# 03 Plant Kingdom

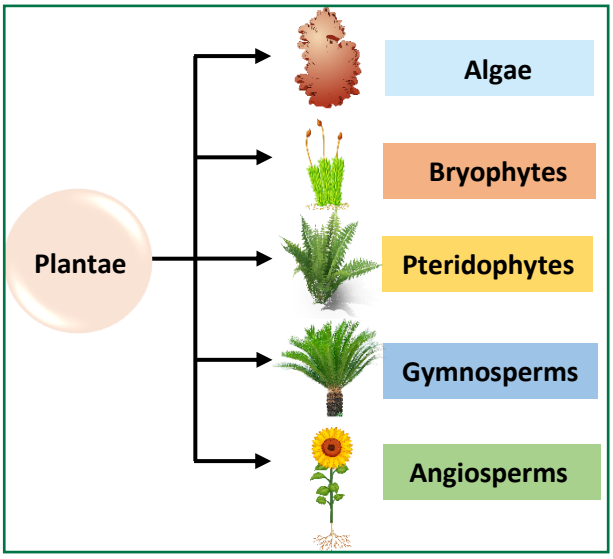
## 01. INTRODUCTION

- Includes all eukaryotic (cell wall mainly made of cellulose), chlorophyll containing organisms.
- Most of them are autotrophs with a few exceptions are partially heterotrophs such as insectivorous plants **e.g**. Bladder wort *(Utricularia)* and Venus fly trap plant *(Dionaea).*
- *Cuscuta* (Amerbel or dodder plant) is the example of parasitic Angiosperms.

### (A) NEED OF CLASSIFICATION :

(a) Enormous biodiversity

(b) It is nearly impossible to study, all the living organism, it is necessary to devise. Some means to make this possible.




- The art of **identifying** distinctions among organisms and placing them into **groups** that reflect their most significant **features and relationship** is called biological classification.
- The **purpose of biological classification** is to organise the vast number of known organisms into categories that could be remembered and studied easily.

| Previous/old classification | Modern classification |
|---|---|
| Fungi, members of the Monera and Protista placed in the same kingdom (plantae) based on cell wall. | Fungi, members of the Monera and Protista placed in the different kingdom (Excluded from plantae). |

## (B) TYPES OF CLASSIFICATION :

**(i) Practical classification :** In this type of classification, plants are classified on the basis of their economic importance or **human use (food, shelter, clothing)**. This classification system is the **earliest system**.

***e.g.*** Oil yielding plants: Coconut, Walnut ***e.g.*** Spices yielding plants: Turmeric, Ginger, Clove.




**Limitation**: In this classification, any one plant can be a member of more than one groups.

***e.g.*** Turmeric: Multi uses plant, it gives both medicines and spices.

**(ii) Artificial classification :** In this type of classification plants are classified on the basis of **one or few superficial morphological characters like habit, colour, number and shape of leaves**. *i.e.* over all morphology is not considered.

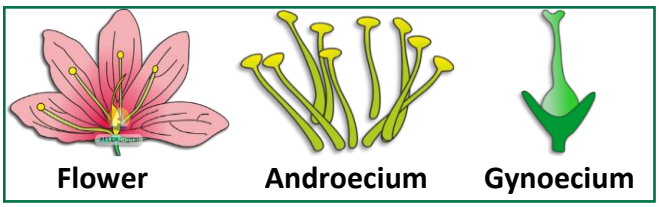
- Classification proposed by **Linnaeus** is Artificial, Based on **Androecium structure and numbers.**
- In this system **equal weightage** is given to both vegetative and reproductive characters.
- Not acceptable because vegetative characters are more easily affected by **environment**.

**(iii) Natural classification :** In this type, plants are classified on the basis of their **complete (gross) morphological** characters of (stem, root, leaves, flowers etc.). Based on **natural affinities** among the organism and consider not only the **external character**, but also **internal features**, like ultra-structure, anatomy, embryology, and phytochemistry.

- **Natural classification of flowering plants was given by George Bentham and Joseph Dalton Hooker also.**

**Importance :**

- Natural classification is believed to be the **best classification**, because it represents the natural (affinities) **similarities and dissimilarities** of plants *i.e.* it represents the inter relationship among plants.

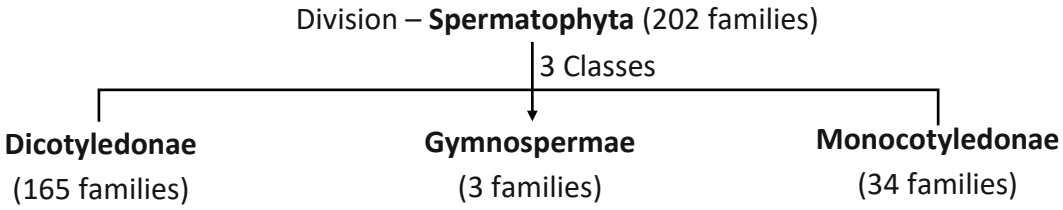



- In natural classifications more, weightage is given to **floral or sexual characters** because they are more conservative characters in comparison to vegetative characters.

**GEORGE BENTHAM AND JOSEPH DALTON HOOKER :**

(i) Both Bentham and Hooker are related to **Royal botanical garden**.

(ii) Bentham and Hooker gave the **biggest** and **natural classification** of Spermatophyta (seeded plants) as -




**Merits of Bentham and Hooker classification :-**

- The classification is natural, mainly based on the **floral characters** and **actual observations**.

**Demerits of Bentham and Hooker :-**

- In this classification the phylogeny of plants is not considered, the correct sequence of evolution is– **Phylogeny = Gymnosperm → Dicots → Monocots**

**Natural Classification is of Two Types :**

**(a) Natural non-phylogenetic :** In this classification, the phylogeny of the plants is not considered *i.e.* only the gross morphology of the plant is considered.

**(b) Natural phylogenetic :** In this classification, both **gross morphology** and **phylogeny** are considered. In phylogenetic classification, the plants are arranged on the basis of their **evolution** (organisms belong same taxa have a common ancestor.)

- **Phylogenetic classifications are also known as cladistic classifications, because when they are demonstrated in outline from, they appear tree like because taxa are arranged according to their evolutionary sequence.**

**Note :** The plants are arranged on the basis of their **evolution**.

**Algae → Bryophytes → Pteridophytes → Gymnosperms → Angiosperms**

**Primitive** → **Advanced**

- At present **phylogenetic classification systems** based on evolutionary relationships between the various organisms are acceptable. This assumes that organisms belonging to the same taxa have a common ancestor. We now use information from many other sources too to help

resolve difficulties in classification. These become more important when there is no supporting fossil evidence.

**(iv) Phenetic classification or Numerical classification :**

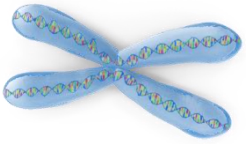
- In it plants are classified on the basis of numbers of **similarities and dissimilarities**.
- This classification is easily carried out by using **computers** and it is based on **all observable characteristics**.
- In this classification **number and codes** are assigned to all the characters and the data are prepared and then processed. Those organisms which have maximum similarities are placed in same group. In this way each character is given **equal importance** and at the same time hundreds of characters can be considered.

## (C) TAXONOMY AND IT'S TYPE :

**Taxonomy → Taxis = Arrangement, nomos = Law**

Branch of biology dealing with **identification**, **nomenclature** and **classification** of organisms is called taxonomy. This word was proposed by **A.P. de. Candolle**.

**Types of taxonomy :**



**(i) Cytotaxonomy:** The use of **cytological characters** of plants in classification or in solving taxonomic problems is called cytotaxonomy. Cytotaxonomy is based on **cytological information** like chromosome number, structure and behaviour etc.

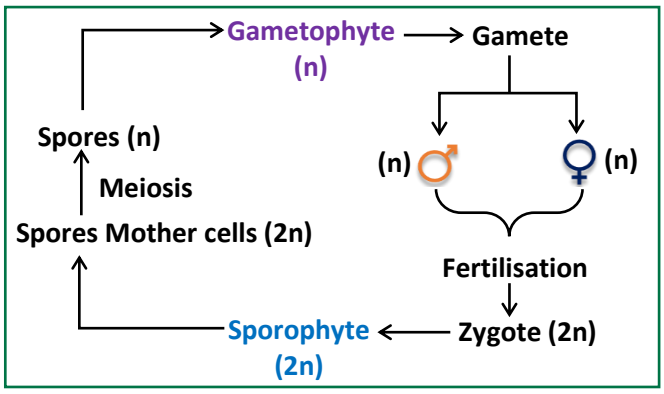
**(ii) Chemotaxonomy:** It is based on the **chemical constituents** of plants. The basic chemical compounds used in chemotaxonomy are alkaloids, carotenoids, tannins, polysaccharide, nucleic acids, fatty acids, amino acids, aromatic compounds etc.

**(iii) Numerical or phenetic taxonomy :** It is now easily carried out using computers is based on all observable characteristics. Number and codes are assigned to all the characters and the data are then processed. In this way each character is given equal importance and at the same time hundreds of characters can be considered. This taxonomy saves our time and hard work.

The plant cells have an eukaryotic structure with prominent chloroplasts and cell wall mainly made of cellulose.

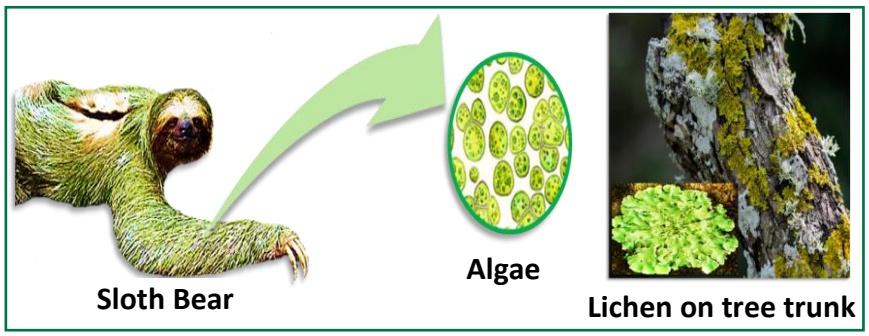
**Alternation of generation**

- Life cycle of plants has two distinct phases the diploid **sporophytic** and the haploid **gametophytic**.
- These **sporophyte** and **gametophyte** alternate with each other. Their length and nature (free living or dependent) very among different group of plants.




## 02. ALGAE

**General Characters :** Algae are chlorophyll – bearing, **simple, thalloid, autotrophic and largely aquatic** (both fresh water and marine) organisms.




- They occur in a variety of other habitats : moist stones, soils and wood. Some of them also occur in **association with fungi (lichen) and animals (*e.g*. On the sloth bear, *Cyanoderma* and *Trichophilus* are present)**

**Nature :-**

- Algae are found in **both fresh** and **marine water**. Algae are found in many forms like **filamentous** (*Ulothrix* and *Spirogyra*), **colonial** (*Volvox*) and microscopic **unicellular** form like *Chlamydomonas*. A few of the marine forms like *Ulothrix* and *Spirogyra*.
- A few of the marine forms such as kelps, form massive plant bodies.
- Algae are surrounded by mucilaginous sheath and below the sheath cell wall is present which is made up of **cellulose, galactans, mannans and minerals.**
- Body of algae is thallus or thallus like (thalloid) *i.e.,* plant body is not differentiated in leaves, stem and roots.

- On the basis of nutrition, algae are **photoautotrophic (Oxygenic phototrophs)**. They have plastid in which photosynthetic pigments are present.
- Plant body of maximum algae is made of haploid cells.
- Algae are non-vascular plants means they don't have vascular tissues.

