AEP STUDY CIRCLE
SINCE 2001...
IIT-NEET-CBSE
ACCENTS EDUCATIONAL PROMOTERS

24 YEARS OF LEGACY

YOUR GATEWAY TO EXCELLENCE IN
IIT-JEE, NEET AND CBSE EXAMS

XI NEET

2

PLANT KINGDOM
BIOLOGY

PLANT KINGDOM

BIOLOGY

IIT-JEE
NEET
CBSE

CONTACT US:
+91-9939586130
+91-9955930311

www.aepstudycircle.com

aepstudycircle@gmail.com

FLOOR, SATKOUDI COMPLEX, THANA CHOWK, RAMGARH - 829122 JH

PLANT KINGDOM

CHAPTER : 03

CHARACTERISTICS FEATURE OF KINGDOM PLANTAE

- The Kingdom Plantae includes plants which are multicellular eukaryotes.
- All plants contain plastids. Plastids are double membrane organelle that possess photosynthetic pigments. They are called chloroplasts.
- They are usually autotrophic. Chloroplast contains a green colour pigment called chlorophyll and prepares its own food by the process of photosynthesis.
- The cell walls possess mainly cellulose.
- The plant body may be thalloid or differentiated into root, stem and leaves.
- They may be non-vascular or vascular.
- They have two stages in their life cycle- a haploid, sexually reproducing gametophytic generation and a diploid, asexually reproducings porophytic generation. The two generations alternate. This is called **alternation of generations**.

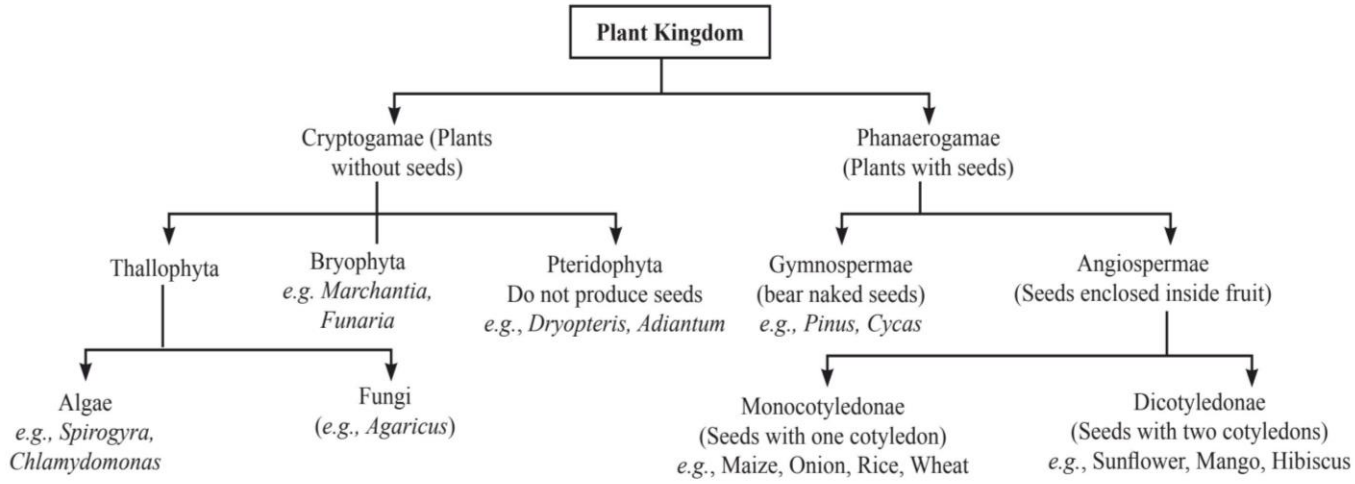
CLASSIFICATION WITHIN ANGIOSPERMS

- **Artificial system of classification**
  - ➢ It was given by **Linnaeus**.
  - ➢ They were based mainly on vegetative characters and androecium structures.
  - ➢ This artificial system classification separated the closely related species since they were based on a few characteristics. They gave equal importance to vegetative and sexual characteristics, which is not acceptable since we know that often the vegetative characters are more easily affected by environment.
- **Natural system of classification**
  - ➢ It was given by **George Bentham** and **Joseph Dalton Hooker**.
  - ➢ It was based on natural affinities among the organisms and considers not only the external features, but also internal features, like ultrastructure, anatomy, embryology and phytochemistry.
- **Phylogenetic system of classification**
  - ➢ This is accepted system of classification as it is based on evolutionary relationship between the organisms.
  - ➢ This assumes that organisms belonging to the same taxa have a common ancestor.
- **Numerical taxonomy**
  - ➢ It is based on all observable characteristics.
  - ➢ Numbers and codes are assigned to all characters and the data are then processed. In this way each character is given equal importance and at the same time hundreds of characters can be considered.
  - ➢ Easily carried out using computers.
- **Cytotaxonomy**
  - ➢ It is based on cytological information such as chromosome number, structure, behaviour.
- **Chemotaxonomy**
  - ➢ It is based on chemical constituents of plant to resolve doubts and confusions.

KINGDOM PLANTAE

- Kingdom plantae shows a lot of diversity, because of which, it has been divided into four divisions: **Algae, Bryophyta, Pteridophyta, and Spermatophyta (Gymnosperms and Angiosperms).**

Classification of Kingdom Plantae



Cryptaegamae and Phanerogamae

In 1883, *Eichler* **divided** the kingdom plante into two sub-kingdoms, Cryptogamae and Phanerogamae.

Sub-kingdom Cryptagamae (Greek-cryptos-hidden, gamos-marriage)

(i) These include lower plants that do not bear flower or seed. They are known as seedless plants.
(ii) The reproductive organs are inconspicuous.
(iii) The embryo, if present, is naked and called spores.
(iv) It includes three divisions: Thallophyta, Bryophyta and Pteridophyta.

Sub-kingdom Phanerogamae (Greek-phaneros-visible, gamos-marriage)

(i) These include plant that bears flowers and seeds.
(ii) The plant body is well differentiated into true stem, leaves and roots.
(iii) Main reproductive organ is seed. Seeds are formed as result of sexual reproduction. The male and female gametes fuse together inside the ovary (female part of flower) and develop into seed. In some plants seed is not produced inside an ovary.
(iv) It includes a single division of spermatophyte.

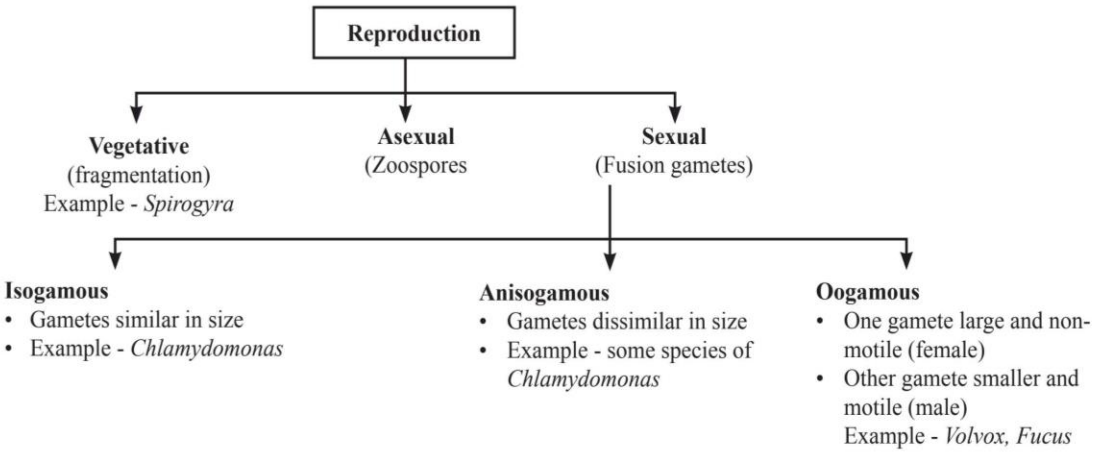
DIVISION THALLOPHTA (GREEK: THALLOS UNDIFFERENTIATED, PHYTON-PLANT)

- Plants of this division comprise the simplest plants that do not have well-differentiated body design.
- The body design is simple *i.e.* not differentiated into stem, root and leaves. It is often called thallus.
- They are unicellular.
- Thallophyta includes a single sub-division of algae.

Sub-Division Algae

- **Habit and habitat:** Algae are largely aquatic either freshwater or marine organisms. Some members of algae occur in association with fungi (lichens) and animals (on sloth bear).
- **Characteristic features:**
  - ➢ Algae are chlorophyll-bearing, simple, thalloid, autotrophic organisms.
  - ➢ Their size ranges from microscopic unicellular forms such as *Chlamydomonas* to colonial forms such as *Volvox* and to filamentous forms such as *Ulothrix* and *Spirogyra*. Massive plant-like bodies are seen in some marine forms (such as kelps).
  - ➢ Their body is unicellular (*Chlamydomonas*), Colonial (*Volvox*) or filamentous (*Spirogyra*) or thalloid (*Sargassum*).
  - ➢ Algae are covered over by mucilage, which protects them from epiphytic growth and decaying effect of water.
- **Reproduction:** The algae reproduce vegetatively, asexually and sexually.
  - ➢ **Vegetative Reproduction:** Vegetative reproduction is by fragmentation. Each fragment develops into a thallus.
  - ➢ **Asexual Reproduction:** It takes place by means of different kinds of spores like zoospores, aplanospores and akinetes. Zoospores are naked, flagellated and motile. (E.g. *Chlamydomonas*). Aplanospores are thin walled and non-motile (E.g. *Chlorella*).
  - ➢ Akinetes are thick walled and non-motile spores (E.g. *Pithophora*).
  - ➢ **Sexual reproduction:** Sexual reproduction involves fusion of two gametes. If fusing gametes belong to the same thallus it is called homothallic and if they belong to different thalli it is heterothallic. Fusing gametes may be isogametes or heterogametes.

- **Isogamy:** It is the fusion of two morphologically and physiologically similar gametes. E.g. *Spirogyra* and some species of *Chlamydomonas*.
- **Anisogamy:** It is the fusion of two gametes which are morphologically dissimilar but physiologically similar (both motile or both non-motile). E.g. some species of *Chlamydomonas*.
- **Oogamy:** It refers to the fusion of gametes which are both morphologically and physiologically dissimilar. In this type of fusion the male gamete is usually referred to as **antherozoid** which is usually motile and smaller in size and the female gamete which is usually non- motile and bigger in size is referred to as **egg.** The sex organ which produces the antherozoids is called **antheridium** and the egg is produced in **oogonium.** The fusion product of antherozoid and egg is called **zygote.** The zygote may germinate directly after meiosis or may produce **meiospores** which in turn will germinate. E.g., *Volvox, Fucus.*



Economic Importance of Algae

Algae have diverse economic uses. They perform half of the total carbon dioxide-fixation on earth by photosynthesis, acting as the primary producers in aquatic habitats.

- **Food source:** Many species of marine algae such as *Porphyra*, *Sargassum*, and *Laminaria* are edible. *Chlorella* and *Spirulina* are rich in proteins. Thus, they are used as food supplements.
- **Commercial importance:** Agar is used in the preparation of jellies and ice-cream. It is obtained from *Gelidium* and *Gracilaria*. Carrageenin is used as an emulsifier in chocolates, paints, and toothpastes. It is obtained from the red algae. Algin from *Laminaria, Fucus*, and *Sargassum* is used in stabilising emulsions *i.e.* shaving creams, shampoos, ice creams etc.
- **Medicines:** Many red algae such as *Corallina* are used in treating worm infections.
- **Sewage disposal:** *Chlamydomonas* and *Chlorella* are used for sewage disposal. They are the algae of sewage oxidation tanks which provide aerobic conditions for disposal of sewage by decomposers.

  The algae are divided into three classes based on their main pigments: Chlorophyceae, Phaeophyceae, and Rhodophyceae.
- These divisions are based on the following factors:
  - ➢ Major photosynthetic pigments present
  - ➢ Form of stored food
  - ➢ Cell wall composition

(a) Class I– Chlorophyceae (Green algae)

- ➢ The members of chlorophyceae are commonly called green algae.
- ➢ The plant body may be unicellular, colonial or filamentous.
- ➢ The major pigments are Chlorophyll *a* and *b*. The pigments are localised in definite chloroplasts.
- ➢ Most of the members have one or more storage bodies called pyrenoids located in the chloroplasts. Pyrenoids contain protein besides starch.
- ➢ **Stored food :** They store their food in the form of starch. Some algae may store food in the form of oil droplets.
- ➢ **Cell wall composition :** Green algae usually have a rigid cell wall made of an inner layer of cellulose and an outer layer of pectose.

- **Reproduction:**
  - ➢ Vegetative reproduction usually takes place by fragmentation or by formation of different types of spores.
  - ➢ Asexual reproduction is by spores. The common asexual spores are flagellated zoospores produced in zoosporangia, aplanospores, hypnospores, akinetes etc.
  - ➢ The sexual reproduction may be isogamous, anisogamous or oogamous.

    E.g. *Chlamydomonas, Volvox, Ulothrix, Spirogyra, Chara, etc.*

(b) Class II– Phaeophyceae (Brown algae)

- ➢ The members of Phaeophyceae are commonly called brown algae.
- ➢ **Habit and habitat:** Brown algae are found primarily in marine habitats.
- ➢ **Size and Form:** They show great variation in size and form. Body consists of branched, filamentous structures (e.g. *Ectocarpus*) to profusely branched forms as represented by kelps, which may reach a height of 100 metres.
- ➢ The plant body is usually attached to the substratum by a holdfast, and has a stalk, the stipe and leaf like photosynthetic organ called the frond.
- ➢ **Major pigments:** They possess chlorophyll *a*, *c*, carotenoids and xanthophyll pigment, called fucoxanthin. The brown colour of algae is due to the presence of large amount of xanthophyll pigment.
- ➢ **Stored Food :** Food is stored as complex carbohydrates, which may be in the form of laminarin or mannitol.
- ➢ **Cell wall composition:** The cells have a cellulosic wall usually covered on the outside by a gelatinous coating of algin.

