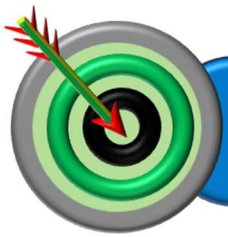
Chapter
03

# Plant Kingdom



## OBJECTIVES

- INTRODUCTION
- CLASSIFICATION SYSTEMS
- ALGAE
- BRYOPHYTES
- PTERIDOPHYTES
- GYMNOSPERMS
- ANGIOSPERMS

## INTRODUCTION

In the previous chapter, we explored Whittaker's Five Kingdom Classification (1969), which categorized living organisms into Monera, Protista, Fungi, Animalia, and Plantae. Earlier, in the Two-Kingdom System, all organisms with cell walls—including bacteria and fungi—were classified under Plantae. However, with advancements in scientific understanding, Fungi, Monera, and Protists with cell walls have been excluded from this kingdom.

It is important to note that cyanobacteria (commonly called blue-green algae) were once considered part of the algae group. However, since they are prokaryotic, they are now classified under Monera, not Plantae.

In this chapter, we will describe Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms under Plantae.

## 3.1. CLASSIFICATION SYSTEMS

There are three main types of systems of classification i.e., artificial, natural and phylogenetic.

### 1. Artificial System of Classification

**(a) Basis:** The earliest systems of classification used only gross superficial morphological characters such as habit, colour, number and shape of leaves, etc. It was based mainly on vegetative characters or on the androecium structure (system given by Linnaeus).

**(b) Drawbacks:** They separated the closely related species as they were based on few characteristics. Also, equal weightage to vegetative and sexual characteristics were given. Since the vegetative characters are more affected by environment, so this was not acceptable. Looking into these drawbacks, the natural classification system was developed.

### 2. Natural System of Classification:

**(a) Basis:** It was based on natural affinities among the organisms. It considered not only the external features, but also internal features, like ultrastructure, anatomy, embryology and phytochemistry.

**(b) Given by**- The natural classification for flowering plants was given by George Bentham and Joseph Dalton Hooker

### 3. Phylogenetic System of Classification

**(a) Basis:** It was based on evolutionary relationships between the various organisms. This assumes that organisms belonging to the same taxa have a common ancestor.

**(b) Given by: Engler and Prantl, Hutchinson, Takhtajan**

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.

### Branches of Taxonomy

**1. Numerical Taxonomy (Phenetics):** It involves usage of numerical methods for the evaluation of similarities and differences between species with the help of computers.

Steps involved in numerical taxonomy:

- Each observable characteristic is assigned numerical values or codes, such as (+) for presence, (-) for absence, and (0) for data not available
- Computers analyze and compare all possible characters, giving them equal importance in classification.
- The core principle of numerical taxonomy lies in the systematic organization and analysis of large datasets to establish relationships between species
- One of the major benefits of this taxonomic method is that hundreds of characters can be considered at the same time.

**2. Cytotaxonomy/karyotaxonomy:** It is based on cytological information like chromosome number, structure, behaviour etc.

**3. Chemotaxonomy:** It is based on the chemical constituents of the plant. For example- DNA sequence, chemical nature of proteins, crystals (Calcium oxalate or calcium carbonate) and aromatic compounds are used by scientists to resolve confusions in classification.

**TOPIC CENTRIC EXERCISE -01**

**Q1. Natural system of classification is based on**
(a) External features (b) Ultrastructure and anatomy
(c) Embryology and phytochemistry (d) All of the above

**Q2. Which among the following is incorrect about artificial classification of plant kingdom?**
(a) This classification is mainly based on external features of a plant than that of their internal features.
(b) It was given by Linnaeus.
(c) Sexual organs are given more preference than vegetative organs.
(d) Artificial classification classifies closely related species.

**Q3. Classification which is based on evolutionary relationships of various organisms is**
(a) Artificial classification (b) Natural classification
(c) Phylogenetic classification (d) Two kingdom classification

**Q4. Cytotaxonomy is based on**
(a) Chemical constituents
(b) Morphological characters
(c) Structure and behaviour of chromosomes
(d) Both (a) and (b)

**Q5. Classification which is based only on morphological characters is called**
(a) Artificial system (b) Natural system
(c) Phylogenetic system (d) Numerical taxonomy

According to the traditional systems of classification, the Kingdom Plantae is divided into two subkingdoms: Cryptogamae and Phanerogamae. Cryptogamae is further divided into Algae, Bryophyta and Pteridophyta, while Phanerogamae is divided into Gymnospermae and Angiospermae.

**Critical Thinking**

Plants called cryptogams do not bear conspicuous reproductive structures like seeds i.e., seedless plants. Plant body is not well organised and do not bear flowers, fruits and seeds. The reproductive structures or sex organs are invisible.

**Phanerogamae:** Phanerogams are flowering or seed plants. The plant body is differentiated into root, stem and leaves. They bear visible reproductive structures like cones and flowers. These are vascular plants, *i.e.,* presence of xylem and phloem.

## 3.2 ALGAE

Algae are chlorophyll-bearing, simple, thalloid and non-vascular autotrophic organisms. They occur in aquatic (both fresh and marine) habitat. They are found in damp places, water bodies, in conditions of extreme temperatures (hot spring or in cold-ice), on the barks of trees, on rocks and wood, on moist terrestrial habitat etc. They are also associated with other organisms. For example, they may be present inside the tissues of other plants (as endophytes), in association with fungi and animals (e.g. on sloth bear).

The form and size of algae is highly variable, ranging from colonial *(Volvox*), filamentous *(Ulothrix* and *Spirogyra*) and marine forms such as kelps which form massive plant bodies.

### 3.2.1 Reproduction

The algae reproduce by vegetative, asexual and sexual methods. Vegetative reproduction is by fragmentation. Each fragment develops into a thallus. Asexual reproduction is by the production of different types of spores, the most common being the zoospores. They are flagellated (motile) and on germination gives rise to new plants. Sexual reproduction takes place through fusion of two gametes. These involves isogamy, anisogamy and oogamy.

I. If both male and female gametes are similar in size and flagellated (*Ulothrix*) or non-flagellated (non-motile) but similar in size (*Spirogyra*), then the type of reproduction is called isogamous.
II. Fusion of two gametes dissimilar in size is termed as anisogamous. E.g., *Eudorina*.
III. Fusion between one large, non-motile (static) female gamete and a smaller, motile male gamete is termed oogamous, e.g. *Volvox*, *Fucus*.

**Critical Thinking**

Study of algae is called Phycology. Algae are non-embryophytes, i.e., they do not produce embryo and have unicellular non jacketed sex organs.

*Macrocystis pyrifera* is the largest of all algae.

Some brown algal cells possess refractile vesicles called fucosan vesicles (contain a phenolic chemical named fucosan).

*Spirogyra* is commonly known as pond silk as its filaments shine like silk due to presence of mucilage.

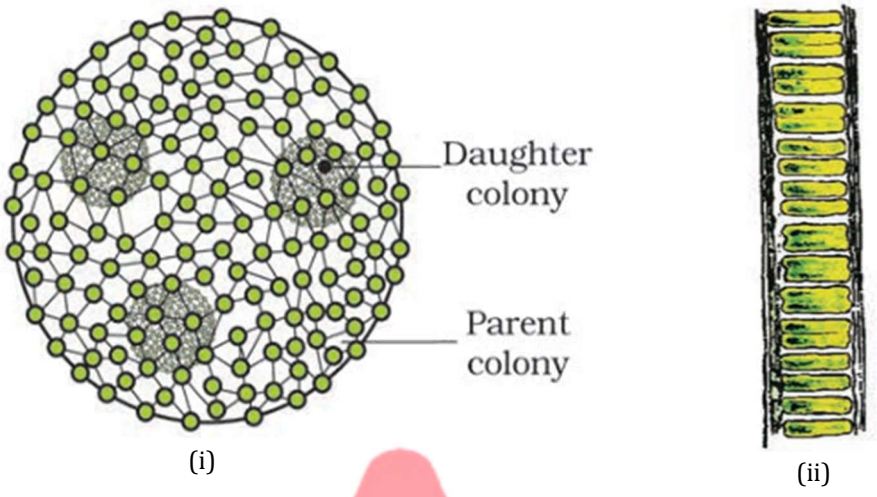
### 3.2.2 Classification of Algae:

The classification of algae is mainly based on the photosynthetic pigments, and stored food material and in addition to this, cell wall composition is also forming the basis of classification. The algae are divided into three main classes.

| | | | |
|---|---|---|---|
| (1) | Chlorophyceae | – | Green Algae |
| (2) | Phaeophyceae | – | Brown Algae |
| (3) | Rhodophyceae | – | Red Algae |

#### 3.2.2.1 Chlorophyceae

- The members of Chlorophyceae are commonly called green algae. The plant body may be unicellular, colonial, or filamentous. They resemble land plants in their pigmentation and reserve food.
- The pigments are localized in definite chloroplasts, chlorophyll- *a*, chlorophyll-*b*, beta carotene, and xanthophylls. They are usually grass green in colour due to dominance of pigments chlorophyll- *a* and chlorophyll- *b*.
- The chloroplasts may be discoid, plate-like, reticulate, cup-shaped, spiral or ribbon-shaped in different species. Chloroplasts are green coloured plastids. Most of the members have one or more storage bodies called pyrenoids located in the chloroplasts. Pyrenoids contain protein besides starch. Some algae may store food in the form of oil droplets.
- Green algae usually have a rigid cell wall made of an inner layer of cellulose and an outer layer of pectose. Vegetative reproduction usually takes place by fragmentation or by formation of different types of spores.
- Asexual reproduction is by flagellated zoospores produced in zoosporangia. Zoospores are pear shaped/pyriform with 2-8, equal and apical flagella.
- The sexual reproduction shows considerable variation in the type and formation of sex cells and it may be isogamous *(Spirogyra, Ulothrix),* anisogamous (*Eudorina*) or oogamous (*Volvox, Chara*). Some commonly found green algae are: *Chlamydomonas, Volvox, Ulothrix, Spirogyra* and *Chara.*

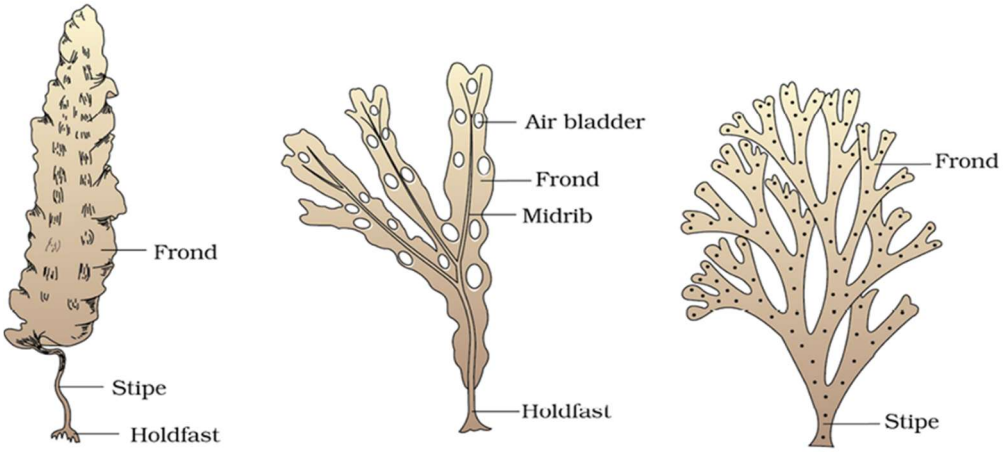



(i) (ii)

**Fig.** (a) Green Algae (i) *Volvox* (ii) *Ulothrix*

### 3.2.2.2 Phaeophyceae

- The members of phaeophyceae are commonly called brown algae. They are primarily found in marine habitats majority in colder areas. They possess the pigments chlorophyll a and chlorophyll c, carotenoids and xanthophylls (especially fucoxanthin).
- They vary in colour from olive green to various shades of brown depending upon amount of xanthophyll pigment, fucoxanthin present in them.
- Food is stored as complex carbohydrate in the form of **laminarin or mannitol** (alcoholic sugar). The vegetative cells have a cellulosic wall usually covered on the outside by a gelatinous coating of **algin**. Algin is a hydrocolloid which has good water holding capacity.
- The protoplast contains, in addition to plastids, a centrally located vacuole and nucleus. They show great variation in size and form. In *Ectocarpus,* the body is simple, branched, and filamentous, whereas in kelps the body is profusely branched. e.g: *Laminaria, Sargassum, Fucus*, (Kelps) may reach a height of 100 meters.
- The plant body is often differentiated into **holdfast** (for attachment to a substratum), **stipe** (stalk) and leaf like photosynthetic organ called **frond**. The large forms often possess air bladders for providing buoyancy (*Fucus*).
- Vegetative reproduction takes place by fragmentation. Asexual reproduction in most brown algae is by biflagellated zoospores that are pear-shaped and have two unequal laterally attached flagella. Sexual reproduction may be isogamous, anisogamous, or oogamous.
- Union of gametes may take place in water or within the oogonium (oogamous species). The gametes are pyriform (pear-shaped) and bear two laterally attached flagella. The common forms are *Ectocarpus, Dictyota, Laminaria, Sargassum* and *Fucus*.