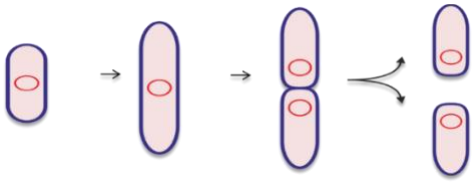
## Reproduction :

(a) Vegetative

(b) Asexual

(c) Sexual

**(a) Vegetative reproduction :**

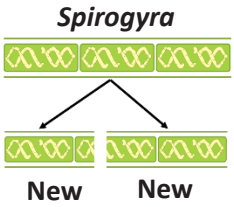


It is of following type –

**(i) Binary fission** - Cell is divided into **two parts**.

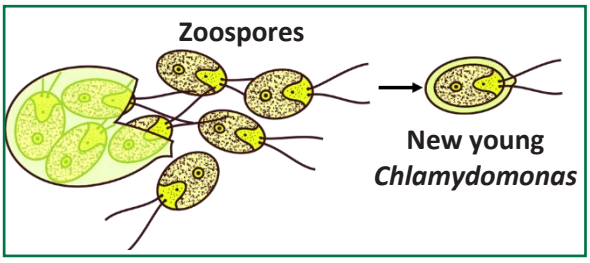
***e.g.*** Found only in Unicellular algae.

**(ii) Fragmentation** - In filamentous algae their filaments break down into **small pieces** & form new filaments. ***e.g.*** All filamentous algae.




**(b) Asexual reproduction :**

- **Zoospores (motile)** are formed in **favourable** conditions. They are flagellated (motile) and on germination gives rise to new plants.
- Hypnospore, aplanospore and Akinete are formed in **unfavourable** condition.



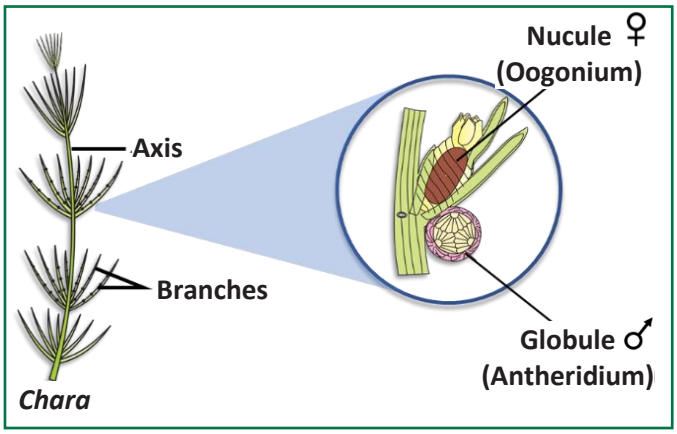

**Aplanospore**
(Thin walled spores)

**Hypnospore**
(Thick walled spores)

**Akinetes**
(Mother cell converts into thick walled spores)

**(c) Sexual Reproduction :**

- Gametic fusion occurs in sexual reproduction. Male sex organ is called **antheridium** and female is called **oogonium.** The sex organs of algae are **unicellular** & **jacketless**, so more correctly they are called male sex cells and female sex cells respectively.




***Chara*** :- Sex organs are **multicellular** and **jacketed**

## Sexual Reproduction is of Three Types :

- **Isogamy :** It is the simplest way of sexual reproduction. In isogamy the fusing gametes are **morphologically** (*i.e.* shape, size, structure) **similar**. E.g. Flagellated isogamy in ***Ulothrix***

**Note :** In ***Spirogyra*** gametes are identical (Isogamy) and non-motile (Non-flagellated).

- **Anisogamy :** The fusing gametes are **morphologically dissimilar** (smaller - larger) **e.g. *Eudorina***
- **Oogamy :** It is the developed form of Anisogamy. Male **gamete is small and motile or immotile while female gamete is large and immotile**. In oogamy female gamete does not come outside the female reproductive cell and fertilisation takes place in sex organs or female reproductive cell only. **e.g. *Volvox, Fucus, Sargassum, Chara,* Red algae.**
- Different species of *Chlamydomonas* exhibit isogamy, anisogamy and oogamy so **complete evolution of sexual reproduction** can be seen in the single genus *Chlamydomonas*.

## Economic Importance of Algae :

**Algae are useful to man in a variety of ways :**

- ***Chlorella*** a unicellular alga rich in protein is used as food supplement even by space travellers.
- Many species of ***Porphyra, Laminaria*** and ***Sargassum*** are among the 70 species of marine algae used as food.
- **Certain marine brown and red algae produce large amount of hydrocolloids (water holding substances), *e.g.,* Algin (brown algae) and Carrageen (red algae, *Chondrus crispus*) are used commercially.**
- ***Gelidium and Gracilaria*** - Agar - Agar is a hydrocolloid (Water holding substance) is obtained from these red algae. It is used to prepare culture medium to grow microbes and in preparation of ice creams and jellies.

- **Alginates or Alginic acid** - Obtained from *Laminaria, Fucus* and *Macrocystis* and used for dentury measurement, polish and manufacturing of soap, ice-creams.
- **Iodine** and **Bromine** both are obtained from ***Laminaria.***
- At least a **half of the total carbon dioxide** fixation on earth is carried out by algae through **photosynthesis**. Being photosynthetic, they increase the level of dissolved oxygen in their immediate environment.
- They are of paramount importance as **primary producers** of energy-rich compounds which form the basis of the food cycles of all aquatic animals.

**NCERT Question :**

What is the basis of classification of algae?

## Algae - Classes (Chlorophyceae, Phaeophyceae and Rhodophyceae) :

**Algae are divided into following classes mainly on the basis of photosynthetic pigments –**

| | | |
|---|---|---|
| (A) CHLOROPHYCEAE | – | Green algae |
| (B) PHAEOPHYCEAE | – | Brown algae |
| (C) RHODOPHYCEAE | – | Red algae |

## (A) CHLOROPHYCEAE (GREEN ALGAE) :

- They are usually **grass green** due to the dominance of pigments chlorophyll **a** and **b.**
- Green algae are the **most advanced algae**. It is believed that green algae are the **ancestors** of the higher plants.

**Habitat :** Green algae are cosmopolitan in nature, fresh, brackish, and salty water.

**Structure :** Green algae usually have a rigid cell wall made up of an inner layer of **cellulose** and outer layer of **pectose**.

**Green algae are found in many forms:**

**(i) Unicellular :-**

***e.g. Chlamydomonas*** - Motile unicellular algae. These algae move with the help of flagella.

***Chlorella*** – non motile algae

**(ii) Colonial :-** ***e.g. Volvox*** - Motile colony

**(iii) Multicellular filamentous :-** Mostly the green algae are multicellular and filamentous.

***e.g. Ulothrix, Spirogyra*** (Unbranched filamentous), ***Chara*** (Branched filamentous)

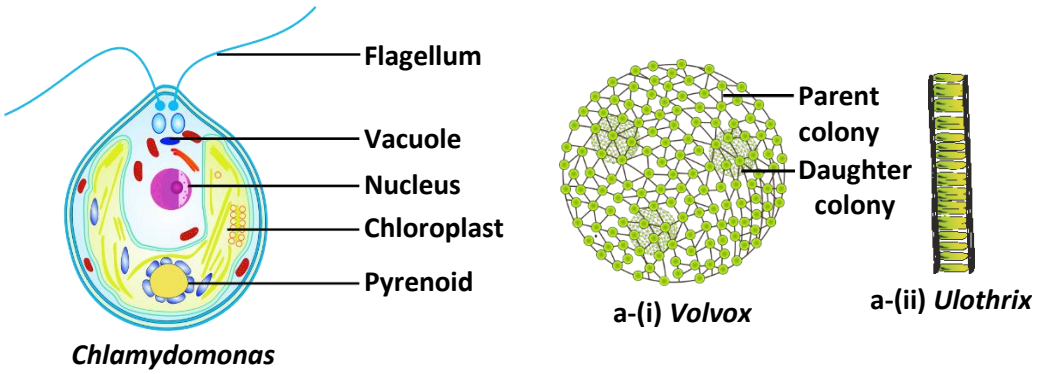



**Figure 3.1 Algae : (a) Green algae (i) *Volvox* (ii) *Ulothrix***

**Photosynthetic Pigments :**

- The pigments are localised in definite chloroplasts. The chloroplast may be discoid, reticulate, cup shaped, spiral or ribbon shaped in different species.

| | |
|---|---|
| **Chlorophyll** | **Chl 'a' and Chl 'b'** |
| **Carotene** | **β-carotene** |
| **Xanthophyll** | **Yellow coloured (Luteoxanthin, Violaxanthin)** |

**Stored food** – Most of the members of green algae have starch as stored food and some have oil droplet also.

**Vegetative reproduction** — **By fragmentation**

**Asexual reproduction** — **Zoospores** are formed in favourable condition (Zoosporangia). Aplanospore, Hypnospore, Akinete are formed in unfavourable condition.

**Sexual reproduction** — Sexual reproduction shows considerable variation in the type and formation of sex cell and it may be **isogamous, anisogamous or oogamous**.

- On the basis of pigments (**Chl 'a', Chl 'b'**, Carotenoids), stored food (**starch**) & cell wall (made up of **cellulose and pectose**), green algae are considered similar to higher plants.
- Most of the members have one or **more** storage bodies called **Pyrenoids** located in the chloroplasts. Pyrenoids contain **protein besides starch**.

Some commonly found green algae are: *Chlamydomonas, Volvox, Ulothrix, Spirogyra* and *Chara*

## (B) PHAEOPHYCEAE (BROWN ALGAE) :

**Brown algae or Sea weeds**

**Habitat :** The members of Phaeophyceae are found primarily in marine habitats.

**Structure :** Brown algae show great variation in size and form. They range from simple branched, filamentous **form** (*Ectocarpus*) to profusely branched forms like **Kelps.**

- Brown algae are the **largest** in size (up to 100 meter in length) (**Kelp**).
- The plant body is usually attached to substratum by a **holdfast** and has a **stalk (stipe)** and leaf like photosynthetic part, **frond or lamina**, so brown algae are also known as **leafy algae**. (*e.g.* ***Laminaria***)
- The vegetative cells have a **cellulosic wall** usually covered on the outside by a gelatinous coating of algin. In brown algae protoplast contains plastid, centrally located vacuole and nucleus. *e.g.* ***Fucus, Dictyota, Ectocarpus***

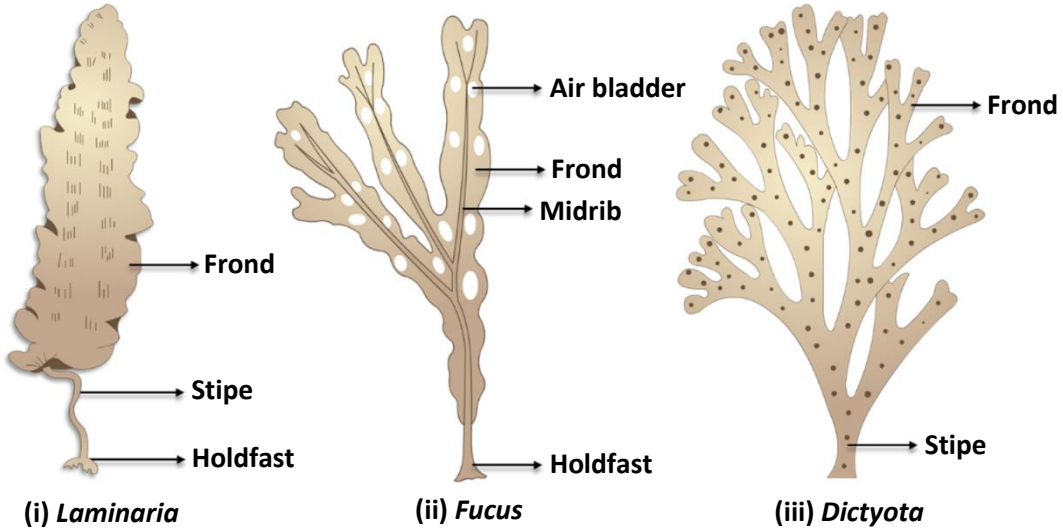



**Figure 3.1 Algae : (b) Brown algae (i) *Laminaria* (ii) *Fucus* (iii) *Dictyota***

**Gelatinous Coating/Phycocolloids/Hydrocolloids :** Gelatinous coating made up of algin has very high-water holding capacity.