- **Reproduction**
  - ➢ Vegetative reproduction takes place by fragmentation.
  - ➢ Asexual reproduction is by biflagellate zoospores that are pear-shaped and have two unequal laterally attached flagella.
  - ➢ Sexual reproduction may be isogamous, anisogamous or oogamous. In isogamy and anisogamy both the gametes are motile while in oogamy, only the male gametes are motile or flagellate. The female gametes are non-motile. The 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.

    E.g. *Ectocarpus, Dictyota, Fucus, Sargassum, Laminaria,*

(c) Class III– Rhodophyceae (Red algae)

- ➢ **Common name:** Rhodophyta are commonly called red algae because of the predominance of the red pigment, r-phycoerythrin in their body.
- ➢ **Habit and habitat:** Majority of the red algae are marine except for a few fresh water species. 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.
- ➢ **Major pigments:** They possess chlorophyll *a* and *b*, and phycoerythrin. The red colour of the red algae is due to abundant formation of phycoerythrin.
- ➢ **Stored food:** The food is stored as floridean starch. Its constituent is very similar to amylopectin and glycogen in structure.
- ➢ **Cell wall:** It is made of cellulose, pectin, and polysulphate esters. Some red algae have an incrustation of calcium carbonate over their walls. They appear coral like and are called coralline. *Corallina* algae produce limestone and are important component of reef formations along with corals.
- ➢ Flagella is absent in members of this class.
- ➢ **Reproduction:**
  - ♦ The red algae usually reproduce vegetatively by fragmentation.
  - ♦ They reproduce asexually by non-motile spores.
  - ♦ They reproduce sexually by non-motile gametes. Sexual reproduction is oogamous. The male sex organ is called antheridium. It produces non flagellate male gametes called spermatium. The female sex organ is flask shaped and is termed carpogonium. It possesses an elongated receptive organ called trichogyne. Male gamete is carried by water currents to trichogyne for effective fertilization.

  E.g. *Polysiphonia, Porphyra, Gracilaria, Gelidium*

Divisions of algae and their main characteristics

Classes	Common name	Major pigments	Stored food	Cell wall	Flagellar number and position of insertions	Habitat
Chlorophyceae	Green algae	Chlorophyll *a*, *b*	Starch	Cellulose	2-8, equal, apical	Fresh water, brackish water, salt water
Phaeophyceae	Brown algae	Chlorophyll *a*, *c*, fucoxanthin	Mannitol, laminarin	Cellulose and algin	2, unequal, lateral	Fresh water (rare), brackish water, salt water
Rhodophyceae	Red algae	Chlorophyll *a*, *d*, phycoerythrin	Floridean starch	Cellulose	Absent	Fresh water (some), brackish water, salt water (most)

DIVISION BRYOPHYTA (Greek: Bryon-Moss, Phyton-Plant)

- **Habit and habitat:** They usually occur in cool, damp, and shady areas. They are known as amphibians of plant kingdom since they live on land, but depend on water for sexual reproduction.
- **Characteristics:**
  - ➢ Bryophyte is a division of non-vascular plants having an embryo stage in their developmental process.
  - ➢ Plant body is more differentiated than algae.
  - ➢ The plant body is thallus-like and is attached to substratum by rhizoids. Rhizoids may be unicellular or multicellular. Roots are absent.
  - ➢ Bryophytes lack true roots, stem and leaves; They may possesses root-like, stem-like, and leaf-like structures
  - ➢ They have no specialized tissue for the conduction of water and other substances from one part of the body to another.
  - ➢ The dominant phase in the life cycle is haploid **gametophyte**. It may be a flattened thallus or differentiated into stem-like, root-like and leaf-like structures. The root-like structures are called **rhizoids.**
  - ➢ The gametophyte bears sex organs. Sex organs are multicellular and jacketed.
  - ➢ They are of two types:
    - ♦ The male sex organ is called **antheridium,** which produces biflagellate antherozoids or sperms.
    - ♦ The female sex organ is called **archegonium**. Archegonium is flask-shaped and produces a fertile egg or oosphere.
  - ➢ The antherozoid fuses with the egg to produce **zygote**. The zygote produces a multicellular body called a **sporophyte.**
  - ➢ The sporophyte is not free-living but attached to the photosynthetic gametophyte and derives nourishment from it. That means, the sporophyte is dependent on the gametophyte.

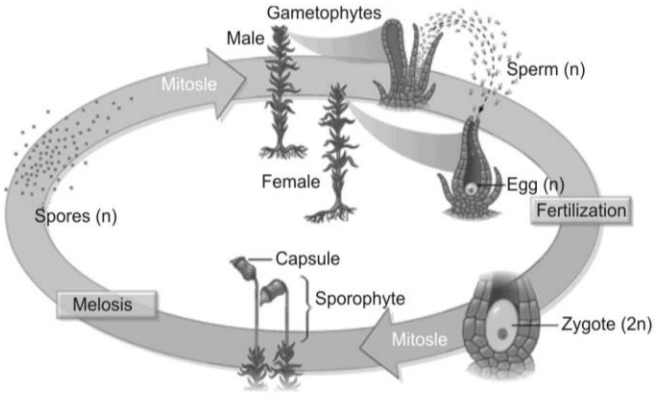


Fig. Life cycle of a bryophyte

  - ➢ The sporophyte reproduces asexually by producing spores. Meiosis takes place during spore formation, hence they are haploid. These spores germinate to produce the gametophyte.
  - ➢ Bryophytes show distinct alternation of gametophytic generation with sporophytic generation.

Gametophyte and Sporophyte

Gametophyte (Greek-gametos-spouse, phyton-plant): Gametophyte is a haploid plant structure that produces gametes directly.
Sporophyte (Greek-Sporos-seed, phyton-plant): Sporophyte is diploid (2n) plant structure that produces haploid spores. Sporophyte is formed form diploid zygote or fusion of gametes.

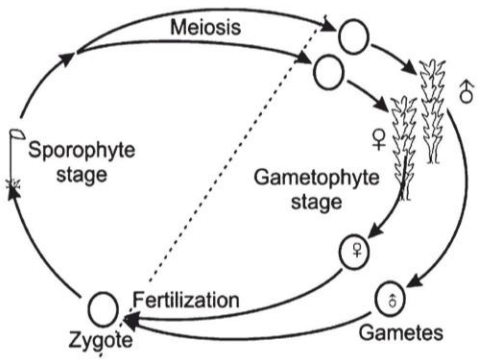


Fig.: Life history of bryophytes

- **Economic Importance of Bryophytes**
  - ➢ **Food:** Some mosses are good source of food for herbaceous mammals, birds and other animals.
  - ➢ **Peat:** ***Sphagnum*** in form of peat is used as fuel and also used for trans-shipment of living material as it has water holding capacity, prevent soil erosion, along with lichens are first colonisers on barren rocks.
  - ➢ **Soil formation:** Mosses along with lichens are the first organisms to colonise rocks and hence, are of great ecological importance. They decompose rocks making the substrate suitable for the growth of higher plants.
  - ➢ **Prevention of soil erosion:** Bryophytes especially mosses form dense mats on the soil, reduce the impact of falling rain and prevent soil erosion.
- The bryophytes are divided into three classes:
  - ♦ **Hepaticopsida** (Liverworts): *e.g. Riccia, Marchantia, Pellia, Sphaerocarpos.*
  - ♦ **Anthocerotopsida** (Hornworts): *e.g. Anthoceros, Notothylas.*
  - ♦ **Bryopsida** (Mosses): *e.g.Funaria, Sphagnum, Polytrichum.*

Liverworts

- **Characteristics:**
  - ➢ **Habit and habitat:** The liverworts grow usually in moist, shady habitats such as banks of streams,

marshy ground, damp soil, bark of trees and deep in the woods.

- **Body features:** The plant body of a liverwort is thalloid, e.g., *Marchantia*. The thallus is dorsi-ventral and closely appressed to the substrate.
- **Reproduction:**
  - **Asexual reproduction:** It takes place by fragmentation of thalli, or by the formation of **gemmae**. **Gemmae** are small green, multicellular, asexual buds, which are borne dorsally inside gemma cups located on the thalli. The mature gemmae separate from the parent body and germinate to form new individuals.
  - **Sexual reproduction:** The male and female sex organs are produced either on the same or on different thalli. Fertilization produces zygote which grows to form diploid sporophyte. Each sporophyte is differentiated into a foot, seta and capsule. After meiosis, spores are produced within the capsule. These spores germinate to form free-living gametophytes.
- **Common examples:** *Riccia, Marchantia etc.*

Mosses

- **Characteristics:**
  - The predominant stage of the life cycle of a moss is the gametophyte which consists of two stages.
    - **Protonema stage:** It is the first stage and develops directly from a spore. It is a creeping, green, branched and frequently filamentous stage.
    - **Leafy stage:** It is the second stage, which develops from the secondary protonema as a lateral bud. They consist of upright, slender axis bearing spirally arranged leaves. They are attached to the soil through multicellular and branched rhizoids. This stage bears the sex organs.
  - **Reproduction**
    - **Vegetative reproduction:** It is by fragmentation and budding in the secondary protonema.
    - **Sexual reproduction:** In mosses, the primary protonema (developed in the first stage) develops into the secondary protonema. Both these stages are haploid or gametophytic. The secondary protonema bears the sex organs antheridia and archegonia, which produce gametes. These gametes fuse to form a zygote. The zygote develops into a sporophyte, consisting of foot, seta and capsule. The capsule contains spores. Many spores are formed as a result of the reduction division taking place in the capsule of this sporophyte.
  - **Common Examples:** *Funaria, Polytrichum and Sphagnum etc.*

Difference between Liverworts and Moss

Liverworts	Moss
They have unicellular rhizoids.	They have multicellular rhizoids.
Scales are present very often	Scales are absent
They are generally thalloid, with dichotomous branching.	They are foliage, with lateral branching.
Gemma cups are present	Gemma cups are absent
Sporophyte has very little photosynthetic tissue	Sporophyte has abundant photosynthetic tissue

DIVISION PTERIDOPHYTA (Greek. Pteris-fern, phyton-plant)

- **Habit and habitat:** The pteridophytes are found in cool, damp, shady places though some may flourish well in sandy-soil conditions.
- **Characteristic features:**
  - They are first terrestrial plants which possess vascular tissue *i.e.* xylem and phloem.
  - It is a division of seedless vascular plants. Hence commonly known as vascular cryptogams.
  - They have well developed vascular system (sylem and phloem).
  - The dominant plant body is sporophyte, which is differentiated into true root, stem and leaves. These organs possess well-differentiated vascular tissues.
  - The leaves in pteridophyta are small (microphylls) as in *Selaginella* or large (macrophylls) as in ferns.
  - The sporophytes bear sporangia that develop in association with leaf-like appendages called **sporophylls**.
  - In some pteridophytes, sporophylls form distinct, compact structures called **strobili** or **cones** (*Selaginella, Equisetum*).
  - Seeds are absent. They produce naked embryos called **spores**.
    - **Homosporous pteridophytes:** They bear spores that are of same type. They produce bisexual gametophytes. E.g. *Pteris, Adiantum,Nephrolepis, Lycopodium*.
    - **Heterosporous pteridophytes:** They bear two kinds of spores-microspores (small) and megaspores (large). They produce unisexual gametophytes. E.g. *Selaginella, Salvinia*, *Marsilea.*
  - The sporangia produce spores by meiosis in spore mother cells.
  - The spores germinate to give rise to inconspicuous, small but multicellular, free-living, mostly photosynthetic thalloid gametophytes called **prothallus**.
  - The gametophyte, prothallus bear male and female sex organs called antheridia and archegonia, respectively.
  - Antheridia are small and sessile. Archegonia are

partially embedded. Archegonial neck is four-rowed.

- Sperms are motile and require an external supply of water to reach archegonia.
- Fusion of male gamete with the egg present in the archegonium result in the formation of zygote.
- Zygote thereafter produces a multicellular well-differentiated sporophyte which is the dominant phase of the pteridophytes.
- Spores may be similar (homosporous) as in majority of pteridophytes. However, few plants are heterosporous. They produce two types of spores-microspores and megaspores.
- The megaspores and microspores germinate and give rise to female and male gametophytes, respectively. The female gametophytes in these plants are retained on the parent sporophytes for variable periods. The development of the zygotes into young embryos takes place within the female gametophytes.