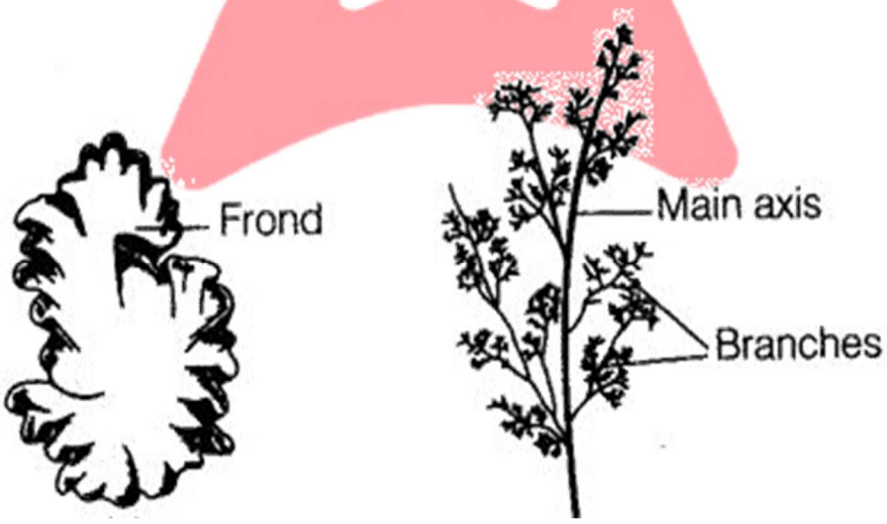



(i) (ii) (iii)

**Fig**. (b) Brown Algae (i) *Laminaria* (ii) *Fucus* (iii) *Dictyota*

### 3.2.2.3 Rhodophyceae

- The members of rhodophyceae are commonly called red algae because of the predominance of the red pigment, r-phycoerythrin (water soluble) in their body.
- The pigments present in them are r-phycoerythrin(red), chlorophyll-a and chlorophyll-d, carotenoids. Majority of the red algae are marine with greater concentrations found in the warmer areas.
- They occur in both well-lighted regions close to the surface of water and also at great depths in oceans where relatively little light penetrates.
- The red thalli of most of the red algae are multicellular. Some of them have complex body organisation.
- Cell wall is composed of cellulose, pectin and hydrocolloids like agar and carrageen. Food is stored in the form of floridean starch which is structurally very similar to amylopectin and glycogen in structures.
- The red algae usually reproduce vegetatively by fragmentation. Red algae reproduce asexually by non-motile spores. Sexual reproduction is oogamous and accompanied by complex post fertilization developments. The common members are: *Polysiphonia, Porphyra, Gracilaria, Gelidium.*




(i) (ii)

**Fig.**(c) Red algae (i) *Prophyra* (ii) *Polysiphonia*

**Table: -Division of algae and their main characteristics**

| Classes | Major Pigments | Stored Food | Cell Wall | Flagellar Number and Position of Insertion | Habitat | Example |
|---|---|---|---|---|---|---|
| Chlorophyceae (Green algae) | Chlorophyll a, b | Starch and oil droplets | Cellulose | 2-8, equal, apical | Fresh water, brackish water, salt water | *Chlamydomonas*, *Volvox*, *Ulothrix*, *Spirogyra* and *Chara* |
| Phaeophyceae (Brown algae) | Chlorophyll a, c, fucoxanthin | Mannitol, laminarin | Cellulose and algin (outer gelatinous coating of cellulosic wall) | 2, unequal, laterally attached | Fresh water (rare) brackish water, salt water | *Ectocarpus, Dictyota, Laminaria, Sargassum* and *Fucus* |
| Rhodophyceae (Red algae) | Chlorophyll a, d, phycoerythrin | Floridean starch | Cellulose, pectin and polysulphate esters | Absent | Fresh water (some), brackish water, salt water (most) | *Polysiphonia, Porphyra, Gracilaria* and *Gelidium* |

### 3.2.3 Economic Importance of Algae:

- **Photosynthesis:** 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 (as during photosynthesis oxygen is released). It is essential for respiration of aquatic life.
- **Primary producers:** Algae are primary producers of energy-rich compounds (food). This forms the basis of food cycles of all aquatic animals.
- **Food supplements:** Many species of *Porphyra* (Red algae), *Laminaria* and *Sargassum* (Brown algae) are among the 70 species of marine algae used as food. Certain unicellular algae like *Chlorella* and *Spirulina* are rich in proteins and are used as food supplements even by space travelers.
- **Hydrocolloids:** Hydrocolloids are water-holding substances. Certain marine brown and red algae produce large amounts of hydrocolloids which are used commercially. Algin and carrageen are hydrocolloids obtained from brown and red algae, respectively. Agar (a hydrocolloid) is one of the commercial products obtained from *Gelidium* and *Gracilaria* and are used to grow microbes and in preparations of ice-creams and jellies.
- **Iodine:** *Fucus* and *Laminaria* are rich sources of iodine.

**TOPIC CENTRIC EXERCISE -02**

**Q1. Pyrenoids are structures made of**
(a) Protein and starch (b) Starch and lipids
(c) Protein and lipids (d) Proteins, starch and lipids.

**Q2. The stored food found in phaeophyceae is**
(a) Starch (b) Mannitol
(c) Laminarin (d) Both (b) and (c)

**Q3. The red thalli of most of the red algae are**
(a) Unicellular (b) Multicellular
(c) Acellular (d) Non-cellular

**Q4. In which of the following algae cell wall is made up of polysulphate esters?**
(a) *Porphyra*, *Gracilaria* (c) *Gelidium*, *Laminaria*
(b) *Ectocarpus*, *Dictyota* (d) *Fucus*, *Chara*

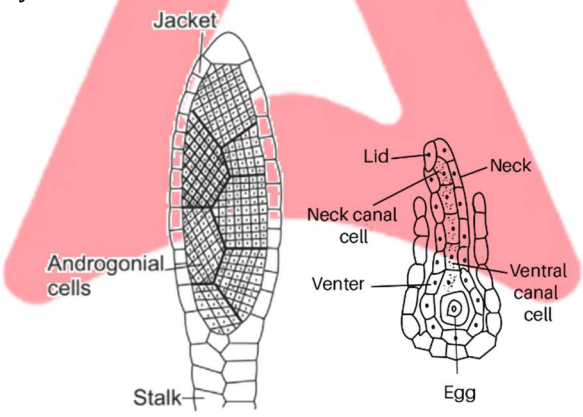
**Q5. Algae which contain Chl d and having oogamous sexual reproduction is**
(a) *Gelidium* (b) *Polysiphonia*
(c) *Dictyota* (d) *Chara*

## 3.3 BRYOPHYTES

Bryophytes are non-vascular terrestrial plants that thrive in moist habitats. In their life cycle, the multicellular diploid sporophyte depends parasitically on the independent multicellular haploid gametophyte for nutrition. They include various mosses and liverworts, commonly found growing in moist, shaded areas, especially in hilly regions.

**The main characteristics of bryophytes are**:

- They are found commonly in damp, humid and shaded localities. The plants are small. They seldom attain great length or height. They are also called **amphibians of the plant kingdom** because these plants can live in soil but are dependent on water for sexual reproduction.
- The plant body of bryophytes is more differentiated than that of algae. It is thallus-like and may be prostrate or erect.
- They lack true roots, stems or leaves but possess root-like, leaf-like or stem-like structures. The plant body is attached to the substratum by root-like structures called **rhizoids**. The rhizoids may be unicellular or multicellular.
- Bryophytes lack vascular tissues such as xylem and phloem. The dominant phase of their life cycle is the haploid gametophyte, which is free-living, while the diploid sporophyte remains dependent and parasitic on the gametophyte for its nutrition.
- The gametophyte produces gametes through mitosis, earning its name. It bears multicellular sex organs, with the male reproductive organ called the antheridium and the female reproductive organ called the archegonium.
- The **antheridium** is enclosed by a sterile jacket that protects sperm mother cells (**androcytes**), which produce two biflagellate **antherozoids** (motile male gametes). The **archegonium** is flask-shaped, consisting of a swollen venter and a tubular neck. The venter cavity holds a sterile venter canal cell and a fertile egg, while the neck encloses several sterile neck canal cells. Both the male and female sex organs are protected by a jacket layer.




(a) (b)

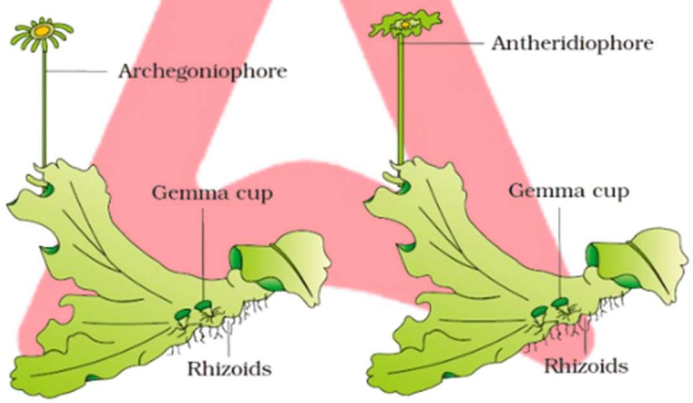
**Fig.:** (a) An antheridium, (b) An archegonia

- An external layer of water is essential for the swimming of antherozoids to the archegonia. Fertilisation produces zygote that is formed inside the archegonia.
- Zygotes do not undergo reduction division (meiosis) immediately instead they undergo mitotic division to form the embryo which develop further into diploid multicellular sporophyte. They are the first embryophytes.
- The sporophyte is not free-living but attached to the photosynthetic gametophyte and derives nourishment from, it. The sporophyte of bryophytes consists of three parts namely capsule, seta and foot. Inside the capsule, the spore mother cells undergo meiosis to produce haploid spores (sporic meiosis).

- Bryophytes are homosporous i.e., they produce only one type of spores. The spores get disseminated by wind. As the air shakes the capsule, the spores come out and are dispersed. Spores have the ability to germinate immediately after falling on the suitable substratum.
- When the spores fall on a suitable substratum, they germinate either directly into the thalloid gametophyte (as in liverworts) or through a filamentous stage called protonema (as in mosses). Vegetative reproduction occurs through fragmentation, gemmae and budding. The bryophytes are divided into liverworts and mosses.

### 3.3.1 Liverworts

- Liverworts grow usually in moist, shady habitats such as banks of streams, marshy ground, damp soil, bark of trees and deep in the woods. The plant body of liverwort is thalloid as in Marchantia. The thallus is dorsiventral and closely appressed to the substratum.
- The leafy members like *Porella* have tiny leaf-like appendages in two rows on the stem like structure. Asexual reproduction occurs by means of fragmentation 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. Mature gemmae become detached from the parent body and germinate to form new individual.
- During sexual reproduction, the sex organs antheridia (male) and archegonia (female) are produced either on the same (*Riccia*) or on different thalli (*Marchantia*). In *Marchantia,* sex organs are present on stalked receptacles.
- The male sex organs are present on antheridiophore and female sex organs are borne on the archegoniophore.




(a) (b)

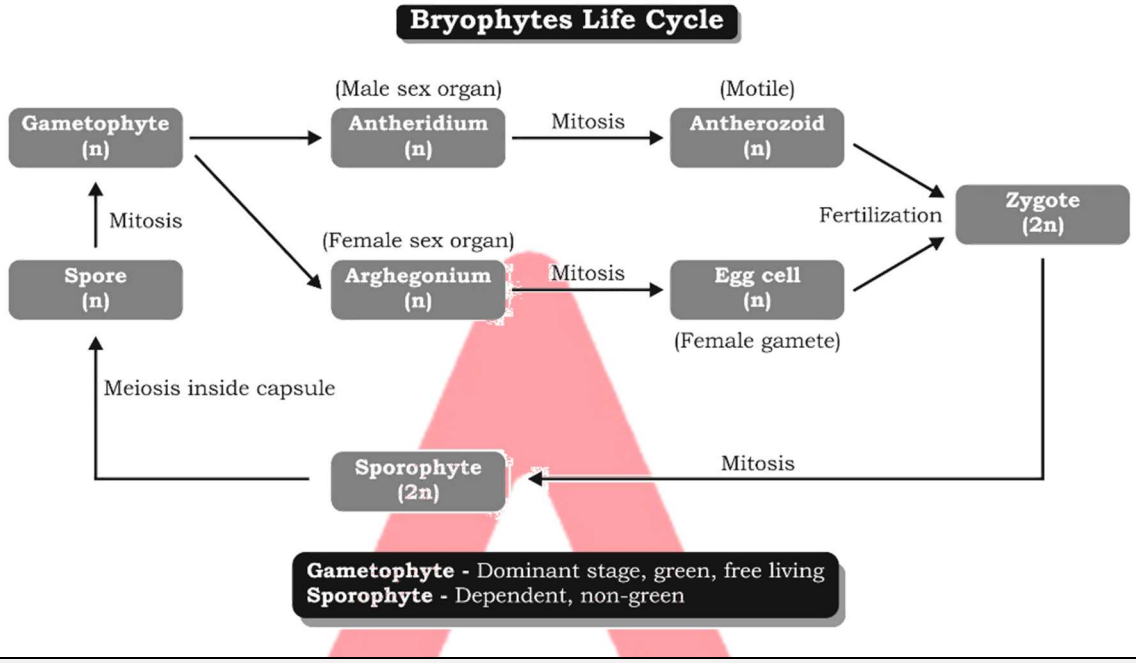
**Fig.:** Bryophytes: A liverwort – *Marchantia* (a) Female thallus (b) Male thallus

- Fusion of gametes results in the formation of zygote which develops into an embryo.
- The embryo in tum develops into sporophyte (diploid). The sporophyte is differentiated into foot, seta and capsule. Within the capsule, the spore mother cells undergo meiosis to produce the haploid spores.
- Spores on liberation germinate into the haploid free- living gametophyte.

### 3.3.2 Mosses

- The predominant stage of the moss life cycle is the gametophyte, which consists of two stages: protonema and leafy stage. The plant body is a leafy gametophyte with multicellular, branched rhizoids for anchorage. It features an upright, slender axis bearing spirally arranged leaves.
- This stage carries the sex organs for reproduction. During sexual reproduction, the antheridia (male organs) and archegonia (female organs) develop at the apex of the leafy shoot. Both sex organs are present on the same plant but on different branches.