- **Phycocolloids (Algin)** protects brown-algae against desiccation and shocks. Phycocolloids are used in ice-cream as thickening agent. **Algin or Alginate salt** is used for dentury measurement.
- Algin is used in the manufacturing of soap, ice-cream, polish, cream and plastic.

**Pigments :**

Chlorophyll - Chl 'a', Chl 'c'

Carotene - Only β-carotene

Xanthophylls - Mainly Fucoxanthin (brown colour)

**Stored food :** Food is stored as complex carbohydrates, which may be in the form of **Laminarin and mannitol**.

**Vegetative reproduction:** By fragmentation

**Asexual reproduction:** In most brown algae it is by **biflagellate zoospores** that are **pear- shaped** and have two unequal laterally attached flagella.

**Sexual reproduction :** it may be isogamous, anisogamous or oogamous. Union of gametes may take place in water or within the oogonium (oogonium species).

- Gametes are **pear shaped (pyriform)** and have two unequal laterally attached flagella.
- **Kelps: Profusely branched and giant algae are known as kelps.**

The common form are *Ectocarpus, Dictyota, Laminaria, Sargassum and Fucus.*

## (C) RHODOPHYCEAE (RED ALGAE) :

- **Commonly called red algae because of the pre-dominance of the red pigment r-Phycoerythrin in their body.**
- Red algae are ancient (**Primitive**) algae.
  ***e.g.*** *Polysiphonia*
- There is **no motile stage** found in life cycle of red algae *i.e.* cilia & flagella are absent.
- Some of them have complex body organisation.

**Habitat** : Majority of the red algae mainly found in marine water with greater concentration found in the warmer areas.

**Structure:**

- The red thalli of the red algae are **multicellular**.
- Cell wall made up of **cellulose and pectin and polysulphate esters**.

**Pigment:**

**Chlorophyll – Chl 'a' and Chl 'd'**

**Carotenes – β- carotene**

**Phycobilins – r - phycoerythrin (red coloured) and r- phycocyanin (blue coloured)**

- Red algae occur in both well lighted regions close to the surface of water and also at great depths in ocean where relatively little light penetrates.
- R- phycoerythrin give them to ability to photosynthesize even in deep areas.

**Stored food :**

**Floridean starch -** The food is stored as floridean starch which is structurally similar to glycogen and amylopectin.

**Reproduction :**

**Vegetative reproduction:** Red algae usually reproduce by by fragmentation.

**Asexual reproduction:** They reproduce asexually by non-motile spores.

**Sexual reproduction:** Sexual reproduction is oogamous and accompanied by complex post fertilization developments (non-motile gamete). Gametes produced in red algae are non-motile means, without cilia or flagella.

The common members are: *Polysiphonia, Porphyra, Gracilaria* and *Gelidium*.

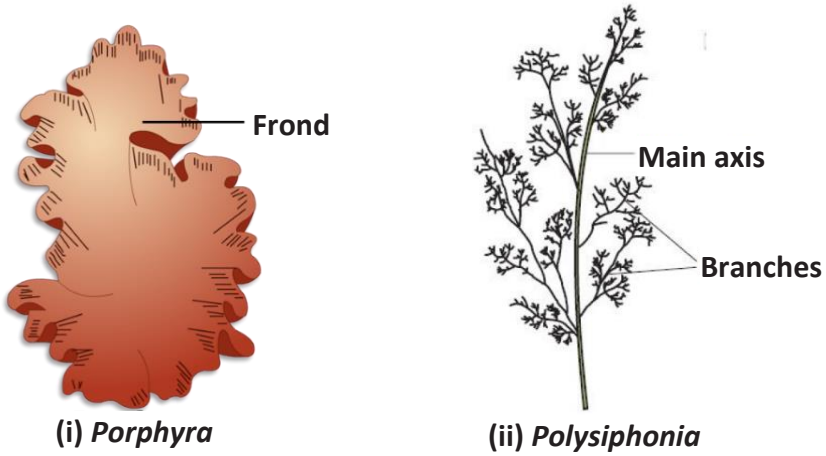



**Figure 3.1 Algae : (c) Red algae (i) *Porphyra* (ii) *Polysiphonia***

**NCERT Question :**

Differentiate between the red algae and brown algae.

**CLASSES OF ALGAE AND THEIR MAIN CHARACTERISTICS**

| Classes | Common Name | Major Pigments | Stored Food | Cell Well | Flagella Number and Position of Insertion | Habitat |
|---|---|---|---|---|---|---|
| **Chlorophyceae** | Green algae | Chlorophyll a, b | Starch | Cellulose and Pectose | 2-8, equal, apical | Fresh water brackish water, salt water |
| **Phaeophyceae** | Brown algae | Chlorophyll a, c fucoxanthin | Mannitol, laminarin | Cellulose and algin | 2, unequal lateral, | Fresh water (rare) brackish water, salt water |
| **Rhodophyceae** | Red algae | Chlorophyll a, d, phycoerythrin | Floridean starch | Cellulose and Pectin with Polysulphate ester | Absent | Fresh water (some), brackish water, salt water (most) |

★ Golden Key Points ★

- Algae are chlorophyll-bearing, simple, thalloid, autotrophic and largely aquatic (both fresh water and marine) organisms.
- *Chlorella* a unicellular alga rich in proteins is used as food supplement even by space travellers.
- The plant body is usually attached to the substratum by a holdfast, and has a stalk, the stipe and leaf like photosynthetic organ – the frond.
- The gametes or zoospores are pyriform (pear-shaped) and bear two laterally attached flagella.
- The members of Rhodophyceae are commonly called red algae because of the predominance of the red pigment, r-phycoerythrin in their body.
- Sexual reproduction is oogamous and accompanied by complex post fertilisation developments.
- Agar, one of the commercial products obtained from *Gelidium* and *Gracilaria* are used to grow microbes and in preparations of ice-creams and jellies.

## BEGINNER'S BOX-1 SYSTEMS OF CLASSIFICATION, TAXONOMY, ALGAE

**1.** According to Whittaker, kingdom plantae includes all :-
(1) Unicellular, eukaryotic autotrophic plants.
(2) Multicellular, eukaryotic, autotrophic plants.
(3) Multicellular, eukaryotic organisms.
(4) Unicellular/multicellular eukaryotic autotrophic plants.

**BPK381**

**2.** Which of the following thick walled spores protect the algae from unfavourable condition ?
(1) Pyrenoids
(2) Zoospore
(3) Hypnospores and Akinetes
(4) Zoospores and Aplanospores

**BPK382**

**3.** Which of the following is not found in algae ?
(1) Meiosis (2) Embryo (3) Zygote (4) Fertilization

**BPK383**

**4.** In *Spirogyra* isogametes are :-
(1) Non-flagellated (2) Single flagellated
(3) Biflagellated (4) Multiflagellated

**BPK384**

**5.** Coenobium is the colony of :-

(1) *Volvox* (2) *Spirogyra* (3) *Ulothrix* (4) *Acetabularia*

**BPK385**

**6.** Globule and nucule are sex organs of :

(1) *Chlorella* (2) *Acetabularia* (3) *Chara* (4) *Ulva*

**BPK386**

**7.** Red algae is used to obtain :-

(1) Agar (2) Carrageen (3) Citric acid (4) Both (1) & (2)

**BPK387**

**8.** Cytological information's like chromosome number, structure and behaviour are related with

(1) Numerical taxonomy (2) Cytotaxonomy

(3) Chemotaxonomy (4) All of these

**BPK388**

**9.** Chemotaxonomy is connected with :-

(1) Classification of plants on the basis of chemicals found in them.

(2) Use of chromosome structures.

(3) Application of chemicals for experiment.

(4) Use of statistical methods in chemical yielding plants.

**BPK389**

**10.** Which of the following is a practical significance of taxonomy?

(1) To know the use of plants.

(2) Identification the unknown organism.

(3) To increase the number of organisms.

(4) None of these.

**BPK390**

**11.** Which of the following are internal characters of the plants?

(1) Ultra structure (2) Anatomy

(3) Phytochemistry (4) All of the above

**BPK391**

**12.** Which of the following algae is used by space travellers as a food ?

(1) *Chlorella* (2) *Gelidium* (3) *Fucus* (4) *Volvox*

**BPK392**

**13.** Agar-agar is obtained from: -

(1) *Porphyra* (2) *Laminaria* (3) *Gracilaria* (4) *Fucus*

**BPK393**

**14.** Which of the following is not an edible alga ?

(1) *Porphyra* (2) *Laminaria* (3) *Sargassum* (4) *Fucus*

**BPK394**

**15.** *Gelidium* is a :-

(1) Brown algae (2) Green algae

(3) Brown algae and green algae (4) Red algae

**BPK395**

**16.** **Assertion (A) :** Phaeophyceae are brown algae.

**Reason (R) :** Phaeophyceae contain large amount of xanthophyll pigment called fucoxanthin which gives brown colour.

(1) If both the Assertion and the Reason are true and the Reason is a correct explanation of the Assertion.

(2) If both the Assertion and Reason are true but the Reason is not a correct explanation of the Assertion.

(3) If the Assertion is true but the Reason is false.

(4) If both the Assertion and Reason are false.

**BPK396**

**17.** Match the column-I and column-II and choose the **correct** combination from the options given:

| Column-I | | Column-II | |
|---|---|---|---|
| (a) | Chlorophyceae | (i) | Chlorophyll a, c |
| (b) | Phaeophyceae | (ii) | Chlorophyll a, d |
| (c) | Rhodophyceae | (iii) | Chlorophyll a, b |

(1) a-iii, b-i, c-ii (2) a-i, b-iii, c-ii

(3) a-ii, b-i, c-iii (4) a-iii, b-ii, c-i

**BPK397**

**18** **Statement-I :** At least 50% of $CO_2$ on earth is fixed by Algae.

**Statement-II :** Brown algae such as *Gelidium* and *Gracilaria* are used in preparations of ice-cream and jellies.

(1) Statement-I & Statement-II both are correct.

(2) Statement-I is correct & Statement-II is incorrect.

(3) Statement-I is incorrect & Statement-II is correct.

(4) Both Statement-I & Statement-II is incorrect.

