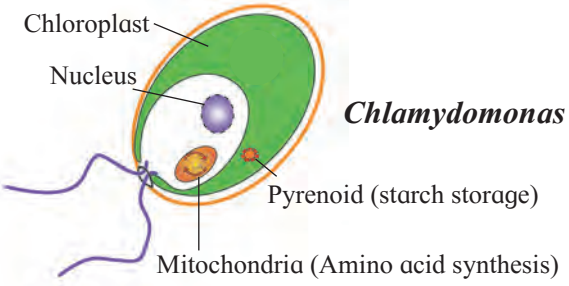
The algal cell wall contains either polysacchrides like cellulose / glucose or a veriety of proteins or both. Reserve food is in the form of starch and its other forms. Reproduction takes place by vegetative, asexual and sexual ways. The life cycle shows phenomenon of alternation of generation, dominant haploid and reduced diploid phases. Algae are classified as per its pigments like chlorophyll, xanthophylls and phycobilin.

a. Chlorophyceae (green algae) :

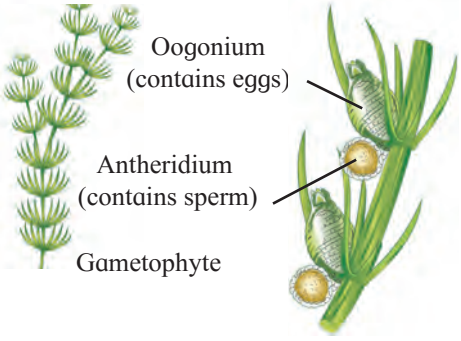
These are mostly fresh water (few brackish water and marine) forms.

Plant body is unicellular, colonial, filamentous. Cell wall contains cellulose.

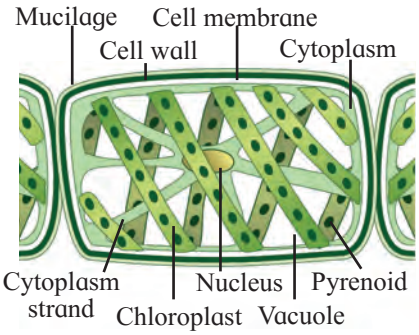
Chloroplasts are of various shapes like discoid, plate-like, reticulate, cup-shaped, ribbon-shaped or spiral with chlorophyll a and b. The stored food is in the form of true starch.



Chlamydomonas



Chara



Spirogyra

Fig. 3.2 Chlorophyceae

Pyrenoids are located on Chloroplast. Members are rich in protein, so used as food; used even by space travellers. e.g. *Chlorella. Chlamydomonas, Spirogyra, Chara, Volvox, Ulothrix etc.*

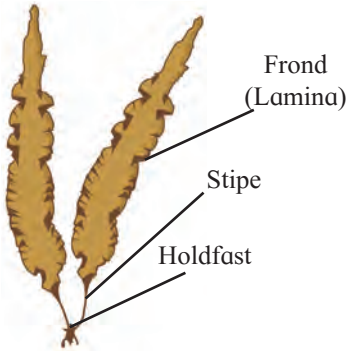
Internet my friend

1. Make a list of green algae with their characteristic shape of chloroplast.
2. Enlist the forms of filamentous algae.
3. Write different pigments found algae.

b. Phaeophyceae (Brown algae) :

Plant body : Mostly marine, rarely fresh water. Simple branched / filamentous (e.g. *Ectocarpus*) / profusely branched (*Petalonia*).

Cell wall has cellulose, fucans and algin. Photosynthetic pigments like chlorophyll-a, -c and fucoxanthin are present. Mannitol, laminarin and starch are the stored food materials. Body is usually differentiated into **holdfast**, stalk called **stipe** and leaf-like photosynthetic organ called **frond**. Many species of marine algae are used as food. e.g. *Laminaria*, *Sargassum*. Some species are used for production of hydrocolloids. e.g. *Ectocarpus, Fucus,* etc.



Laminaria

Sargassum

Fucus

Fig. 3.3 Phaeophyceae

c. Rhodophyceae (Red algae) :

Plant body These are found in marine as well as fresh water on the surface, deep sea and brakish water. Plant body is thalloid. Cells contain chlorophyll a, d and phycoerythrin. Cell wall is made up of cellulose and pectin glued with other carbohydrates. Stored food is in the form of Floridean starch. Commercially important agar-agar which is used as solidifying agent in tissue culture medium, is obtained from red algae. e.g. *Chondrus, Batrachospermum Porphyra, Gelidium , Gracillaria, Polysiphonia,* etc.