- Each antheridium produces multiple biflagellate antherozoids (male gametes), while each archegonium produces a single fertile egg ready for fertilization. Fusion of gametes with the help of water leads to the formation of zygote.
- The zygote develops into a sporophyte which is differentiated into foot, seta and capsule. The capsule encloses two spore sacs, where spores are formed by meiosis. The mosses have an elaborate mechanism of spore dispersal. The spores on liberation germinate into a creeping, green, branched and frequently filamentous stage called **protonema** (juvenile stage).
- Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema. Leafy stage develops from the secondary protonema as a lateral bud. Common examples of mosses are *Funaria*, *Polytrichum* and *Sphagnum*.




**TOPIC CENTRIC EXERCISE -03**

**Q1.** **Multicellular branched rhizoids and leafy gametophytes are the characteristics of**
(a) Some bryophytes (b) Pteridophytes
(c) All bryophytes (d) Both (a) and (b)

**Q2.** **Erect gametophyte with two row of leaf is present in-**
(a) *Funaria* (b) *Polytrichum*
(c) *Sphagnum* (d) Liverworts

**Q3.** **The difference between *Sphagnum* and *Marchantia* is**
(a) Presence of protonema (b) Multicellular rhizoids
(c) Spore dispersal mechanism (d) All of these.

**Q4.** **Which one of the following is not a characteristic feature of bryophytes?**
(a) Dominant gametophytic generation (b) Filamentous rhizoids
(c) Amphibious habitat (d) Vascular tissues

**Q5.** **Which is the incorrect regarding protonema?**
(a) Filamentous (b) Bears sex organs
(c) Photosynthetic (d) Develops directly from spore

## 3.4 PTERIDOPHYTES

- The pteridophytes including horsetails and ferns are the first terrestrial plants to possess vascular tissues, i.e., xylem and phloem. These are found in cool, damp, shady places. Some may flourish well in sandy soil conditions as well.

- In pteridophytes, the main plant body is a sporophyte which is differentiated into true root, stem and leaves. The leaves are small called microphylls (as in *Selaginella*) and large or macrophylls (as in ferns).
- Leaves bearing sporangia are called **sporophylls** which may be widely scattered or clustered in definite areas and structures called cones or strobili (*Selaginella, Equisetum*).
- The diploid spore mother cells within the sporangia undergo meiosis (or reduction division) to form haploid spores. The spores germinate to give rise to inconspicuous, small but multicellular, free-living mostly photosynthetic thalloid gametophytes called prothallus.
- Gametophytes usually require cool, damp, shady places to grow spread of living pteridophytes is limited and restricted to narrow geographical regions, because of the specific restricted requirement and the need for water for fertilisation.
- The sexual reproduction is **oogamous**. Gametophytes bear male and female sex organ. Antheridia are small and sessile male sex organs comprising of androcytes each of which produces a male antherozoid. Archegonia are female sex organs partially embedded and consists of 4-rowed neck.
- The male gametes antherozoids released from the antheridia are transferred to the mouth of archegonium via water where they fuse with the egg present in the archegonium. This results in the formation of **zygote**. Zygote thereafter produces a multicellular well-differentiated sporophyte which is the dominant phase, of the pteridophytes.

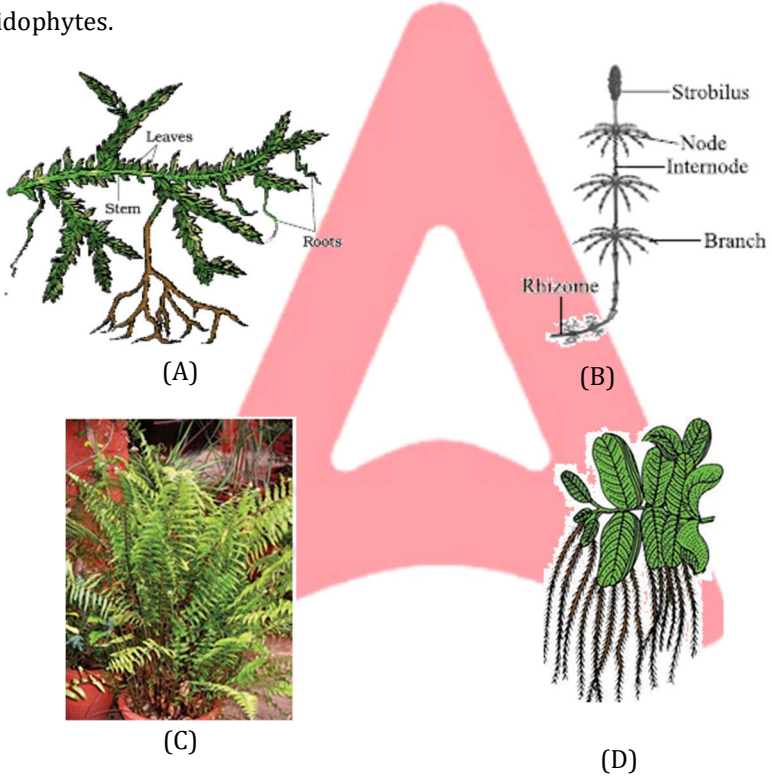



**Fig.:** Pteridophytes: (A) *Selaginella* (B) *Equisetum* (C) Fern (D) *Salvinia*

- The spores produced are of two types: those produced of only one type are homosporous pteridophytes (e.g., *Lycopodium, Pteridium*) whereas those produced of two types (smaller microspores and larger megaspore) are heterosporous pteridophytes (e.g., *Selaginella, Salvinia*).
- The megaspore and microspore germinate and give rise to female and male gametophytes, respectively.
- The female gametophyte retained on the parent sporophyte for variable periods.
- The diploid zygote formed after fertilisation develops into an embryo within the female gametophyte and gets nourishment during its early stage of development.
- The differentiation of spores into microspores and megaspores and their dependence on the parent sporophyte for the nutrition are certain features considered as pre-requisites for the formation of seeds.

The development of zygote into young embryos takes place within female gametophytes. E.g., *Selaginella* is a precursor to the evolution of seed habit.

### 3.4.1 Classification of Pteridophyta

Pteridophytes are further classified into four class:

(i) Psilopsida e.g., *Psilotum*

(ii) Lycopsida e.g., *Selaginella, Lycopodium*

(iii) Sphenopsida e.g., *Equisetum*

(iv) Pteropsida e.g., *Dryopteris, Pteris, Adiantum*

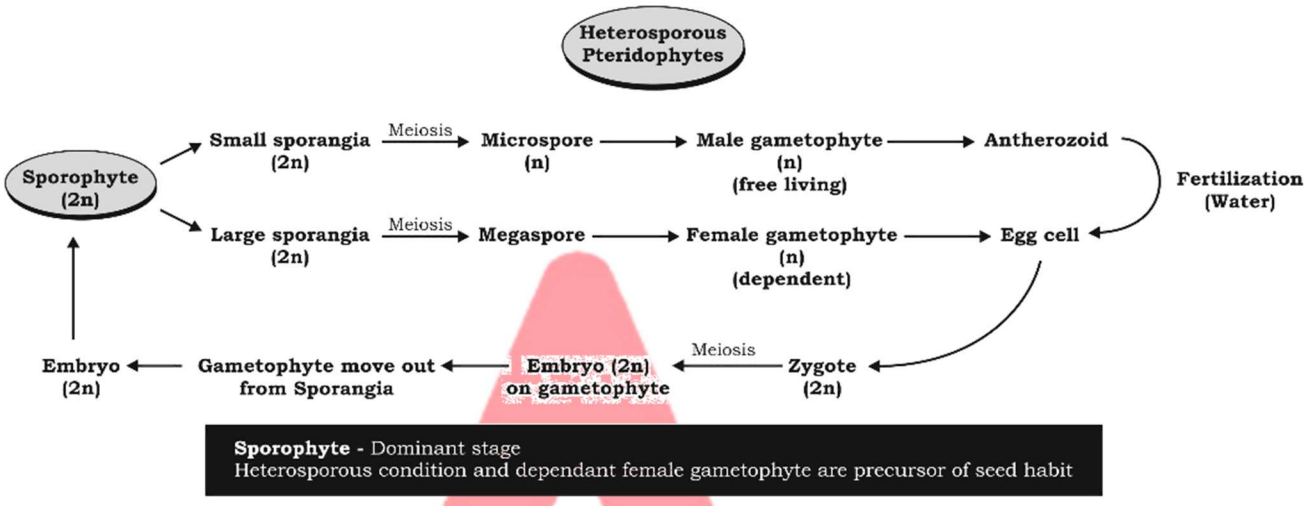



**Fig.:** Life cycle of a Heterosporous Pteridophytes

### 3.4.2 Economic importance:

(i) Soil binding: Pteridophytes bind the soil even along hill slopes. The soil is protected from erosion.

(ii) Medicines: An anthelmintic drug is obtained from a pteridophyte called *Dryopteris*.

(iii) Ornamentals: Ferns are grown as ornamental plants for their delicate and graceful leaves.

(iv) Food: *Marsilea*, a water fern yields starch that constitute a good source of food for certain tribals.

(v) Scouring: Equisetum stems have been used in scouring (cleaning of utensils) and polishing of metals.

**TOPIC CENTRIC EXERCISE -04**

**Q1. Which condition is considered as a precursor of seed habit and development in pteridophyte-**

(a) Double fertilization

(b) Female gametophyte retained on sporophyte

(c) Development of zygote within female gametophyte

(d) Both (b) and (c)

**Q2. Selaginella have not a feature of –**

(a) Heterosporous (b) Diploid

(c) Naked seed (d) Vascular.

**Q3. Which is incorrect about gametophyte of Pteridophyte?**

(a) Inconspicuous (b) Thalloid

(c) Photosynthetic (d) Dependent.

**Q4. Which of the following is not a pteridophyte?**

(a) *Ginkgo* (b) *Selaginella*

(c) *Pteris* (d) *Equisetum*

**Q5. Mosses and ferns are found in moist and shady places because both**

(a) Require presence of water for fertilization

(b) Do not need sunlight for photosynthesis

(c) Depend for their nutrition on microorganisms which can survive only at low temperature
(d) Cannot compete with sun-loving plants

## 3.5 GYMNOSPERMS

- Gymnosperms (gymnos-naked, sperma-seeds) are plants in which the ovules are not enclosed by any ovary wall and remain exposed, both before and after fertilization.
- The seeds that develop post-fertilization, are not covered, i.e., are naked. Gymnosperms include medium-sized trees or tall trees and shrubs only; no herbs are found.
- The plant is diploid sporophyte which is well differentiated into roots, stems, and leaves. One of the gymnosperms, the *Sequoia* (Giant red wood tree) is one of the tallest tree species (100m). Roots are generally tap roots.
- Roots in some genera like *Pinus* have fungal association in the form of mycorrhiza.
- Mycorrhiza is symbiotic association of fungus and root of higher plant. Pinus seeds cannot germinate and establish without mycorrhizal association. In genera like *Cycas* has small specialized roots called coralloid roots are associated with $N_2$ - fixing cyanobacteria.
- The stems are unbranched as in *Cycas* and branched as in *Pinus*, *Cedrus*. The leaves may be simple or compound. In *Cycas,* pinnate leaves persist for few years.
- The leaves in gymnosperms are well-adapted to withstand extremes of 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. Leaves of *Ginkgo* are fan shaped. They have well developed xylem & phloem. Vessels in xylem and companion cells and sieve tube in phloem are absent.
- The gymnosperms are heterosporous that is produces smaller microspores and larger megaspores in two types of sporangia i.e. microsporangia and megasporangia respectively.
- These sporangia are borne on different sporophylls i.e., microsporophylls and megasporophylls. Microsporophylls & megasporophylls are arranged spirally along an axis to form lax or compact strobili or cones. The strobili bearing **microsporophylls** and **microsporangia** are called microsporangiate or **male strobili** or cone.
- The cones bearing megasporophylls with ovules or **megasporangia** are called macrosporangiate or **female strobili** or cone. The male or female cones or strobili may be borne on the same tree (*Pinus*), it is monoecious. However, in Cycas (*dioecious*) male cones and megasporophylls are borne on different trees, here no female cone is found because megasporophyll is scattered.
- Microsporophylls are compactly arranged on a central axis to form male strobilus or microsporangiate or pollen cone.
- They bear microsporangia where microspore mother cells undergo meiosis to form microspores.
- The microspores develop into a male gametophytic generation which is highly reduced and is confined to only a limited number of cells. This reduced male gametophyte is called a **pollen grain**. The development of pollen grains take place within the microsporangia.
- Megasporophylls are compactly arranged to form female strobilus or macrosporangiate or seed cone. They bear integumented megasporangia called as **ovules**. (The nucellus is protected by envelopes and the composite structure is called an ovule).
- The ovules are borne on megasporophylls which may be clustered to form the female cones. The megaspore mother cell is differentiated from one of the cells of the nucellus. The megaspore mother cell divides meiotically to form four megaspores(tetrad).
- One of the functional megaspores enclosed within the **megasporangium** (nucellus) undergoes repeated mitosis and develops into a multicellular female gametophyte that bears two or more archegonia (female sex organs).
- The multicellular female gametophyte is also retained within megasporangium (parent sporophyte). Unlike bryophytes and pteridophytes, in gymnosperms the male and the female gametophytes do not have an independent free-living existence.

- They remain within the sporangia retained on the sporophytes. The pollen grain is released from the microsporangium. They are carried in air currents (wind pollination) and come in contact with the opening of the ovules borne on megasporophylls.
- The pollen tube carrying the male gametes grows towards archegonia in the ovules and discharge their contents near the mouth of the archegonia. Following fertilisation, zygote develops into an embryo and the ovules into seeds. These seeds are not covered.