**BPK398**

**NCERT Question :**

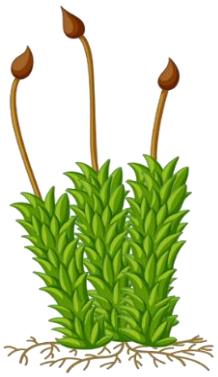
Explain briefly the following terms with suitable examples:-

(i) Protonema (ii) Antheridium (iii) Archegonium (iv) Diplontic (v) Sporophyll (vi) Isogamy

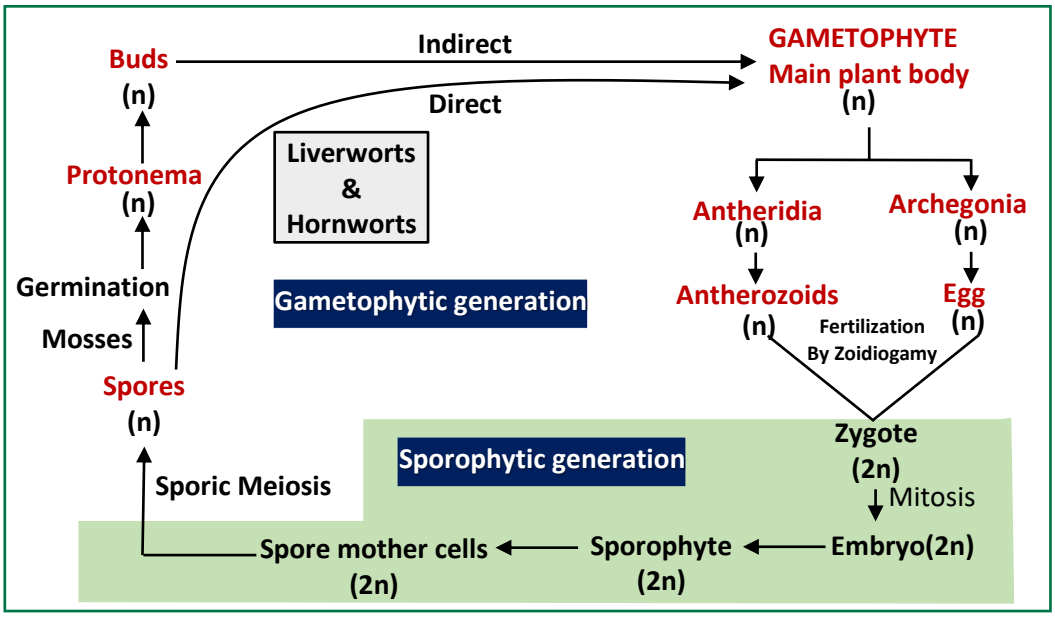
## 03. BRYOPHYTES

### (A) GENERAL CHARACTERS AND LIFE CYCLE :

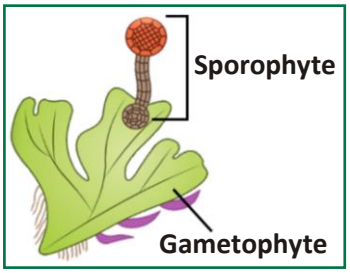
- Bryophytes are the **first land plants**. It is believed that, they originated from aquatic plant.
- Bryophytes are **not** considered as the **successful land** plants because vascular tissue is absent and they need water for fertilisation.
- Bryophytes are known as **amphibians of the plant kingdom**, because these plants can live in soil but are dependent on water for fertilisation.
- **They lack true roots, stem or leaves. They may possess root-like, leaf-like or stem-like structures.**
- Bryophytes are **Sciophytes**, *i.e.* bryophytes prefer to grow in **cool, moist** (wet) and **shady** places.
- Bryophytes in general are of little economic importance but some mosses provide food for herbaceous mammals, birds and other animals.
- The water conducting tissue in Bryophyta is **parenchyma**.
- Bryophytes include the various mosses and liverworts that are found commonly growing in **moist and** shaded areas in the hills.



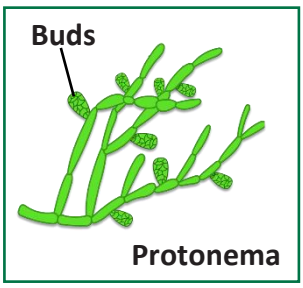
**Life Cycle of Bryophytes :**



- The main plant body of bryophyte is **haploid**. It produces gametes, hence is called a gametophyte.
- Sex organs are formed on gametophyte. Sex organs are **multicellular and jacketed** in bryophytes. Male sex organ is called **antheridium** and female sex organ is called **archegonium**. An archegonium is **flask** shaped and produce single egg.
- The male gametes of bryophytes are **motile**. These motile male gametes are called as **antherozoids**. Antherozoids are usually **comma shaped** and **biflagellate**. Female gamete is called egg or ovum.




- In Bryophyta, fertilization is performed by **zoidogamy** i.e. male gamete swims into water to reach the female gametes and fertilizes it.
- As a result of the fertilization, a diploid zygote is formed. Zygotes do not undergo reduction division (meiosis) immediately.
- Zygote forms embryo and then sporophyte by mitosis. The zygote initiates the sporophyte generation. **Sporophyte** generation is a **diploid** stage.
- The sporophyte is not free-living but attached to the photosynthetic gametophyte and derives nourishment from it. The sporophyte of Bryophyta is not made of **root, stem and leaves**, but it is made of **foot, seta and capsule**, so it is known as **sporogonium**. Some cells present in capsule of sporophyte function as **spore mother cells**. Now meiosis takes place in spore mother cells. to form haploid spores.
- **In bryophyta the sporophyte is dependent on gametophyte. This is a unique character of bryophyta.**
- The germination of spores is **direct or indirect**. In **liverworts** the germination of spore is direct *i.e.* each spore forms a **gametophyte or a thallus** after germination. The germination of spores in **mosses is indirect**. In mosses a multicellular filament is formed after the germination of spore. This filament is known as **protonema**.

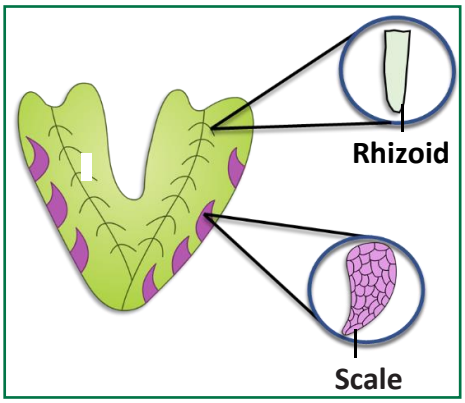



- Protonema developed from spores is called **primary protonema** and the protonema developed from parts other than spores are known as **secondary protonema**.
- Protonema is creeping, green, branched and filamentous.

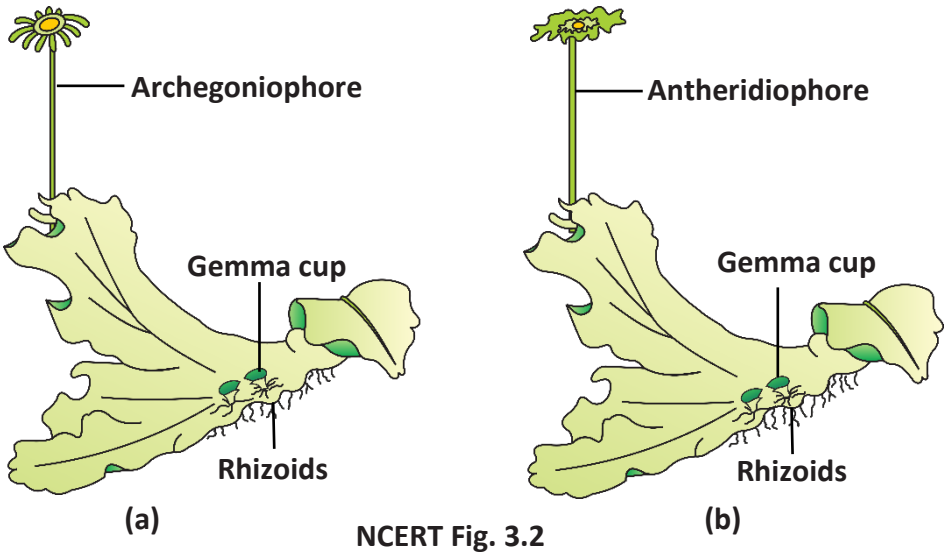
- Now lateral buds are formed on protonema. Each bud develops and forms a gametophyte plant. Indirect germination is best for survival. Mosses are gregarious in nature because they appear in group.

## (B) LIVERWORTS :

- Bryophytes included in this class have shape like liver (*e.g., Marchantia*) or flat (*e.g. Riccia*) so they are known as liverworts.
- Plant body of this group is **thallus** like. The thallus is dorsiventral and closely appressed to the substrate.. **Rhizoids** and scales are present on thallus. Rhizoids are **unicellular** and **unbranched**. Scales are **multicellular** and protective in functions.
- The **leafy members** (*e.g. Porella*) have tiny leaf like appendages in two rows on the stem like structures.
- The sporophyte of Liverworts is **completely dependent** on gametophyte i.e. it is dependent on gametophyte for food, water and habitat.
- The sporophyte of Liverworts is made up of **foot, seta** and **capsule**, after meiosis, spores are produced within the capsule. These spores germinate to form **free- living gametophytes**.




- True elaters are present in sporophyte of some members of liverworts. Elaters are hygroscopic and they help in dispersal of spores.
- **Asexual (vegetative)** reproduction in Liverworts takes place by fragmentation of thalli, or by the formation of specialised structures called gemmae (sing. **Gemma**). Gemmae are **green, multicellular, asexual buds**, which develop in small receptacles called Gemma cups located on the thalli. The **gemmae** become detached from the parental body and germinate to form new individuals. ***e.g.*** *Marchantia*
- During sexual reproduction male and female sex organs are produced either on same (***e.g.*** *Riccia*) or on different thallus (***e.g.*** *Marchantia*).

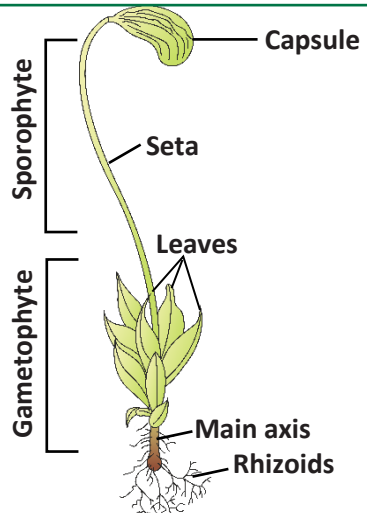



NCERT Fig. 3.2
Bryophytes: A liverwort – *Marchantia*
(a) Female thallus (b) Male thallus Mosses

**NCERT Question :**

Differentiate between the liverworts and moss.

## (C) MOSSES :



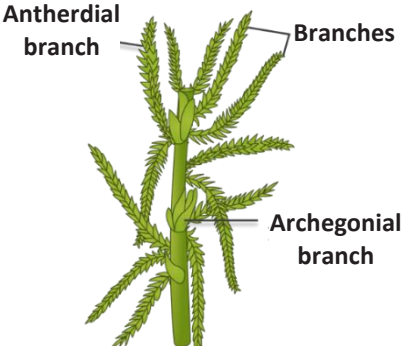

NCERT Fig. 3.2 (c) *Funaria*, gametophyte and sporophyte

- The predominant stage of the life cycle of a moss is the gametophyte which consist of two stages. The first stage is the **protonema** stage, which develops directly from a spore. It is creeping, green, branched and frequently filamentous stage.
- The **second stage** is the leafy stage, which develops from the secondary protonema as a lateral **bud**. They consist of upright, slender axes bearing spirally arranged leaves.
- The main plant body or gametophyte of mosses is made up of stem like, leaf like and **rhizoids** (roots like). They are attached to the soil through rhizoids. The rhizoids present in the class are **multicellular, branched and obliquely** septate.
- Vegetative reproduction in mosses is by **fragmentation** and **budding** in the secondary protonema.

- In sexual reproduction, the sex organs **antheridia** and **archegonia** are produced at the apex of the leafy shoots. After fertilization, the zygote develops into a sporophyte, consisting of a foot, seta and capsule. The capsule contains **spores**. Spores are formed after meiosis.
- The sporophyte in mosses is more elaborated (developed) than that in liverworts.
- The sporophyte of mosses is also **partially dependent (semi parasite)** like that of hornworts. *i.e.* it is photosynthetic. The Mosses has an elaborate mechanism of spore dispersal.
- **Peristomial teeth** are present in moss sporophyte which help in spore dispersal.
- **Common example of mosses are *Funaria*, *Polytrichum* and *Sphagnum*.**

### *Sphagnum :*

- **Peat moss –** It is a fossil fuel that obtained from bog. The formation of peat takes place by the fossilization of ***Sphagnum* –** *Sphagnum* grows in acidic bog. The number of bacteria is less in bog due to which the degradation of dead cell could not takes place. Hence it is present in the form of fossil.
- **Absorbent cotton : *Sphagnum*** can absorb water in very high amount, therefore it is used in the form of absorbent cotton in Europe.