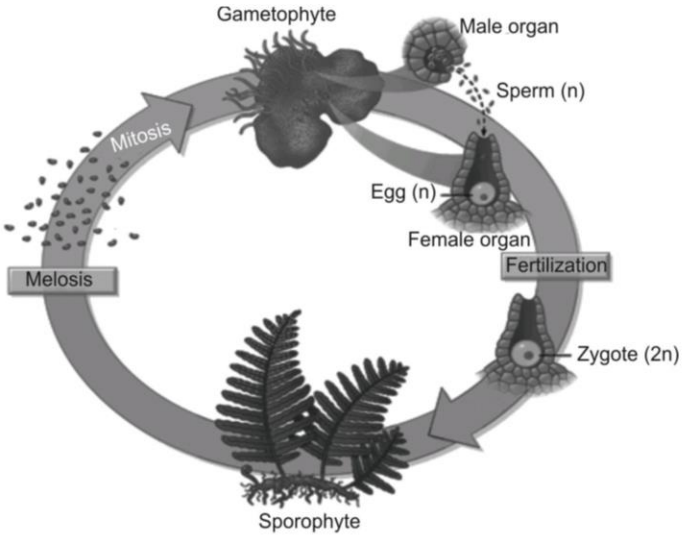
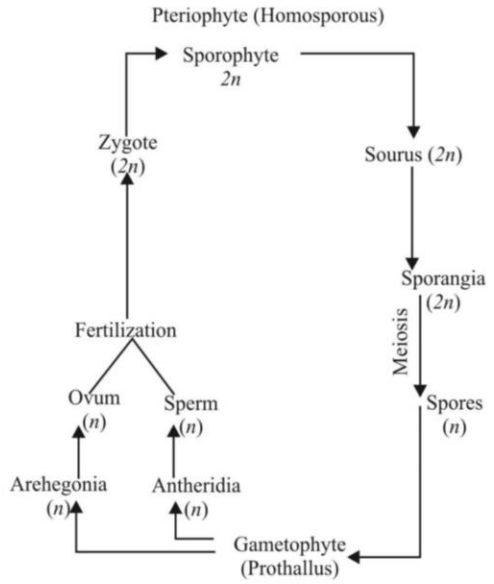


Fig. : Life cycle of a fern



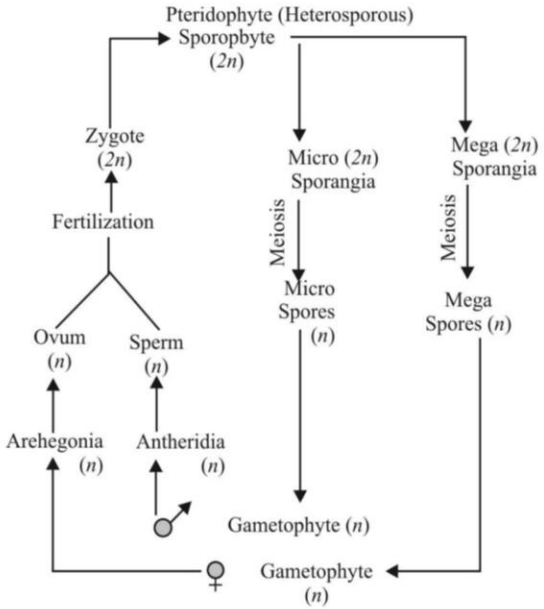


Fig. Graphical representation of life cycle of pteridophytes

- The pteridophytes are divided into four classes:
  - **Psilopsida** (Whisk ferns): E.g.*Psilotum*, *Rhynia.*
  - **Lycopsida** (Club mosses): E.g. *Lycopodium, Selaginella*.
  - **Sphenopsida** (Horse tails): E.g. *Equisetum, Hyenia*
  - **Pteropsida** (Ferns): E.g. *Pteris, Adiantum, Dryopteris*.

Life Cycle of a Fern (*Dryopteris*)

- *Dryopteris* is a common fern with pinnately-compound leaves.
- The main plant-body is sporophytic. Many sporangia are borne on the lower surfaces of its mature leaves.
- Each sporangium has spore mother cells which undergo meiosis to produce haploid spores.
- On maturing, these spores dehisce and germinate to give rise to a heart-shaped gametophyte called prothallus.
- The prothallus bears the male and female sex organs called antheridia and archegonia respectively.
- The antheridia produce sperms that swim in water to reach the archegonia. The egg is produced by the archegonia.
- Fusion of male gamete with the egg present in the archegonium result in the formation of zygote.
- The zygote forms an embryo, which in turn develops into a new sporophyte. The young plant comes out of the archegonium of the parent gametophyte.

Heterospory

- Heterospory evolved first in pteridophytes such as *Selaginella* and *Salvinia* and is considered an important step in evolution as it is a precursor to the seed habit.
- Heterospory is a phenomenon in which two kinds of spores are borne by the same plant. These spores differ in size. The smaller one is known as microspore and the larger one is known as megaspore. The microspore germinates to

form the male gametophyte and the megaspore germinates to form the female gametophyte. The male gametophyte releases the male gametes and these reach the female gametophyte to fuse with the egg. The development of the zygote takes place inside the female gametophyte.

- This retention and germination of the megaspore within the megasporangium ensures proper development of the zygote. The zygote develops into the future sporophyte. The evolution of the seed habit is related to the retention of the megaspore.

Economic Importance of Pteridophytes

(i) **Food:** Pteridophytes form a good source of food to animals. E.g. *Marsilea,* a water fern is cooked and eaten by certain tribals.

(ii) **Soil binding:** Pteridophytes bind the soil along hill slopes and also protect the soil from erosion.

(iii) **Nitrogen fixation:** Some pteridophytes like *Azolla,* a water fern has a symbiotic association with N_2 fixing cyanobacterium called *Anaebaena azollae.*

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

Difference between Bryophytes and Pteridophytes

Bryophytes	Pteridophytes
The main plant body is gametophyte.	The main plant body is sporophyte.
Vascular tissues (i.e. Xylem and phloem) are absent.	Vascular tissues are present.
Sporophytes are parasitic over gametophyte.	Both sporophyte and gametophyte are independent.
Plant body can be thalloid or foliose	Plant body is differentiated into stem, leaves and roots.
Instead of roots, rhizoids are present.	Roots are present.
Haploid gametophytic phase is long lived while sporophytic phase is short lived..	Diploid sporophytic phase is long lived while gametophytic phase is short lived.
Antheridium is stalked and archegoniumis commonly exposed.	Antheridium is sessile and archegoniumis partially embedded.

- The first three divisions of plantae, namely algae, bryophyta and pteridophyta are often collectively called non-flowering plants. They do not produce any flowers or seeds.

DIVISION SPERMATOPHYTA (Greek. Sperma: Seed, Phyton: Seed)

Characteristics:

- It is a division of seed-producing plants. A seed has an embryo that contains reserve food for its future growth.
- The main plant body is sporophyte which is differentiated into stem, leaves and roots.
- Male and female gametophytes are distinct. They are small and dependent on sporophyte for their nutrition.
- They have well-developed vascular tissues throughout the plant body.
- The reproductive process produces seeds which on germination forms a new plant.
- Plants show heterospory or two types of meiospores, microspores and megaspores.
- Spores are produced in two types of sporangia, microsporangia (pollen sacs) and megasporangia. They are borne on two distinct sporophylls called microsporophylls and megasporophylls respectively.
- The gametophytes are completely parasitic.
- Fertilization occurs with the help of a tube formed by male gametophytes, called pollen tube. The process is known as siphonogamy.

The gametophyte is reduced to two microscopic structures:

- **a pollen grain** – a tiny male gametophyte containing sperm.
- **a small portion inside an ovule** – a tiny female gametophyte containing an egg cell. After pollination, an ovule develops into a seed.

Spermatophyta has two sub-divisions- Gymnospermae and Angiospermae.

Sub- Division Gymnospermae (Gymnos – Naked, Sperma – Seeds)

Characteristic Features

- The term gymnosperm refers to plants with naked seeds, *i.e.*, the seeds (ovules) are not enclosed inside a fruit. They are naked.
- All gymnosperms are perennial and woody. The plant-body ranges from medium to tall trees and shrubs.
- The root system consists of tap roots.
- Roots in some genera show symbiotic associations.
  - ➢ Mycorrhiza shows association of fungi with *Pinus* roots.
  - ➢ The small specialized roots, *in Cycas* called coralloid roots are associated with nitrogen-fixing cyanobacteria.
- The stem can be branched (as *in Pinus* and *Cedrus*) or un-branched (as in *Cycas*).
- The leaves can be simple (as *in Pinus*) or compound (pinnate *in Cycas)*.
- The leaves are needle-like, with a thick cuticle and sunken stomata. These help in preventing water loss.
- Gymnosperms are heterosporous. They bear two kinds of spores, haploid microspores and megaspores.
- The two kinds of spores are produced within sporangia. Sporangia are borne on sporophylls, microsporophylls and megasporophylls that are usually aggregated to form distinct cones or strobili.
  - ➢ The strobili bearing microsporophylls and microsporangia are called **male strobili** or **male cone**.

- ➢ The microspores develop into a male gametophytic generation which is highly reduced and is confined to only a limited number of cells. This reduced gametophyte is called a pollen grain.
- ➢ The development of pollen grains takes place within the microsporangia.
- ➢ The strobili bearing megasporophylls with ovules or megasporangia are called **female strobili** or **female cone**.
- ➢ The male or cones or strobili may be borne on the same tree *(Pinus)* or on different trees *(Cycas)*.

- The male gametophyte produces two male gametes and female gametophyte contains archegonia.
- External water is not required for transport of male gametes. Instead, the male gametophyte produces pollen tube to carry the male gametes towards archegonia. The process is known as **siphonogamy**.
- 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.
- Pollination occurs mostly through wind and pollen grains reach the pollen chamber of the ovule through the micropyle, borne on megasporophylls.
- The pollen tube carrying the male gametes grows towards archegonia in the ovules and discharges their contents near the mouth of the archegonia. Following fertilisation, zygote develops into an embryo and the ovules into seeds. These seeds contain haploid endosperms and remain uncovered.
- The megaspore mother cell is differentiated from one of the cells of the nucellus.
- 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 divides meiotically to form four megaspores.
- One of the megaspores enclosed within the megasporangium (nucellus) develops into a multicellular female gametophyte that bears two or more archegonia or female sex organs.
- The multicellular female gametophyte is also retained within megasporangium.

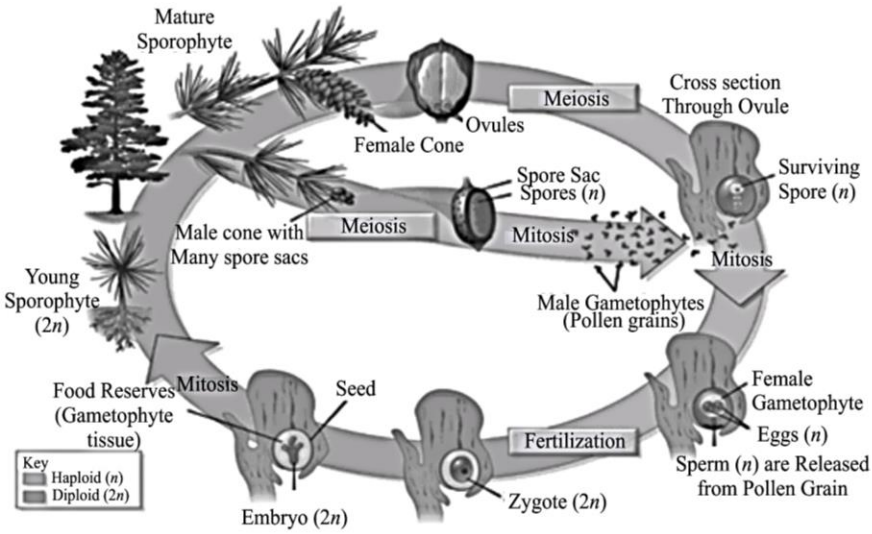


Fig. Life cycle of gymnosperm

- The gymnosperms are divided into three classes-
  - ➢ **Cycadopsida:** E.g. *Cycas*
  - ➢ **Coniferopsida:** E.g. *Pinus, Cedrus, Sequoia*
  - ➢ **Gnetopsida:** E.g. *Gnetum, Ephedra, Ginkgo*
- **Cycas** is also called living fossil because it possesses a number of characters of extinct pteridophytes and cycads.
- **Economic importance of gymnosperms**
  - ➢ **Construction purposes:** Many conifers such as pine, cedar, etc., are sources of the soft wood used in construction and packing.
  - ➢ **Medicinal uses:** An anticancer drug Taxol is obtained from *Taxus*. Many species of *Ephedra* produce ephedrine, which can be used in the treatment of asthma and bronchitis.
  - ➢ **Food source:** The seeds of *Pinus gerardiana* (known as chilgoza) are edible.
  - ➢ **Source of resins:** Resins are used commercially for manufacturing sealing waxes and water-proof paints. A type of resin known as turpentine is obtained from various species of *Pinus*.

Sub-Division Angiosperms (Greek. Angios- cover, spermae - seed)

- **Habit and habitat:** The angiosperms are an exceptionally large group of plants occurring in wide range of habitats.
- **Size:** They range in size from tiny, almost microscopic *Wolfia* to tall trees of *Eucalyptus*, which is over 100 metres.
- **Characteristic features:**
  - ➢ Angiosperms are also known as flowering plants which bear flowers and produce fruit enclosing the seeds. They are the most recently and highly evolved plants.
  - ➢ The plant body is a sporophyte which differentiated into underground root system and aerial shoot system.
  - ➢ They have sporophyll that aggregate to form flowers with the perianth.
  - ➢ Both microsporophylls and megasporophylls are specialised.
  - ➢ A microsporophyll or stamen or androecium consists of a slender filament with an anther at the tip. The anthers produce pollen grains by meiosis.
  - ➢ The megasporophylls are delicate and rolled, forming carpels or pistils or gynoecium. Pistil contains the ovary, style, and stigma. The ovules are present inside the ovary. A highly reduced haploid female gametophyte called **embryo sac** develops inside the ovule.
  - ➢ The embryo-sac formation is preceded by meiosis. Hence, each of the cells of an embryo-sac is haploid.
  - ➢ 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.
- The pollen grain itself is not, the male gamete. It is a structure which produces male gametes; therefore pollen grain is the male gametophyte.
  - ➢ **Pollination:** Pollen grains, after dispersal from the anthers, are carried by wind or various other agencies to the stigma of a pistil. This is termed as pollination.
  - ➢ **Fertilization:** 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 tubes enter the embryo-sac where two male gametes are discharged. One of the male gametes fuses with the egg cell (syngamy) and forms a diploid zygote. The other male gamete fuses with the diploid secondary nucleus to form primary endosperm nucleus (PEN), which is triploid in nature. Since, two types of fusion, syngamy and triple fusion takes place in the embryo sac, the process is known as **double fertilisation**.
  - ➢ **After fertilization,** zygote develops into an embryo (with one or two cotyledons) and the primary endosperm nucleus develops into endosperm which provides nourishment to the developing embryo. Later, the synergids and antipodal cells degenerate. During these events the ovules develop into seeds and the ovaries develop into fruit.