Batrachospermum

Gracillaria

Polysiphonia

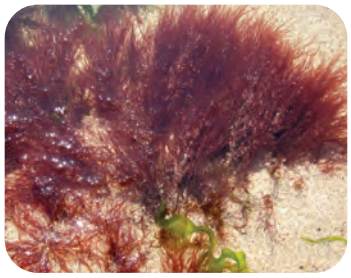


Fig. 3.4 Rhodophyceae

Internet my friend

1. Economic importance of algae.
2. Role of algae in environment.
3. Different forms of green, red, brown and blue green algae.

Do you know ?

Brown algae- kelps may grow up to 100 meters in height. Find out more information about Sargasso sea.

Can you tell?

1. What are the three major groups of Cryptogams ?
2. Name the accessory pigments of algae.
3. Give salient features of algae
4. Differentiate between Chlorophyceae and Phaeophyceae.
5. Enlist examples of Chlorophyceae and Rhodophyceae.

Observe and Discuss

You may have seen *Funaria* plant in rainy season. Why is it called amphibious plant?

B. Bryophyta
(Bryon : moss ; phyton : plant)

Bryophytes are mostly terrestrial plants. They are found in moist shady places. But they need badly water for fertilization and completion of their life cycle. Hence they are called 'amphibious plants'. They include approximately 960 genera and about 25,000 species.

Life cycle of Bryophytes shows sporophytic and gametophytic stages. Vegetative plant body is thalloid or leafy which represents gametophytic generation. Spore producing capsule represents sporophytic generation.

Bryophytes have root-like structures called **rhizoids**. Rhizoids are unicellular in liverworts while multicellular in mosses. Rhizoids absorb water and minerals and also help in fixation of thallus on the substratum.

Bryophytes are divided into two groups : liverworts and mosses.

a. Liverworts (Hepaticeae) :

These are lower members of Bryophyta. These are primitive group of Bryophytes. Gametophyte possesses flat plant body called **thallus**. The thallus is green, dorsiventral, prostrate with unicellular rhizoids. e.g. *Riccia, Marchantia.*

Hornworts (Anthocerotae) - These member possess flattened thallus. The thallus produces horny structures which are called sporophytes hence the name hornworts. e.g. *Anthoceros*.

b. Mosses (Musci) :

These are advanced members of Bryophyta which possess erect plant body.

Gametophytic phase of the life cycle includes two stages namely; **protonema** stage and **leafy** stage. The protonema is prostrate green, branched and filamentous (it is also called juvenile gametophyte). It bears many buds. Leafy stage is produced from each bud. Thus protonema helps in the vegetative propagation. The leafy stage has erect, slender stem like (Cauloid) main axis bearing spirally arranged leaf like structures (Phylloid). It is fixed in soil by multicellular branched rhizoids. This stage bears sex organs. Vegetative reproduction takes place by fragmentation and budding in secondary protonema.
e.g. *Funaria, Polytrichum, Sphagnum,* etc.

Riccia (Liverworts)

Anthoceros

Funaria

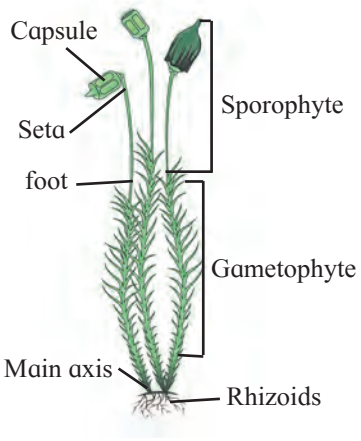


Fig. 3.5 Mosses

Economic importance -

Some mosses provide food for herbivorous mammals, birds, etc. Species of *Sphagnum,* a moss; provides peat used as fuel. Mosses are also used as packing material for transport of living materials because they have significant water holding capacity. Just like lichens, mosses are the first living beings to grow on rocks. They decompose rocks to form soil and make them suitable for growth of higher plants. Dense mats of mosses help in prevention of soil erosion, thus act as soil binders.