***Sphagnum* gametophyte**
**NCERT Fig. 3.2**
**(d) *Sphagnum* gametophyte**

- Bryophytes in general are of little economic importance but some mosses provide food for **herbaceous mammals, birds** and other **animals**. Species of Sphagnum, a moss, provide **peat** that have long been used as **fuel**, and because of their capacity to hold water as packing material for **trans-shipment** of living Mosses along with **lichens** are the first organisms to colonise rocks and hence, are of great ecological importance. They decompose rocks making the substrate suitable for the growth of higher plants. Since mosses form dense mats on the soil, they reduce the impact of falling rain and prevent **soil erosion**.

## 04. PTERIDOPHYTES

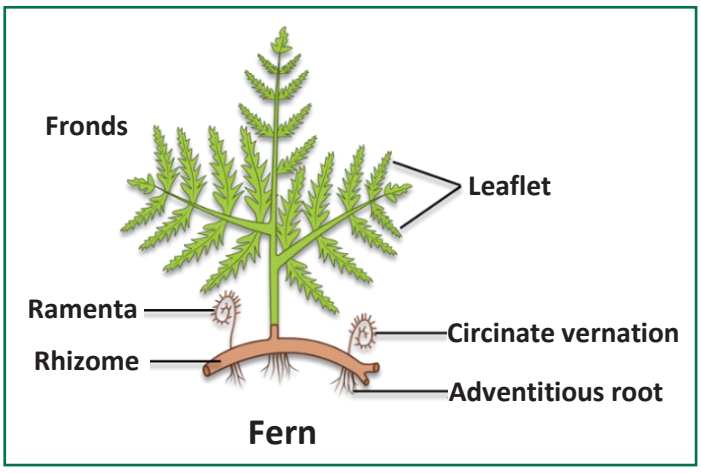
### (A) GENERAL CHARACTERS :

**Pteridophyte** Ptero = wings (Feathers), phyta - plants

- They are beautiful **non seeded** first vascular plants on the earth.
- Pteridophytes include **whisk ferns**, **club mosses, horse tails** and **ferns**. They are used form **medicinal purpose** and as **soil binders** and also frequently grown as **ornamentals**.
- Evolutionarily they are **first terrestrial plants** to possess vascular tissues – **xylem** and **phloem**.
- Pteridophytes are found in cool, damp, and shady places but some may grow well in sandy soil conditions also.
- You know in bryophytes, dominant phase in their life cycle is the **gametophytic** plant body but in pteridophytes the main plant body is a **sporophyte** which is differentiated into true **root, stem**, and **leaves.**
- These organs have well differentiated **vascular tissues**. In both pteridophyte and gymnosperms, **xylems lacks vessels** and **phloem lacks sieve tubes** and **companion cells**.
- **Cambium** is also **absent** in pteridophytes, so they generally do not exhibit **secondary growth** therefor they are herbs or shrub like plants.
- Pteridophytes are not **completely successful land plants** because they also need **water for fertilisation**.
- On the basis of leaves, pteridophytes are of two types :-

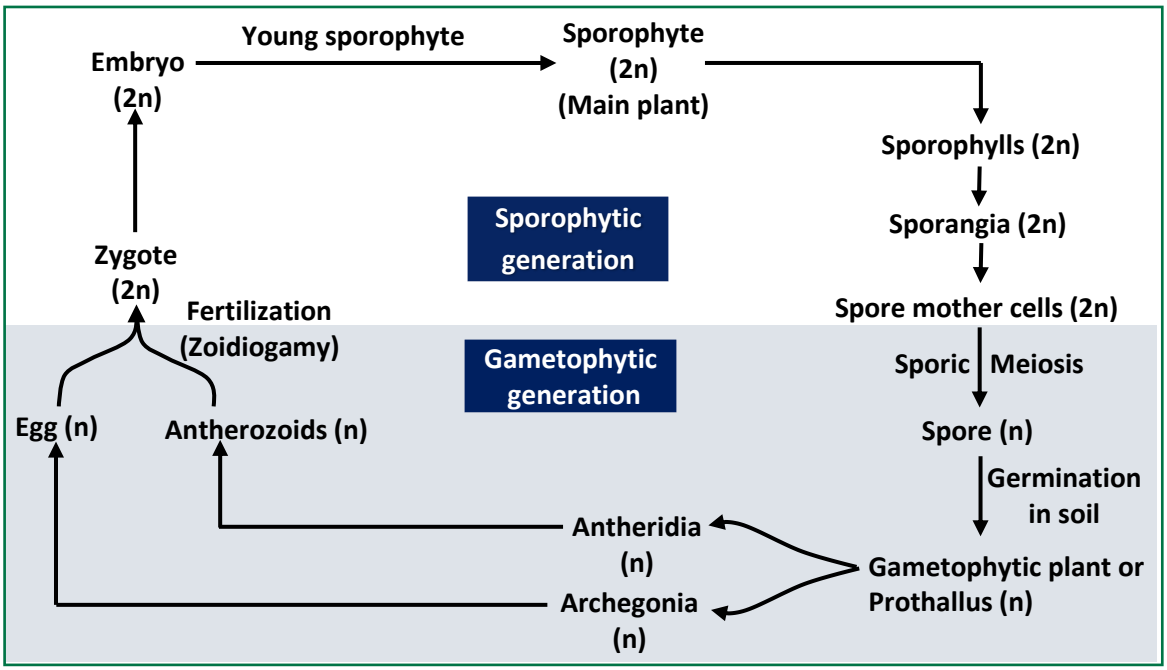
  **First** in which stem is smaller while leaves are larger. They are known as **megaphyllous** pteridophytes. *e.g.* **Ferns**

  **Second,** in which stem is larger and leaves are smaller. They are called as **microphyllous** pteridophytes. *e.g.* ***Selaginella***
- Stem is erect or prostrate. When the stem is underground, it is known as **rhizome.**



Fern

## (B) LIFE CYCLE OF PTERIDOPHYTES :

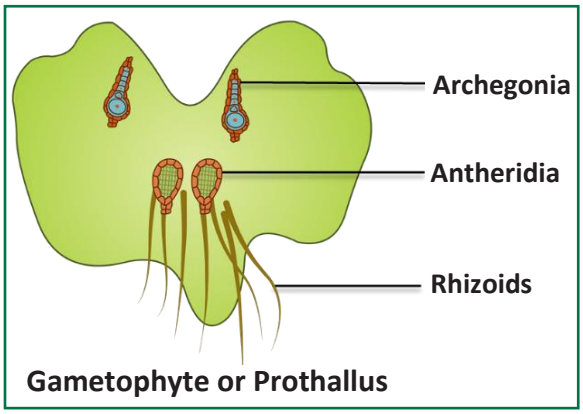



- The sporophyte bear sporangia that are subtended by leaflike appendages called sporophyll.
- Plant is **sporophyte**. *i.e.* made of diploid cell and it reproduce by spore formation. Formation of spores takes place in **sporangia**. Sporangia are mostly formed on leaves.
- Most of the pteridophytes are **homosporous** *i.e.* only one type of spores are formed during reproduction.

  **Exception** - Some pteridophytes are **heterosporous** *i.e.* two types of spores microspores and megaspores.
- Green and normal photosynthetic leaves are known as trophophylls or foliage or vegetative leaves, and the leaves on which sporangia are formed are called **sporophylls (reproductive leaves)**. Sporangia are present in groups these groups are called sorus (Plural-sori). Sori are found on **sporophylls**.
- **In ferns, sporophylls are also photosynthetic. This is a unique character of them, otherwise sporophylls are generally non green.**
- Spore mother cells are present in sporangia. Spores are formed within **sporangium** by **meiosis** in spore mother cells and these spores start the gametophytic generation.
- In soil, **small** but **multicellular, inconspicuous (unclear) and non-vascular thalloid gametophyte** is formed by the germination of each spore, which is also known as **prothallus**. The formation of gametophyte takes place in the soil therefore it is **free (independent)** and

**mostly photosynthetic**. These gametophytes require cool, damp, shady places to grow. Because of this specific restricted requirement and the need for water for fertilisation, the spread of living pteridophytes is limited and restricted to narrow geographical regions.

- There is no attachment between the main sporophytic plant and gametophyte plant hence both are free living and thus exhibit free living/independent generation (prothallus).
- On ventral side of prothallus rhizoid and sex organ are formed. Male sex organ is called **antheridium** and female sex organ is called as **archegonium**. The formation of male gametes takes place in antheridia which are called as antherozoids. Antherozoids are **spiral** and **multiflagellate** but exceptionally antherozoid of *Selaginella* are spindle shaped and **biflagellate**. A female gamete egg or ovum is formed in an archegonium.



Gametophyte or Prothallus

- Fertilization takes place by **zoidogamy** and zygote is formed as a result of fertilization. Zygote develops and forms an **embryo**. Now this embryo develops and forms young **sporophytic plant and also root, stem, leaves.**
- **In plant kingdom, gametophyte is always non-vascular**.

**NCERT Question :**

What is heterospory? Briefly comment on its significance. Give two examples.

**NCERT Question :**

Differentiate between the homosporous and heterosporous pteridophyte.

## Heterospory :

- In few pteridophytes two types of spores are formed *i.e.* microspore and megaspores in microsporangium and megasporangium respectively, this phenomenon is known as **heterospory** or heterosporous condition.
- Some heterosporous pteridophytes are : ***Selaginella, Salvinia, Marsilea***
- In heterosporous pteridophytes, microspore produces **male gametophyte** and megaspore produces **female gametophyte.**

- The development of zygote into young embryo takes place within the **female gametophyte**.
- This event is precursor of **seed habit** considered an important step in evolution.
- The female gametophytes in these plants are retained on the parent sporophyte for variable periods takes place inside **megasporangium.**
- Even than presence of heterosporous condition in pteridophyte, seed formation could not possible because -
- For seed formation integument megasporangium or ovule is necessary through which developing embryo can not come outside, and thus entire structure converts into seed.
- In heterosporous pteridophyte this megasporangium is not covered by the integuments, so seed formation is not formed in them.

## (C) CLASSIFICATION OF PETERIDOPHYTA :

**(i) Psilopsida**: This is the class of **most primitive vascular plants** and their body is made of stem (rhizome), scaly leaves and rhizoids.

***e.g.* *Psilotum* -A living fossil**

**(ii) Lycopsida**: Commonly known as **club moss**. Their body is made of root, stem and leaves (microphylls) Generally, they produce cones/strobili at top of stem or branches. Cones are aggregation of sporophylls. ***e.g.* *Lycopodium*** and ***Selaginella.*** *Selaginella* is pioneer of heterospory.