Difference between Syngamy and Triple Fusion

Syngamy	Triple fusion
It is the process of fusion of the male gamete with the egg in an angiosperm.	It is the process of fusion of the male gamete with the diploid secondary nucleus in an angiosperm.
A diploid zygote is formed as a result of syngamy.	A triploid primary endosperm is formed as a result of triple fusion.
Zygote forms the embryo.	Primary endosperm cell produces a food laden endosperm.

Difference between Reproductive Organs of Gymnosperms and Angiosperms

Gymnosperms	Angiosperms
The sporophylls are aggregated to form compact cones.	Sporophylls are aggregate to form flowers with the perianth.
The microsporophylls are broad and are not distinguished into filaments and anthers.	The microsporophylls consist of stamens containing pollen sacs. These sacs bear the male gametes called pollen grains.
The megasporophylls are woody and lack the ovary, style, and stigma, because of which the ovules lie exposed. The female gametophyte consists of archegonia.	The megasporophylls are delicate and rolled, forming carpels that contain the ovary, style, and stigma. The ovules are present inside the ovary.
The fertilisation process involves the fusion of a male gamete with the female gamete. Their endosperm is haploid.	Two male gametes enter the egg apparatus at the time of fertilisation. One male gamete fertilises the egg and the other fuses with the diploid secondary nucleus to form an endosperm. The resulting endosperm is thus triploid.
The seeds are naked as there is no fruit formation.	Seeds are covered inside the ovary part of the carpel.

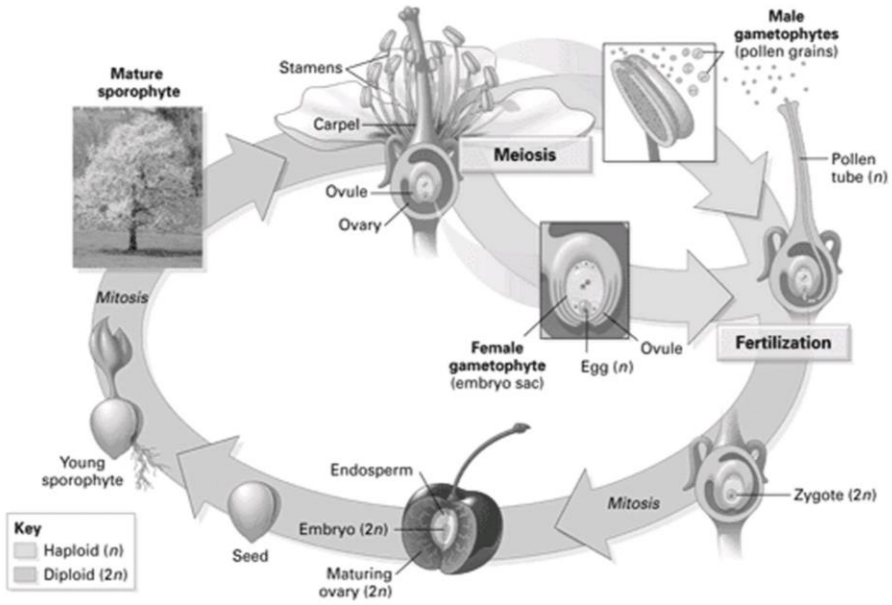


Fig. Life cycle of an angiosperm

Angiosperms are divided into two classes:

(i) Dicotyledonae: They are characterised by having two cotyledons in their seeds. E.g: Mustard, bengal gram, pea, potato, rose, banyan, apple etc.

(ii) Monocotyledonae: They are characterised by having one cotyledon in their seeds. E.g: grasses, coconut, maize, wheat, rice, sugarcane, banyan etc.

- Monocots and dicots can be differentiated through their morphological and anatomical characteristics.

Characteristic features	Monocot	Dicot
Morphological characters		
Flowers	Flowers are usually trimerous.	Flowers are generally pentamerous or tetramerous.
Cotyledons in seed	The seeds contain one cotyledon.	The seed contains usually two cotyledons.
Venation	Leaves possess parallel venation with few exceptions.	Leaves possess reticulate venation.
Roots	Root is short lived forming fibrous root system.	Root is long lived forming tap root system.
Anatomical features		
Vascular bundles in stem	Vascular bundles of monocot stem are scattered and possess closed cambium.	Vascular bundles of stem are arranged in a ring form. They possess open cambium, so that secondary growth is possible.
No of vascular bundles	Vascular bundles are many, more than 8.	Vascular bundles are few (2-6).
Leaves	Leaves are isobilateral	Leaves are dorsi-ventral.

PLANT LIFE CYCLES AND ALTERNATION OF GENERATIONS

- There is alternation of generations between haploid gametophyte and diploid sporophyte in the life cycle of a plant.
- In plants, both haploid and diploid cells can divide by mitosis.Hence, there are two different plant bodies - haploid and diploid.The haploid plant body produces gametes by mitosis and represents a gametophyte.
- Mitotic division is encountered in diploid cells when zygote divides by mitosis to produce sporophytic plant body after fertilization.
- This sporophyte produces haploid spores by meiosis. Spores in turn undergo mitosis to form haploid plant body.

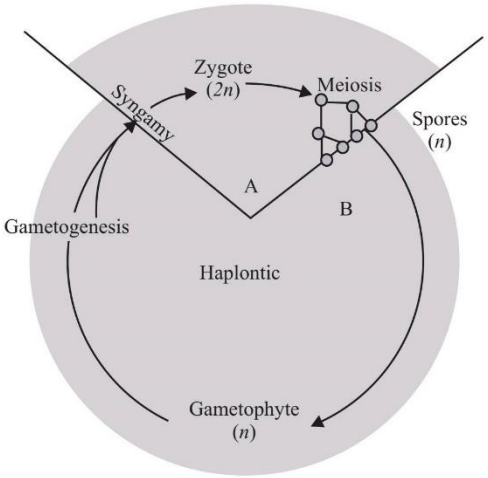
Types of Life Cycles in Plants

Different plant groups complete their life cycle in different patterns.

1. Haplontic life cycle

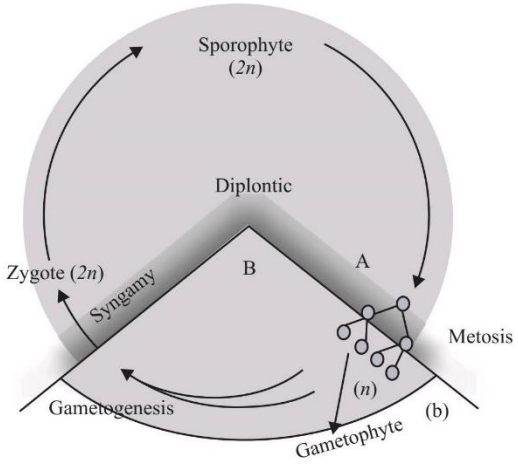
- In the haplontic life cycle the multicellular organism is haploid and the zygote is the only diploid stage. In this life cycle, after the egg and sperm join to form zygote meiosis takes place to produce haploid cells called spores. The spores undergo mitosis and produce a multicellular individual which is haploid. The multicellular organism releases egg and or sperm (sometimes from the same individual, sometimes different individuals) that fuse and become the zygote.

- Thus, in haplontic life cycle, the dominant and photosynthetic phase is the free-living haploid gametophyte. The sporophytic generation (diploid stage) is represented only by the one-celled zygote. There are no free-living sporophytes.
- In this type of life cycle, zygotic meiosis occurs.
- **Example -** Algae such as *Spirogyra.*



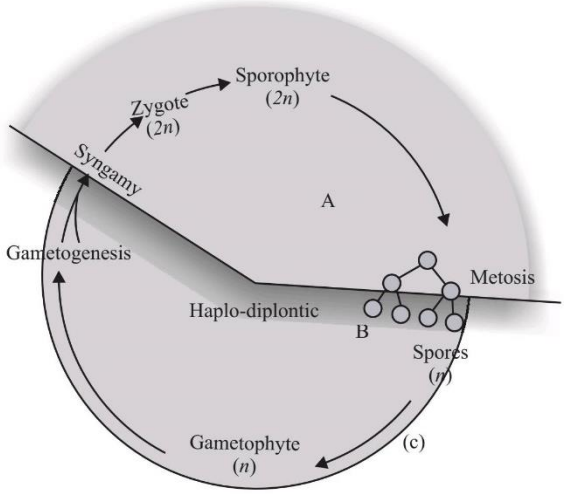
2. Diplontic life cycle

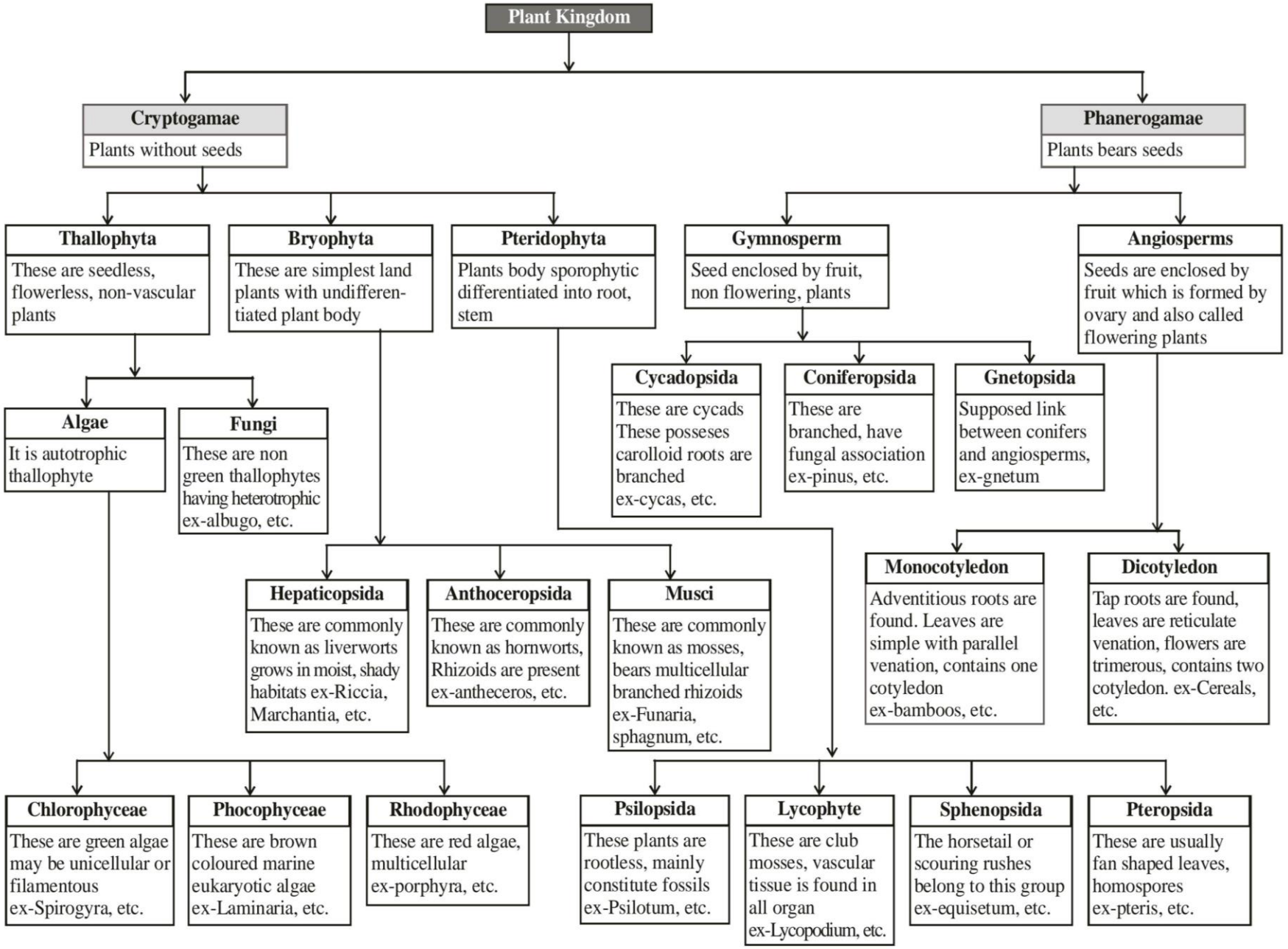
- In diplontic life cycle, diploid sporophyte is the dominant, photosynthetic, independent phase of the plant. The gametophytic phase is represented by the single celled (gametes) to few-celled haploid gametophyte.
- In this life cycle, cells within the multicellular, diploid (2n) mature organism undergo meiosis and become eggs and sperm. An egg and sperm fuse (fertilization) to form a 2n zygote. The zygote undergoes mitotic divisions and cytokinesis to form the embryo and eventually develops and grows into a mature individual. The only haploid portions of the life cycle are the single celled gametes, the egg and the sperm.
- In this type of life cycle, gametic meiosis occurs.
- Example: All seed-bearing plants, gymnosperms, and angiosperms, some algae-like *Fucus.*



3. Haplodiplontic life cycle (Alternation of Generations):

- Haplodiplontic cycle is an intermediate condition of haplontic and diplontic life cycles. Both gametophytic (haploid) and sporophytic phases (diploid) are multicellular and often free-living. However, they differ in their dominant phases.
- The diploid generation is called a sporophyte and it produces spores *via* meiosis. The spores than undergo mitosis to form a multicellular haploid organism called the gametophyte. The gametophyte then produces the haploid gametes. Gametes come together in fertilization to form a zygote. The zygote undergoes mitosis to form the diploid sporophyte generation. There is thus a clear alternation of generations between a haploid gamete producing gametophyte and a diploid spores producing sporophyte in diplohaplontic life cycle.
- Thus, it represents true alternation of generation. This type of life cycle is found in bryophytes, pteridophytes and in some algal like *ectocarpus*, *Polysiphonia*.