C. Pteridophyta
(Pteron : feather, phyton : plant)

Evolutionarily, Pteridophytes are the first vascular and true land plants. Hence considered as the first successful terrestrial plants with true roots, stem and leaves. These plants have a primitive conducting system and they are the only Cryptogams with vascular tissues. The late Paleozoic era is regarded as the age of Pteridophytes. The group has about 400 genera and 11,000 species. The plants consist of pinnate (feather like) leaves. Leaves may be small called **microphylls** (e.g. *Selaginella*) or large called **macrophylls** (e.g. *Nephrolepis* / fern).

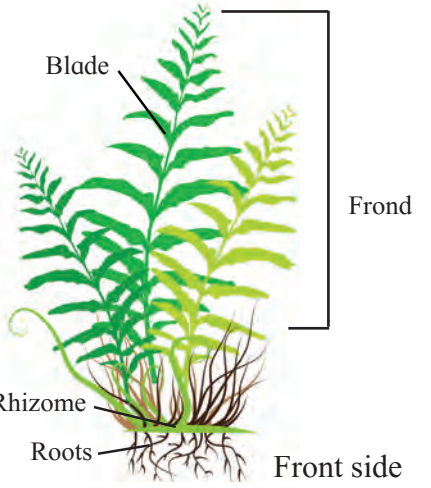


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Fig. 3.6 *Nephrolepis* (Fern)

Observe and Discuss

You may have seen the various plants which do not bear flowers, fruits and seeds but they have well developed root, stem and leaves. Discuss.

Pteridophytes grow in moist and shady places. Pteridophytes show sporophytic and gametophytic stages in life cycle. e.g. Ferns, Horsetail. Some are aquatic (*Azolla, Marsilea*), xerophytic (*Equisetum*) and epiphytic (*Lycopodium*).

Pteriodphytes show heteromorphic alternation of generations in which the sporophyte is diploid, dominant, autotrophic and independent. It is differentiated into root, stem and leaves. The primary root is short lived and soon replaced by adventitious roots while the stem may be aerial or underground. Leaves may be scaly (*Equisetum*), simple and sessile (*Lycopodium*) or large and pinnately compound (*Nephrolepis* / Ferns).

In these members, xylem consists of only tracheids and Phloem consists of only sieve cells. Secondary growth is not seen in Pteridophytes due to absence of cambium.

Pteridophytes are classified as - Psilopsida- (*Psilotum*), Lycopsida - (*Selaginella* and *Lycopodium*), Sphenopsida - (*Equiesetum*) and Pteropsida - (*Dryopteris*, *Pteris* and *Adiantum*)

Economic importance - Pteridophytes are Used for medicinal purpose and as soil binders. Many varieties are grown as ornamental plants.

Can you tell?

1. Distinguish between Bryophyta and Pteridophyta.
2. Why Bryophyta are called amphibians of Plant Kingdom?
3. Pteridophytes are also known as vascular Cryptogams - Justify.
4. Give one example of aquatic and xerophytic Pteridophytes.

Observe and Discuss

Observe all garden plants like *Cycas*, Thuja, *Pinus*, Sunflower, *Canna* and compare them. Note similarities and dissimilarities among them. Which differences did you notice between Gymnosperms and Angiosperms?

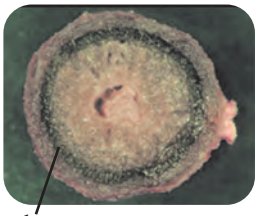
3.3 Salient features of major plant groups under Phanerogamae:

A. Gymnospermae (Gymnos : naked, sperma : seed) :-

There are about 70 genera and 1000 living species of Gymnosperms in world. In India group is represented by 16 genera and 53 species.

a. *Cycas* plant body

b. Corraloid roots of *Cycas*



c. T. S. of Coralloid root of *Cycas*

d. Male cone of *Cycas* having microsporophylls

e. Megasporophyll of *Cycas*

Fig. 3.7 *Cycas* plant details

Most of the Gymnosperms are evergreen, shrubs or woody trees. These are primitive group of flowering plants producing naked seeds. They are vascular plants predominantly having Xylem with tracheids and Phloem with sieve cells.

The plant body is sporophyte. It is differentiated into root, stem and leaves. The root system is tap root type. In some, roots form symbiotic association with other life forms. Coralloid roots of *Cycas,* show association with blue green algae and roots of *Pinus* show association with endophytic fungi called mycorrhizae.

In Gymnosperms, stem is mostly erect, aerial, solid and cylindrical. Secondary growth is seen in Gymnosperms due to presence of cambium. In *Cycas* it is usually unbranched, while in conifers it is branched. The leaves are **dimorphic**. The foliage leaves are green, simple needle like or pinnately compound, where as scale leaves are small, membranous and brown. Spores are produced by microsporophyll (Male) and megasporophyll (Female).