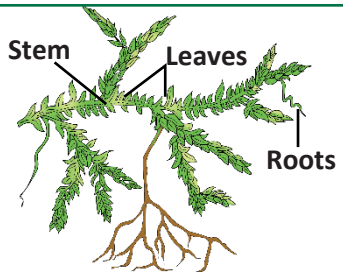
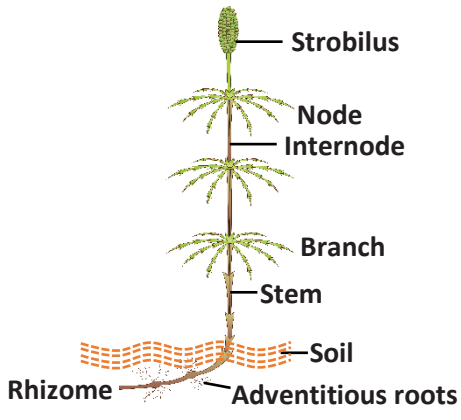



**Figure 3.3 Pteridophytes : (a) *Selaginella***

**(iii) Sphenopsida :** Commonly known as **horse tails**. Their body is made of root, stem, rhizome and scaly leaves. Stem is distinctly differentiated into nodes and internodes. They also form cone/strobillus at top of aerial stem. ***e.g.*** *Equisetum*



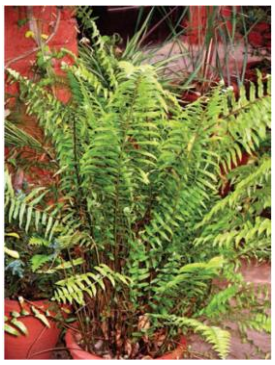

**NCERT Fig. 3.3 Pteridophytes : (b) *Equisetum***

**(iv) Pteropsida :**

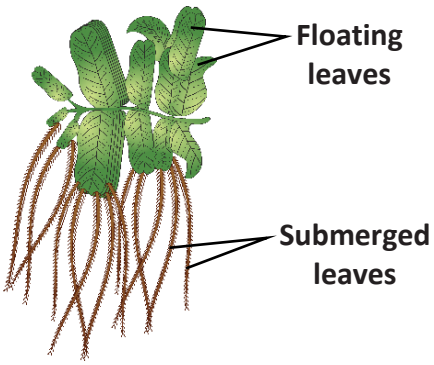
- Commonly known as ferns, they are very good **ornamental plants**.
- Body is made of root, stem, rhizome large leaves (**macrophylls or megaphylls**)
- Leaves are pinnately compound and circinately coiled in young stage, so known as **frond**.

**Examples :** *Azolla* (smallest fern), *Salvinia, Marsilea, Dryopteris, Pteris, Pteridium, Adiantum*.

- Most of fossil fuels (coal) we obtained presently is the result of fossilization of **giants ferns** (Pteridophytes).



Ferns




*Salvinia*

**Figure 3.3 Pteridophytes : (c) Ferns (d) *Salvinia***

**NCERT Question :**

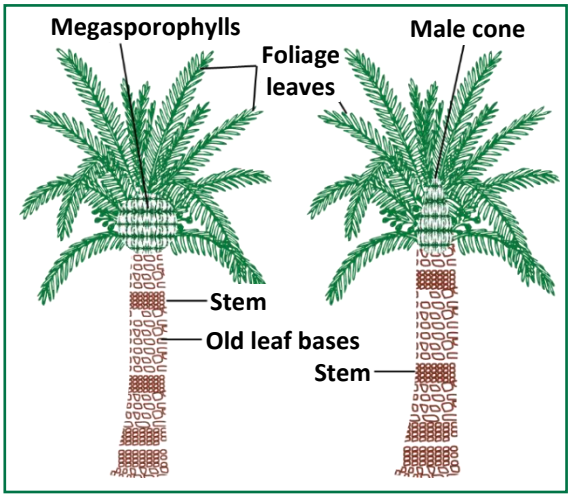
Both gymnosperms and angiosperms bear seeds, then why are they classified separately?

## 05. GYMNOSPERMS

### (A) GENERAL CHARACTERS :

- The gymnosperms (*gymnos* = naked, *sperma* = seed) and plants in which the **ovules are not enclosed** by any ovary wall and remain exposed, both before and after fertilization.
- First completely successful terrestrial plants.
- Hard, woody and tree habit-Arborescent nature. Gymnosperm are **only perennials in nature**.
- Main plant body of gymnosperm is divided in to **root, stem and leaves**.
- The roots are generally **tap roots**.

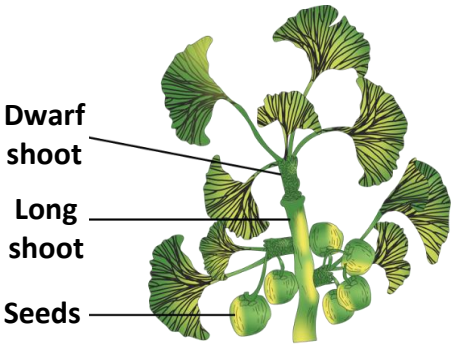
- Roots in some genera have fungal association in the form of **mycorrhiza** (***Pinus***), while in some others (***Cycas***) small specialised roots called **coralloid roots** are associated with $N_2$-fixing **cyanobacteria**
- In *Cycas* roots are of two types *i.e.* tap root and coralloid roots.
- The stems are **unbranched (*Cycas*) or branched (*Pinus*, *Cedrus*)**.
- The leaves may be **simple or compound.**
- In *Cycas* the **pinnate** leaves persist for a few years.
- The leaves in gymnosperms are **well-adapted to extreme conditions** like temperature, humidity and wind.




- In conifers the needle like leaves reduce the surface area, their thick cuticle and sunken stomata also help to **reduce water loss**.
- Gymnosperms are naked seeded plant *i.e.* **no fruit** formation takes place in these plants. In gymnosperm embryo & seed formation takes place but no fruit formation.
- Gymnosperms include **medium-sized trees or tall trees and shrubs**. One of the gymnosperms, the giant **redwood tree *Sequoia*** is one of the tallest tree species.

**(a) *Cycas***

**(b) *Pinus* monoecious plant**




**(c) *Ginkgo biloba***

**NCERT Fig. 3.4 Gymnosperms: (a) *Cycas* (b) *Pinus* (c) *Ginkgo***

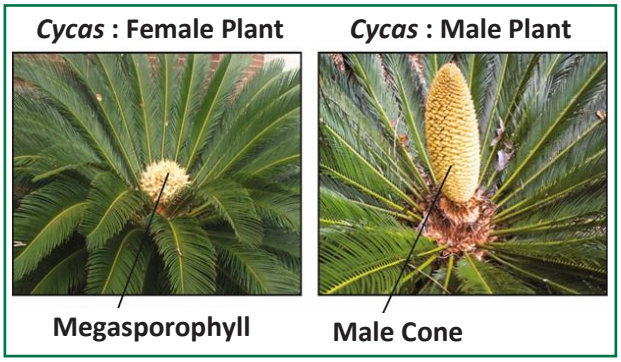
- All gymnosperms are vascular plants. Their xylem lacks **vessels** & phloem lacks **sieve tubes** and **companion cells**. Exceptionally in Gnetales order of gymnosperms, vessels are present.
- *Cycas* is a living fossil.

## (B) LIFE CYCLE OF GYMNOSPERMS :

(i) The main plant body in gymnosperm is **sporophyte** – and made of (2n) diploid cell. Most of Gymnosperms are Dioecious *i.e.* male and female plants are separate.

(ii) All the gymnosperms are heterosporous - *i.e.* two types of spores are formed during reproduction.

- **Microspores (male)**
- **Megaspores (female)**

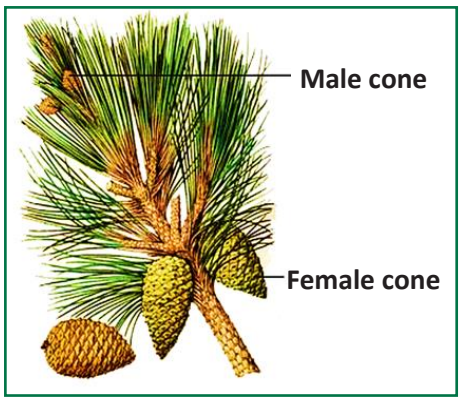



(iii) These two types of spores are formed in two different sporangia.

- Microspores are formed in **microsporangia.**
- Megaspores are formed in **megasporangia**. Megasporangia are integumented so they are called ovules.

(iv) These two different types of sporangia are formed on different sporophylls.

- Microsporangia are formed on **Microsporophylls.**
- Megasporangia are formed on **Megasporophylls**.




(v) These two types of sporophylls form **male cone** and **female cone** respectively. The Cones or strobili may form loose or compact cones.

(vi) **Microspores** are formed by **meiosis** in the cells of microsporangium. **Megaspores** are formed by meiosis in the cells of **megasporangium (ovule)**.

(vii) Microspores germinate and form **male gametophyte**. Male gametophyte is also called **Pollen grain**.

**Male gametophyte** forms male gametes.

**Antheridia are absent in gymnosperms. Pteridophyta is the last group with Antheridia**.

(viii) Male gametes are **motile** and **multiciliate** in very few gymnosperms like *Cycas, Ginkgo* while male gametes are **non-motile** in maximum higher gymnosperms *i.e.* cilia and flagella are absent.

(ix) Main body of ovule is made of a diploid tissue known as **nucellus or megasporangium**.

A cell of **nucellus acts as megaspore mother cell** which undergoes meiosis and forms four haploid megaspores, out of which only one remains functional and rest three degenerate.

This megaspore further develops into **female gametophyte or endosperm**.

- The cells of **female gametophyte or endosperm** behave like archegonial initials and form two or more archegonia.
- Archegonium - It forms egg (Female gamete)

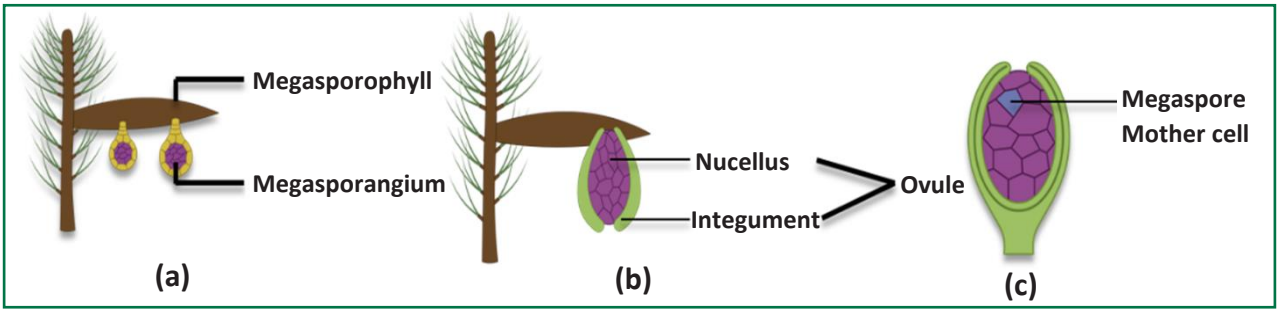
(x) Now Pollen grains reach the ovule by pollination. Pollination in gymnosperms is performed by wind (Anemophily).

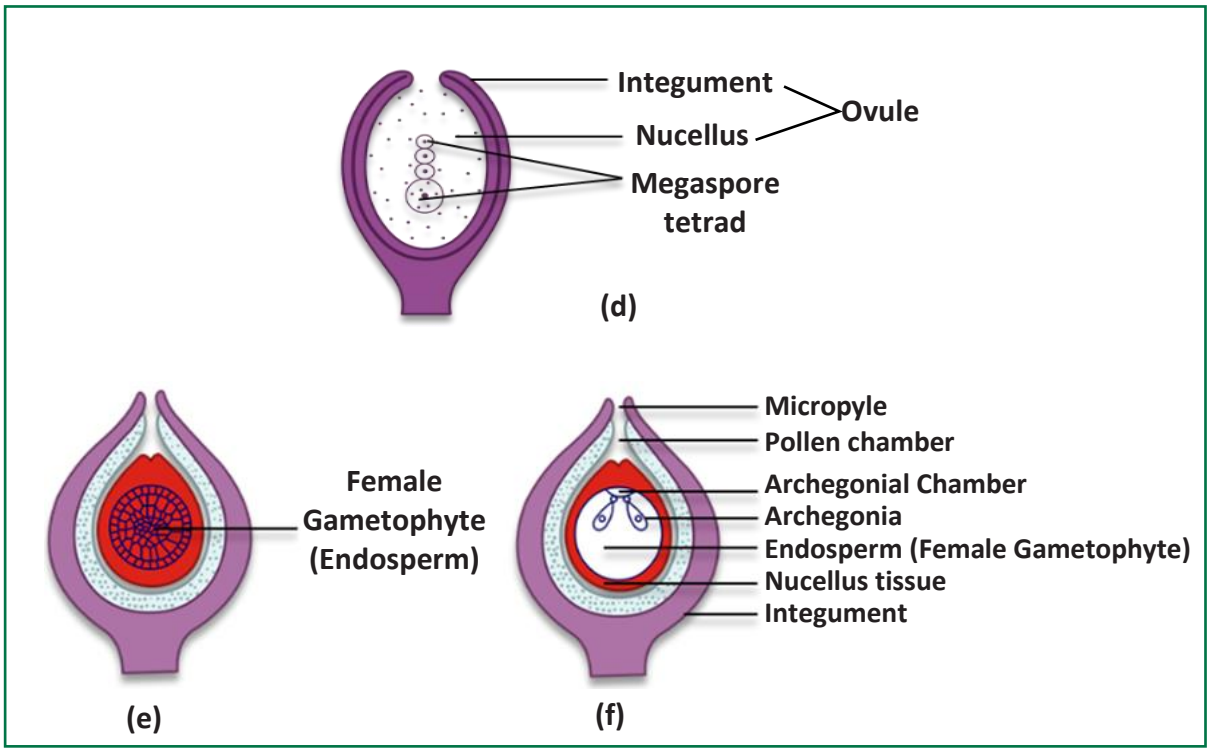
**Development of Zygote :**

(a) Embryo is formed by the development of zygote. After the formation of embryo, the ovule is called **seed** [seed - ovule with embryo].