EXERCISE - 1
Conceptual Questions

1. The yield of paddy can be increased by the application of-
(a) *Nostoc* (b) Symbiotic bacteria
(c) Iron bacteria (d) Archaebacteria

2. Red tides are caused by-
(a) *Anabaena* (b) *Nostoc*
(c) *Gleocapsa* (d) *Trichodesmium*

3. Which blue-green alga remain in symbiotic association with *Anthoceros* ?
(a) *Azolla* (b) *Spirochaete*
(c) *Spirullina* (d) *Nostoc*

4. Alga associated with *Cycas* root is –
(a) *Anabaena* (b) *Chara*
(c) *Chlorella* (d) *Cladophora*

5. What is true about male and female gametophyte in plant kingdom ?
(a) In bryophytes and pteridophytes they have independent free-living existence.
(b) In gymnosperms and angiosperms they have no independent free-living existence.
(c) Both (a) and (b)
(d) In bryophytes, pteridophytes and angiosperms they have free-living life. They remain in sporangia which are retained on sporophytes.

6. Agar-agar is obtained from
(a) *Gigartina* (b) *Gelidium*
(c) *Gracillaria* (d) All of these

7. Which of the following occurs both in fresh as well as in marine water?
(a) *Oedogonium* (b) *Cladophora*
(c) *Spirogyra* (d) None of these

8. Which one is a parasitic algae?
(a) *Vaucheria* (b) *Polysiphonia*
(c) *Cephaleuros* (d) *Batrachospermum*

9. Which one is incorrect character of brown algae ?
(a) Presence of chl *a* and *b*
(b) It remain attached to substratum
(c) Presence of chl *a* and *c*
(d) Presence of fucoxanthin

10. Pyrenoids in green algal cells are related to
(a) Starch formation
(b) Protein storage
(c) General metabolism
(d) Enzyme secretion

11. The product of conjugation of *Spirogyra* is called
(a) Zoospore (b) Akinete
(c) Chlamydospore (d) Zygospore

12. Which type of sexual reproduction is found in *Spirogyra*?
(a) Conjugation (b) Binary fission
(c) Fragmentation (d) Spores formation

13. Reindeer moss is the common name of –
(a) *Usnea comosa*
(b) *Cladonia rangifera*
(c) *Funaria hygrometrica*
(d) *Sphagnum aceutifolium*

14. Which commonly known as 'Peat moss' or 'Bog moss' ?
(a) *Polytrichum* (b) *Funaria*
(c) *Sphagnum* (d) *Riccia*

15. Elaters are present in capsule of
(a) *Riccia* (b) *Marchantia*
(c) *Anthoceros* (d) *Funaria*

16. In *Funaria* –
(a) Outer peristome teeth are hygroscopic than the inner teeth
(b) Both the types of teeth are hygroscopic
(c) Inner teeth are responsible for spores dispersal
(d) Outer teeth are diploid and inner haploid

17. A bryophyte differs from pteridophytes in –
(a) Archegonia
(b) Lack of vascular tissue
(c) Swimming antherozoids
(d) Independent gametophytes

18. The unique feature of bryophytes compared to other plant groups is that –
(a) They produce spores
(b) They lack vascular tissues
(c) They lack roots
(d) Their sporophyte is attached to the gametophyte

19. Chloroplast of *Chlamydomonas* is
(a) stellate-shaped (b) cup-shaped
(c) collar-shaped (d) spiral-shaped

20. Sporophyte is dependent on gametophyte in
(a) Bryophytes (b) Gymnosperms
(c) Angiosperms (d) Pteridophytes

21. Floridean starch is found in
(a) chlorophyceae (b) rhodophyceae
(c) myxophyceae (d) cyanophyceae

22. Bryophytes are different from fungi in having
(a) Land habit
(b) Sterile jacket layers
(c) Multiflagellate gametes
(d) Gametophytic plant body

23. *Funaria* may be differentiated from *Pinus* by the character
(a) No fruits are produced
(b) No seeds are produced
(c) Antheridia and archegonia
(d) Both (a) and (b)

24. Female reproductive part of bryophytes is
(a) Antheridium (b) Oogonium
(c) Archegonium (d) Sporangium

25. A research student collected certain alga and found that its cells contained both chlorophyll *a* and chlorophyll *b* as well as phycoerythrin.The alga belongs to
(a) rhodophyceae (b) bacillariophyceae
(c) chlorophyceae (d) phaeophyceae

26. Protonema stage is found in
(a) Ferns (b) Mosses
(c) Liverworts (d) Fungi

27. Apophysis in moss capsule is
(a) Upper part (b) Middle part
(c) Lower part (d) Fertile part

28. Which of the following stage of *Funaria* is haploid?
(a) Gametophte (b) Sporophyte
(c) Both (a) and (b) (d) None of these

29. Which among the following is considered advanced among pteridophytes ?
(a) Club mosses (b) Ferns
(c) Quillworts (d) Scouring rushers

30. Which one of the following pairs of plants are not seed producers?
(a) *Funaria* and *Pinus* (b) Fern and *Funaria*
(c) *Funaria* and *Ficus* (d) *Ficus* and *Chlamydomonas*

31. Fern plant is a –
(a) Haploid gametophyte
(b) Diploid gametophyte
(c) Diploid sporophyte
(d) Haploid sporophyte

32. Seed habit first originated in
(a) Certain pteridophytes (b) Certain pines
(c) Certain monocots (d) Certain dicots

33. Which of the following plants exhibit independent alternation of generation ?
(a) Angiosperms (b) Gymnosperms
(c) Pteridophytes (d) Bryophytes

34. *Laminaria* (kelp) and *Fucus* (rock weed) are the examples of
(a) red algae (b) brown algae
(c) green algae (d) golden brown algae

35. Protonema occurs in the life cycle of
(a) *Riccia* (b) *Funaria*
(c) *Chara* (d) *Spirogyra*

36. Indusium is found in –
(a) Fungi (b) Moss
(c) Algae (d) Fern

37. The plant group that produces spores and embryo but lacks vascular tissues and seeds is
(a) pteridophyta (b) rhodophyta
(c) bryophyta (d) phaeophyta

38. Prothallus means –
(a) Immature gametophyte
(b) Immature sporophyte
(c) Immature archegonium
(d) None of these

39. Which of the following is not a pteridophyte?
(a) *Ginkgo* (b) *Selaginella*
(c) *Polypodium* (d) *Azolla*

40. 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 micro-organisms which can survive only at low temperature.
(d) Can not compete with sun-loving plants.

41. The gametophyte of fern bears
(a) True roots (b) Antheridia
(c) Archegonia (d) Both (b) and (c)

42. Sporangia and spore bearing leaf in fern is called as
(a) Ramentum (b) Sorus
(c) Indusium (d) Sporophyll/Frond

43. Which of the following is known as 'resurrection plant'?
(a) *Selaginella* (b) *Welwitschia*
(c) *Rafflesia* (d) *Chlorella*

44. Neck canal cells are absent in archegonia of –
(a) Bryophytes (b) Gymnosperms
(c) Pteridophytes (d) All of these

45. The plant body of moss (*Funaria*) is
(a) completely sporophyte
(b) completely gametophyte
(c) predominantly sporophyte with gametophyte
(d) predominantly gametophyte with sporophyte

46. Resin canals and mucilage canal of gymnosperms are example of-
(a) Schizogenous cavity (b) Lysigenous cavity
(c) Large vacuole (d) Inter cellular cavity

47. Endosperm in Gymnosperm is formed –
(a) At the time of fertilization
(b) Before fertilization
(c) After fertilization
(d) Along with the development of embryo

48. In Gymnosperm, endosperm is formed by –
(a) Fusion between a male gamete and two polar nuclei
(b) Fusion between a male gamete and a polar nuclei
(c) Fusion between egg and male gamete
(d) Germination of megaspore

49. The endosperm of Gymnosperm is-
(a) Haploid (b) Diploid
(c) Triploid (d) Tetraploid

50. Fruits are not formed in Gymnosperms because of –
(a) Absence of pollination
(b) Absence of seed
(c) Absence of fertilization
(d) Absence of ovary

51. Phloem element of Gymnosperm lacks –
(a) Sieve element (b) Companion cell
(c) Parenchyma (d) Sclerenchyma

52. Non-porous wood is the characteristic feature of–
(a) Gymnosperm (b) Angiosperm
(c) Both (a) and (b) (d) None of these

53. Archegonia are absent in the ovules of –
(a) *Gnetum* (b) *Welwestchia*
(c) *Ephedra* (d) Both (a) and (b)

54. In *Funaria* the haploid structure is
(a) protonema (b) capsule
(c) columella (d) seta

55. In which of the following, fertilization is possible without water ?
(a) Algae (b) Bryophytes
(c) Pteridophytes (d) Gymnosperm

56. Multicellular branched rhizoids and leafy gametophytes are characteristic of
(a) all bryophytes (b) some bryophytes
(c) all pteridophytes (d) some pteridophytes

57. In Gymnosperms, the seeds are naked because they lack-
(a) Integuments (b) Pericarp
(c) Nucellus (d) Parienth

58. Cones and flowers are similar because –
(a) Both are bright and showy
(b) Both are reproductive organs
(c) Do not contain endosperm
(d) Do not contain starch

59. Pollination of pollen grains in *Pinus* takes place at
(a) One celled stage (b) Two celled stage
(c) Three celled stage (d) Four celled stage

60. Which of the following structures in *Pinus* are haploid?
(a) Megaspore, integument, root
(b) Endosperm, megaspore, pollen grain
(c) Pollen grain, leaf, root
(d) Megaspore, endosperm, embryo

61. In *Pinus* male and female reproductive structures occur
(a) On different branches of the same plant
(b) On different plants
(c) On same branch
(d) None of these

62. Coralloid roots of *Cycas* are useful in
(a) N_2-fixation (b) Absorption of water
(c) Transpiration (d) Fixation

63. Which of the following is a important characteristic of angiosperms?
(a) presence of vessels (b) double fertilisation
(c) secondary growth (d) autotrophic nutrition

64. Perisperm is remaining part of –
(a) Endosperm (b) Ovule
(c) Nucellus (d) Integument

65. If there are 4 cells in anther, what will be the number of pollen grains –
(a) 8 (b) 4
(c) 16 (d) 12

66. If the cells of root in wheat plant have 42 chromosomes, then the no. of chromosome in the cell of pollen grain is –
(a) 14 (b) 21
(c) 28 (d) 42

67. Vessels and companion cells are characteristics of
(a) Angiosperm (b) Gymnosperm
(c) Pteridophyta (d) Fern

68. Angiosperms and gymnosperms resemble in having
(a) Vessels in wood (b) Mode of fertilization
(c) Siphonogamy (d) Nature of endosperm

69. In a moss the sporophyte
(a) produces gametes that give rise to the gametophyte
(b) arises from a spore produced from the gametophyte
(c) manufactures food for itself as well as for the gametophyte
(d) is partially parasitic on the gametophyte

70. Spore dissemination in some liverworts is aided by
(a) indusium (b) calyptra
(c) peristome teeth (d) elaters

71. In which one of the following, male and female gametophytes do not have free living independent existence?
(a) *Pteris* (b) *Funaria*
(c) *Polytrichum* (d) *Cedrus*

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

73. In angiosperms, functional megaspore develops into
(a) embryo sac (b) ovule
(c) endosperm (d) pollen sac

74. *Cycas* and *Adiantum* resemble each other in having:
(a) Seeds (b) Motile Sperms
(c) Cambium (d) Vessels

75. Gymnosperms are also called soft wood spermatophytes because they lack :
(a) Cambium (b) Phloem fibres
(c) Thick-walled tracheids (d) Xylem fibres

EXERCISE - 2
Applied Questions

1. Peat Moss is used as a packing material for sending flowers and live plants to distant places because
(a) it is hygroscopic
(b) it reduces transpiration
(c) it serves as a disinfectant
(d) it is easily available

2. Conifers differ from grasses in the
(a) lack of xylem tracheids
(b) absence of pollen tubes
(c) formation of endosperm before fertilization
(d) production of seeds from ovules

3. In the prothallus of a vascular cryptogam, the antherozoids and eggs mature a different times. As a result
(a) there is high degree of sterility
(b) one can conclude that the plant is apomictic
(c) self-fertilization is prevented
(d) there is no change in success rate of fertilization

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

5. Flagellated male gametes are present in all the three of which one of the following sets
(a) *Zygnema*, *Saprolegnia* and *Hydrilla*
(b) *Fucus*, *Marsilea* and *Calotropis*
(c) *Riccia*, *Dryopteris* and *Cycas*
(d) *Anthoceros*, *Funaria* and *Spirogyra*

6. In gymnosperms, the pollen chamber represents
(a) a cavity in the ovule in which pollen grains are stored after pollination
(b) an opening in the megagametophyte through which the pollen tube approaches the egg
(c) the microsporangium in which pollen grains develop
(d) a cell in the pollen grain in which the sperms are formed.