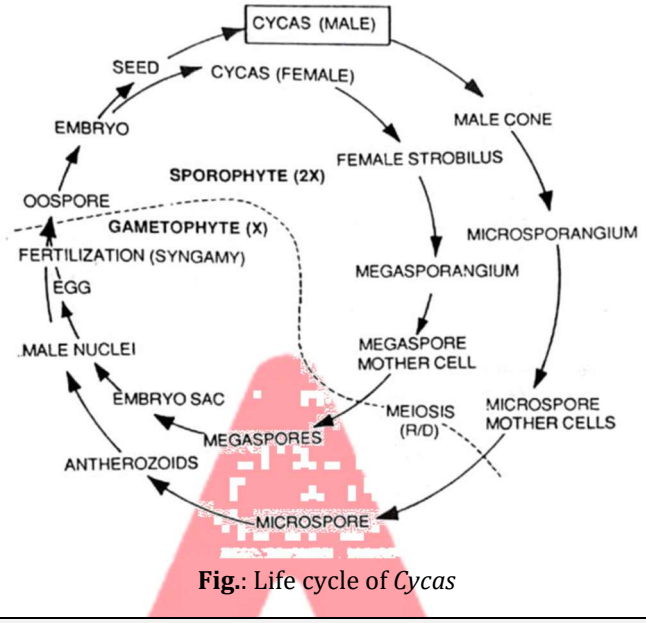



**Fig.**: Life cycle of *Cycas*

**TOPIC CENTRIC EXERCISE -05**

**Q1.** **Select the mismatch pair.**
(a) *Cycas* – Dioecious (b) *Salvinia* – Heterosporous
(c) *Equisetum* –Homosporous (d) *Pinus* – Dioecious

**Q2.** **All are the features of Pinus, except**
(a) Needle shape leaf (b) Branched Stem
(c) Coralloid roots (d) Diploid sporophyte

**Q3.** **Which of the following is found in algal zone of Cycas coralloid roots?**
(a) Cyanobacteria (b) Rhodophyceae
(c) Chlorophyceae (d) Phaeophyaceae

**Q4.** **The gametophyte does not have/an independent free existence in**
(a) *Polytrichum* (b) *Adiantum*
(c) *Pteris* (d) *Cycas*

**Q5.** **Unbranched stems are found in**
(a) *Cycas* (b) *Pinus*
(c) *Cedrus* (d) All of these

## 3.6 ANGIOSPERMS

- Angiosperms (or flowering plants) are seed plants in which pollen grains and ovules are developed in flowers and seeds are formed inside fruits. They are the most recently and highly evolved plants and thus, are found in most environments on the earth.
- They range in size from the smallest *Wolffia* to tall trees of *Eucalyptus* (over 100 metres). They provide us with food, fodder, fuel, medicines and several other commercially important products.
- Plant body is sporophytic and represented by herbs, shrubs, trees twiners, trailers, climbers, etc.

- Sporophytic plant body is differentiated into roots, stem and leaves Depending upon the number of cotyledons (embryonic leaves) in the seeds, angiosperms are divided into two subgroups: dicotyledonous and monocotyledonous plants.

**Table: Comparison between dicots and monocots**

| S. No. | Features | Dicots | Monocots |
|---|---|---|---|
| (i) | Cotyledons | Usually two | One cotyledon |
| (ii) | Flowers | Penta or tetramerous (four or five members in each floral whorls) | Trimerous (three members in each floral whorls) |
| (iii) | Leaf venation | Reticulate | Parallel except a few |

- Sporophylls are aggregated to form flowers. Both microsporophylls and megasporophylls are specialised to form stamen (male sex organ) and pistil (female sex organ) which produces male and female gametes respectively.
- Each stamen consists of a slender filament with an anther at the tip. Within the anthers, the pollen mother cell divides by meiosis to produce microspores which mature into pollen grains.
- The female sex organ pistil consists of a swollen ovary at its base, a long slender style and stigma. Ovules are present inside the ovary.
- Generally, each ovule has a megaspore mother cell that undergoes meiosis to form four haploid megaspores. Three of them degenerate and one divides to form the embryo sac.

(a) (b)

**Figure:** Angiosperms: (a) A dicotyledon (b) A monocotyledon

- Each embryo sac has a three-celled egg apparatus - one egg cell and two synergids, three antipodal cells and two polar nuclei. The polar nuclei eventually fuse to produce a diploid secondary nucleus.
- Pollen grain after dispersal from the anthers are carried to stigma of pistil by the process known as pollination.
- Pollination takes place by several agencies such as air, water, birds, insects, bats, etc.
- The pollen grains germinate on the stigma and the resulting pollen tubes grow through the tissues of stigma and style and reach the ovule.
- The pollen tube enters the embryo sac where two male gametes are discharged. One of the two male gametes, fuses with egg cell (syngamy) to form zygote while other fuses with central cell to form primary endosperm nucleus (PEN).
- This process of two fusions is called double fertilization which is characteristic feature of angiosperms.
- The zygote develops into an embryo (with one or two cotyledons) and central cell containing triploid primary endosperm nucleus forms triploid endosperm which provides nourishment to developing embryo.
- Synergids and antipodals degenerate after fertilization. Fertilized ovules ripen into seeds and a fruit is a ripened ovary which not only protects the seeds but also help in their dispersal.

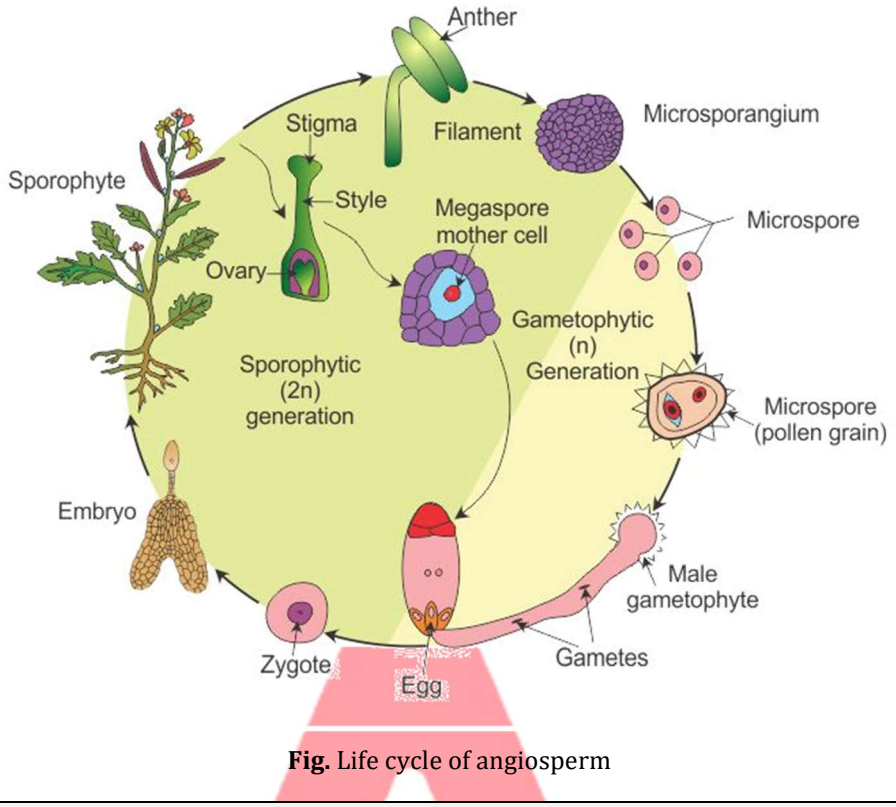



**Fig.** Life cycle of angiosperm

**TOPIC CENTRIC EXERCISE -06**

**Q1. Which of the following is not a character of a monocot?**

(a) Presence of a single seed leaf
(b) Endosperm presents in the mature seed
(c) Leaves with parallel veins and smooth edges
(d) Floral whorls are multiple of four or five

**Q2. In angiosperms, triple fusion results in the formation of**

(a) Secondary nucleus (b) Polar nuclei
(c) Primary endosperm nucleus (d) Zygote.

**Q3. In angiosperms, functional megaspore develops into a/an**

(a) Embryo sac (b) Ovule
(c) Endosperm (d) Pollen sac.

**Q4. Size of Eucalyptus ranges**

(a) Below 2 metres (b) Over 100 metres
(c) Below 100 metres (d) Below 50 m.

**Q5. Embryo sac consists of**

(a) 2 egg cell, 3 synergids, 2 synergids
(b) 1 polar nuclei, 3 synergid, 1 egg cell
(c) 1 egg cell, 2 synergids, 3 antipodals, 2 polar nuclei
(d) 2 synergids, 1 egg cell, 1 polar nuclei.

**Table: Comparison between different classes of Plant Kingdom**

| Feature | Algae | Bryophyte | Pteridophyte | Gymnosperm | Angiosperm |
|---|---|---|---|---|---|
| Embryophytes | No | Present | Present | Present | Present |
| Tracheophyte | No vascular bundle | No V.B. | Present | Present | Present |
| Spermatophyta | No seed | No seed | No seed | Seed-naked | Seed-covered |
| Dominant phase | Gametophyte | Gametophyte | Sporophyte | Sporophyte | Sporophyte |
| Main Plant body | Haploid | Haploid | Diploid | Diploid | Diploid |
| Spore | Homosporous | Homosporous | Mostly homosporous, Heterosporous (*Salvinia* and *Selaginella*), Diploid | Heterosporous | Heterosporous |
| Sex organ | Haploid oogonium (Female sex organ) Antheridium (male sex organ) | Haploid<br>Archegonium, Antheridium | - Sporangia (Antheridium) Archegonium develop on prothallus | Diploid sporangia – Microsporangia – Megasporangia (Female cone) bears two or more archegonia | Diploid sporangia - Microsporangia (In Anther) – Megasporangia (In pistil) |

**Solved Examples**

**Ex: 1. Phylogenetic classification considers**

(a) Morphological characteristics (b) Embryological characteristics

(c) Evolutionary relationship (d) Ultrastructure

**Sol.** **(c)** Phylogenetic classification is based on the evolutionary relationships among organisms, showing their common ancestry and evolutionary history.

**Ex: 2. Which among the following is incorrect about cytotaxonomy and chemotaxonomy?**

(a) Cytotaxonomy is based on the number of chromosomes present in the organism.

(b) Chemotaxonomy is based on the chemical composition of plants.

(c) Cytotaxonomy is based on the behaviour of chromosomes.

(d) Cytotaxonomy involves only external characteristics.

**Sol.** **(d)** Cytotaxonomy is based on the number, structure, and behavior of chromosomes during cell division, not external characteristics.

**Ex: 3. Classification based on cytological information like chromosome number, structure and behaviour is called**

(a) Numerical Taxonomy (b) Cytotaxonomy

(c) Chemotaxonomy (d) Nuclear Taxonomy

**Sol.** **(b)** Cytotaxonomy is the classification of organisms based on cytological information, including chromosome number, structure, and behavior

**Ex: 4. Which of the algae forms the motile gametes?**

(a) Volvox (b) Gelidium

(c) Spirogyra (d) Porphyra

**Sol.** **(a)** Volvox have motile gametes

**Ex:5. Chlorophyll a, c, carotenoids and xanthophylls are present in**

(a) Phaeophyceae (b) Chlorophyceae
(c) Rhodophyceae (d) None of these

**Sol.** **(a)** Phaeophyceae (brown algae) contains chlorophyll a, chlorophyll c, carotenoids, and xanthophylls

**Ex:6.** **Kelps may reach a height of**
(a) 50 metres (b) 100 metres
(c) 100 cm (d) 100 inches

**Sol.** **(b)** Kelps may reach a height of 100 metres

**Ex:7.** **In *Gracilaria*, sexual reproduction is**
(a) Isogamous (b) Anisogamous
(c) Oogamous (d) Both (a) & (b)

**Sol.** **(c)** In *Gracilaria*, Sexual reproduction is oogamous and accompanied by complex post fertilization developments

**Ex:8.** **Peat is obtained from**
(a) Sphagnum (b) Funaria
(c) Riccia (d) Marchantia

**Sol.** **(a)** Peat is obtained from Sphagnum, a type of moss commonly known as peat moss.

**Ex:9.** **In mosses, the sex organs are present in the**
(a) Primary protonema (b) Secondary protonema
(c) Leafy stage (d) Both (a) & (b)

**Sol.** **(c)** Leafy stage in mosses bears sex organs

**Ex:10.** **Which among the following is odd?**
(a) Lycopsida (b) Pteropsida
(c) Sphenopsida (d) Sporopsida

**Sol.** (d) Lycopsida, Pteropsida, and Sphenopsida are classes of Pteridophytes (vascular plants without seeds)

# Exercise-01 Level -01

**1.** An algae which is used as food supplements even by space travellers is
(a) *Spirogyra* (b) *Dictyota*
(c) *Spirulina* (d) *Gracilaria*

**2.** Agar is obtained from
(a) *Polysiphonia* and *Porphyra*
(b) *Chlamydomonas* and *Spirogyra*
(c) *Gelidium* and *Gracilaria*
(d) *Chara* and *Chlamydomonas*

**3.** Red algae are named so because of the predominance of
(a) Xanthophyll (b) r-phycoerythrin
(c) Carotene (d) Chlorophyll a & b

**4.** The cell wall of brown algae is made up of
(a) Cellulose and chitin
(b) Cellulose and peptidoglycan
(c) Cellulose and algin
(d) Cellulose and starch

**5.** Which of the statement is **incorrect** for pteridophyte?
(a) Free living sporophyte
(b) Free living gametophyte
(c) Restricted to narrow regions
(d) Dominant plant body is Gametophyte