Economic importance - *Cycas* is grown as ornamental plant. *Pinus* is used as source of pine wood, turpentine oil and pine resin.

Fig. 3.8 *Pinus* tree with cones

Do you know ?

Gymnosperms like *Ginkgo biloba* is called living fossil. It is because the plant is found in living as well as fossil form and the number of fossil forms is much more than the living forms.

Gymnosperms vary in their size. e.g. *Sequoia sempervirens* is the tallest living plant in the world. It is commonly called coast red wood of California. The height of the plant is about 366 feet. *Taxodium mucronatum* has a girth of about 125 feet. *Zamia pygmaea* is the smallest Gymnosperms and is about *25* cms. only.

Try this

Study the leaves of *Hibiscus*, Peepal, *Canna*, Grass and Tulsi. Classify them as Monocot and Dicot.

Can you recall?

1. What are the salient features of Angiospermae?
2. What is double fertilization ?
3. Explain in brief two classes of Angiospermae? Draw and label one example of each class.

B. Angiospermae (Angios : enclosed : vessel, Sperma : seed)

Angiosperms are the most advanced group of flowering plants. In these plants the seeds are enclosed within the fruit i.e. ovary. Angiosperms is a group of highly evolved plants, primarily adapted to terrestrial habitat. They vary in size.

Angiosperms show heteromorphic alternation of generation in which the sporophyte is diploid, dominant, autotrophic and independent. The gametophytes (male or female) are haploid, reduced, parasitic and concealed in the sporophyte.

Angiosperms are heterosporous. Microspores (commonly called pollens) are formed in microsporangia (of anthers). They develop in highly specialized microsporophylls or **stamens** while megaspores are formed in megasporangia (or ovules) borne on highly specialized megasporophyll called **carpel**.

Besides the essential whorls of microsporophylls (Androecium) and megasporophylls (Gynoecium), there are accessory whorls namely calyx (sepals) and corolla (petals) arranged together to form flowers.

Do you know ?

Wolffia is the smallest Angiosperm, 1mm in size and *Eucalyptus* grows to over 100 meters high.

Angiosperms are subdivided into two classes:

a. Dicotyledonae : These plants have two cotyledons in their embryo. They have a tap root system and the stem is branched. Leaves show reticulate venation while the flowers show tetra- or pentamerous symmetry.

Vascular bundles are conjoint, collateral and open type. Cambium is present between Xylem and Phloem for secondary growth. In Dicots, secondary growth is commonly found. e.g. *Helianthus annuus* (sunflower), *Hibiscus rosa-sinensis* (China rose).

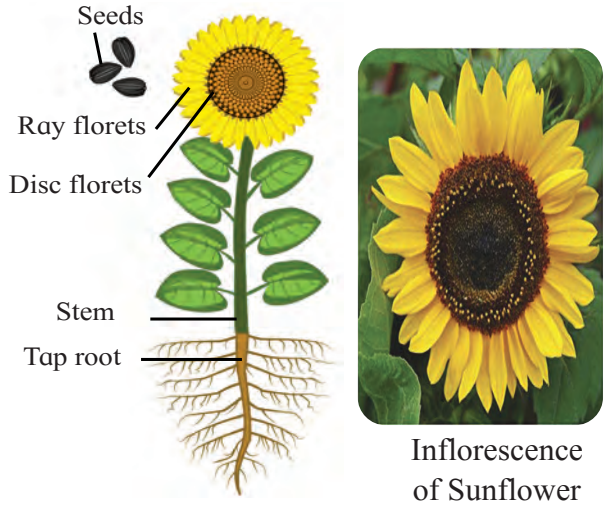


Fig. 3.9 *Helianthus annuus* (Sunflower)

a. Monocotyledonae : These plants have single cotyledon in their embryo. They have adventitious root system and stem is rarely branched. Leaves generally have sheathing leaf base and parallel venation while the flowers are generally trimerous.

The vascular bundles are conjoint, collateral and closed type. In Monocots, except few plants secondary growth is absent. e.g. *Zea mays* (Maize), *Sorghum vulgare* (Jowar).