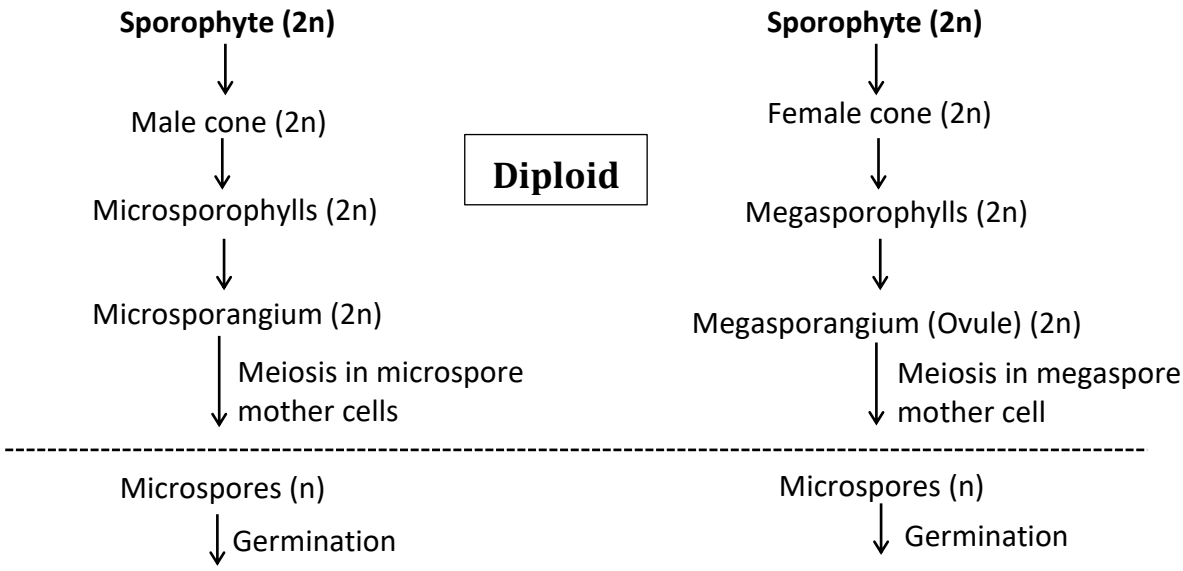
(b) Embryo is enclosed inside the seed. Now this seed ruptures by absorbing water and the embryo germinates to form a diploid plant (sporophyte).

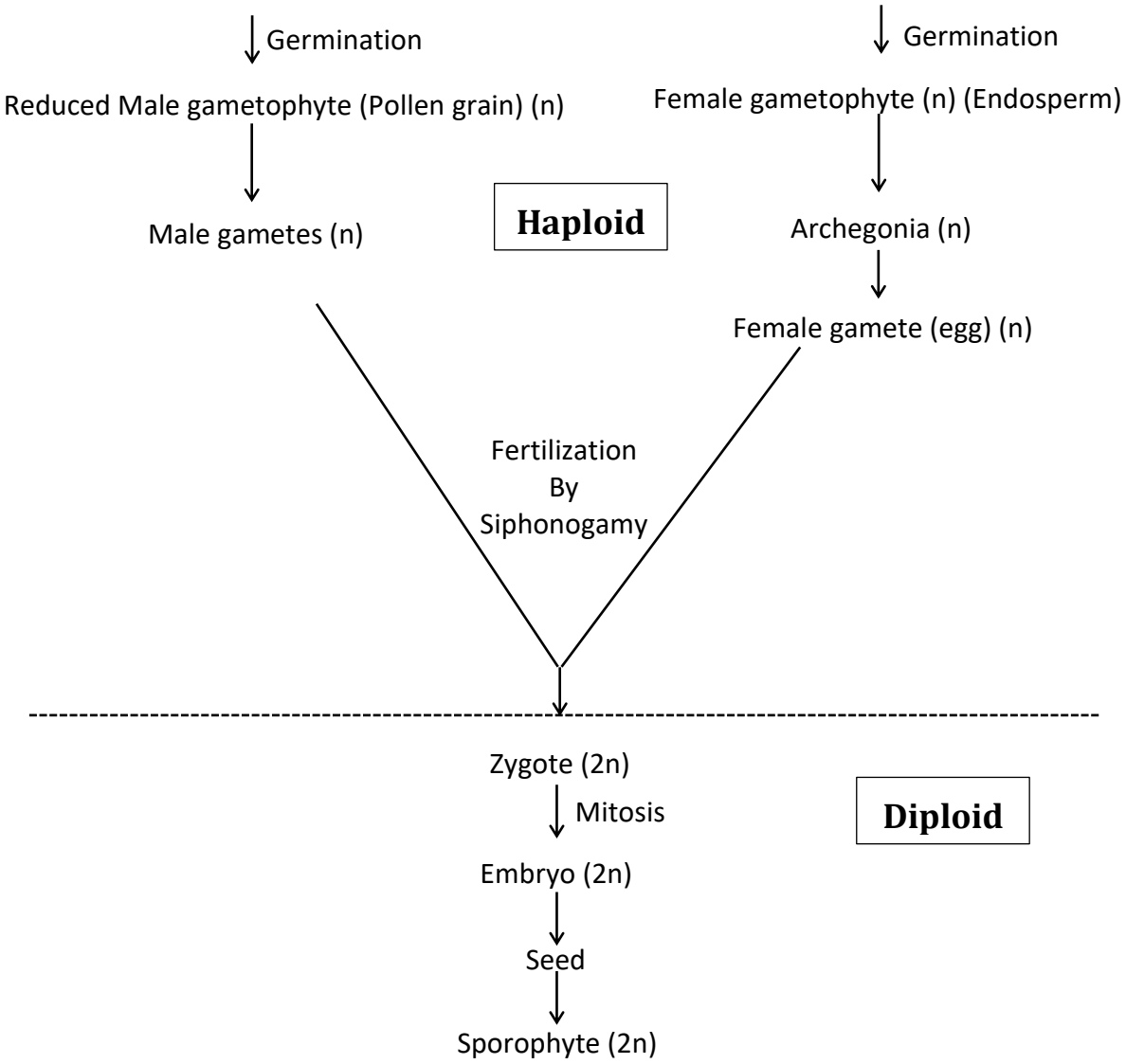
- **In bryophytes and pteridophytes, the male and female gametophytes have an independent free-living existence.**






- **In gymnosperm and angiosperm male and female gametophyte do not have free living existence. They remain within the sporangia retained on the sporophyte.**






- Economic importance of gymnosperms.
- Economic importance seeds.
- Dry fruits, medicinal importance, timber, wood.

**NCERT Question :**

Write a note on economic importance of algae and gymnosperms.

**NCERT Question :**

Mention the ploidy of the following: protonemal cell of a moss; primary endosperm nucleus in dicot, leaf cell of a moss; prothallus cell of a fern; gemma cell in *Marchantia*; meristem cell of monocot, ovum of a liverwort, and zygote of a fern.

**NCERT Question :**

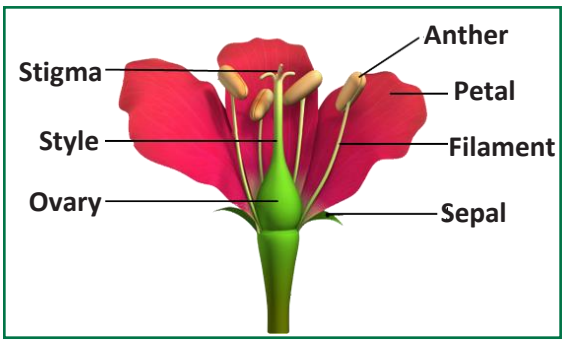
When and where does reduction division take place in the life cycle of a liverwort, a moss, a fern, a gymnosperm and an angiosperm?

**NCERT Question :**

Name three groups of plants that bear archegonia. Briefly describe the life cycle of any one of them.

## 06. ANGIOSPERMS

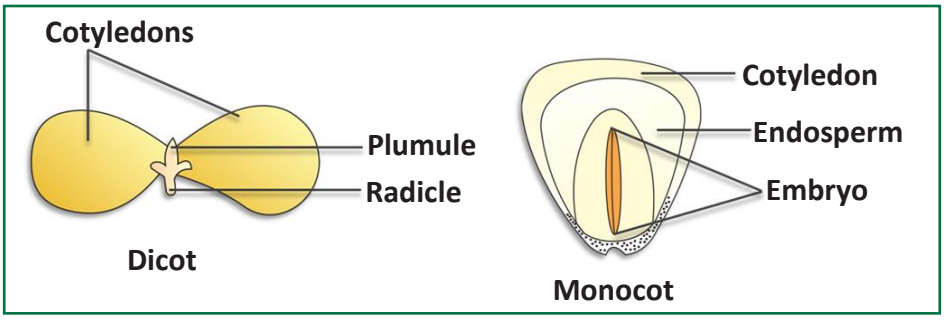
### General Characters :




- Angiosperms is a large group of plants, which occur in wide range of habitats.
- In the angiosperms or **flowering plants, the pollen grain and ovules are developed in specialised structure called flowers**.
- A typical flower is made up of **four whorls** viz; Calyx, corolla, Androecium, and Gynoecium.
- Calyx (sepal) and corolla(petal) are called **non-essential** or **accessory part** of the flower.
- Androecium and gynoecium are the essential parts of the flower.
- In angiosperms, the seeds are enclosed in **fruits.**
- They range in size from the **smallest *Wolffia*** to **tall trees of *Eucalyptus*** (over 100 meters).
- Angiosperms provide us with food, fodder, fuel: fertilization, fibers medicines and many other products.
- Angiosperms are of two types.

**(a) Dicotyledons** – The dicotyledons are characterised by seeds having two cotyledons *e.g.* **pulses.**

**(b) Monocotyledons** – The monocotyledons on the other hand are characterised by single cotyledonous seeds *e.g*. **Cereals & grasses**.