**6.** Which of the following statement is incorrect regarding bryophytes?
(a) The female sex organ is flask shaped
(b) The antherozoids are released into water
(c) The antherozoids are biflagellated
(d) Zygote formed undergoes meiosis immediately

**7.** Select the incorrect statement w.r.t. characters of true moss
(a) Multicelled branched rhizoids
(b) Presence of scales
(c) Presence of protonema
(d) Erect leafy axis as mature gametophyte

**8.** How many of the given organisms lack motile gametes?
*Volvox, Fucus, Porphyra, Ulothrix, Polysiphonia*
(a) One (b) Two
(c) Three (d) Four

**9.** Karyotaxonomy is based on all, except
(a) Chromosome number
(b) Chromosome structure
(c) Aromatic compounds
(d) Chromosome behaviour

**10.** Which of the following possess photosynthetic pigments but lack vascular tissues?
(a) *Polysiphonia* (b) *Pinus*
(c) *Adiantum* (d) *Cycas*

**11.** The algae in which cell wall contains cellulose, pectin and polysulphate, hydrocolloids has
(a) Chlorophyll a & d
(b) Chlorophyll a & b
(c) Chlorophyll a & c
(d) Chlorophyll b & d

**12.** Which one of the following pair is wrongly matched?
(a) Gymnosperms – Homosporous plants
(b) Cycas – Pinnate leaves
(c) Angiosperms – Non-archegoniate phanerogams
(d) Sequoia – Tallest gymnosperm

**13.** In pteridophytes, the main plant body is
(a) Thalloid gametophyte
(b) Thalloid sporophyte
(c) Gametophyte which is differentiated into root, stem & leaves
(d) Sporophyte which is differentiated into root, stem & leaves

**14.** Which of the following systems of classification involves usage of one or few morphological characters for grouping of organisms?
(a) Artificial system
(b) Natural system
(c) Phylogenetic system
(d) Bentham and Hooker's system

**15.** Which of the following is a correct statement?
(a) Spores germinate to produce dorsiventral thallus in mosses
(b) Spores germinate to give rise to protonema in ferns
(c) Gemmae are non-green, unicellular structures of liverworts
(d) Mosses along with lichens are the first organisms to colonise rocks

**16.** Floridean starch is stored food material in
(a) *Chara* (b) *Porphyra*
(c) *Ectocarpus* (d) *Cedrus*

**17.** How many of the following plant groups show (s) formation of embryo?
Algae, Bryophytes, Pteridophytes, Angiosperms
(a) 3 (b) 2
(c) 1 (d) 4

**18.** In Pteridophytes, reduction division occurs when
(a) Prothallus is formed
(b) Sex organs are formed
(c) Spores are formed
(d) Gametes are formed

**19.** Algae, bryophytes and pteridophytes resemble with each other in which one of the following features?
(a) Gametophytic plant body
(b) Dependence on water for fertilization
(c) Presence of Chl. a and c
(d) Presence of embryo

**20.** All are the features of prothallus, **except**
(a) Multicellular
(b) Photosynthetic
(c) Dependent
(d) Haploid

**21.** Which one is wrongly matched?
(a) Uniflagellate gametes – *Polysiphonia*
(b) Biflagellate zoospores – Brown algae
(c) Unicellular organism – *Chlorella*
(d) Gemma cups – *Marchantia*

**22.** Which one of the following statements is wrong?
(a) Algae increase the level of dissolved oxygen in the immediate environment
(b) Algin is obtained from red algae, and carrageen from brown algae
(c) Agar-agar is obtained from *Gelidium* and *Gracilaria*
(d) *Laminaria* and *Sargassum* are used as food

**23.** Which one is a wrong statement?
(a) *Fucus* have chlorophyll a and c, and fucoxanthin
(b) Archegonia are found in Bryophyta, Pteridophyta and Gymnosperms
(c) Motile male gamete is found in *Porphyra*
(d) Haploid endosperm is typical feature of gymnosperms

**24.** Male gametes are flagellated in:
(a) *Spirogyra* (b) *Polysiphonia*
(c) *Anabaena* (d) *Ectocarpus*

**25.** Which one of the following shows isogamy with non-flagellated gametes?
(a) *Sargassum* (b) *Ectocarpus*
(c) *Ulothrix* (d) *Spirogyra*

**26.** *Selaginella* and *Salvinia* are considered to represent a significant step toward evolution of seed habit because
(a) Megaspores possess endosperm and embryo surrounded by seed coat
(b) Embryo develops in female gametophyte which is retained on parent sporophyte
(c) Female gametophyte is free and gets dispersed like seeds
(d) Female gametophyte lacks archegonia

**27.** *Cycas* and *Adiantum* resemble each other in having:
(a) Cambium
(b) Vessels
(c) Seeds
(d) Presence of archegonium

**28.** Which one of the following is a correct statement?
(a) Antheridiophores and archegoniophores are present in pteridophytes
(b) Origin of seed habit can be traced in pteridophytes
(c) Gametophyte of pteridophyte has a protonema and leafy stage
(d) In gymnosperms, female gametophyte is free-living

**29.** Male and female gametophytes are independent and free-living in
(a) *Sphagnum* (b) Mustard
(c) Castor (d) *Pinus*

**30.** If you are asked to classify the various algae into distinct groups, which of the following characters you should choose?
(a) Chemical composition of the cell wall
(b) Types of piugments present in the cell
(c) Nature of stored food materials in the cell
(d) Structural organization of thallus

**31.** Conifers differ from grasses in the:
(a) Production of seeds from ovules
(b) Lack of xylem tracheids
(c) Absence of pollen tubes
(d) Formation of endosperm before fertilization

**32.** The pyrenoids are made up of
(a) Proteinaceous centre and starchy sheath
(b) Core of nucleic acid surrounded by protein sheath
(c) Core of protein surrounded by fatty sheath
(d) Core of starch surrounded by sheath of protein

**33.** A system of classification, in which a large number of traits are considered, is
(a) Natural system

(b) Phylogenetic system
(c) Artificial system
(d) Synthetic system

**34.** In *Eudorina*, the mode of sexual reproduction is -
(a) Isogamy (b) Anisogamy
(c) Oogamy (d) All of these

**35.** Multicellular branched rhizoids and leafy gametophytes are the characteristics of
(a) Some bryophytes (b) Pteridophytes
(c) All bryophytes (d) Gymnosperms

**36.** All have photosynthetic sporophyte, except
(a) *Pinus* (b) *Psilotum*
(c) *Polytrichum* (d) *Cycas*

**37.** Which of the following statement is wrong?
(a) Leafy stage of mosses bears spirally arranged leaves
(b) Algae increases the level of dissolved oxygen in their immediate environment
(c) Hydrocolloids are produced by certain marine red and brown algae
(d) *Porphyra*, *Volvox* and *Fucus* are used as food

**38.** Among- *Ulothrix*, *Volvox*, *Porphyra*, *Spirogyra*, *Gracilaria*, *Fucus*, *Ectocarpus*
How many have non-motile gametes?
(a) One (b) Two
(c) Three (d) Four

**39.** Features like – Heterosporous, Cone, Chl. a, Dependent female gametophyte
These features are present in -
(a) *Ectocarpus* and Kelp
(b) *Pinus* and *Selaginella*
(c) *Cycas* and *Marchantia*
(d) *Selaginella* and *Pteris*

**40.** Few features like- Chl. b, Algin, Carrageen, Oogamous reproduction, Photosynthetic gametophyte, Chl. c
How many of the above features are present in Volvox?
(a) Two (b) Three
(c) Four (d) Five

**41.** Mark the correctly matched pair-
(a) *Psilotum* - Non-Motile male gamete
(b) *Selaginella* - Homosporous
(c) Protonema stage - Develops directly from spore
(d) Fucus - Chl. d

**42.** Features like - Chl a, Chl b, megasporophylls, Coralloid roots, pinnate leaves.
The above features are present in-
(a) *Pinus* (b) *Cycas*
(c) *Cedrus* (d) *Ginkgo*

**43.** Mark the **correctly** matched pair-
(a) *Dictyota* – Equal apical flagella
(b) Kelp - Algin
(c) *Porphyra* - Pyrenoids
(d) *Volvox* – Isogamous

**44.** Mannitol, algin and fucoxanthin is a feature of-
(a) *Marchantia* (b) *Polysiphonia*
(c) *Sargassum* (d) *Volvox*

**45.** Lateral and unequal flagella is present in-
(a) Gamete of *Porphyra*
(b) Zoospore of *Ulothrix*
(c) Gamete of *Dictyota*
(d) Gamete of *Spirogyra*

**46.** Which of the following is not feature of *Sargassum*?
(a) Unequal size flagella
(b) Fucoxanthin
(c) Pyrenoid
(d) Algin in cell wall

**47.** *Cycas* and *Psilotum* resembles each other in having-
(a) Seeds
(b) Presence of vascular tissues
(c) Independent gametophyte
(d) Flagellated male gamete

**48.** Among- *Fucus*, *Volvox*, *Cycas*, *Ginkgo*, *Adiantum*, *Marchantia*, *Ulothrix*, *Spirogyra*, Mustard
How many shows motile-male gametes?
(a) Three (b) Five
(c) Six (d) Four

**49.** Gametophyte has not an independent, free-living generation in-
(a) Cedrus (b) Polytrichum
(c) Psilotum (d) Marchantia

**50.** Zoospores and Oogamous reproduction are features of-
(a) *Spirogyra* (b) *Cycas*
(c) *Marchantia* (d) *Fucus*

# Exercise-02 Level -02

**1.** Fill in the blanks with appropriate words.
(i) Bryophytes are called ___A___ of plant kingdom.
(ii) The sporophyte of bryophytes is __B__ on gametophyte.
(iii) In bryophytes, the haploid spores germinate to produce ___C___.
(a) A-amphibians, B-independent, C-gametophyte
(b) A-amphibians, B-parasitic, C-sporophyte
(c) A-amphibians, B-parasitic, C-gametophyte
(d) A-amphibians, B-dependent, C-gametophyte

**2.** Read the following statements and identity X and Y.
1. Plant 'X' has coralloid roots associated with $N_2$ fixing bacteria.
2. Plant 'Y' have fungal association in the form of mycorrhiza
3. Plant 'X' has pinnate leaves and unbranched stems.
4. Plant 'Y' have needle like leaves which reduces the surface area.
(a) X-*Cedrus*, Y-*Cycas*
(b) X-*Cedrus*, Y-*Pinus*
(c) X-*Pinus*, Y-*Cycas*
(d) X-*Cycas*, Y-*Pinus*

**3.** Select the correct pattern of arrangement of reproductive structures for gymnosperms.
(a) Spores → Sporophylls → Sporangia → Strobili
(b) Spores → Sporangia → Sporophylls → Strobili
(c) Sporangia → Sporophylls → Spores → Strobili
(d) Spores → Sporangia → Strobili → Sporophylls

**4.** Consider the following features of artificial classification system.
A. Used only superficial morphological characters.
B. Both external and internal features are considered.
C. Based on androecium structure.Of these,
(a) A and B are correct
(b) A and C are correct
(c) B and C are correct
(d) A, B and C are correct.

**5.** Identify the incorrect statements with respect to mosses.
I. The predominant stage in life cycle of moss is sporophyte.
II. Protonema stage which is directly developed from a spore, is a creeping and branched.
III. Leafy stage developed from primary protonema as a lateral bud.
IV. Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema.
V. Antheridia and archegonia developed at the apex of leafy shoots.
(a) I and II (b) II, III and V
(c) III and IV (d) I and III

**6.** Select the mismatched pair.
(a) Agar - *Gracilaria*
(b) Source of protein - *Chlorella*
(c) Used as food - *Laminaria*
(d) Algin - *Polysiphonia*

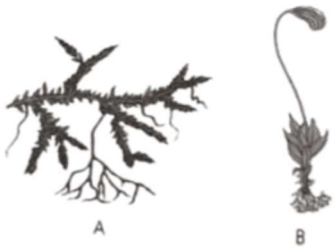
**7.** Select the option that correctly identifies A-E

| | **Algae** | **Major pigments** | **Stored food** | **Examples** |
|---|---|---|---|---|
| 1 | Chlorophyceae | Chlorophyll a, b | **A** | *Volvox, Chara* |
| 2 | Rhodophyceae | **B** | **C** | *Porphyra, Polysiphonia* |
| 3 | Phaeophyceae | Fucoxanthin, Chlorophyll a,c | **D** | **E** |

(a) A - Floridean starch; B - Chl a, d; C – Starch; D - Glucose; E - *Chlamydomonas, Ulothrix*
(b) A - Mannitol; B - Carotenoids; C - Glucose; D - Starch; E - *Laminaria, Gelidium*
(c) A - Starch; B – Phycoerythrin; C - Floridean starch; D - Mannitol, Laminarin; E – *Dictyota, Fucus*
(d) A - Laminarin; B - Phycoerythrin; C-Sucrose; D - Pyrenoids; E - Gracilaria, Spirogyra

**8.** Arrange the steps of reproduction of bryophytes in proper sequence.
I. Sporophyte produce spores that germinate to produce gametophyte.
II. Zygote produce a multicellular sporophyte.
III. Antherozoids are released in water and come in contact with archegonium.
IV. Antherozoids fuses with egg and form zygote.
V. Archegonium and antheridium produce egg and antherozoids respectively.
(a) $I \rightarrow II \rightarrow III \rightarrow IV \rightarrow V$
(b) $III \rightarrow IV \rightarrow I \rightarrow II \rightarrow V$
(c) $V \rightarrow III \rightarrow IV \rightarrow II \rightarrow I$
(d) $IV \rightarrow III \rightarrow I \rightarrow II \rightarrow V$

**9.** Pick the correct difference between the plant A and B.



(a) A is bryophyte whereas B is pteridophyte.
(b) The main plant body of A is sporophyte whereas in B it is gametophyte.
(c) B possess true stem and leaves whereas in A it is absent.
(d) B possess true roots whereas in A, rhizoids are present in place of roots.