7. Which one of the following is heterosporous?
(a) *Dryopteris* (b) *Salvinia*
(c) *Adiantum* (d) *Equisetum*

8. Select one of the following pairs of important features distinguishing *Gnetum* from *Cycas* and *Pinus* and showing affinities with angiosperms
(a) absence of resin duct and leaf venation
(b) presence of vessel elements and absence of archegonia
(c) perianth and two integuments
(d) embryo development and apical meristem

9. Which one of the following has haplontic life cycle?
(a) *Polytrichum* (b) *Ustilago*
(c) Wheat (d) *Funaria*

10. Which one of the following is a vascular cryptogam?
(a) *Ginkgo* (b) *Marchantia*
(c) *Cedrus* (d) *Equisetum*

11. Some hyperthermophilic organisms that grow in highly acidic (pH-2) habitats belong to the two groups:
(a) Eubacteria and archaea
(b) Cyanobacteria and diatoms
(c) Protists and mosses
(d) Liverworts and yeast

12. Besides paddy fields cyanobacteria are also found inside vegetative part of :
(a) *Cycas* (b) *Equisetum*
(c) *Psilotum* (d) *Pinus*

13. Isogamous condition with non-flagellated gametes is found in :
(a) *Spirogyra* (b) *Volvox*
(c) *Fucus* (d) *Chlamydomonas*

14. Read the following statements (A-E) and answer the question which follows them.
1. In liverworts, mosses and ferns gametophytes are free-living.
2. Gymnosperms and some ferns are heterosporous.
3. Sexual reproduction in *Fucus*, *Volvox* and *Albugo* is oogamous.
4. The sporophyte in liveworts is more elaborate than that in mosses.
5. Both, *Pinus* and *Marchantia* are dioecious.

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

15. Which of the following is not correctly matched for the organism and its cell wall degrading enzyme?
(a) Plant cells-Cellulase (b) Algae-Methylase
(c) Fungi-Chitinase (d) Bacteria-Lysozyme

16. The plant body is thalloid in
(a) *Funaria* (b) *Sphagnum*
(c) *Salvinia* (d) *Marchantia*

17. What is common in all the three, *Funaria, Dryopteris* and *Ginkgo?*
(a) Independent sporophyte
(b) Presence of archegonia
(c) Well developed vascular tissues
(d) Independent gametophyte

18. Which one of the following is wrongly matched?
(a) *Nostoc*-Water blooms
(b) *Spirogyra*-Motile gametes
(c) *Sargassum*-Chlorophyll *c*
(d) Basidiomycetes-Puffballs

19. The natural system of classification for flowering plants was given by
(a) Carolus Linnaeus (b) Bentham and Hooker
(c) Engler and Prantl (d) R.H. Whittaker

20. Phylogenetic classification systems are based on—
(a) morphological characters of various organisms
(b) anatomical characters of various organisms
(c) physiological characters of various organisms
(d) evolutionary relationships between the various organisms.

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

22. Which of the following correctly explains why rhodophyta exhibit a red colour ?
(a) Since most rhodophyta grow at great depths, the chlorophyll can only absorb light in the red area of the spectrum.
(b) The wavelengths of light that are absorbed by chlorophyll are passed to phycoerythrin (a red pigment).
(c) Phycoerythrin absorbs all the light waves.
(d) Light reaching the greatest depth in water is in the blue-green region of the spectrum. This light is absorbed by phycoerythrin.

23. Consider the following four statements :
(I) The sporophyte in liverworts is more elaborate than that in mosses.
(II) *Salvinia* is heterosporous.
(III) The life-cycle in all seed-bearing plants is diplontic.
(IV) In *Pinus* male and female cones are borne on different trees.
Which two statements out of four are wrong ?
(a) Statements (I) and (III)
(b) Statements (I) and (IV)
(c) Statements (II) and (III)
(d) Statements (I) and (II)

24. Which one of the following is the correct about *Pinus* ?
(a) Monoecious – Male (microsporangiate) and female (megasporangiate) cones are produced on same plant.
(b) Monoecious – Male and female sporophylls borne on same strobilus.
(c) Dioecious – Male and female cones are produced on different plants.
(d) Monoecious – Micro and megasporocarp develop on same plant.

25. The embryo sac in a angiosperm is a –
(a) Megasporangium (b) Megaspore mother cell
(c) Megagametophyte (d) Megaspore

26. In angiosperms, a mature male gametophyte is derived from a pollen mother cell by –
(a) Three mitotic divisions
(b) One meiotic and two mitotic divisions
(c) Two meiotic divisions
(d) A single meiotic division

27. The role of double fertilization in angiosperms is to produce.
(a) Endosperm (b) Integuments
(c) Cotyledons (d) Endocarp

28. Cytological information like chromosome number, structure, behaviour are related with
(a) numerical taxonomy (b) cytotaxonomy
(c) chemotaxonomy (d) All of the above

29. Flagellate isogametes and anisogametes are found in
(a) *Spirogyra* (b) *Fucus*
(c) *Volvox* (d) *Chlamydomonas*

30. Fusion of two gametes which are dissimilar in size is termed as_____.
(a) isogamous (b) oogamous
(c) anisogamous (d) agamous

31. Algin, carrageen and proteins are obtained from
(a) Red algae, brown algae, green algae respectively
(b) Brown algae, red algae, green algae respectively
(c) Red algae, green algae, brown algae respectively
(d) Green algae, brown algae, red algae respectively

32. Which of the following class of algae rarely found in fresh water?
(a) Chlorophyceae (b) Phaeophyceae
(c) Rhodophyceae (d) Both (a) and (b)

33. Which of the following class of algae mostly found in salt water?
(a) Phaeophyceae (b) Rhodophyceae
(c) Chlorophyceae (d) Both (a) and (b)

34. What is the number and positions of insertions of flagella in class Rhodophyceae?
(a) 2 – 8, equal, apical (b) 2, unequal, lateral
(c) 2 – 6, equal, lateral (d) Absent

35. In class phaeophyceae, the plant body is usually attached to the substratum by a _____(A)_____, and has a stalk, the _____(B)_____ and leaf like photosynthetic organ the _____(C)_____.
(a) A – holdfast, B – stipe, C – frond
(b) A – stipe, B – holdfast, C – frond
(c) A – frond, B – stipe, C – holdfast
(d) A – stipe, B – frond, C – holdfast

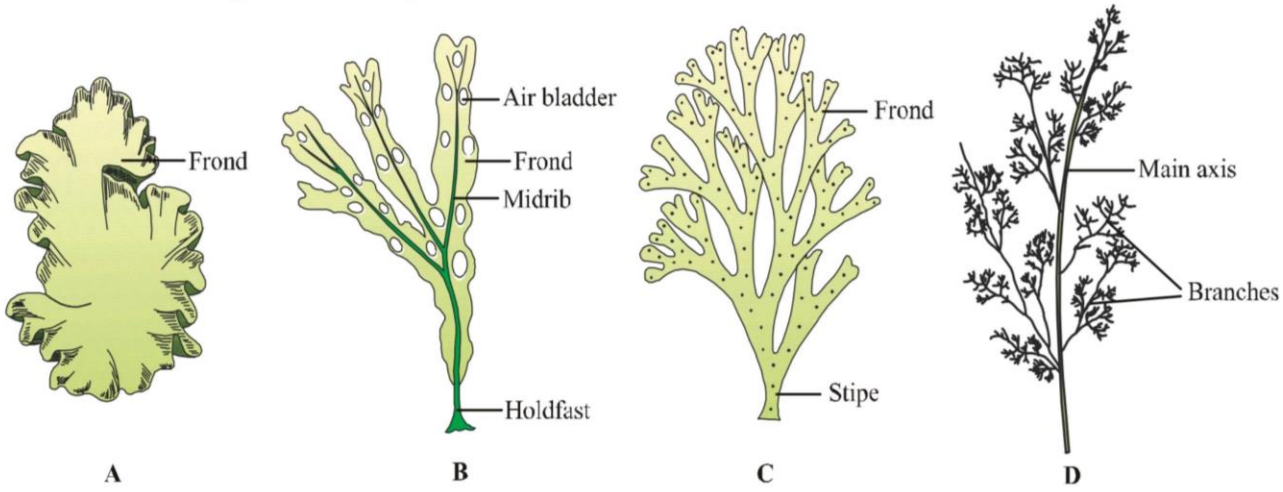
36. Which of the following groups of plants play an important role in plant succession on bare rocks/soil?
(a) Algae (b) Bryophytes
(c) Pteridophytes (d) Gymnosperms

37. _____ represent the reproductive organs amongst gymnosperms.
(a) Prothallus (b) Capsules
(c) Setae (d) Cones

38. In bryophytes, male and female sex organs are called _____ and _____ respectively.
(a) microsporangia; macrosporangia
(b) male strobili; female strobili
(c) antheridia; archegonia
(d) androecium; gynoecium

39. Laminaria (kelp) and *Fucus* (Rock weed) are examples of
(a) green algae (b) brown algae
(c) red algae (d) golden brown algae

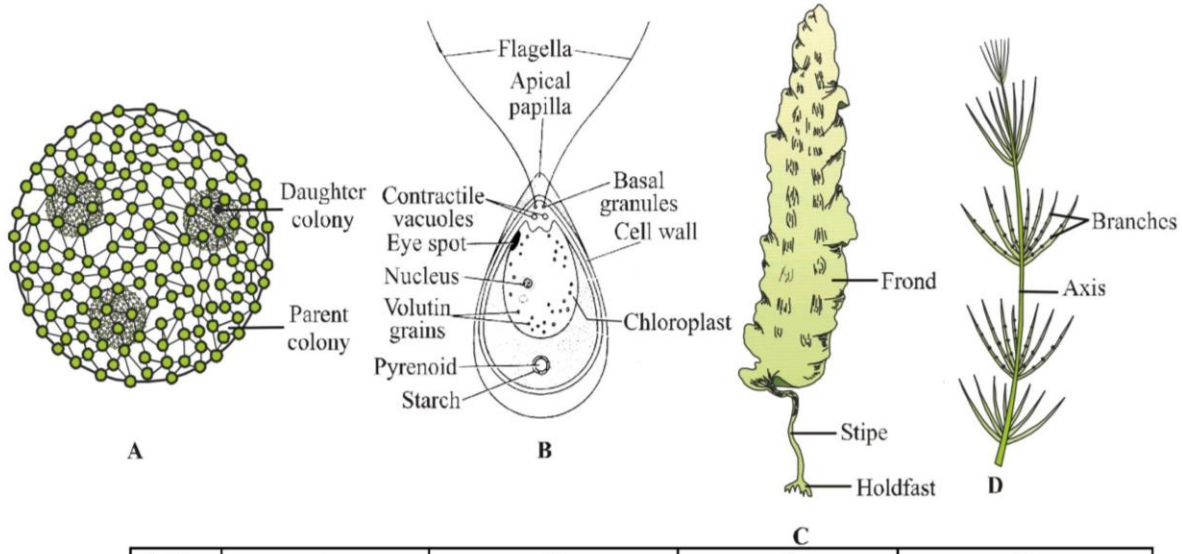
40. Which of the following is the correct option ?



A B C D

S. No.	A	B	C	D
(a)	*Porphyra*	*Fucus*	*Dictyota*	*Polysiphonia*
(b)	*Polysiphonia*	*Porphyra*	*Dictyota*	*Fucus*
(c)	*Fucus*	*Dictyota*	*Porphyra*	*Polysiphonia*
(d)	*Porphyra*	*Polysiphonia*	*Fucus*	*Dictyota*

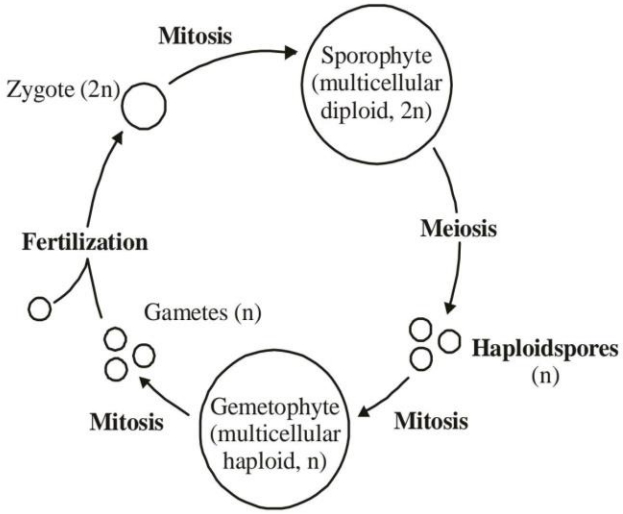
41. Choose the right option.



A B C D

S. No.	A	B	C	D
(a)	*Volvox*	*Chlamydomonas*	*Laminaria*	*Chara*
(b)	*Chara*	*Laminaria*	*Volvox*	*Chlamydomonas*
(c)	*Laminaria*	*Volvox*	*Chlamydomonas*	*Chara*
(d)	*Chlamydomonas*	*Chara*	*Laminaria*	*Volvox*

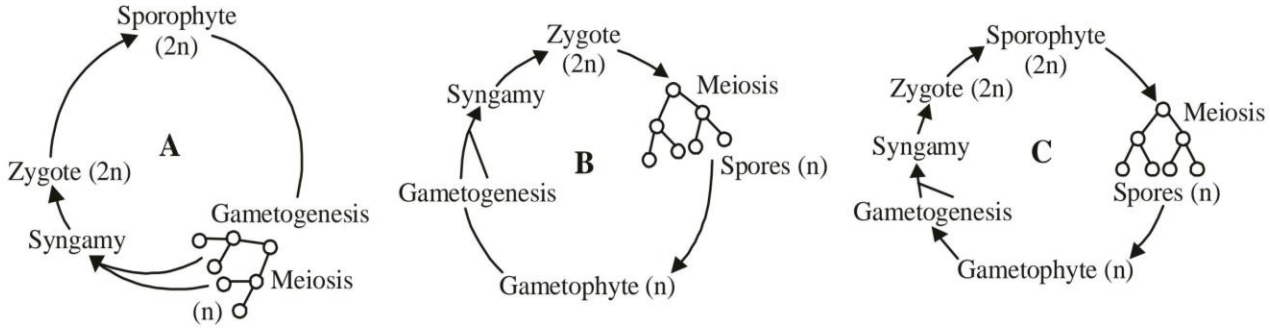
42. What structures A and B respectively indicate in the life cycle of bryophytes, pteridophytes and gymnosperms?