## BEGINNER'S BOX-2 BRYOPHYTA, PTERIDOPHYTA AND GYMNOSPERM

**1.** True elaters and gemmae are concerned with :-

(1) *Riccia* (2) *Marchantia* (3) *Anthoceros* (4) *Polytrichum*

**BPK399**

**2.** The sporophyte of mosses is :-

(1) Parasite (2) Semi-parasite (3) Free living (4) Most advanced

**BPK400**

**3.** In *Cycas* specialised roots are associated with $N_2$ fixing cyanobacteria, called :-

(1) Tap root (2) Coralloid root

(3) Adventitious root (4) All the above

**BPK401**

**4.** Which of the following fern spreads very fast by means of leaf tip ?

(1) *Pteridium* (2) *Azolla* (3) *Adiantum* (4) *Pteris*

**BPK402**

**5.** The functional megaspore of gymnosperm germinate :-

(1) Inside the megaspore mother cell

(2) Inside the megasporangium

(3) Inside the soil

(4) Into endosperm after fertilization

**BPK403**

**6.** Which of the following group of members have vessels in xylem exceptionally ?

(1) Ginkgoales (2) Coniferales (3) Gnetales (4) Cycadales

**BPK404**

**7.** A plant shows thallus level of organisation. It shows rhizoids and is haploid. It needs water to complete its life cycle because the male gametes are motile. Identify the group to which it belongs to:

(1) Bryophytes (2) Pteridophytes (3) Gymnosperms (4) Angiosperms

**BPK405**

**8.** Roots, stem and leaves, constitute the plant body of :-

(1) Pteridophytes (2) Gymnosperms (3) Angiosperms (4) All of these

**BPK406**

**9.** Protonema and prothallus are respectively :-

(1) Diploid and Haploid (2) Diploid and Diploid

(3) Haploid and Diploid (4) Haploid and Haploid

**BPK407**

**10.** In gymnosperms gametophyte are :-

(1) Monoecious (2) Dioecious (3) Heterosporous (4) Homosporous

**BPK408**

**11.** Bryophytes are amphibians of plant kingdom because :-

(1) They require water for carrying out fertilisation

(2) They occur in dry places

(3) They are mostly aquatic

(4) All the above

**BPK409**

**12.** Male and female gametophytes are independent and free living in :-

(1) Mustard (2) Castor (3) *Pinus* (4) *Marchantia*

**BPK410**

**13.** Vegetative reproduction in mosses occurs by :-

(1) Fragmentation (2) Budding

(3) Both Fragmentation & Budding (4) By spore

**BPK411**

**14.** Rhizoids in Hepaticopsida and Anthocerotopsida are: -

(1) Multicellular and branched

(2) Unicellular and unbranched

(3) Unicellular and branched

(4) Multicellular and unbranched

**BPK412**

**15.** Which of the following Pteridophytes belong to class Pteropsida?

(1) *Equisetum* and *Psilotum* (2) *Lycopodium* and *Adiantum*

(3) *Selaginella* and *Pteris* (4) *Pteris* and *Adiantum*

**BPK413**

**16.** Given below are two statements :

**Statement-I :** Mosses along with lichens are the first organisms to colonise rocks and hence, are of great ecological importance.

**Statement-II :** Lichens degrade rocks making them suitable for the growth of other plants.

In the light of the above statements choose the correct answer from the options given below:

(1) Both Statement-I and Statement-II are correct.

(2) Both Statement-I and Statement-II are incorrect.

(3) Statement-I is correct and Statement-II is incorrect.

(4) Statement-I is incorrect but Statement-II is correct.

**BPK414**

**17.** **Assertion :** Heterosporous condition in pteridophytes is considered as an event which is precursor to seed habit.

**Reason :** The female gametophytes in heterosporous pteridophytes are retained on the parent sporophytes for variable periods and the development of the zygotes into young embryo take place within the female gametophytes.

(1) Both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(2) Both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) Assertion is True but the Reason is False.

(4) Both Assertion & Reason are False.

**BPK415**

**18.** Match Column-I with Column-II :

| Column-I | | Column-II | |
|---|---|---|---|
| (a) | Giant red wood tree | (i) | *Cycas* |
| (b) | Mycorrhiza | (ii) | *Cedrus* |
| (c) | Coralloid roots | (iii) | *Sequoia* |
| (d) | Branched stem | (iv) | *Pinus* |

(1) (a–i); (b–ii); (c–iii); (d–iv)

(2) (a–iii); (b–ii); (c–iv); (d–i)

(3) (a–iii); (b–iv); (c–i); (d–ii)

(4) (a–iv); (b–iii); (c–ii); (d–i)

**BPK416**

## BEGINNER'S BOX — ANSWERS KEY

| BEGINNER'S BOX-1 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Ans. | 2 | 3 | 2 | 1 | 1 | 3 | 4 | 2 | 1 | 2 |
| | Que. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | |
| | Ans. | 4 | 1 | 3 | 4 | 4 | 1 | 1 | 2 | | |

| BEGINNER'S BOX-2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Ans. | 2 | 2 | 2 | 3 | 2 | 3 | 1 | 4 | 4 | 3 |
| | Que. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | |
| | Ans. | 1 | 4 | 3 | 2 | 4 | 1 | 1 | 3 | | |

## Golden Key Points

- Bryophytes are amphibians of the plant kingdom because these plants can live in soil but are dependent on water for fertilization.
- In Bryophyta the sporophyte is depend on gametophyte.
- In Bryophyta sporophyte is made of foot, seta and capsule but in *Riccia* it is made of only capsule.
- Most developed gametophyte in kingdom plantae is found in mosses.
- Mosses along with lichens are the first organisms to colonise rocks hence are of great ecological importance.
- Pteridophytes are vascular cryptogams.
- Prothallus is independent and mostly photosynthetic gametophyte.
- *Selaginella, Salvinia, Marsilea* and *Azolla* are heterosporous pteridophytes, which show precursor of seed habit.
- Gametophyte is monoecious in homosporous pteridophytes.
- The ovules are not enclosed by ovary wall and remain exposed, both before and after fertilization in gymnosperms.
- Integumented megasporangium is called ovule.
- In gymnosperm single fertilization takes place so only zygote is formed through fertilization.
- Pollen grains and seeds are winged in *Pinus*.
- *Ephedra* and *Taxus* are medicinal gymnosperms.
- **Zoidogamy :** The process of sexual reproduction or fertilisation in which male gamete is motile means have flagella or cilia, so water is must for fertilisation. Such plants which perform **Zoidogamy** are known as **zoidogamous plants.** They are **Thallophyta (algae), Bryophyta** and **Pteridophyta (Non-spermatophytes / Cryptogams).**
- **Siphonogamy :** The process of sexual reproduction or fertilisation in which male gametes are not motile means they do not have flagella or cilia, so water is not required for this process. In siphonogamy pollen tube is responsible for carrying male gametes up to female gametes. Such plants which perform siphonogamy are known as **siphonogamous plants.** They are **Gymnosperms** and **Angiosperms (spermatophytes / Phanerogams).**

| | Hepaticopsida (Liverwort) | Bryopsida (Moss) |
|---|---|---|
| **Plant body (Gametophyte)** | Dorsiventral thalloid | First stage : Protonema<br>Second stage : Leafy gametophytes |
| **Rhizoids** | Unicellular and unbranched | Multicellular branched |
| **Asexual or vegetative reproduction** | Fragmentation, Gemmae formation | Fragmentation of protonema Bud present on secondary protonema |
| **Sporophyte** | Foot, seta and capsule, Completely dependent on gametophytes | Foot, seta and capsule Partially dependent on gametophytes |

- Most developed gametophytes : Bryophyta
- Most reduced sporophytic generation : Algae
- Most developed sporophytic generation: Angiosperms
- Most reduced gametophytes : Angiosperms
- Group of archegoniate : Bryophytes, pteridophytes and gymnosperms
- Antheridium is present in algae, bryophytes and pteridophytes
- Water is required for fertilization in cryptogams
- Siphonogamy is present in spermatophytes

**Pteriodophytes classified into four classes :**

1. Psilopsida e.g. *Psilotum*
2. Lycopsida e.g. *Selaginella, Lycopodium*
3. Sphenopsida e.g. *Equisetum*
4. Pteropsida e.g. *Dryopteris, Pteris, Adiantum*

| S.No. | Characters | Algae | Bryophytes | Pteridophytes | Gymnosperm | Angiosperm |
|---|---|---|---|---|---|---|
| 1. | **Common Name** | Multicellular thalloid, Photosynthetic thallophyte | First land plants, Amphibians of plant kingdom | First vascular land plants, Reptiles of plant kingdom (Botanical snakes) | First seeded plants, First completely successful plants on earth | Flowering plants |
| 2. | **Main Plant Body** | Gametophyte | Gametophyte, short living sporophyte made of foot, seta, capsule | Sporophyte, short living sporophyte (prothallus) | Sporophyte | Sporophyte |
| 3. | **Real Roots** | Absent | Absent | Present | Present | Present |
| 4. | **Has Vascular Tissue** | No | No | Yes | Yes | Yes |
| 5. | **Has Flowers** | No | No | No | No | Yes |
| 6. | **True Leaf** | Absent | Absent | Present | Present | Present |
| 7. | **Endosperm** | Absent | Absent | Absent | Present, Haploid (before fertilisation) | Present, Triploid (after fertilisation) |
| 8. | **Embryo Formation** | Absent | Present | Present | Present | Present |
| 9. | **Seed** | Absent | Absent | Absent | Present (Ovules not covered by ovary wall) | Present (Covered by ovary wall) |
| 10. | **Female Sex Organ** | Oogonium (Unicellular) | Archegonium | Archegonium | Archegonium inside the ovule | Carpel |
| 11. | **Type of Meiosis** | Mainly Zygotic meiosis | Sporic | Sporic | Sporic | Sporic |
| 12. | **Types of syngamy** | Isogamy anisogamy oogamous | Oogamous | Oogamous | Oogamous | Oogamous |

# NCERT SUMMARY

Plant kingdom includes algae, bryophytes, pteridophytes, gymnosperms and angiosperms. Algae are chlorophyll-bearing simple, thalloid, autotrophic and largely aquatic organisms. Depending on the type of pigment possessed and the type of stored food, algae are classified into three classes, namely **Chlorophyceae, Phaeophyceae** and **Rhodophyceae**.

Algae usually reproduce vegetatively by fragmentation, asexually by formation of different types of spores and sexually by formation of gametes which may show **isogamy, anisogamy** or **oogamy**.

Bryophytes are plants which can live in soil but are dependent on water for sexual reproduction. Their plant body is more differentiated than that of algae. It is thallus-like and prostrate or erect and attached to the substratum by **rhizoids**. They possess **root-like, leaf-like** and **stem-like** structures. The bryophytes are divided into **liverworts** and **mosses**. The plant body of liverworts is thalloid and dorsiventral whereas mosses have upright, slender axes bearing spirally arranged leaves. The main plant body of a bryophyte is gamete-producing and is called a gametophyte. It bears the male sex organs called **antheridia** and female sex organs called **archegonia**. The male and female gametes produced fuse to form zygote which produces a multicellular body called a sporophyte. It produces haploid spores. The spores germinate to form gametophytes.

In pteridophytes the main plant is a sporophyte which is differentiated into true root, stem and leaves. These organs possess **well-differentiated vascular tissues**. The sporophytes bear sporangia which produce spores. The spores germinate to form gametophytes which require cool, damp places to grow. The gametophytes bear male and female sex organs called antheridia and archegonia, respectively. Water is required for transfer of male gametes to archegonium where zygote is formed after fertilisation. The zygote produces a sporophyte.

The gymnosperms are the plants in which ovules are not enclosed by any ovary wall. After fertilisation the seeds remain exposed and therefore these plants are called **naked-seeded plants**. The gymnosperms produce **microspores** and **megaspores** which are produced in microsporangia and megasporangia borne on the sporophylls. The sporophylls **microsporophylls** and **megasporophylls** are arranged spirally on axis to form male and female cones, respectively. The pollen grain germinates and pollen tube releases the male gamete into the ovule, where it fuses with the egg cell in archegonia. Following fertilisation, the zygote develops into embryo and the ovules into seeds. The angiosperms are divided into two classes – **the dicotyledons** and **the monocotyledons.**