**10.** If we remove the marked structure 'X' from Marchantia, then which process is likely to be affected?


(a) Spore formation
(b) Sexual reproduction
(c) Vegetative reproduction
(d) Spore dispersal

**11.** Read the following statements w.r.t. pteridophytes.
A. Equisetum may form distinct compact structures called strobili or cones.
B. Sporangia produce spores by mitosis in spore mother cells
C. Water is necessary for fertilization.
D. Male and female sex organs are called antheridia and archegonia respectively.
E. Zygote produces a unicellular sporophyte.
Of these,
(a) A, B and C are correct
(b) A, C and D are correct
(c) B, D and E are correct
(d) A and B are correct

**12.** Identify the incorrect statements about gymnosperms.
I. Gymnosperms are homosporous.
II. Spores are produced within sporangia that are borne on sporophylls that form cones or strobili
III. Microspores develop into highly reduced female gametophyte and have unlimited number of cells.
IV. Development of pollen grains take place within the microsporangia.
V. Nucellus is protected by ovary.
(a) I, II and V (b) II and III
(c) I, III and V (d) All of these

**13.** Select the option that correctly place the given examples into different divisions of plant kingdom.
*Salvinia, Sphagnum, Pinus, Marchantia, Equisetum, Cycas, Adiantum, Wolffia, Eucalyptus,* Mustard

| | **Bryophyte** | **Pteridophyte** | **Gymnosperm** | **Angiosperm** |
|---|---|---|---|---|
| (a) | 3 | 2 | 2 | 3 |
| (b) | 4 | 2 | 2 | 2 |
| (c) | 4 | 0 | 4 | 2 |
| (d) | 2 | 3 | 2 | 3 |

**14.** Choose the correct option to complete the given paragraph.
In Phaeophyceae, the cellulosic wall is usually covered on the outside by a gelatinous coating of (i). The plant body is usually attached to the substratum by a (ii) and has a stalk, the (iii) and leaf-like photosynthetic organ the (iv).

| | **(i)** | **(ii)** | **(iii)** | **(iv)** |
|---|---|---|---|---|
| (a) | Chitin | Frond | Holdfast | Stipe |
| (b) | Algin | Holdfast | Stipe | Frond |
| (c) | Chitin | Stipe | Fond | Holdfast |
| (d) | Algin | Frond | Stipe | Holdfast |

**15.** Which of the following statements is wrong about bryophytes?
(a) Bryophytes are also called amphibians of the plant kingdom.
(b) The gametophyte is the main plant body.
(c) Sexual reproduction takes place in the presence of water.
(d) Zygote develops into a gametophyte.

**16.** Which of the following are heterosporous pteridophytes?
I. Adiantum
II. Selaginella
III. Psilotum
IV. Salvinia
(a) I and II only (b) II and III only
(c) III and IV only (d) II and IV only

**17.** What is not true about the *Salvinia*?
(a) It is a heterosporous plant.
(b) The megaspore and microspore germinate to give rise to male and female gametophyte respectively.

(c) The female gametophyte is retained on the parent sporophyte for variable periods.
(d) The development of zygote into young embryo takes place within the female gametophyte.

**18.** Consider the following statements regarding gymnosperms and choose the correct option.
I. In gymnosperms, the male and female gametophytes have an independent existence.
II. The multicellular female gametophyte is retained within the megasporangium.
III. All gymnosperms are heterosporous.
(a) I and II are true but III is false.
(b) I and III are true but II is false.
(c) II and III are false but I is true.
(d) II and III are true but I is false.

**19.** Read the following statements and identify the correct options.
(A) Angiosperms range in size from microscopic Wolffia to tall trees of Eucalyptus.
(B) In angiosperms, the seeds are enclosed in fruits.
(C) Double fertilization is an event unique to angiosperms.
(D) In angiosperms, each cell of an embryo sac is diploid.
(E) In angiosperms, the zygote develops into an endosperm.Of the above statements
(a) (A), (B) and (D) are correct
(b) (A), (B) and (E) are correct
(c) (A), (B) and (C) are correct
(d) (B), (C) and (D) are correct.

**20.** Which one of the following is wrong about Chara?
(a) The pigments are localised in definite chloroplasts.
(b) Major photosynthetic pigment is chlorophyll a and b.
(c) Stored food is in the form of floridean starch.
(d) Asexual reproduction is by flagellated zoospores produced in zoosporangia.

**21.** Read the following statements (A-E) and answer the question which follows them.
(A) In liverworts, mosses and ferns gametophytes are free-living.
(B) Gymnosperms and some ferns are heterosporous.
(C) Sexual reproduction in *Fucus* and *Volvox* is oogamous.
(D) The sporophyte in liverworts is more elaborate than that in mosses.
(E) Both *Pinus* and *Marchantia* are dioecious.
How many of the above statements are correct?
(a) Three (b) Four
(c) One (d) Two

**22.** Find out the wrong statements.
A. *Ulothrix* and *Spirogyra* are filamentous forms.
B. *Porphyra* and *Laminaria* are fresh water algae.
C. Stored food is in the form of mannitol in Rhodophycean members.
D. *Chlorella* is unicellular algae.
(a) A and B (b) B and C
(c) A and C (d) A and D

**23.** Which out of the following is a mismatched pair?
(a) Rhodophyceae - Floridean starch, phycoerythrin
(b) Chlorophyceae – Laminarin, Mannitol
(c) Rhodophyceae - Non-flagellated gametes
(d) Phaeophyceae – Chlorophyll a and c, fucoxanthin

**24.** Which one of the following statements is wrong?
(a) Algae increase the level of dissolved oxygen in the immediate environment.
(b) Algin is obtained from red algae.
(c) Agar is obtained from *Gelidium* and *Gracilaria*.
(d) Pyrenoids contain protein besides starch.

**25.** In *Cycas*
(a) Male cones and female cones are present on same plant
(b) Male cones and megasporophylls are present on different-plants
(c) Male cones and megasporophylls are present on same plant
(d) Male cones and microsporophylls are found on different plant.

**26.** Consider the following statements (A)-(D) about algae.
(A) Highly variable in form and size.
(B) Commonly asexual reproduction by exogenous motile spores.
(C) Simple, thalloid and largely aquatic organisms.
(D) A few of the marine forms such as kelps, form massive plant bodies.
(a) Only (D) is incorrect
(b) Only (C) is incorrect
(c) (A), (C) & (D) are correct
(d) All statements are correct

**27.** Consider the given statements and select the correct options.

(A) *Salvinia* is heterosporous terrestrial algae.
(B) The male and female gametophytes do not have an independent free-living existence in gymnosperms.
(C) The sporophyte is dominant in *Wolfia*

(a) All are correct
(b) Only (B) is correct
(c) Only (A) is incorrect
(d) (A) & (C) are correct

**28.** How many statement(s) is/are correct?
(i) Some brown algae may store food in the form of oil droplets.
(ii) Coralloid roots of gymnosperms can fix nitrogen.
(iii) Needle-like leaf of gymnosperms reduces surface area.
(iv) Brown algae produce large amounts of hydrocolloids.
(a) One (b) Three
(c) Two (d) Four

**29.** Choose a correct statement among the following:
(a) Red algae usually reproduce vegetatively by budding.
(b) Gymnosperms include medium-sized trees or tall trees and shrubs.
(c) Pinus is one of the tallest tree species.
(d) The leaves in bryophytes are well-adapted to withstand extremes of temperature, humidity and wind.

**30.** How many statement(s) is/are incorrect?
(a) Pyrenoids contain protein besides starch.
(b) Brown algae are found primarily in marine habitats.
(c) In red algae, the food is stored as floridean starch.
(d) Brown algae contain chlorophyll a, d and fucoxanthin.
(a) One (b) Three
(c) Two (d) Four

**31.** Identify the types of reproduction in algae and the corresponding examples:
(A) Vegetative reproduction by binary fission
(B) Asexual reproduction by zoospores
(C) Isogamous sexual reproduction in *Ulothrix*
(D) Anisogamous sexual reproduction in *Eudorina*
(E) Oogamous sexual reproduction in *Spirogyra*
Choose the correct option:
(a) (A), (B) and (D) only
(b) (B), (C) and (D) only
(c) (A), (C), (D) and (E) only
(d) (B), (C), (D) and (E) only

**32.** Which of the following components are not part of Marchantia?
(a) Holdfast (b) Rhizoids
(c) Antheridiophore (d) Strobilus
(e) Gemma cup
Choose the correct answer from the options given below:
(a) (a), (b) and (d) only
(b) (b), (d) and (e) only
(c) (a) and (d) only
(d) (b), (c) and (e) only

**33.** Read the option: given statements about algae and select the correct option:
(a) Plant body is thalloid
(b) Mainly they are aquatic
(c) Reproduction by vegetative, asexual and sexual methods
(d) *Chlamydomonas*, *Volvox* and *Ulothrix* are the multicellular algae
(a) Statements (a) and (b) are true
(b) Statements (b) and (c) are true
(c) Statements (a), (b) and (c) are true
(d) All statements are true

**34.** How many of the given characters are associated with brown algae?

| |
|---|
| Laminarin, Polysulphate ester, Floridean starch, Fucoxanthin, Lateral flagella, Phycoerythrin, Starch, Chlorophyll c, Mannitol |

(a) Eight (b) Six
(c) Seven (d) Five

**35.** Resemblances between algae and bryophytes include
(a) Presence of root-like, stem-like and leaf-like structures
(b) Thallus-like plant body, lack of vascular tissues, autotrophic nutrition
(c) Thallus-like plant body, presence of vascular tissues, autotrophic nutrition
(d) Presence of roots, heterotrophic nutrition.

**36.** The members of Rhodophyceae are commonly called red algae because:
(a) They are found in greater concentrations in warmer area of ocean.
(b) They have floridean starch as a stored food.
(c) They show predominance of r-phycoerythrin in their body.
(d) They show complex post-fertilization developments.

**37.** The correct sequence of the ploidy in moss protonemal cell, primary endosperm nucleus in dicots, leaf cell of a moss, prothallus cell of a fern, gemma cell in Marchantia, meristematic cell of monocot, ovum of liverwort, and zygote of fern-
(a) N, 3N, N, N, N, 2N, N, 2N

(b) 3N, 2N, N, N, N, 2N, N, N
(c) 2N, 3N, 2N, N, N, N, N, N
(d) N, 3N, N, N, N, N, 2N, 2N

**38.** Consider the following four statements whether they are correct or wrong:
(A) The sporophyte in liverworts is more elaborate than that in mosses
(B) *Salvinia* is heterosporous
(C) The sporophyte in all seed-bearing plants is dominant
(D) In Pinus male and female cones are born on different trees
The two wrong statements together are:
(a) Statements (A) and (C)
(b) Statements (A) and (D)
(c) Statements (B) and (C)
(d) Statements (A) and (B)

**39.** In gymnosperms, microspore develops into a male gametophytic generation which is highly reduced and is confined to only a limited number of cells. This reduced gametophyte is known as
(a) Pollen grain (b) Endosperm
(c) Prothallus (d) Embryo sac

**40.** Consider the following statements -
A. Sea Weeds include Phaeophyceae and Rhodophyceae.
B. Red algae differ from green and brown algae in not having any flagellate stage.
C. Bryophytes absorb most of their water through above-ground structures.
D. Bryophytes seldom reach a height of more than 20 cm because they lack vascular system, roots and mechanical tissues.
E. The gametophyte in the life cycle of a fern is independent and autotrophic.
The above statements
(a) A and B are correct
(b) B and C are correct
(c) C and D are correct
(d) All are correct.

**41.** Go through the following statements–
A. The food in red algae is stored as floridean starch which is very similar to amylopectin and glycogen in structure.
B. In *Cycas*, pollination is by wind.
C. Pyriform gametes are present in *Porphyra*
D. The leafy members of liverworts have tiny leaf-like appendages in two rows on the stem-like structures
E. Gymnosperms do not have vessels, sieve tubes and companion cells.
How many statements is wrong:
(a) 1 (b) 2
(c) 4 (d) 5

**42.** Which one of the following is a correct statement
(a) In Pteridophyte, gametophyte has a protonema and leafy stage
(b) In gymnosperms female gametophyte is free-living
(c) Antheridiophores and archegoniophores are present in pteridophytes.
(d) Origin of seed habit can be traced in pteridophytes

**43.** Go through the statements
A. Oogamous sexual reproduction involves fusion of motile and non-motile gametes.
B. Protonema stage in moss develops directly from a spore.
C. In Selaginella sporophyte is dominant.
D. Strobili or cones are found in *Selaginella* and *Equisetum*
E. Prothallus is small, conspicuous, small and unicellular free-living gametophyte in pteridophytes
Which of the above statement is correct?
(a) A, B, E only (b) B, C, E only
(c) A, D, E only (d) A, B, C, D only

**44.** In which of the following, all listed genera belong to the same class of algae
(a) *Porphyra*, *Ectocarpus*, *Ulothrix*
(b) *Volvox*, *Spirogyra*, *Chlamydomonas*
(c) *Chara*, *Fucus*, *Polysiphonia*
(d) *Sargassum*, *Laminaria*, *Gracilaria*

**45.** In a moss, the sporophyte
(a) Arises from a spore produced from the gametophyte
(b) Produces gametes that give rise to the gametophyte
(c) Is partially parasitic on the gametophyte
(d) Manufactures food for itself, as well as for the gametophyte

**46.** Read the following statements (A-E) and answer question which follows them:
(A) In liverworts, mosses, and ferns gametophytes are free - living
(B) Gymnosperms and some ferns are heterosporous
(C) Sexual reproduction in *Fucus* and *Volvox* is oogamous
(D) The sporophyte in liverworts is more elaborate than that in mosses
(E) Both, *Pinus* and *Marchantia* are dioecious