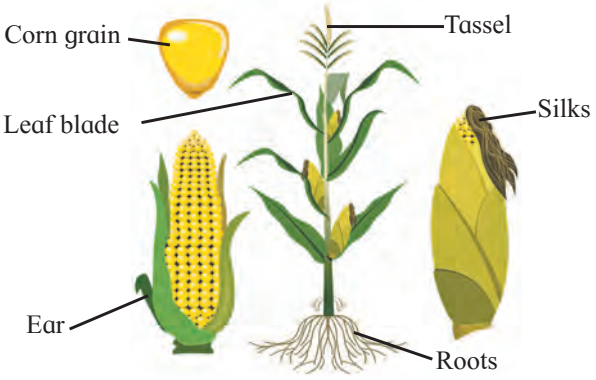


Fig. 3.10 *Zea mays* (Maize)

Can you tell?

1. Give general chara cters of Gymnosper-mae and Angiospermae.
2. Distinguish between Dicotyledonae and Monocotyledonae.
3. Why do Dicots show secondary growth while Monocots don't?

3.4 Plant life cycle and alternation of generations:

Life cycle of a plant includes two phases or distinct generations namely sporophyte (diploid : 2n) and gametophyte (haploid : n). Some special diploid cells of sporophyte divide by **meiosis** to produce haploid cells. These haploid cells divide mitotically to give rise to gametophyte. The gametophyte produces separately male and female gametes which fuse during fertilization to produce diploid **zygote**. It divides by mitosis to form **diploid sporophyte**. The sporophytic and gametophytic generations generally occur alternately in the life cycle of a plant. This phenomenon is called **alternation of generations**.

Distinct alternation of these two generations is observed in Bryophytes and Pteridophytes. In Gymnosperms and Angiosperms, gametophyte is much reduced and exists within sporophyte. In algae, based upon the nature of dominant phase in life cycle, it is called haplontic, diplontic or haplo-diplontic life cycle.

In Bryophytes haploid gametophyte is dominant. It is photosynthetic, independent thalloid or erect phase. Sporophyte is short lived, multicellular and depends totally or partially on gametophyte for nutrition and anchorage. Whereas in Pteridophytes, sporophyte is dominant, independent and vascular plant body. Haploid multicellular independent, non vascular gametophyte is generally autotrophic and short lived. It alternates with Sporophyte.

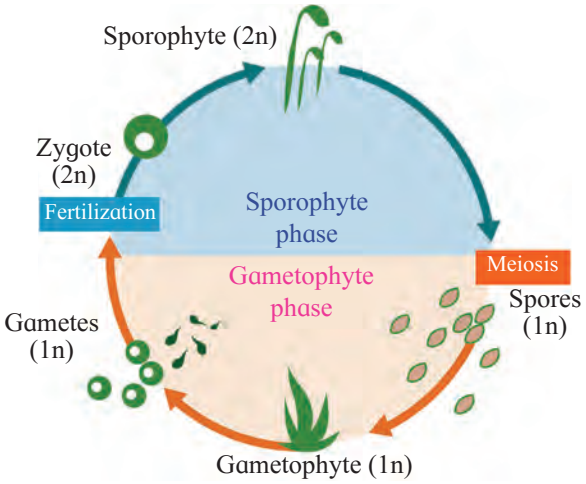


Fig. 3.11 Alternation of generation

Can you tell?