	A		B
(a)	Bryophytes	:	sporangium, capsule
	Pteridophytes	:	strobili, sporangia
	Gymnosperms	:	flowers, cones
	Gymnosperms	:	flowers, cones
(b)	Bryophytes	:	capsule, protonema (gametophores)
	Pteridophytes	:	sporangia, cones, sporophyll
	Gymnosperms	:	fertile fronds, megasporangia and microsporangia

	A		B
(c)	Bryophytes	:	protonema, gametophores
	Pteridophytes	:	strobili, sporangia
	Gymnosperms	:	flowers, cones
(d)	Bryophytes	:	strobili, capsule
	Peteridophytes	:	cones, sporangia
	Gymnosperms	:	flowers, cones

43. Which one of the following option correctly represents the type of life cycle patterns?



(a) A - Diplontic, B - Haplodiplontic, C - Haplontic
(b) A - Haplodiplontic,B - Haplontic, C - Diplontic
(c) A - Haplontic, B - Diplontic, C - Haplodiplontic
(d) A - Diplontic, B - Haplontic, C - Haplodiplontic

44. Match the following and choose the corect option :

Column I (Classes of pteridophytes)	**Column II (Examples)**
(A) Psilopsida	1. *Selaginella*
(B) hycopsida	2. *Psilotum*
(C) Sphenopsida	3. *Dryopteris*
(D) Pteropsida	4. *Equisetum*

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

45. Match Column -I with Column -II.

Column I	**Column II**
A. Algae	1. *Solanum tuberosum*
B. Fungi	2. *Equisetum*
C. Angiosperm	3. *Cycas*
D. Pteridophyte	4. *Chlamydomonas*
E. Gymnosperm	5. *Rhizopus*

(a) A → 5; B → 4; C → 1; D → 2; E → 3
(b) A → 4; B → 5; C → 1; D → 2, E → 3
(c) A → 4; B → 1; C → 5; D → 2, E → 3
(d) A → 4; B → 1; C → 5; D → 3, E → 2

46. **Match Column -I with Column -II.**

Column-I	Column-II
A. *Anthoceros*	1. Walking fern
B. *Adiantum*	2. Alga
C. *Sargassum*	3. Inferae
D. *Asterales*	4. Gametophyte
	5. Hornwort
	6. Liverwort

(a) A → 6; B → 5; C → 1; D → 3
(b) A → 5; B → 4; C → 3; D → 2
(c) A → 5; B → 1; C → 2; D → 4
(d) A → 3; B → 2; C → 1; D → 5

47. Which of the following statement(s) is/are true about gemmae?
(i) These are specialised structures by which asexual reproduction take place in liverworts.
(ii) They are green and multicellular.
(iii) They develop in small receptacles called gemma cups.
(iv) They detach from parent body and germinate to form new individuals.
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i), (ii) and (iii) (d) All of these

48. (1) Green algae occur in fresh water, brackish water, salt water.
(2) Habitat of brown algae-fresh water (rare), brackish water, salt water
(3) Some red algae are found in fresh water, mostly occur in salt water, some are in brackish water.
(4) Most of the red algae are multicellular.
(5) Red alga may occur in both well lighted regions close to water-surface and also at great depths in oceans where light penetration is little.
(6) Cell wall of red algae consists of cellulose + agar.
(7) 2 – 8, equal and apical flagella in green algae
(a) All are correct
(b) All are false
(c) (1) and (6) are correct
(d) (2), (3) and (5) are correct

DIRECTIONS for Qs. 49 and 50 : Each questions contain STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct.

a) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(b) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(c) Statement - 1 is True, Statement- 2 is False
(d) Both the Statements are False.

49. **Statement 1 :** Algae and fungi are grouped in thallophyta.
Statement 2 : Algae and fungi show no differentiation in thallus.

50. **Statement 1 :** Mosses are evolved from algae.
Statement 2 : Protonema of mosses is similar to some green algae.

EXERCISE - 3
Exemplar & Past Years NEET/AIPMT Questions

Exemplar Questions

1. *Cyanobacteria* are classified under
(a) Protista (b) Plantae
(c) Monera (d) Algae

2. Fusion of two motile gametes which are dissimilar in size is termed as
(a) oogamy (b) isogamy
(c) anisogamy (d) zoogamy

3. Holdfast, stipe and frond constitutes the plant body in case of
(a) Rhodophyceae (b) Chlorophyceae
(c) Phaeophyceae (d) All of these

4. A plant shows thallus level of organisation. It shows rhizoids and is haploid. It needs water to complete its life cycle because the male gametes are motile. Identify the group to which it belongs to
(a) pteridophytes (b) gymnosperms
(c) monocots (d) bryophytes

5. A prothallus is
(a) a structure in pteridophytes formed before the thallus develops
(b) a sporophytic free living structure formed in pteridophytes
(c) a gametophyte free living structure formed in pteridophytes
(d) a primitive structure formed after fertilisation in pteridophytes

6. Plants of this group are diploid and well adapted to extreme conditions. They grow bearing sporophylls in compact structures called cones. The group in reference is
(a) monocots (b) dicots
(c) pteridophytes (d) gymnosperms

7. The embryo sac of an angiosperm is made up of
(a) 8 cells (b) 7 cells and 8 nuclei
(c) 8 nuclei (d) 7 cells and 7 nuclei

8. If the diploid number of a flowering plant is 36. What would be the chromosome number in its endosperm?
(a) 36 (b) 18
(c) 54 (d) 72

9. Protonema is
(a) haploid and is found in mosses
(b) diploid and is found in liverworts
(c) diploid and is found in pteridophytes
(d) haploid and is found in pteridophytes

10. The giant redwood tree (*Sequoia sempervirens*) is a/an
(a) angiosperm (b) free fern
(c) pteridophyte (d) gymnosperm

NEET/AIPMT (2013-2017) Questions

11. Besides paddy fields cyanobacteria are also found inside vegetative part of : ***[2013]***
(a) *Cycas* (b) *Equisetum*
(c) *Psilotum* (d) *Pinus*

12. Isogamous condition with non-flagellated gametes is found in : ***[2013]***
(a) *Spirogyra* (b) *Volvox*
(c) *Fucus* (d) *Chlamydomonas*

13. Read the following statements (A-E) and answer the question which follows them. ***[2013]***
1. In liverworts, mosses and ferns gametophytes are free-living
2. Gymnosperms and some ferns are heterosporous.
3. Sexual reproduction in *Fucus*, *Volvox* and *Albugo* is oogamous
4. The sporophyte in liveworts is more elaborate than that in mosses
5. Both, *Pinus* and *Marchantia* are dioecious

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

14. Which of the following is not correctly matched for the organism and its cell wall degrading enzyme? ***[2013]***
(a) Plant cells-Cellulase
(b) Algae-Methylase
(c) Fungi-Chitinase
(d) Bacteria-Lysozyme

15. The plant body is thalloid in ***[NEET Kar. 2013]***
(a) *Funaria* (b) *Sphagnum*
(c) *Salvinia* (d) *Marchantia*

16. What is common in all the three, *Funaria, Dryopteris* and *Ginkgo?* ***[NEET Kar. 2013]***
(a) Independent sporophyte
(b) Presence of archegonia
(c) Well developed vascular tissues
(d) Independent gametophyte

17. Which one of the following is wrongly matched?
(a) *Nostoc*-Water blooms ***[NEET Kar. 2013]***
(b) *Spirogyra*-Motile gametes
(c) *Sargassum*-Chlorophyll *c*
(d) Basidiomycetes-Puffballs

18. Which one of the following shows isogamy with non-flagellated gametes? ***[2014]***
(a) *Sargassum* (b) *Ectocarpus*
(c) *Ulothrix* (d) *Spirogyra*

19. Which one of the following is **wrong** about ***Chara***? ***[2014]***
(a) Upper oogonium and lower round antheridium.
(b) Globule and nucule present on the same plant.
(c) Upper antheridium and lower oogonium.
(d) Globule is male reproductive structure.

20. Which of the following is responsible for peat formation?
(a) *Marchanita* (b) *Riccia* ***[2014]***
(c) *Funaria* (d) *Sphagnum*

21. An alga which can be employed as food for human being is:
(a) *Ulothrix* (b) *Chlorella* ***[2014]***
(c) *Spirogyra* (d) *Polysiphonia*

22. In which of the following gametophyte is not independent free living ? ***[2015 RS]***
(a) *Marchantia* (b) *Pteris*
(c) *Pinus* (d) *Funaria*

23. Read the following five statements (A to E) and select the option with all correct statements : ***[2015 RS]***
(A) Mosses and Lichens are the first organisms to colonise a bare rock.
(B) *Selaginella* is a homosporous pteridophyte
(C) Coralloid roots in Cycas have VAM
(D) Main plant body in bryophytes is gametophytic, whereas in pteridophytes it is sporophytic
(E) In gymnosperms, male and female gametophytes are present within sporangia located on sporophyte
(a) (B), (C) and (D) (b) (A), (D) and (E)
(c) (B), (C) and (E) (d) (A), (C) and (D)

24. Male gemetes are flagellated in : ***[2015 RS]***
(a) *Anabaena* (b) *Ectocarpus*
(c) *Spirogyra* (d) *Polysiphonia*

25. Which one of the following statements is wrong? ***[2015 RS]***
(a) Agar - agar is obtained from *Gelidium* and *Gracilaria*
(b) *Chlorella* and *Spirulina* are used as space food
(c) Mannitol is stored food in Rhodophyceae
(d) Algin and carragen are products of algae

26. Male gametophyte in angiosperms produces: ***[2015 RS]***
(a) Single sperm and vegetative cell
(b) Single sperm and two vegetative cells
(c) Three sperms
(d) Two sperms and a vegetative cell

27. In angiosperms, microsporogenesis and megasporogenesis : ***[2015 RS]***
(a) form gametes without further divisions
(b) Involve meiosis
(c) occur in ovule
(d) occur in anther

28. Which one is wrong statement ? ***[2015 RS]***
(a) *Mucor* has biflagellate zoospores
(b) Haploid endosperm is typical feature of gymnosperms
(c) Brown algae have chlorophyll *a* and *c* and fucoxanthin
(d) Archegonia are found in Bryophyta, Pteridophyta and Gymnosperms.

29. Select the correct statement :- ***[2016]***
(a) Gymnosperms are both homosporous and heterosporous
(b) *Salvinia*, *Ginkgo* and *Pinus* all are gymnosperms
(c) *Sequoia* is one of the tallest trees
(d) The leaves of gymnosperms are not well adapted to extremes of climate

30. In bryophytes and pteridophytes, transport of male gametes requires ***[2016]***
(a) Wind (b) Insects
(c) Birds (d) Water

31. An example of colonial alga is : ***[2017]***
(a) *Volvox* (b) *Ulothrix*
(c) *Spirogyra* (d) *Chlorella*

32. Zygotic meiosis is characteristic of: ***[2017]***
(a) *Fucus* (b) *Funaria*
(c) *Chlamydomonas* (d) *Marchantia*

33. Life cycle of *Ectocarpus* and *Fucus* respectively are: ***[2017]***
(a) Diplontic, Haplodiplontic
(b) Haplodiplontic, Diplontic
(c) Haplodiplontic, Haplontic
(d) Haplontic, Diplontic

34. Select the mismatch ***[2017]***
(a) *Cycas* – Dioecious
(b) *Salvinia* – Heterosporous
(c) *Equisetum* – Homosporous
(d) *Pinus* – Dioecious