How many of the above statements are correct?
(a) One (b) Two
(c) Three (d) Four

**47.** A. Companion cells and sieve tubes are absent in bryophytes
B. Gametophyte of pteridophytes require cool, dry and shady places to grow
C. Prothallus is found in Dryopteris
(a) Only C is correct
(b) Only A is correct
(c) A and B are correct
(d) Only B is incorrect

**48.** In which of the following groups of plants does the description given below fits –
they have no roots, flower and seeds, the plant body is characterized by a green thallus or sometimes erect shoot and female reproductive organ is archegonia.
(a) Gymnosperm (b) Bryophyta
(c) Pteridophyte (d) Angiosperm

**49.** How many plants in the list given below are the members of non-vascular embryophytes?
*Spirogyra, Volvox, Fucus, Polysiphonia, Polytrichum, Sphagnum, Marchantia, Funaria, Selaginella, Equisetum*
(a) Six (b) Three
(c) Four (d) Five

**50.** Some characteristic structures are given below. How many of them are found in both Bryophyta and pteridophyta?
A. Archegonium
B. Protonema
C. Embryo
D. Ovule
E. Vascular tissue
F. Antheridium
Option-
(a) Two (b) Three
(c) Four (d) Five

# Exercise-03 Level -03

## Assertion & Reason Based Questions

**1.** **Assertion:** The earliest systems of classification used only superficial morphological characters.
**Reason:** Artificial system gave equal weightage to vegetative and sexual characteristics.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**2.** **Assertion:** Cytotaxonomy is based on the cytological information like chromosome number, structure and behaviour.
**Reason:** Chemotaxonomy that uses the chemical constituents of the plants.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**3.** **Assertion:** Bryophytes are called amphibian of plant kingdom.
**Reason:** Prothallus stage is seen in the life cycle of bryophytes.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**4.** **Assertion:** Mosses along with lichens are the first organisms to colonize rocks.
**Reason:** They decompose rocks by secreting acid substances.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**5.** **Assertion:** Pteridophytes are used for medicinal purposes and soil binders.

**Reason:** They are the first terrestrial plants to possess vascular tissues.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**6.** **Assertion:** Only the red algae is able to flourish at the great depth of sea.

**Reason:** Red algae have the pigments r-phycoerythrin and r-phycocyanin.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**7.** **Assertion:** Gymnosperms are heterosporous.

**Reason:** They produce haploid microspores and megaspores.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**8.** **Assertion:** In *Pinus*, the coralloid roots are associated with nitrogen fixing cyanobacteria.

**Reason:** In Cycas, mycorrhiza is present.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**9.** **Assertion:** Pyrenoids are storage bodies in *Porphyra*.

**Reason:** Pyrenoids contains lipids and proteins.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**10.** **Assertion:** *Chlorella* used as a food supplement by space travelers.

**Reason:** *Chlorella* is a unicellular green alga.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**11.** **Assertion:** *Sphagnum* is used for transshipment of living material like seedlings.

**Reason:** *Sphagnum* has capacity of water retention.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**12.** **Assertion:** Pteridophytes evolutionarily, are first terrestrial vascular plants.

**Reason:** Pteridophytes are soil binder.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**13.** **Assertion:** The spread of living Pteridophytes is restricted to narrow geographical region.

**Reason:** They require cool, dry and shady place to grow and require water for fertilization.

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**14.** **Assertion:** Leaves of gymnosperm can't withstand extremes of temperature.
**Reason:** Leaves of gymnosperm possess large surface area with thin cuticle.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**15.** **Assertion:** Natural system of classification based on natural affinities among the organisms.
**Reason:** Natural system gave equal weightage to vegetative and sexual characteristics.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false

**16.** **Assertion:** Algae are the primary producers of many food cycles.
**Reason:** Being photosynthetic they decrease the level of dissolved oxygen in their immediate environment.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false.

**17.** **Assertion:** Majority of the red algae are marine with greater concentrations found in the warmer areas.
**Reason:** They occur in both well-lighted regions close to the surface of water and also at great depths in oceans where relatively little light penetrates.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false.

**18.** **Assertion:** Bryophytes are the amphibians of plant kingdom.
**Reason:** They are found in swamps and the areas, where water and land meet.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false.

**19.** **Assertion:** *Lycopodium* and *Selaginella* are heterosporous.
**Reason:** In heterosporous condition, one kind of spores are produced by the plant.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false.

**20.** **Assertion:** Production of two types of spores is a pre-requisite of seed habit.
**Reason:** In pteridophytes, *Lycopodium* is precursor of seed habit.
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.
(c) If the assertion is true but the reason is false.
(d) If both the assertion and reason are false.

## Statement Based Questions

**21.** **Statement-I:** Agar is used in preparation of ice-creams.
**Statement-II:** Agar is obtained from *Gracilaria* and *Gelidium*.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.

(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**22.** **Statement-I:** The second stage in moss life cycle is protonema stage.
**Statement-II:** The first stage in moss life cycle is leafy stage.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**23.** **Statement-I:** Mosses and lichens are first to colonise bare rocks.
**Statement-II:** Mosses enhance the impact of falling rain.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**24.** **Statement-I:** The leaves in gymnosperms are well-adapted to withstand extreme temperature, humidity and wind.
**Statement-II:** Unlike bryophytes and pteridophytes, in gymnosperms the male and female gametophytes do not have an independent free-living existence.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**25.** **Statement-I:** The pteridophytes are frequently grown as ornamentals.
**Statement-II:** In bryophytes, haploid gametophyte is totally or partially dependent on the sporophyte.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**26.** **Statement-I:** Gymnosperms do not produce fruits.
**Statement-II:** Ovules of gymnosperms are enclosed within the ovaries.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**27.** **Statement-I:** The primary mode of vegetative reproduction in mosses involves fragmentation and budding in the secondary protonema.
**Statement-II:** Leafy stage in moss bears the sex organs
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**28.** **Statement-I:** Kelp is a marine alga which form massive plant body.
**Statement-II:** Anisogamous reproduction is seen in *Eudorina*.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**29.** **Statement-I:** Many species of Ectocarpus, Dictyota and Sargassum are among the 70 species of marine algae used as food.
**Statement-II:** Asexual reproduction in most brown algae is by biflagellate zoospores.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**30.** **Statement-I:** Sexual reproduction of Spirogyra is isogamous type.
**Statement-II:** Both of the fusing gametes of Spirogyra are non-flagellated and similar in size.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.

(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct.

**31.** **Statement I:** Development of seed habit in pteridophytes is an important step in evolution.
**Statement II:** In bryophytes, young embryo develops within the female gametophyte.
(a) Both Statement I and Statement II are correct.
(b) Both Statement I and Statement II are incorrect.
(c) Statement I is correct but Statement II is incorrect.
(d) Statement I is incorrect but Statement II is correct.

**32.** **Statement I:** Gymnosperms generally have tap roots
**Statement II:** *Pinus* and *Cedrus* are branched while Cycas is unbranched
(a) Both statements I and II are correct.
(b) Both statements I and II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct

**33.** **Statement I:** In Cycas the pinnate leaves persist for a few years.
**Statement II:** Pteridophytes have well developed vascular tissues.
(a) Both statements I and II are correct.
(b) Both statements I and II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct

**34.** **Statement I:** In *Cycas*, male cones and megasporophylls are borne on different trees.
**Statement II:** Peat is used as fuel.
(a) Both statements I and II are correct.
(b) Both statements I and II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct

**35.** **Statement I:** The endosperm in gymnosperm is formed after fertilization.
**Statement II:** The endosperm of gymnosperm is formed by triple fusion.
(a) Both statements I and II are true.
(b) Statement I is true but statement II is false.
(c) Statement I is false but statement II is true.
(d) Both statements I and II are false.

## Match up Based Questions

**36.** Match the following and choose the correct combination.

| | Column-I | | Column-II |
|---|---|---|---|
| A | Red algae | 1 | *Marchantia* |
| B | Liverwort | 2 | *Pinus* |
| C | Fern | 3 | *Polysiphonia* |
| D | Gymnosperm | 4 | *Adiantum* |

(a) A–1, B–2, C–4, D–3
(b) A–2, B–4, C–3, D–1
(c) A–2, B–3, C–1, D–4
(d) A–3, B–1, C–4, D–2

**37.** Match column I with column II and select the correct option.

| | Column-I | | Column-II |
|---|---|---|---|
| I | Natural classification | A | Assumes that organism |
| II | Artificial classification | B | belonging to same taxa have a common ancestor. |
| III | Phylogenetic classification | C | Separated the closely classification related species. |

(a) I–A, II–B, III–C
(b) I–B, II–A, III–C
(c) I–C, II–A, III–B
(d) I–B, II–C, III–A

**38.** Match column I with column II and select the correct option.

| | Column-I | | Column-II |
|---|---|---|---|
| I | Numerical taxonomy | A | Based on cytological information like chromosome number, structure and behaviour |
| II | Cytotaxonomy | B | Carried out by using computers based on all observable characteristics |

| | | | |
|---|---|---|---|
| III | Chemotaxonomy | C | Uses chemical constituents of plants |

(a) I–C, II–A, III–B
(b) I–A, II–B, III–C
(c) I–B, II–A, III–C
(d) I–A, II–C, III–B

**39.** Match column I with column II.

| | Column-I | | Column-II |
|---|---|---|---|
| A | Sexual reproduction | I | Isogamous |
| B | Asexual reproduction | II | Fragmentation |
| C | Vegetative reproduction | III | Oogamous |
| | | IV | Zoospores |
| | | V | Anisogamous |

(a) A-I; B-II; C-III, IV, V
(b) A-I, IV; B-II, V; C-III
(c) A-I; III, V; B-IV; C-II
(d) A-I; B-II, V; C-III, IV

**40.** Match column I with column II and select the correct option.

| | Column-I | | Column-II |
|---|---|---|---|
| A | Isogamous | I | Gametes dissimilar in size |
| B | Anisogamous | II | Fusion of non-motile egg with motile sperm |
| C | Oogamous | III | Gametes similar in size |

(a) A-III, B-II, C-I
(b) A-I, B-II, C-III
(c) A-I, B-III, C-II
(d) A-III, B-I, C-II

**41.** Match column I with column II and select the correct option.

| | Column-I | | Column-II |
|---|---|---|---|
| 1 | Homosporous | A | *Selaginella, Salvinia* |
| 2 | Heterosporous | B | *Psilotum, Lycopodium* |
| | | C | Spores of similar types |
| | | D | Macrospores and microspores |

(a) 1-B, C; 2-A, D
(b) 1-A, B; 2-C, D
(c) 1-A, C; 2-B, D
(d) 1-A, D; 2-B, C

**42.** Match class of pteridophyte in column I with their appropriate

| | Column-I | | Column-II |
|---|---|---|---|
| 1 | Psilopsida | A | *Adiantum* |
| 2 | Lycopsida | B | *Psilotum* |
| 3 | Sphenopsida | C | *Selaginella* |
| 4 | Pteropsida | D | *Equisetum* |

(a) 1-C, 2-B, 3-A, 4-D
(b) 1-B, 2-A, 3-D, 4-C
(c) 1-B, 2-C, 3-D, 4-A
(d) 1-B, 2-D, 3-A, 4-C

**43.** Match column I with column II and select the correct option.

| | Column-I | | Column-II |
|---|---|---|---|
| A | *Sargassum* | 1 | 2-8, equal apical flagella |
| B | *Porphyra* | 2 | Elaborate mechanism of spore dispersal |
| C | *Ulothrix* | 3 | Used as food |
| D | *Funaria* | 4 | Non-motile asexual spores |

(a) A-1, B-2, C-3, D-4
(b) A-2, B-3, C-1, D-4
(c) A-4, B-1, C-2, D-3
(d) A-3, B-4, C-1, D-2

**44.** Match the column I with column II and choose the correct option from those given below.

| | Column-I | | Column-II |
|---|---|---|---|
| A | *Volvox* | p | Gymnosperm |
| B | *Marchantia* | q | Fucoxanthin |
| C | *Sargassum* | r | Pyrenoids |

| | | | |
|---|---|---|---|
| D | *Cedrus* | s | Liverwort |

(a) A - (r), B - (s), C - (q), D - (p)
(b) A - (p), B - (s), C - (q), D - (r)
(c) A - (s), B - (p), C - (r), D - (q)
(d) A - (r), B - (q), C - (s), D - (p)

**45.** Match the plant structures given in the column I with their plants given in the column II.

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| A | Prothallus | p | Bryophytes |
| B | Microsporophyll | q | Pteridophytes |
| C | Protonema | r | Angiosperms |
| D | PEN | s | Gymnosperms |

(a) A - s, B – r, C – p, D – q
(b) A – r, B – p, C – s, D – q
(c) A – q, B – s, C – p, D – r
(d) A – q, B – s, C – r, D – p

**46.** Match the column-I and column-II and choose the appropriate option.

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| A | Phylogenetic | 1 | Based on number of chromosomes |
| B | Numerical | 2 | Based on evolutionary relationships |
| C | Cytotaxonomy | 3 | Based on all observable characteristics |
| D | Natural | 4 | Based on anatomy and embryology |

(a) (A)-(2); (B)-(3); (C)-(1); (D)-(4)
(b) (A)-(1); (B)-(3); (C)-(4); (D)-(2)
(c) (A)-(2); (B)-(1); (C)-(3); (D)-(4)
(d) (A)-(3); (B)-(2); (C)-(1); (D)-(4)

**47.** Match the column-I and column-II and find out the correct combination:

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| A | *Pteris* | 1 | Coralloid roots |
| B | *Cycas* | 2 | Peat moss |
| C | *Sphagnum* | 3 | Algin |
| D | *Sargassum* | 4 | Green and inconspicuous gametophyte |