1. What is alternation of generations?
2. Which phase is dominant in the life cycle of Bryophyta and Pteridophyta ?

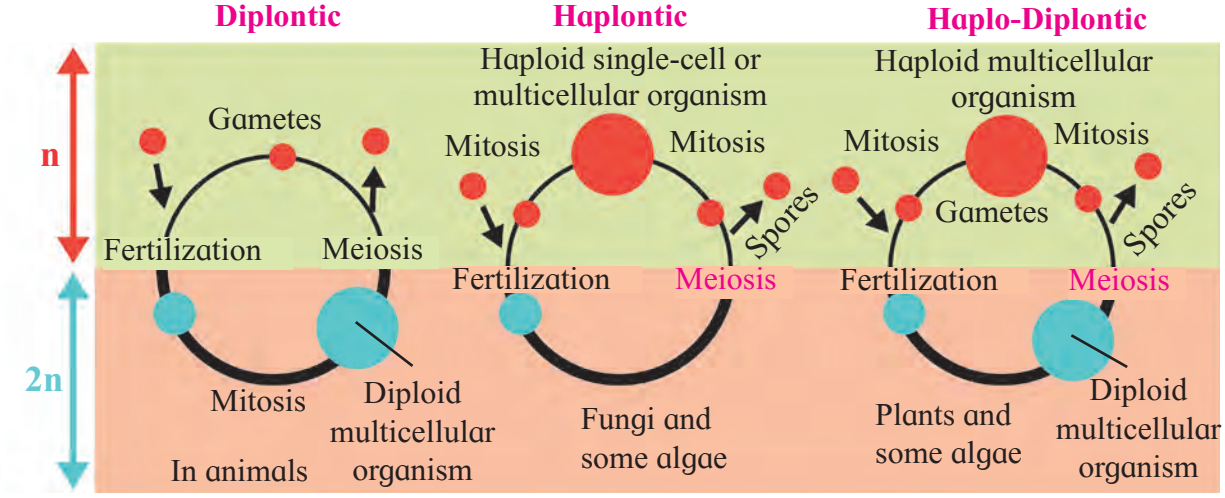


Fig. 3.12 Types of life cycle

Diplontic :
Here mitotic divisions occurs only in diploid cells. Gametes formed through meiosis are haploid in nature. The diploid zygote divide mitotically. In this process production of multicellular diploid organism or in the production of many diploid single cells takes place. E.g. Animals.

Haplontic :
Here mitosis occurs in haploid cells. It results in the formation of single haploid cells or a multicellular haploid organism. These forms produce the gametes through mitosis. Zygote is formed after fertilization. This cell is the only diploid cell in the entire life cycle of the organism. Thus the same zygotic cell later undergoes **meiosis**. E.g. Some Algae and Fungi.

Haplo-diplontic :
Here mitosis occur in both diploid and haploid cells. These organisms undergo through a phase in which they are multicellular and haploid (the gametophyte), and a phase in which they are multicellular and diploid (the sporophyte). E.g. Land plants and in many algae.

Exercise

1. Choose correct option

A. Which is the dominant phase in Pteridophytes?
   a. Capsule b. Gametophyte
   c. Sporophyte d. Embryo

B. The tallest living gymnosperm among the following is .....
   a. *Sequoia sempervirens*
   b. *Taxodium mucronatum*
   c. *Zamia pygmaea*
   d. *Ginkgo biloba*

C. In Bryophytes .....
   a. Sporophyte and gametophyte generations are independent
   b. Sporophyte is partially dependent upon gametophyte
   c. Gametophyte is dependent upon Sporophyte
   d. Inconspicuous gametophyte is present

D. A characteristic of Angiosperm is .....
   a. Collateral vascular bundles
   b. Radial vascular bundles
   c. Seed formation
   d. Double fertilization

E. Angiosperms differ from Gymnosperms in having .....
   a. Vessels in wood
   b. Autotrophic Mode of nutrition
   c. Siphonogamy
   d. Enclosed seed

2. How you place the pea, jawar and fern at its proper systematic position? Draw a flow chart of each.

3. Complete the following table

Groups of algae	Chlorophyceae	Phaeophyceae	Rhodophyceae
1. Stored food	Starch		
2. Cell Wall		Cellulose and algin	
3. Major pigments			Chl- a, d and Phycoerythrin

4. Differentiate between Dicotyledonae and Monocotyledonae based on the following characters

a. Type of roots

b. Venation in the leaves

c. Symmetry of flower

5. Answer the following questions

A. We observe that land becomes barren soon after monsoon. But in the next monsoon it flourishes again with varieties we observed in season earlier. How you think it takes place?

B. Fern is a vascular plant. Yet it is not considered a Phanerogams. Why?

C. *Chlamydomonas* is microscopic whereas *Sargassum* is macroscopic, both are algae. Which characters of these plants includes them in one group?

6. Girth of a Maize plant does not increase over a period of time. Justify

7. Radha observed a plant in rainy season on the compound wall of her school. The plant did not have true roots but rootlike structures were present. To which group the plant may belong?

8. Draw neat labelled diagrams

A. *Spirogyra*

B. *Chlamydomonas*

C. *Funaria*

D. *Nephrolepis*

E. Haplontic and haplodiplontic life cycle

9. Identify the plant groups on the basis of following features.

A. Seed producing plants

B. Spore producing plants

C. Plant body undifferenciated into Root, Stem and leaves

D. Plant need water for fertilization

E. First vascular plants

Practical / Project :

1. **Study the *Nephrolepis* plant in detail.**
2. **Study the coralloid roots, scale leaf and megasporophyll of *Cycas* in detail.**

10. Observe the following diagram. Correct it and write the information in your words.