35. Double fertilization is exhibited by : ***[2017]***
(a) Algae
(b) Fungi
(c) Angiosperms
(d) Gymnosperms

Hints & Solutions

EXERCISE - 1

1. (a) 2. (d) 3. (d) 4. (a) 5. (c)
6. (d) Agar-agar is a jelly like substance. It is a non-nitrogenous carbohydrate consisting of two polysaccharides namely agarose and agaropectin. It is obtained from several red algae, *e.g.*, *Gracillaria, Gelidium, Gigartina*.
7. (b)
8. (c) *Cephaleuros virescens* is a member of class chlorophyceae and causes red rust of tea leaf (*Thea sinensis*).
9. (a)
10. (a) Pyrenoids are the rounded bodies found in the chloroplast of green algae and are the centres of conversion of glucose to starch and also collection of starch.
11. (d) 12. (a) 13. (b) 14. (c) 15. (b)
16. (a) 17. (b) 18. (d) 19. (b) 20. (a)
21. (b)
22. (b) Bryophytes are different from fungi in having sterile jacket layers.
23. (b)
24 (c) Female sex organ is called archegonium which is flask shaped with a tubular neck and a swollen venter.
25. (a) 26. (b)
27. (c) Apophysis is basal sterile portion of capsule in continuation with seta. In capsule of *Funaria* stomata present only in apophysis.
28. (a) 29. (b) 30. (b)
31. (c) Fern plant is a diploid sporophyte.
32. (a) 33. (c) 34. (b) 35. (b) 36. (d)
37. (c) 38. (b)
39. (a) *Ginkgo* is a gymnosperm.
40. (a)
41. (d) Gametophyte is free living, photoautoptrophic thalloid also called prothallus. Prothallus bears rhizoids, antheridia and archegonia on its under surface.
42. (d) On sporophylls either on dorsal or on ventral side bear sporangium *e.g.*, *Pteris*, *Dryopteris* etc.
43. (a) In dry conditions, the plant rolls up in to a compact ball and during the rainy conditions the ball on absorbing moisture becomes green again. Such plants are called resurrection plants.
44. (b) 45. (d)
46. (b) Resin canals and mucilage canal of gymnosperms are example of lysigenous cavity.
47. (b) Endosperm in Gymnosperm is formed before fertilization.
48. (d) 49. (a)
50. (d) Fruits are not formed in Gymnosperms because of absence of ovary.
51. (b) 52. (d) 53. (d) 54. (a) 55. (d)
56. (b) 57. (b) 58. (b)
59. (d) Pollination in *Pinus* takes place when two prothallial cell, one generative cell and one tube cell are formed.
60. (b) Because endosperm is haploid (*n*) and formed before fertilization and megaspore mother cell divides reductionally to form a linear tetrad of haploid reductionally to form a linear tetrad of haploid megaspores and microspore (= pollen grain) is the first stage of the gametophyte (*n*).
61. (a)
62. (a) *Anabaena*, *Nostoc* and bacteria are found in coralloid roots hence it helps in fixation of nitrogen.
63. (b) 64. (c) 65. (c) 66. (b) 67. (a)
68. (c) Fertilization occurs by siphonogamy. The male gametes are carried to the archegonia through pollen tube.
69. (d) In moss main plant body is gametophyte & sporophyte is meant for spore dispersal mainly. Hence it is called that the sporophyte is partially parasitic on gametophyte.
70. (d) Elater is an elongated, spirally thickened, water-attracting cell in the capsule of a liverwort, derived from sporogenous tissue and assist in spore dispersal.
71. (d) Male and female gametophytes of *Cedrus* do not have free living independent existence. *Cedrus* belongs to conifer.
72. (d) *Sphagnum* is a bryophyte in which male and female gametophytes are independent and free living.
73. (a) During megagametogenesis functional megaspore (mostly chalazal) gives rise to embryo sac. This is the mature female gametophyte generation.
74. (b) *Cycas* (a gymnosperm) and *Adiantum* known as Maiden hair fern is a pteridophyte resemble each other in having motile sperm. Seeds, cambium are common in gymnosperms and absent in pteridophytes. True vessels are absent in both pteridophytes and gymnospems.
75. (d)

EXERCISE - 2

1. (a) Peat Moss is used wherever we require to retain water for a long time because peat mosses are hygroscopic in nature and they absorb the moisture from the atmosphere and this moisture keep the living materials and flowers fresh for a long time.
2. (c) Conifers (Gymnosperms) differ from grasses (angiosperms) because in gymnosperms the female gametophyte is actually endosperm which is made before fertilization. While in grasses endosperm is a tissue formed by the fertilization of second male gamete to polar nuclei. Moreover in gymnosperms the endosperm is a haploid tissue while in angiosperms it is triploid.
3. (c) In the prothallus of a vascular cryptogams the antherozoids and eggs mature at different times which result in failure of self-fertilization.
4. (d) It will be types of pigment present in the cell like Rhodophyceae shows presence of phycoerythrin, chlorophyceae shows presence of phycocyanin etc.

5. (c) The male gametes of bryophytes are biflagellate, and those of pteriodophytes are multiflagellate, except *Selaginella* having biflagellate gametes. The male gametes of gymnosperms are non motile except those of *Cycas* having multiciliate gametes.
6. (c) The fertile region of microsporophyll bears a number of microsporangia or pollen sacs arranged in sori. The pollen chamber represents microsporangium in which pollen grains develop.
7. (b) *Salvinia* is an aquatic fern with both annual and perennial species. It is heterosporous *i.e.* with two types of spores, microspores and megaspores.
8. (b) The important features distinguishing *Gnetum* from *Cycas* and *Pinus* and showing affinities with angiosperms are presence of vessel elements and absence of archegonia.
9. (b) 10. (d)
11. (a) Hyperthermophilic organisms that grow in highly acidic habitats belong to eubacteria and archae groups.
12. (a) In *Cycas* specialised root called coralloid roots are associated with N_2 – fixing cyanobacteria either *Nostoc* or *Anabaena*. Coralloid roots lie near the soil surface. They are irregular and often dichotomously branched. Root hair and root cap are absent in these roots.
13. (a) In *Spirogyra*, sexual reproduction occurs through conjugation. Gametes are non-flagellated morphologically similar. But physiologically different (isogamy with physiological anisogamy). *Volvox* and *fucus* are examples of oogamous and *Chlamydomonas* contains isogamous flagellated gametes .
14. (b) In liverworts and ferns gametophytes are free living while in fern sporophytes are free living. Gymnosperms and genera like *Selaginella* and *Salvinia* are heterosporous. The sporophyte in mosses are more elaborate than that of liverworts, *Pinus* is monoecious and heterosporous. *Marchantia* is dioecious.
15. (b) Algae is a plant and so its cell wall is made up of cellulose. Cellulase enzyme is needed for degradation of its cell wall.
16. (d) The plant body of a liverwort is haploid (n), gametophytic, small, dorsoventrally flattened, thallose, dichotomously branched fixed by unicellular and unbranched rhizoids, e.g., *Marchantia*.
17. (b) The female sex organ archegonium is formed in bryophytes (*Funaria*), pteridophytes (*Dryopteris*) and gymnosperms (*Ginkgo*).
18. (b) Cyanobacteria, e.g., *Nostoc*, grow in such abundance as to form water blooms. *Sargassum* belongs to brown algae which possess chl *a*, *c*, carotenoids, xanthophyll and a characteristic brown pigment, fucoxanthin. Commonly known forms of basidiomycetes are mushrooms, bracket fungi or puffballs. In *Spirogyra* gametes are non-flagellated (non-motile) but similar in size. They show amoeboid movements.
19. (b) 20. (d) 21. (b) 22. (d) 23. (b)
24. (a) 25. (c) 26. (b)
27. (a) The role of double fertilization in angiosperms is to produce endosperm.
28. (b) 29. (d) 30. (c) 31. (b) 32. (b)
33. (a) 34. (d) 35. (a) 36. (b) 37. (d)
38. (c) 39. (b) 40. (a) 41. (a) 42. (b)
43. (d) 44. (a) 45. (b) 46. (c) 47. (d)
48. (a)
49. (a) On the basis of
    (i) Thallus like non-vascular plant body.
    (ii) Simple, unicellular non-jacketed sex organs and
    (iii) No embryo development after gametic union, the algae and fungi have long been grouped together in thallophyta. The algae and fungi are the result of parallel development and do not indicate any phylogenetic relationship.
50. (a) According to some Botanists, Mosses originated from algae. Protonema of mosses is similar to certain algae.

EXERCISE - 3

Exemplar Questions

1. (c) Kingdom **Monera** exclusively includes all forms of bacteria. All bacteria are prokaryotes and do not possess a well defined nucleus and other cell organelles.
   Protista, Algae and Plantae include eukaryotic and unicellular or multicellular organisms.
2. (c) Lower group of plants like algae exhibit great variation in mode of sexual and asexual reproduction. Some algae produce gametes which are not similar in shape, size and structure. Their fusion is called anisogamy. e.g., *Chlamydomonas*. Isogamy is the fusion of similar gametes, zoogamy is sexual reproduction of animals.
3. (c) **Phaeophyceae :** In the members of the class-Phaeophyceae, the plant body is usually attached to the substratum by means of a holdfast and has a stalk called stipe and a leaf like photosynthetic organ called frond.
4. (d) **Bryophyta** is a group of plants which have gametophytic haploid thalloid body. The motile male gametes are produced in special male reproductive structures called antheridia.
   These gametes need thin film of water to swim and reach the female reproductive organ called archegonia. Pteridophytes, gymnosperm and monocots show higher level of organisation.
5. (c) **Prothallus** is usually a gametophytic phase in the life of a pteridophyte. Spore germinates to form a prothalium, it is short lived inconspicuous heart shaped structure with a number of rhizoids developed beneath and bears sex organs, archegonium and antheridium.
6. (d) **Gymnosperms** include medium sized or tall trees and shrubs. Their plants are well adapted to withstand extremes of temperature, humidity and wind. Reproductive organs are usually in the form of cones or strobili.

The male cones are made up of microsporophyll and female cones are made up of megasporophyll. The presence of sporophyll (micro and megasporophyll) shows the development of seed habit but seeds develop from naked ovule and are not covered .

7. (b) **Embryo sac** in angiosperm contains 2 synergids, 1 egg cell, 3 antipodal cells and one secondary nucleus.
8. (c) **Endosperm** is a product of triple fusion. One male nuclei ($n = 18$) fuses with diploid secondary nucleus ($2n = 36$), so it becomes triploid ($3n = 54$). Thus, ploidy of endosperm is ($3n$) and chromosomes will be 54.
9. (a) The germination of **haploid** spores of mosses produced by sporophyte after reductional division form the protonema. This structure later develops into an independent gametophytic plant.
10. (d) *Sequoia sempervirens* is a gymnosperm. It has thick, woody and branched stems. The plant also shows some xeric adaptations which helps it to survive in adverse climatic conditions.

NEET/AIPMT (2013-2017) Questions

11. (a) In *Cycas* specialised root called coralloid roots are associated with N_2 – fixing cyanobacteria either *Nostoc* or *Anabaena*. Coralloid roots lie near the soil surface. They are irregular and often dichotomously branched. Root hair and root cap are absent in these roots.
12. (a) In *Spirogyra,* sexual reproduction occurs through conjugation. Gametes are non-flagellated, morphologically similar. But physiologically different (isogamy with physiological anisogamy). *Volvox* and *Fucus* are examples of oogamous and *Chlamydomonas* contains isogamous flagellated gametes.
13. (b) In liverworts and ferns gametophytes are free living while in fern, sporophytes are free living. Gymnosperms and genera like *Selaginella* and *Salvinia* are heterosporous. The sporophyte in mosses are more elaborate than that of liverworts, *Pinus* is monoecious and heterosporous. *Marchantia* is dioecious.
14. (b) Algae is a plant and so its cell wall is made up of cellulose. Cellulase enzyme is needed for degradation of its cell wall.
15. (d) The plant body of a liverwort is haploid (n), gametophytic, small, dorsoventrally flattened, thallose, dichotomously branched fixed by unicellular and unbranched rhizoids, *e.g.*, *Marchantia.*
16. (b) The female sex organ archegonium is formed in bryophytes (*Funaria),* pteridophytes (*Dryopteris*) and gymnosperms (*Ginkgo*).
17. (b) Cyanobacteria, e.g., *Nostoc*, grow in such abundance as to form water blooms. *Sargassum* belongs to brown algae which possess chl *a*, *c*, carotenoids, xanthophyll and a characteristic brown pigment, fucoxanthin. Commonly known forms of basidiomycetes are mushrooms, bracket fungi or puffballs. In *Spirogyra* gametes are non-flagellated (non-motile) but similar in size. They show amoeboid movements.
18. (d) In *Spirogyra,* sexual reproduction occurs through conjugation. Gametes are non-flagellated morphologically similar. But physiologically different (isogamy with physiological anisogamy).
19. (c) *Chara* is a green alga found attached to bottoms of shallow water of ponds, pools and lakes. Male sex organ is called antheridium. Female sex organ is called oogonium. Oogonium is borne at the top of the four celled filament.
20. (d) *Sphagnum,* a moss, provides peat that has long been used as fuel. It has the capacity to retain water for long periods and as such used to cover the plant roots during transportation.
21. (b) *Chlorella* and *Spirullina* are unicellular algae, rich in proteins and are used as food supplements by space travellers.
22. (c) Pinus belongs to gymnosperms in which male and female gametophytes do not have an independent free living existance. They remain within the sporangia which are of two types — microsporangia and megasporangia.
23. (b) *Selaginella* is a heterosporus pteridophyte containing micro & megaspores. In *Cycas,* corolloid root has the cyanobacteria - Anabaena.
24. (b) Male gametes are flagellated in *Ectocarpus* (phaeophyceae). They possess heterokont, lateral flagella.
25. (c) Mannitol or laminarin is the stored food in phaeophyceae (brown algae).
26. (d) Two sperms and a vegetative cell are produced by male gametophyte in angiosperms.
27. (b) In meiosis, the number of chromosomes are reduced by half producing haploid daughter cells. The microspore mother cell and the megaspore mother cell undergo meiosis to produce haploid microspore and megaspore respectively.
28. (a) The spores are non motile in *Mucor.*
29. (c) *Sequoia semepervirans* is one of the tallest trees.
30. (d) Bryophytes neither have pollen nor flowers and rely on water to carry the male gametes (sperm) to the female gametes (eggs). The antherozoids (male gametes of pteridophytes) are armed with hair-like or whip-like cilia or flagellae and are able to swim through water; they do not travel great distances and are only released when free water is available.
31. (a) Volvox is motile colonial fresh water green alga. It forms spherical colonies.
32. (c) Chlamydomonas has haplontic life cycle hence shows zygotic meiosis.
33. (b) *Ectocarpus* exhibits haplodiplontic life cycle while *Fucus* has diplontic life cycle.
34. (d) Pinus is a monoecious plant comprising of both male and female cones on same plant.
35. (c) Double fertilization is a unique feature exhibited only by angiosperms. It involves both syngamy and triple fusion.