(a) (A)-(4); (B)-(2); (C)-(1); (D)-(3)
(b) (A)-(4); (B)-(1); (C)-(2); (D)-(3)
(c) (A)-(2); (B)-(3); (C)-(4); (D)-(1)
(d) (A)-(1); (B)-(4); (C)-(3); (D)-(2)

**48.** Match the column-I and column-II and find out the correct combination:

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| A | *Chara* | 1 | Green algae |
| B | *Volvox* | | |
| C | *Fucus* | 2 | Brown algae |
| D | *Dictyota* | | |
| E | *Porphyra* | 3. | Red algae |
| F | *Polysiphonia* | | |

(a) (A), (B)-(1); (C), (D)-(2); (E), (F)-(3)
(b) (A), (C)-(1); (E), (F)-(2); (B), (D)-(3)
(c) (B), (C)-(1); (A), (E)-(2); (D), (F)-(3)
(d) (B), (D)-(1); (A), (C)-(2); (E), (F)-(3)

**49.** Match the column-I and column-II and find out the correct combination:

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| A | Agar | 1 | *Gelidium*, *Gracilaria* |
| B | Algin | 2 | Brown algae |
| C | Carrageen | 3 | Red algae |
| D | Starch | 4 | Green algae |

Choose the correct combination
(a) (A) - (1), (B) - (2), (C) - (3), (D) - (4)
(b) (A) - (4), (B) - (3), (C) - (2), (D) - (1)
(c) (A) - (2), (B) - (1), (C) - (3), (D) - (4)
(d) (A) - (3), (B) - (2), (C) - (1), (D) - (4)

**50.** Match the column-I and column-II and find out the correct combination:

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| A | *Ectocarpus* | 1 | Pinnate leaves |
| B | *Selaginella* | 2 | Pyriform gametes |
| C | *Cycas* | 3 | Heterosporous |

| | | | |
|---|---|---|---|
| D | *Marchantia* | 4 | Gemmae |

(a) (A)-(1), (B)-(3), (C)-(4), (D)-(2)
(b) (A)-(2), (B)-(3), (C)-(1), (D)-(4)
(c) (A)-(3), (B)-(2), (C)-(1), (D)-(4)
(d) (A)-(2), (B)-(1), (C)-(3), (D)-(4)

# Exercise-04 Previous Year Questions

**1.** Read the following statements and choose the set of correct statements: In the membrane of Phaeophycean. **(2024)**

A. Asexual reproduction occurs usually by biflagellate zoospores.
B. Sexual reproduction is by oogamous method only.
C. Stored food is in the form of carbohydrates which is either mannitol or laminarin.
D. The major pigments found are chlorophyll a, c and carotenoids and xanthophyll.
E. Vegetative cells have a cellulosic wall, usually covered on the outside by gelatinous coating of algin.

Choose the correct answer from the option given below.
(a) B, C, D and E only
(b) A, C, D and E only
(c) A, B, C and E only
(d) A, B, C and D only

**2.** Identify the pair of heterosporous pteridophytes among the following: **(2023)**
(a) Equisetum and Salvinia
(b) Lycopodium and Selaginella
(c) Selaginella and Salvinia
(d) Psilotum and Salvinia

**3.** **Assertion (A): -** The first stage of gametophyte in the life cycle of moss is protonema stage.
**Reason (R): -** Protonema develops directly from spores produced in capsule. **(2023)**
(a) A is not correct but R is correct.
(b) Both A and R are correct and R is the correct explanation of A
(c) Both A and R are correct but R is NOT the correct explanation of A
(d) A is correct but R is not correct

**4.** **Assertion A:-** In gymnosperm the pollen grains are released from the microsporangium and carried by air currents.
**Reason R:-** Air currents carry that pollen grains to the mouth of the archegonia where the male gametes are discharged and pollen tube is not formed. **(2023)**
(a) A is false but R is true
(b) Both A and R are true and R is the correct explanation of A
(c) Both A and R are true but R is NOT the correct explanation of A
(d) A is the true but R is false

**5.** Match List - I with List - II. **(2023)**

| | List – I | | List – II |
|---|---|---|---|
| A | Pteropsida | (i) | Psilotum |
| B | Lycopsida | (ii) | Equisetum |
| C | Psilpsida | (iii) | Adiantum |
| D | Sphenopsida | (iv) | Selaginella |

Choose the correct answer from the options given below:
(a) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(b) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(c) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(d) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

**6.** Which classes of algae possess pigment fucoxanthin and pigment phycoerythrin, respectively? **(2023)**
(a) Phaeophyceae and Chlorophyceae
(b) Phaeophyceae and Rhodophyceae
(c) Chlorophyces and Rhodophycea
(d) Rhodophyceae and Phaeophycea

**7.** Match List - I with List - II. **(2022)**

| List – I | | List – II | |
|---|---|---|---|
| A | Chlamydomonas | (i) | Moss |
| B | Cycas | (ii) | Pteridophyte |
| C | Selaginella | (iii) | Alga |
| D | Sphagnum | (iv) | Gymnosperm |

Choose the correct answer from the options given below

(a) (A)-(ii), (B)-(ii), (C)-(i), (D)-(iv)
(b) (A)-(iii), (B)-(i), (C)-(ii), (D)-(iv)
(c) (A)-(iii), (B)-(iv), (C)-(ii), (D)- (i)
(d) (A)-(iii), (B)-(ii), (C)-(i), (D) (iv)

**8.** Read the following statements and identify the characters related to the alga shown in the diagram: **(2022)**

(A) It is a member of Chlorophyceae
(B) Food is stored in the form of starch
(C) It is monoecious plant showing oogonium and antheridium
(D) Food is stored in the form of laminarin or mannitol
(E) It shows dominance of pigments Chlorophyll a, c and Fucoxanthin

Choose the correct answer from the options given below:

(a) (C), (D) and (E) only
(b) (A), and (B) only
(c) (A), (B) and (C) only
(d) (A), (C) and (D) only

**9.** Hydrocolloid carrageen is obtained form: **(2022)**

(a) Chlorophyceae and Phaeophyceae
(b) Phaeophyceae and Rhodophyceae
(c) Rhodophyceae only
(d) Phaeophyceae only

**10.** Which of the following is incorrectly matched? **(2022)**

(a) Ectocarpus-Fucoxanthin
(b) Ulothrix-Mannitol
(c) Porphyra-Floridian Starch
(d) Volvox-Starch

**11.** Match the plant with the kind of life cycle it exhibits: **(2022)**

| List – I | | LIst – II | |
|---|---|---|---|
| A | Spirogyra | (i) | Dominant diploid sporophyte vascular plant, with highly reduced male or female gametophyte |
| B | Fern | (ii) | Dominant haploid free-living gametophyte |
| C | Funaria | (iii) | Dominant diploid sporophyte alternating with reduced gametophyte called prothallus |
| D | Cycas | (iv) | Dominant haploid leafy gametophyte alternating with partially dependent multicellular sporophyte |

Choose the correct answer from the options given below:

(a) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)
(b) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)
(c) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii)
(d) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)

**12.** Which of the following algae produce Carrageen? **(2021)**

(a) Brown algae
(b) Red algae
(c) Blue-green algae
(d) Green algae

**13.** Genera like Selaginella and Salvinia produce two kinds of spores. Such plants are known as: **(2021)**

(a) Heterosorus
(b) Homosporous
(c) Heterosporous
(d) Homosorus

**14.** Which of the following algae contains mannitol as reserve food material? **(2021)**

(a) Gracilaria (b) Volvox

(c) Ulothrix (d) Ectocarpus

**15.** Gemmae are present in: **(2021)**
(a) Pteriodophytes
(b) Some Gymnosperms
(c) Some Liverworts
(d) Mosses

**16.** Which of the following pairs is of unicellular algae? **(2020)**
(a) Gelidium and Gracilaria
(b) Anabaena and Volvox
(c) Chlorella and Spirulina
(d) Laminaria and Sargassum

**17.** Floridean starch has structure similar to: **(2020)**
(a) Amylopectin and glycogen
(b) Mannitol and algin
(c) Laminarin and cellulose
(d) Starch cellulose

**18.** Strobili or cones are found in: **(2020)**
(a) Pteris
(b) Marchantia
(c) Equisetum
(d) Salvinia

**19.** Male and female gametophytes do not have an independent free living existence in: **(2020)**
(a) Algae
(b) Angiosperms
(c) Bryophytes
(d) Pteridophytes

**20.** Phycoerythrin is the major pigment in: **(2020)**
(a) Blue green algae
(b) Green algae
(c) Brown algae
(d) Red algae

**21.** Which of the following statements is incorrect about gymnosperms? **(2020)**
(a) Male and female gametophytes are free living
(b) Most of them have narrow leaves with thick cuticle
(c) Their seeds are not covered
(d) They are heterosporous

## Answer keys

### TOPIC CENTRIC EXERCISE -01 Answer Key

| | | | | |
|---|---|---|---|---|
| **1.** (d) | **2.** (c) | **3.** (c) | **4.** (c) | **5.** (a) |

### TOPIC CENTRIC EXERCISE -02 Answer Key

| | | | | |
|---|---|---|---|---|
| **1.** (a) | **2.** (d) | **3.** (b) | **4.** (a) | **5.** (a) |

### TOPIC CENTRIC EXERCISE -03 Answer Key

| | | | | |
|---|---|---|---|---|
| **1.** (a) | **2.** (d) | **3.** (d) | **4.** (d) | **5.** (b) |

### TOPIC CENTRIC EXERCISE -04 Answer Key

| | | | | |
|---|---|---|---|---|
| **1.** (d) | **2.** (c) | **3.** (a) | **4.** (a) | **5.** (a) |

### TOPIC CENTRIC EXERCISE -05 Answer Key

| | | | | |
|---|---|---|---|---|
| **1.** (d) | **2.** (c) | **3.** (a) | **4.** (d) | **5.** (a) |

### TOPIC CENTRIC EXERCISE -06 Answer Key

| | | | | |
|---|---|---|---|---|
| **1.** (d) | **2.** (c) | **3.** (a) | **4.** (b) | **5.** (c) |

### Exercise-01 Level -01 Answer Key

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** (c) | **6.** (d) | **11.** (a) | **16.** (b) | **21.** (a) | **26.** (b) | **31.** (d) | **36.** (c) | **41.** (c) | **46.** (c) |
| **2.** (c) | **7.** (b) | **12.** (a) | **17.** (a) | **22.** (b) | **27.** (d) | **32.** (a) | **37.** (d) | **42.** (b) | **47.** (b) |
| **3.** (b) | **8.** (b) | **13.** (d) | **18.** (c) | **23.** (c) | **28.** (b) | **33.** (a) | **38.** (c) | **43.** (b) | **48.** (b) |
| **4.** (c) | **9.** (c) | **14.** (a) | **19.** (b) | **24.** (d) | **29.** (a) | **34.** (b) | **39.** (b) | **44.** (c) | **49.** (a) |
| **5.** (d) | **10.** (a) | **15.** (d) | **20.** (c) | **25.** (d) | **30.** (b) | **35.** (a) | **40.** (b) | **45.** (c) | **50.** (d) |

### Exercise-02 Level -02 Answer Key

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** (d) | **6.** (d) | **11.** (b) | **16.** (d) | **21.** (a) | **26.** (c) | **31.** (b) | **36.** (c) | **41.** (a) | **46.** (c) |
| **2.** (d) | **7.** (c) | **12.** (c) | **17.** (b) | **22.** (b) | **27.** (c) | **32.** (c) | **37.** (a) | **42.** (d) | **47.** (d) |
| **3.** (b) | **8.** (c) | **13.** (d) | **18.** (d) | **23.** (b) | **28.** (b) | **33.** (c) | **38.** (b) | **43.** (d) | **48.** (b) |
| **4.** (b) | **9.** (b) | **14.** (b) | **19.** (c) | **24.** (b) | **29.** (b) | **34.** (d) | **39.** (a) | **44.** (b) | **49.** (c) |
| **5.** (d) | **10.** (b) | **15.** (d) | **20.** (c) | **25.** (b) | **30.** (a) | **35.** (b) | **40.** (d) | **45.** (c) | **50.** (b) |

### Exercise-03 Level -03 Answer Key

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** (b) | **6.** (a) | **11.** (a) | **16.** (c) | **21.** (a) | **26.** (c) | **31.** (c) | **36.** (d) | **41.** (a) | **46.** (a) |
| **2.** (b) | **7.** (a) | **12.** (b) | **17.** (b) | **22.** (b) | **27.** (a) | **32.** (a) | **37.** (d) | **42.** (c) | **47.** (b) |
| **3.** (c) | **8.** (d) | **13.** (c) | **18.** (a) | **23.** (c) | **28.** (a) | **33.** (a) | **38.** (c) | **43.** (d) | **48.** (a) |
| **4.** (a) | **9.** (d) | **14.** (d) | **19.** (d) | **24.** (a) | **29.** (d) | **34.** (a) | **39.** (c) | **44.** (a) | **49.** (a) |
| **5.** (b) | **10.** (b) | **15.** (c) | **20.** (c) | **25.** (c) | **30.** (a) | **35.** (d) | **40.** (d) | **45.** (c) | **50.** (b) |

### Exercise-04 Previous Year Questions

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.** (b) | **4.** (d) | **7.** (c) | **10.** (b) | **13.** (c) | **16.** (c) | **19.** (b) |
| **2.** (c) | **5.** (d) | **8.** (c) | **11.** (b) | **14.** (d) | **17.** (a) | **20.** (d) |
| **3.** (b) | **6.** (b) | **9.** (c) | **12.** (b) | **15.** (c) | **18.** (c) | **21.** (a) |